Nitrogen Budgeting Worksheet *for Almond & Walnut Orchards*

I. Background Information

A nitrogen budget accounts for all N inputs and outputs on the farm. Mostly, N is removed from the farm in the crop and comes back in the form of compost, irrigation water, cover crop, and fertilizer.

Nitrogen deficiency is rare in California orchards

In well managed orchards nitrogen deficiency is rare. Most farmers apply plenty of nitrogen fertilizer. Many farmers also have the opportunity to reduce costs, keep good yields, and increase tree health by reducing application rates of N fertilizer.

Post harvest applications of N are not used by the tree

In university experiments with deciduous nut trees, labeled N applied post harvest was not absorbed by the tree. Even the following spring, N applied the previous fall was gone and no N could be found in the tree's wood, roots, leaves, or nuts. Labeled N applied in spring and summer was found in the tree.

Every orchard is different in its nitrogen requirements

Some scientific studies in walnuts and pistachios have shown that even after five years without any applied fertilizer (0 lbs. N/acre), there was no difference in yield from trees fertilized up to 320 lbs. N/acre. However, this does not mean that fertilization can be skipped for 5 years in your orchard, although it is possible in some cases. Trees always need nitrogen every year, but trees can get nitrogen from other sources besides annually applied chemical fertilizer. These alternative sources of N include nitrate in well water, legume cover crops, composts, manures and natural soil fertility.

Table 1. If leaf N is in the low range, increase fertilizer rates. If leaf N is in the high range, decrease fertilizer application rates.

Crop	Low leaf N %	High Leaf N %
Walnuts	<2.3%	>2.7%
Almonds	<2.2%	>2.5%

Sources: *Walnut Production Manual,* p. 200. *Almond Production Manual,* p. 193.

As an extreme example, some BIOS growers have not applied any chemical nitrogen fertilizer for many years, yet still have good leaf tissue N levels and great yields. Their trees are receiving nitrogen from the well water (in some cases over 100 lbs. N/acre), a legume cover crop, a fertile soil with high organic matter content, and sometimes a small amount of additional applied compost.

In most orchards, applied chemical fertilizer will still be needed, but often at a reduced rate. Leaf tissue analysis and a nitrogen budget are two methods to scientifically determine the optimal rate of fertilizer application.

Leaf Tissue Analysis

Leaf tissue analysis, from leaf samples collected in July, can be used to guide nitrogen fertilizer decisions. Table 1 below gives guidelines for increasing or decreasing nitrogen fertilizer rates based of leaf tissue N concentration. Out of 50 walnut and almond BIOS orchards that submitted leaf samples in 1998, only one (2%) was in the low range, yet one half (50%) of the 1998 samples were in the high range. Fertilizer rates can be safely reduced when leaf N is in the high range.

The best information from leaf tissue analysis is gained when samples are collected at the same time in the growing season, year after year. If the trend is a higher and higher leaf tissue N, then fertilizer rates can be reduced. When deciding how much to reduce or increase the N fertilization rate, a nitrogen budget is helpful (see next section).

It is impossible for a single range of leaf tissue N values to be accurate for all of California. In some areas of California, walnut leaf N will never go above 2.3%, even when hundreds of pounds of excess fertilizer are applied! So even if leaf analysis shows N in the good range, in some cases the trees may still be receiving excessive amounts of fertilizer. A nitrogen budget is helpful in this case because actual tree nitrogen needs can be estimated.

Trust your leaf sample results. If your leaves are in the high range, reduce the amount of applied nitrogen fertilizer by the amount indicated from your nitrogen budget.

II. Instructions for Worksheet

Get the necessary papers together: yield data for the past few years, irrigation records, well water analysis and soil analysis reports. A calculator will be helpful.

Line 1. Fruit or nut nitrogen removal. Write down the average yield in tons per acre on the first blank space. Almonds are kernal weight at 5% moisture, walnuts are in-shell at 8% moisture. In the second blank space write 100 for almonds or 36 for walnuts. Multiply. This is the number of lbs. of nitrogen removed each year in the crop.

Line 2. Annual accumulation of N in the tree structure. Select the appropriate value.

Line 3. Total lbs. N used by the tree each year. Add lines 1 and 2. Write your answer on line 3.

Line 4. Pounds N from irrigation water. The concentration of N in irrigation water can be reported with two different units: NO_3-N ppm or NO_3 ppm (mg/l is the same as ppm). Be sure to use the correct units!

Line 5. Native soil fertility from organic matter. Write the percent soil organic matter of your soil on the first blank space. Multiply by 20 to obtain lbs./acre of N released. This is only an approximation. The actual N released from organic matter depends on climatic factors, soil pH, type of material undergoing decomposition, and other factors.

Line 6. Native soil fertility from soil texture. Select the appropriate value.

Line 7. Total lbs. N supplied by soil and irrigation water. Add lines 4, 5, and 6. Write the total on line 7.

Line 8. Manure Write the tons per acre of manure applied on the first blank space. In the second blank space, use Table 2 to decide how many lbs. N per ton of manure is supplied. Write that number in the second blank space. Multiply these two numbers and write your answer on line 8.

Table 2. Nitrogen release from selected types of animal manure.

	Pounds of N released / ton of manure			
Type of manure	**Year 1**	**Year 2**	**Year 3**	**Year 4**
Chicken manure, 1.6% N	29	0.3	0.2	0.1
Fresh bovine waste, 3.5% N	52	2.6	1.5	1.0
Dry corral manure, 2.5% N	20	7.5	1.4	0.6
Dry corral manure, 1.5% N	10	3.0	1.7	1.2
Dry corral manure, 1.0% N	4	1.6	1.1	0.7
Liquid sludge, 2.5% N	18	3.2	1.7	1.4

Line 9. Compost Write the tons per acre of compost applied in the first blank space. Write the percent N on the second blank space. Using Table 3, select the first year release rate and write that number on the third blank line. Multiply these three numbers by 20. This is the lbs. N supplied by compost. Write the answer on line 9.

Line 10. Legume cover crops. Choose the best description of your cover crop and write the lbs. of nitrogen on the first blank line. On the second blank line write 0.5 for mowing or 0.7 for discing . Multiply these two numbers. Write the answer on line 10.

Table 3. First year release rate for composts

Fresh, incorporated	0.6
Fresh, unincorporated	0.3
Medium	0.4
Well composted	0.2

Line 11. Total amount of available N from non-fertilizer resources. Sum lines 7, 8, 9, and 10 together. Multiply this sum by the uptake efficiency factor of 0.67. Write the answer on line 11.

Line 12. Tree N needs. To determine the N needs of the tree beyond that supplied by non-fertilizer sources, subtract line 11 from line 3. Write the answer on line 12. If this number is negative, the trees probably do not need any additional source of nitrogen (no N fertilizer is needed this year).

Line 13. Fertilizer application rate. Multiply line 12 times the appropriate uptake efficiency factor on the worksheet. Write the answer on line 13. This is your estimated fertilization rate. Don't be surprised if the fertilizer rate seems low. Many orchards just don't need much additional fertilizer.

Disclaimer: *Although based on sound scientific principles, calculating a nitrogen budget involves some assumptions and "best guesses" by experts in the field of plant mineral nutrition. Even leaf tissue guidelines are often based on limited data. Therefore, the guidelines presented here are just that, guidelines to help decide how much to reduce fertilizer application rates. Every orchard is different and careful, personal, experimentation in your orchard is the only way to determine optimal fertilization rates without over fertilization.*

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Name Date

Crop Block ID

Nitrogen used by trees

1 Fruit or nut removal (average over 2 or 3 years).

_____ (yield in tons/acre) X _____ (100 lbs. N/ton yield of almonds; 36 lbs. N/ton yield of walnuts)

1 _____ lbs. N/acre lost in crop

2 Annual accumulation in tree structure (after prunning).

Low vigor = 10 lbs. N/acre

Moderate = 15-20 lbs. N/acre

High vigor = 25 lbs. N/acre

2 _____ lbs. N/acre used in growth

3 Add lines 1 and 2, write the answer on line 3.

This is the estimated N used by the trees each year.

3 _____ lbs. N/acre used per year

Nitrogen contributions from non-fertilizer sources

4 Irrigation water (if units are in NO_3-N ppm use the first line, if units are in NO_3 ppm use the second line — not both).

_____ (NO_3-N ppm or mg/l) X _____ (Water applied in feet) X 2.7 =

OR

_____ (NO_3-N ppm or mg/l) X _____ (Water applied in feet) X 0.614 =

Fill in only on line:

4a _____ lbs. N/acre from nitrate-N in H_2O

4b _____ lbs. N/acre from nitrate in H_2O

5 Native soil fertility.

_____ (Soil Organic Matter) % X 20

5 _____ lbs. N/acre from organic matter

6 If your soil is clay loam, put 50 on line 6.

If your soil is silt loam, put 40 on line 6.

If your soil is sandy loam, put 30 on line 6.

6 _____ lbs. N/acre

7 Add lines 4, 5, and 6. This is our estimated total pounds N supplied by soil and irrigation water.

7 _____ lbs. N/acre from soil and water

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Nitrogen contributions from manure & compost

8 Manure. (*If you do not apply manure, skip to line 9.*)

_____ (tons/acre) X _____ (lbs. N released/ton of manure)

8 _____ lbs. N/acre from manure

9 Compost. (*If you do not apply compost, skip to line 10. Compost tons is in **dry weight!***)

_____ (tons/acre dry) X _____ (percent N in compost) % X _____ (first year release rate) X 20

9 _____ lbs. N/acre from compost

Nitrogen contributions from legume cover crips

10 Legume cover crops

_____ (lbs. N/acre in cover crop) X _____ (for mow only: 0.5; for discing in: 0.7)

Cover crop lbs./acre N (assuming 75% floor planted)

Poor crop	Good crop	Great crop	Weeds	Summer grass
30	70	120	0	-30

10 _____ lbs. N/acre from cover crop

All available nitrogen

11 Total nitrogen available from all non-fertilizer sources. Add lines 7, 8, 9 and 10. Then multiply this sum times 0.67 and write the answer on line 11.

11 _____ lbs N/acre

Additional nitrogen needs

12 Additional tree N needs.

To figure how much additional nitrogen is needed by your trees, subtact line 11 from line 3. Write the answer on line 12. If the answer is negative, no fertilizer is needed.

12 _____ lbs. N/acre needed by trees

Nitrogen fertilizer application rate

13 Fertilizer aplication rate.

_____ (Line 12) X _____ (Uptake efficiency)

Fertilizer uptake efficiency

Low (single application)	Medium (split applications)	High (fertigation)
3	2	1.5

13 _____ lbs. N/acre fertilizer rate

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Congratulations! You have just completed a N budget for your orchard. If you think your calculated fertilizer recommendation is too high or too low, here are some things to check:

- Did you use the correct units for yield, tons/acre not lbs./acre?
- Do you have well water with a lot of nitrate? In some orchards well water can supply ALL of the trees' needs.
- If line 12 was negative, that means all N needs are supplied by sources other than fertilizer. You probably do not need to apply any fertilizer this year, especially if your leaf tissue is in the high range.
- Did you use the correct units of N in the water (NO_3 ppm or NO_3-N ppm)?
- Does you orchard currently have high vigor that requires a lot of pruning? High vigor can use nitrogen that really isn't needed by the tree.
- What are your leaf tissue samples like, are they high or low, and how do they compare to your N budget?

If July leaf N is in the low range, increase fertilizer rates. If leaf N is in the high range, decrease fertilizer application rates.

This Nitrogen Budgeting Worksheet was developed in March, 1999 by Max Stevenson, BIOS Staff Scientist.

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