University of California

Nitrogen Management Training

for Certified Crop Advisers

COMPETENCY AREA 5

Nitrogen Budgeting 2

Daniel Geisseler
Department of Land, Air and Water Resources; UC Davis

University of California
Agriculture and Natural Resources

Review of part 1

- Nitrogen budgets can support decisions about N management for specific fields
- Nitrogen budgets can help evaluate N management decisions
- Budgets consist of a three elements:
  - Sink term (crop N requirement or N removal)
  - Source term (non-fertilizer N credits)
  - Closing source term (fertilizer N)
- Budget approach introduced in part 1 was based on results from N rate trials

Method 2: N harvest removal

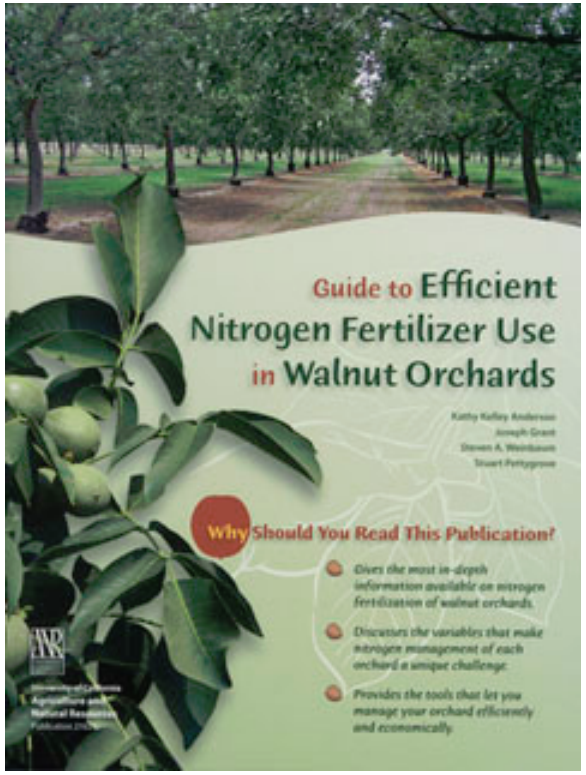
Nitrogen Budgeting Worksheet for Walnuts

Name | **Date**

Block ID

1	**Nitrogen removed in the crop**	1a._____ (Yield in tons of walnuts/acre) x 40 (lb N/ton yield of walnuts) =	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 = OR 2c._____ lb N/acre x 0.7 = (Estimated N recovery) 2b._____ (NO_3 ppm or mg/l) x _____ (Water applied (ft)) x 0.614 =	2._____ lb N/acre from irrigation water
3	**Nitrogen contributions from manure or compost**	If none applied, skip to line 4. 3a._____ (Tons/acre dry) x 3b._____ (% N) x 3c._____ (% N released*) x 0.5 x 0.2** (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._____ (lb N/orchard acre in cover crop) x 4b._____ (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.



Method 2: N harvest removal

N BUDGET			Walnut orchard B 2014		
Crop N Requirement				lbs N/acre	
1	N removed with crop:			RF	
	32 lbs N/ton				
2	Yield target:	3 tons/acre			
3	N in woody tissue:	30 lbs/acre			
4	Total required available N (lines 1 x 2 + 3)				126
Non-fertilizer N inputs, credits, adjustments					
5	N in irrigation water		43	x 0.7	30
6	Residual soil nitrate-N		29	x 0.7	20
7	N from manure, compost				
8	N from cover crop				
9	Total adjustments (sum of lines 5-8)				50
Planned N fertilizer application					
10	Additional N needed (line 4 – line 9)				76
11	Total fertilizer N to apply (line 10 / RF)			/ 0.7	109

15-40 lbs/ac can be added to account for N in woody tissue.

Method 2: N harvest removal

N BUDGET	Walnut orchard B 2014		
Crop N Requirement		lbs N/acre	
1 N removed with crop:		**RF**	
32 lbs N/ton			
2 Yield target: 3 tons/acre			
3 N in woody tissue: 30 lbs/acre			
4 Total required available N (lines 1 x 2 + 3)			126
Non-fertilizer N inputs, credits, adjustments			
5 N in irrigation water	43	x **0.7**	**30**
6 Residual soil nitrate-N	29	x **0.7**	**20**
7 N from manure, compost			
8 N from cover crop			
9 Total adjustments (sum of lines 5-8)			50
Planned N fertilizer application			
10 Additional N needed (line 4 – line 9)			76
11 Total fertilizer N to apply (line 10 / RF)		/ **0.7**	109

N in leaves is not included.

Method 2: N harvest removal

N BUDGET	Walnut orchard B 2014		
Crop N Requirement		lbs N/acre	
1 N removed with crop:		**RF**	
32 lbs N/ton			
2 Yield target: 3 tons/acre			
3 N in woody tissue: 30 lbs/acre			
4 Total required available N (lines 1 x 2 + 3)			126
Non-fertilizer N inputs, credits, adjustments			
5 N in irrigation water	43	x 0.7	30
6 Residual soil nitrate-N	29	x 0.7	20
7 N from manure, compost			
8 N from cover crop			
9 Total adjustments (sum of lines 5-8)			50
Planned N fertilizer application			
10 Additional N needed (line 4 – line 9)			76
11 Total fertilizer N to apply (line 10 / RF)		/ 0.7	109

All N sources are multi-plied by "N recovery factor (RF)". RF mainly depends on irrigation management.

Method 2: N harvest removal

N BUDGET	Walnut orchard B 2014		
Crop N Requirement		lbs N/acre	
1 N removed with crop:		**RF**	
32 lbs N/ton			
2 Yield target: 3 tons/acre			
3 N in woody tissue: 30 lbs/acre			
4 Total required available N (lines 1 x 2 + 3)			126
Non-fertilizer N inputs, credits, adjustments			
5 N in irrigation water	43	x 0.7	30
6 Residual soil nitrate-N	29	x 0.7	20
7 N from manure, compost			
8 N from cover crop			
9 Total adjustments (sum of lines 5-8)			50
Planned N fertilizer application			
10 Additional N needed (line 4 – line 9)			76
11 Total fertilizer N to apply (line 10 / RF)		/ 0.7	109

Method 2: N harvest removal

N BUDGET	Walnut orchard B 2014		
Crop N Requirement		lbs N/acre	
1 N removed with crop:		**RF**	
32 lbs N/ton			
2 Yield target: 3 tons/acre			
3 N in woody tissue: 30 lbs/acre			
4 Total required available N (lines 1 x 2 + 3)			126
Non-fertilizer N inputs, credits, adjustments			
5 N in irrigation water	43	x 0.7	30
6 Residual soil nitrate-N	29	x 0.7	20
7 N from manure, compost			
8 N from cover crop			
9 Total adjustments (sum of lines 5-8)			50
Planned N fertilizer application			
10 Additional N needed (line 4 – line 9)			76
11 Total fertilizer N to apply (line 10 / RF)		/ 0.7	109

Method 2: N harvest removal

N BUDGET	Walnut orchard B 2014		
Crop N Requirement		lbs N/acre	
1 N removed with crop:		**RF**	
32 lbs N/ton			
2 Yield target: 3 tons/acre			
3 N in woody tissue: 30 lbs/acre			
4 Total required available N (lines 1 x 2 + 3)			126
Non-fertilizer N inputs, credits, adjustments			
5 N in irrigation water	43	x 0.7	30
6 Residual soil nitrate-N	29	x 0.7	20
7 N from manure, compost			
8 N from cover crop			
9 Total adjustments (sum of lines 5-8)			50
Planned N fertilizer application			
10 Additional N needed (line 4 – line 9)			76
11 Total fertilizer N to apply (line 10 / RF)		/ 0.7	109

Nitrogen management worksheet

CROP NITROGEN MANAGEMENT PLANNING	
6. Crop	Walnuts
7. Production Unit	tons/ac
8. Projected Yield	3
9. N Recommended	126
10. Acres	
POST PRODUCTION ACTUALS	
11. Actual Yield (Units/ac)	
12. Total N Applied (lbs/ac)	
13. ** N Removed (lbs N/ac)	
14. ***Notes:	

N APPLICATIONS/CREDITS	15. Recommended/ Planned N	16. Actual N
17. NITROGEN FERTILIZERS APPLIED		
18. Dry/Liquid N (lbs/ac)	109	
19. Foliar N (lbs/ac)		
20. ORGANIC MATERIAL N		
21. Available N in Manure/Compost (lbs/ac estimate)		
22. Total N Applied + Available (lbs per ac) (Box 18+19+21)	109	
23. NITROGEN CREDITS (EST)		
24. * Available N carryover in soil; (annualized lbs/ac)	29	
25. * N in Irrigation water (annualized, lbs/ac)	43	
26. Total N Credits (lbs per ac) (Box 24+25)	72	
27. Total N Applied + Available + Credits (Box 22+26)	181 Transfer to Box 9	Transfer to Box 12

Nitrogen management worksheet

CROP NITROGEN MANAGEMENT PLANNING	
6. Crop	Walnuts
7. Production Unit	tons/ac
8. Projected Yield	3
9. N Recommended	126
10. Acres	
POST PRODUCTION ACTUALS	
11. Actual Yield (Units/ac)	
12. Total N Applied (lbs/ac)	
13. ** N Removed (lbs N/ac)	
14. ***Notes:	

N APPLICATIONS/CREDITS	15. Recommended/ Planned N	16. Actual N
17. NITROGEN FERTILIZERS APPLIED		
18. Dry/Liquid N (lbs/ac)	109	
19. Foliar N (lbs/ac)		
20. ORGANIC MATERIAL N		
21. Available N in Manure/Compost (lbs/ac estimate)		
22. Total N Applied + Available (lbs per ac) (Box 18+19+21)	109	
23. NITROGEN CREDITS (EST)		
24. * Available N carryover in soil; (annualized lbs/ac)	29	
25. * N in Irrigation water (annualized, lbs/ac)	43	
26. Total N Credits (lbs per ac) (Box 24+25)	72	
27. Total N Applied + Available + Credits (Box 22+26)	181 Transfer to Box 9	Transfer to Box 12

Method 2: N harvest removal

N BUDGET	Walnut orchard B 2014		
Crop N Requirement		lbs N/acre	
1 N removed with crop:		**RF**	
32 lbs N/ton			
2 Yield target: 3 tons/acre			
3 N in woody tissue: 30 lbs/acre			
4 Total required available N (lines 1 x 2 + 3)			126
Non-fertilizer N inputs, credits, adjustments			
5 N in irrigation water	43	x 0.7	30
6 Residual soil nitrate-N	29	x 0.7	20
7 N from manure, compost			
8 N from cover crop			
9 Total adjustments (sum of lines 5-8)			50
Planned N fertilizer application			
10 Additional N needed (line 4 – line 9)			76
11 Total fertilizer N to apply (line 10 / RF)		/ 0.7	109

Nitrogen management worksheet

CROP NITROGEN MANAGEMENT PLANNING	
6. Crop	Walnuts
7. Production Unit	tons/ac
8. Projected Yield	3
9. N Recommended	126
10. Acres	
POST PRODUCTION ACTUALS	
11. Actual Yield (Units/ac)	
12. Total N Applied (lbs/ac)	
13. ** N Removed (lbs N/ac)	
14. ***Notes:	

N APPLICATIONS/CREDITS	15. Recommended/ Planned N	16. Actual N
17. NITROGEN FERTILIZERS APPLIED		
18. Dry/Liquid N (lbs/ac)	109	
19. Foliar N (lbs/ac)		
20. ORGANIC MATERIAL N		
21. Available N in Manure/Compost (lbs/ac estimate)		
22. Total N Applied + Available (lbs per ac) (Box 18+19+21)	109	
23. NITROGEN CREDITS (EST)		
24. * Available N carryover in soil; (annualized lbs/ac)	29	
25. * N in Irrigation water (annualized, lbs/ac)	43	
26. Total N Credits (lbs per ac) (Box 24+25)	72	
27. Total N Applied + Available + Credits (Box 22+26)	181 Transfer to Box 9	Transfer to Box 12

Nitrogen management worksheet

CROP NITROGEN MANAGEMENT PLANNING	
6. Crop	Walnuts
7. Production Unit	tons/ac
8. Projected Yield	3
9. N Recommended	126
10. Acres	
POST PRODUCTION ACTUALS	
11. Actual Yield (Units/ac)	3
12. Total N Applied (lbs/ac)	181
13. ** N Removed (lbs N/ac)	126
14. ***Notes:	

N APPLICATIONS/CREDITS	15. Recommended/ Planned N	16. Actual N
17. NITROGEN FERTILIZERS APPLIED		
18. Dry/Liquid N (lbs/ac)	109	
19. Foliar N (lbs/ac)		
20. ORGANIC MATERIAL N		
21. Available N in Manure/Compost (lbs/ac estimate)		
22. Total N Applied + Available (lbs per ac) (Box 18+19+21)	109	
23. NITROGEN CREDITS (EST)		
24. * Available N carryover in soil; (annualized lbs/ac)	29	
25. * N in Irrigation water (annualized, lbs/ac)	43	
26. Total N Credits (lbs per ac) (Box 24+25)	72	
27. Total N Applied + Available + Credits (Box 22+26)	181 Transfer to Box 9	Transfer to Box 12

Nitrogen management worksheet

CROP NITROGEN MANAGEMENT PLANNING	
6. Crop	Walnuts
7. Production Unit	tons/ac
8. Projected Yield	3
9. N Recommended	126
10. Acres	
POST PRODUCTION ACTUALS	
11. Actual Yield (Units/ac)	3
12. Total N Applied (lbs/ac)	181
13. ** N Removed (lbs N/ac)	126
14. ***Notes:	

N APPLICATIONS/CREDITS	15. Recommended/ Planned N	16. Actual N
17. NITROGEN FERTILIZERS APPLIED		
18. Dry/Liquid N (lbs/ac)	109	109
19. Foliar N (lbs/ac)		
20. ORGANIC MATERIAL N		
21. Available N in Manure/Compost (lbs/ac estimate)		
22. Total N Applied + Available (lbs per ac) (Box 18+19+21)	109	109
23. NITROGEN CREDITS (EST)		
24. * Available N carryover in soil; (annualized lbs/ac)	29	29
25. *N in Irrigation water (annualized, lbs/ac)	43	43
26. Total N Credits (lbs per ac) (Box 24+25)	72	72
27. Total N Applied + Available + Credits (Box 22+26)	181 Transfer to Box 9	181 Transfer to Box 12

Partial Nitrogen Balance:

(eq 1) % crop recovery = $\frac{126}{181} = 70\%$

(eq 2) Applied/Removed = $\frac{181}{126} = 1.44$

How to approach optimal N rate

1. Determine optimal N rate
2. Manage fields with different yield potentials separately
3. Ensure that irrigation management is efficient
4. Synchronize N applications with crop N uptake
5. Optimize fertilizer placement
6. Choose appropriate fertilizer type

⇨ With these considerations, the risk of yield losses is minimized when the N rate is adjusted

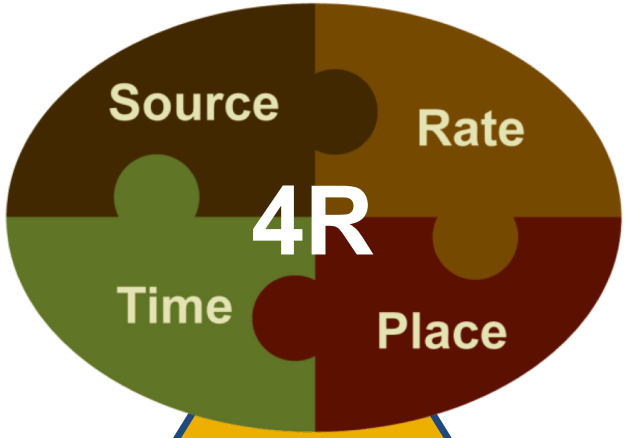
Implementing a new fertilizer program I

- Start with small plots within a field
  - Big enough to harvest plots with regular equipment
- When establishing small plots is not possible, chose several fields with similar characteristics and yield potential. Test new approach in one of these fields.
- Proceed in small steps
  - If the potential reduction in N application rate is big, approach the optimal rate in several steps over 2-3 years

Implementing a new fertilizer program II

- Monitor the field during the season
  - Take soil or plant tissue samples during the season
  - Continue more intensive sampling protocol for another year or two (especially important for perennial crops)

Nutrient management is more than adjusting N rates



University of California

Nitrogen Management Training

for Certified Crop Advisers

Course materials available at:

ciwr.ucanr.edu/NitrogenManagement

Contributing partners:

University of California
Agriculture and Natural Resources
web: ucanr.edu
Twitter: @ucanr

California Institute for Water Resources
University of California
Agriculture and Natural Resources
web: ciwr.ucanr.edu
Twitter: @ucanrwater

California Department of Food & Agriculture (CDFA)
Fertilizer Research and Education Program
web: www.cdfa.ca.gov
Twitter: @CDFAnews

California Association of Pest Control Advisers (CAPCA)
web: capca.com

University of California
Agriculture and Natural Resources