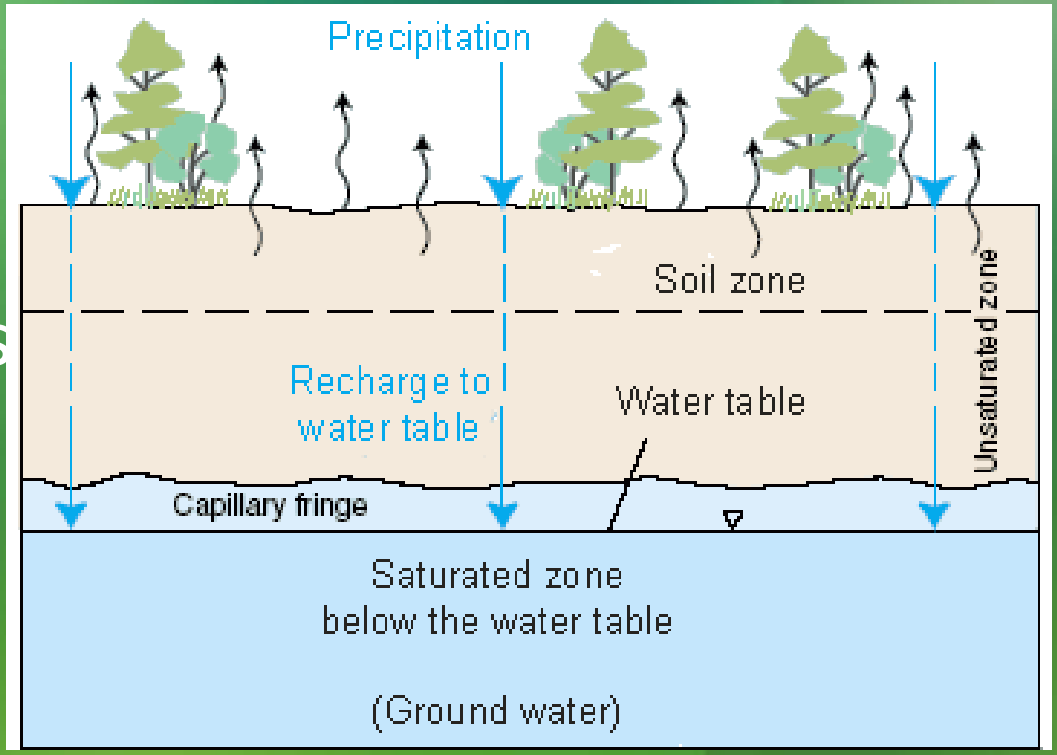
Nitrogen Budgeting for Fun and Profit

Wendy Rash
District Conservationist
USDA-NRCS

Why is N fertilizer an issue?

- Nitrate in drinking water causes “blue baby syndrome” (methemoglobinemia)
- Agriculture uses a lot of N fertilizer
- Nitrate moves through soil in water
- Agricultural nitrates end up in drinking water wells



Why does nitrate (NO_3) leach?

- NO_3 is a negatively-charged ion (or “anion”)
  - Does not “stick” to soil (also negatively charged)
  - Goes anywhere water goes
- NO_3 is applied in excess of crop needs
- Excess irrigation water moves NO_3 past the root zone into water table
- Timing of application does not match crop demand

What can you do to prevent nitrate leaching?

Goal: Don’t let nitrate leave the root zone

- Create a budget for nitrogen
  - Right material
  - Right amount
  - Right time
  - Right place
- Manage water better

What's in a budget?

- "Expenses": N requirement of crop
- "Fixed income": Soil and water N supply
- "Additional income": Fertilizer N needed
- Excess "income" is pollution, not profit

Nitrogen Management Plan worksheet

NITROGEN MANAGEMENT PLAN WORKSHEET

NMP Management Unit: _____

1. Crop Year (Harvested):
2. Member ID#
3. Name:

4. APN(s):	5. Field(s) ID	Acres

CROP NITROGEN MANAGEMENT PLANNING		N APPLICATIONS/CREDITS	15. Recommended/ Planned N	16. Actual N
6. Crop		**17. Nitrogen Fertilizers**		
7. Production Unit		18. Dry/Liquid N (lbs/ac)		
8. Projected Yield (Units/Acre)		19. Foliar N (lbs/ac)		
9. N Recommended (lbs/ac)		**20. Organic Material N**		
10. Acres		21. Available N in Manure/Compost (lbs/ac estimate)		
Post Production Actuals		**22. Total Available N Applied** (lbs per acre)		
11. Actual Yield (Units/Acre)		**23. Nitrogen Credits (est)**		
12. Total N Applied (lbs/ac)		24. Available N carryover in soil; (annualized lbs/acre)		
13. ** N Removed (lbs N/ac)		25. N in Irrigation water (annualized, lbs/ac)		
14. Notes:		**26. Total N Credits** (lbs per acre)		
		27. Total N Applied & Available		

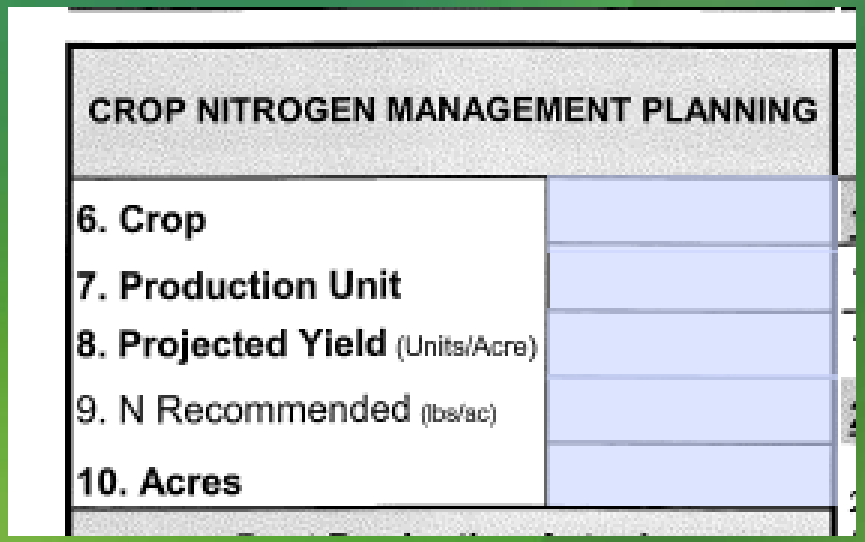
PLAN CERTIFICATION		
28. CERTIFIED BY:	29. CERTIFICATION METHOD	
	30. Low Vulnerability Area, No Certification Needed	
	31. Self-Certified, approved training program attended	
DATE:	32. Self-Certified, UC or NRCS site recommendation	
	33. Nitrogen Management Plan Specialist	

**Your Coalition will provide the method to be used to estimate N Removed. Approved by the Central Valley Water Board 23 December 2014.

Instruction numbering in this document differs slightly from the NMP template approved by the Water Board to accommodate this publication design.

N requirement of crop

- Item #9 on worksheet- “N recommended”
- Includes all of the N required to make the crop
  - Products *and* by-products/residues
  - Can differ based on growing conditions
  - Efficiency of crop N use closely tied with water use



CROP NITROGEN MANAGEMENT PLANNING	
6. Crop	
7. Production Unit	
8. Projected Yield (Units/Acre)	
9. N Recommended (lbs/ac)	
10. Acres	

N requirement: Information Sources

- CDFA Fertilization Guidelines
  - http://apps.cdfa.ca.gov/frep/docs/guidelines.html
  - Brochures- available here

CDFA website (continued)

A collaboration between

cdfa

FERTILIZER RESEARCH AND EDUCATION PROGRAM FREP

UCDAVIS UNIVERSITY OF CALIFORNIA

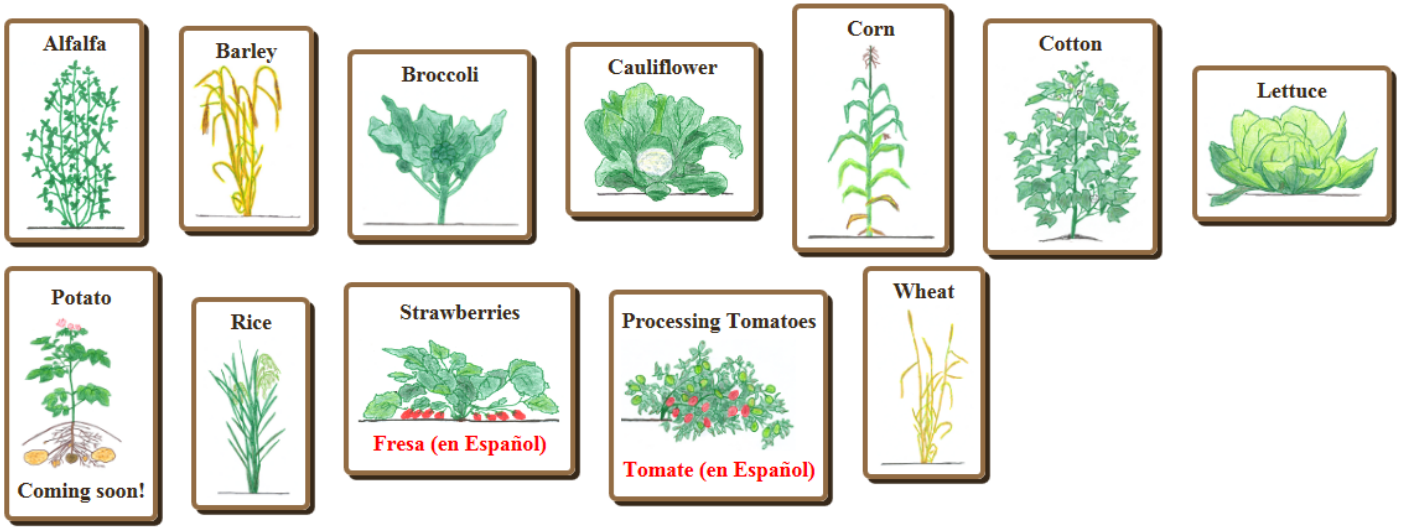
Additional Information

- **Soil and Plant Tissue Sampling**
  - Soil Test Sampling Instructions
  - Sampling for Soil Nitrate Determination
  - Soil Sampling in Orchards
  - Plant Tissue Sampling
- **Resources, Links**
  - Organized by Topic
  - Organized by Source
- **Nitrogen Partitioning and Seasonal Uptake Curves**
- **A Discussion about Site-Specific Adjustments**

California Fertilization Guidelines

These guidelines are based on research results from studies carried out in California and elsewhere. For an optimal fertilization program, site-specific information needs to be take in into account. A discussion about site-specific adjustments can be found **here**.

Field crops and vegetables



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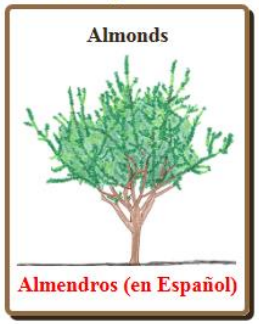
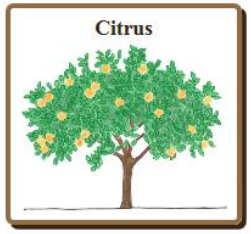
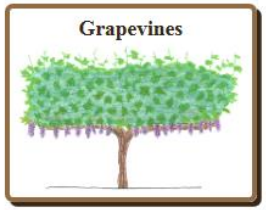
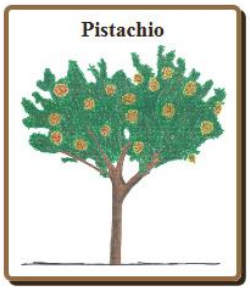
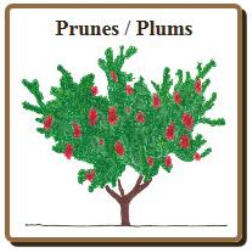
Tree crops

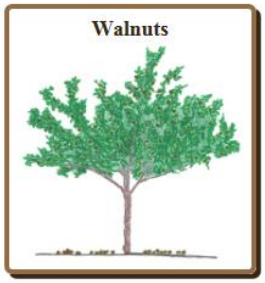












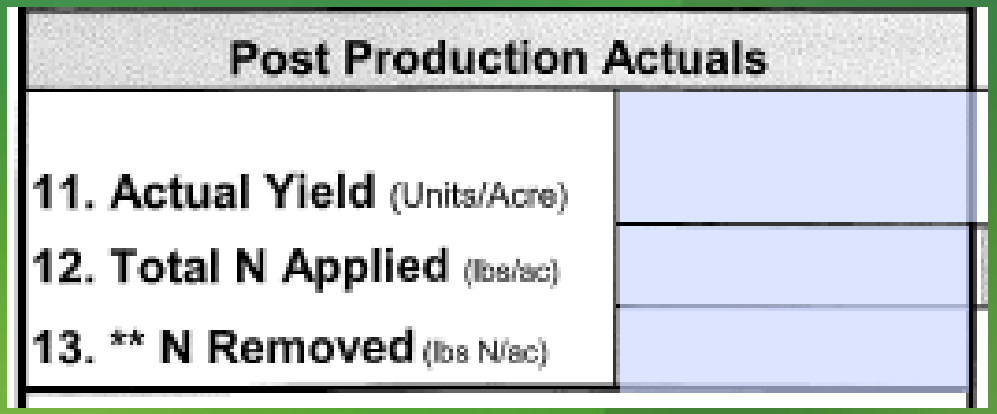
N requirement: Information Sources

- UC Agriculture and Natural Resources
  - http://ucanr.org/sites/nm/

http://ucanr.edu/sites/nm/

N Removed

- N removed ≠ N uptake ≠ N requirement
- Item #13 on worksheet
- This item not reported to Regional Board
- N contained in harvested agricultural product
  - A portion of total N needed
  - Check the weight basis; e.g. almond kernels vs. almonds in shell



Post Production Actuals	
11. Actual Yield (Units/Acre)	
12. Total N Applied (lbs/ac)	
13. ** N Removed (lbs N/ac)	

N Removed: Information Sources

Natural Resources Conservation Service

- PLANTS database crop nutrient tool
  - http://plants.usda.gov/npk/main

N Removed: Information Sources

International Plant Nutrition Institute

- Crop Nutrient Removal Calculator app for i-Phone or i-Pad
  - App Store or i-Tunes
  - https://itunes.apple.com/us/app/crop-nutrient-removal-calculator/id914110406?mt=8

Soil and Water Nitrogen

- Nitrogen “Credits”
- Soil Test Results
  - Soil Organic matter
  - Nitrate-N
- Irrigation Water Test Results
  - Converting ppm to lb/ac

23. Nitrogen Credits (est)		
24. Available N carryover in soil; (annualized lbs/acre)		
25. N in Irrigation water (annualized, lbs/ac)		
26. Total N Credits (lbs per acre)		

Side note: Soil sampling

- How many samples do I need?

It depends:

  - Soil types present
  - Management history
  - Size of management unit
  - Depth of active root zone
- Getting a representative sample
  - Multiple sub-samples
  - Consider field configuration and root zone

Your sampling plan should be site-specific. Ask for advice if you aren't sure!

Soil N contributions

- Item #24 on worksheet
- Soil test results: Soil organic matter given in percent by weight

For 12-inch soil sample:

20-40 lbs N/ac for each 1% SOM

23. Nitrogen Credits (est)		
24. Available N carryover in soil; (annualized lbs/acre)		
25. N in Irrigation water (annualized, lbs/ac)		
26. Total N Credits (lbs per acre)		

Soil N contributions

- Item #24 on worksheet
- Soil nitrate content: Only use *CURRENT* soil test results (Pre-plant quick test)
- Test results in ppm NO_3 or ppm NO_3-N

For 12-inch soil sample:

Soil NO_3-N (ppm) × 4 = lb N/ac

NO_3 × 0.2259 = N

23. Nitrogen Credits (est)		
24. Available N carryover in soil; (annualized lbs/acre)		
25. N in Irrigation water (annualized, lbs/ac)		
26. Total N Credits (lbs per acre)		

Water N contributions

- Item #25 on worksheet
- N or NO_3 measured in ppm
- Need to know how much water is applied: ac-in

For irrigation water sample:

NO_3-N (ppm) × 0.23 = lb N/ac-in

NO_3 (ppm) × 0.052 = lb N/ac-in

23. Nitrogen Credits (est)		
24. Available N carryover in soil; (annualized lbs/acre)		
25. N in Irrigation water (annualized, lbs/ac)		
26. Total N Credits (lbs per acre)		

How much N to apply?

- Item #22 (Column 15) on worksheet
- Planned N: Difference between crop N needs and N credits
- The amount of N is only part of the puzzle
  - "Four R's" of Plant Nutrition
  - Right Rate, Source, Time, Place

N APPLICATIONS/CREDITS	15. Recommended/ Planned N	16. Actual N
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19. Foliar N (lbs/ac)		
20. Organic Material N		
21. Available N in Manure/Compost (lbs/ac estimate)		
22. Total Available N Applied (lbs per acre)		

Fertilizer N needed- Data sources

- Items #18-19 on worksheet, planned and actual
- Your PCA/CCA reports application material, amount
- Field records of material applied and amount
  - Western Fertilizer Handbook table
  - IPNI Nutrient Source Specifics (fact sheets)
  - http://www.ipni.net/specifics-en

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Organic amendments

- Item #21 on worksheet
- Best: test results

TOTAL NUTRIENT ANALYSIS

Physical Characteristics

pH	6.18	
ECe	4.75	mmho/cm
Tot.Dissolved Salts	3040	ppm
Percent Moisture	51.4	% Sample analysis is based on dry weight
Bulk Density (Dry)	579.5	lb/cu.yd.

Chemical Analysis	Analytical Results	Results in lb/ton (dry)
Total-N	2.50 %	50.00
Ammonia-N	2.59 ppm	< .01
Phosphorus-P	0.34 %	6.80
Phosphorus-P2O5	0.78 %	15.60
Potassium-K	0.82 %	16.40
Potash-K2O	0.98 %	19.60
Sulfur	0.4 %	8.00
Sodium	1461.92 ppm	2.92
Calcium	1.95 %	39.00
Magnesium	1.28 %	25.60
Copper	84.06 ppm	0.17
Iron	8619.68 ppm	17.24
Mangnaese	437.46 ppm	0.87
Zinc	155.42 ppm	0.31
Organic Matter	47.80 %	
C/N Ratio	9.94	

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Organic amendments

- Item #21 on worksheet
- Best: test results
- OK in a pinch: “book values”
  - Western Fertilizer Handbook
  - UCANR Publication: “Organic Soil Amendments and Fertilizers”
  - Oregon State online calculator
  - http://smallfarms.oregonstate.edu/calculator

Organic amendments

- Just a note: cover crop contributions not included on worksheet
- If you have significant N-fixing cover crops, you may want to add this to the soil N credit
- Contact me for info on calculating cover crop contributions

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Data and Record Keeping

- Record for each reporting unit
- Electronic
  - NRCS example spreadsheets
  - Your own spreadsheets
- Paper notes

Data and Record Keeping

Need to record:

- Soils and soil test data
- Irrigation water source test data and amount applied
- Fertilizer applications
- Organic material applications
- Crop yield

NRCS assistance available

- Nutrient Management practice-
  - Similar, but includes NPK
- Irrigation water management practice
- Technical assistance
  - Spreadsheets for data records
  - Soil maps, advice on soil sampling
  - Resources, questions
- Financial assistance: Environmental Quality Incentives Program (EQIP)
  - Competitive process

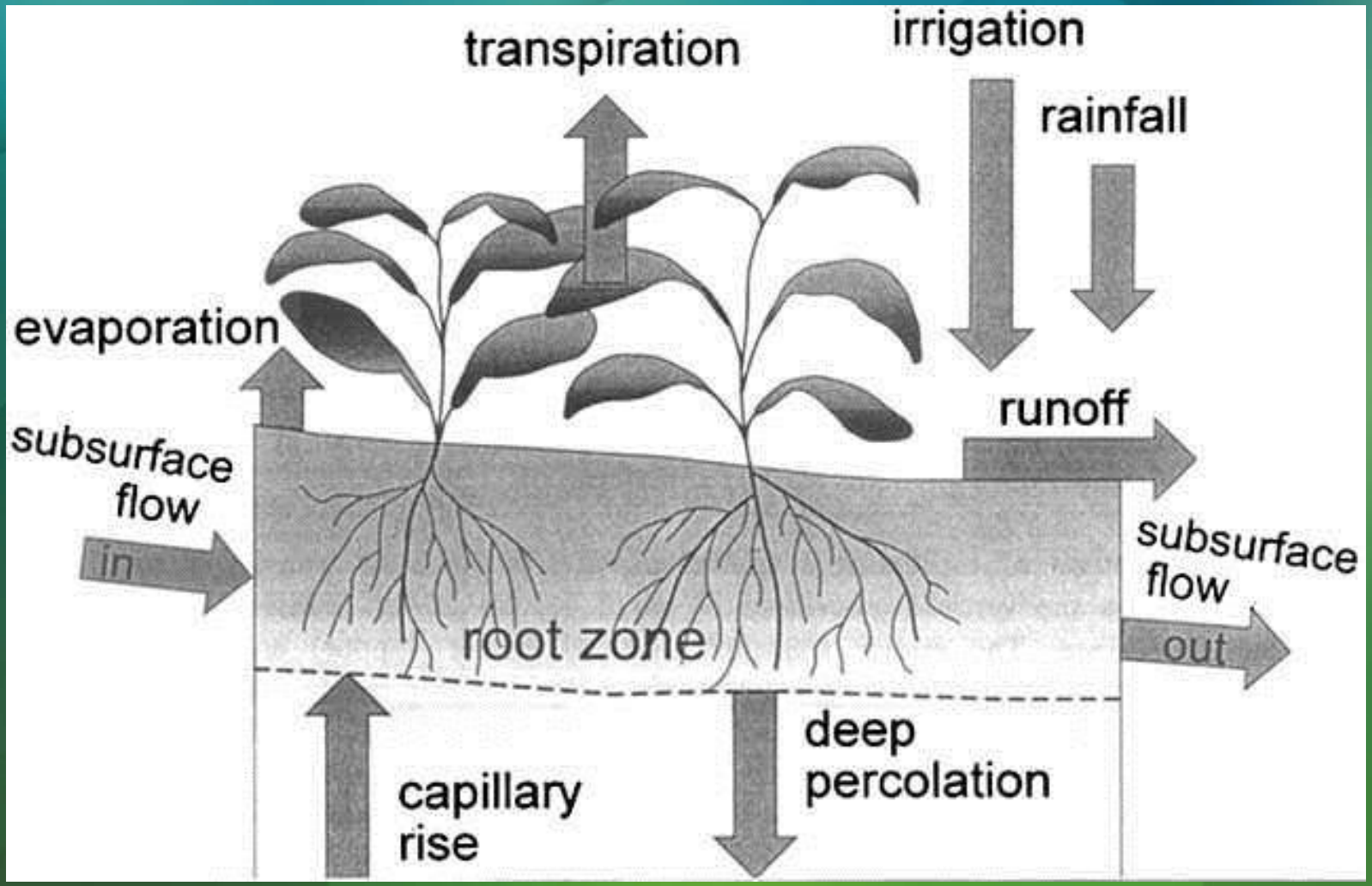
What is Irrigation Water Management?

- Using field-specific data to make irrigation decisions

Goals:

- Provide adequate water for crop
  - Optimize production
  - Potentially reduce costs (water, energy)
- Eliminate excess watering
  - Prevent erosion and excess runoff- sediment
  - Prevent excess deep percolation- nutrients

How much and when?



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Thanks…

- NRCS colleagues
  - Karen Lowell, Z. Kabir
- UC researchers
  - Tim Hartz, Stu Pettygrove, Daniel Geisseler

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Natural Resources Conservation Service