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Climate Change • Sustainable Agriculture
Environmental Quality • Landscape Processes

# Nitrogen removed with harvested crops


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FREP - WPHA Conference

**November 1, 2017**

# Overview

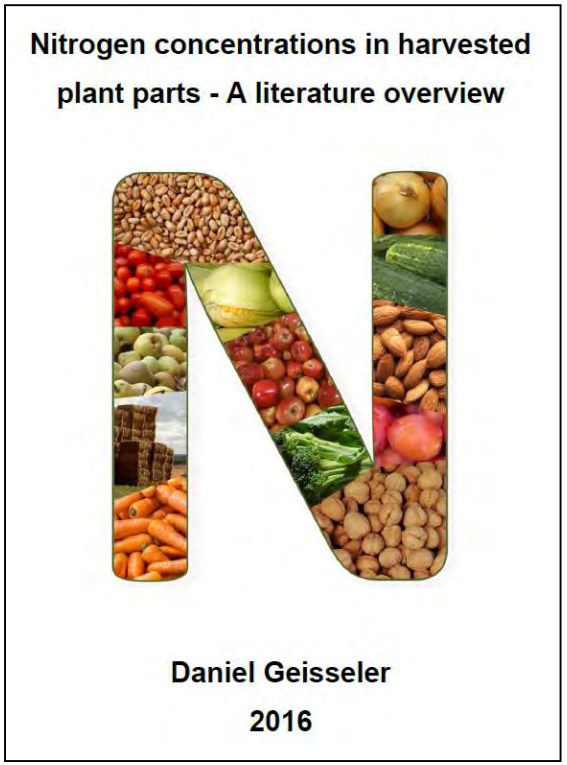
- Background
- Factors contributing to variability of N concentrations in harvested crops
- N removed from field with different crops
- Conclusions

# Background

- The Central Valley Irrigated Lands Regulatory Program aims to reduce nitrate leaching to the groundwater
- The ratio of N applied to N removed is a key metric for the State and Central Valley Regional Water Boards

# How to best determine N applied/N removed?

- **N application rate** reported by growers
- **N removal rate** = yield × N concentration
- Yield is reported by growers
- N concentration can be based on
  - Representative samples taken from the fields at harvest
  - Average values



# How is this related to the N Management Plan?

13 ** N removed

** Your coalition will provide the method to be used to estimate N removed

NITROGEN MANAGEMENT PLAN WORKSHEET

NMP Management Unit: _____

| 1. Crop Year (Harvested): | | 4. APN(s): | 5. Field ID(s) |
|---|---|---|---|
| 2. Member ID# | | | |
| 3. Name: | | | |

| CROP NITROGEN MANAGEMENT PLANNING | | N APPLICATIONS/CREDITS | 15. Recommended Planned N |
|---|---|---|---|
| 6. Crop | | 17. NITROGEN FERTILIZERS APPL | |
| 7. Production Unit | | 18. Dry/Liquid N (lbs/ac) | |
| 8. Projected Yield | | 19. Foliar N (lbs/ac) | |
| 9. N Recommended | | 20. ORGANIC MATERIAL N | |
| 10. Acres | | 21. Available N in Manure/Compost (lbs/ac estimate) | |
| POST PRODUCTION ACTUALS | | 22. Total N Applied + Available (lbs per ac) (Box 18+19+21) | |
| 11. Actual Yield (Units/ac) | | 23. NITROGEN CREDITS (EST) | |
| 12. Total N Applied (lbs/ac) | | | |
| 13. ** N Removed (lbs N/ac) | | 24. * Available N carryover in soil; (annualized lbs/ac) | |
| 14. ***Notes: | | 25. *N in Irrigation water (annualized, lbs/ac) | |

# Content of the N removal report

- Summary of the available literature
- Includes information for 70 commodities grown in the Central Valley
- Information includes
  - Weighted average
  - Number of observations
  - Range of values
  - Coefficient of variability (in % of the mean)

# Key findings – N concentrations are highly variable I

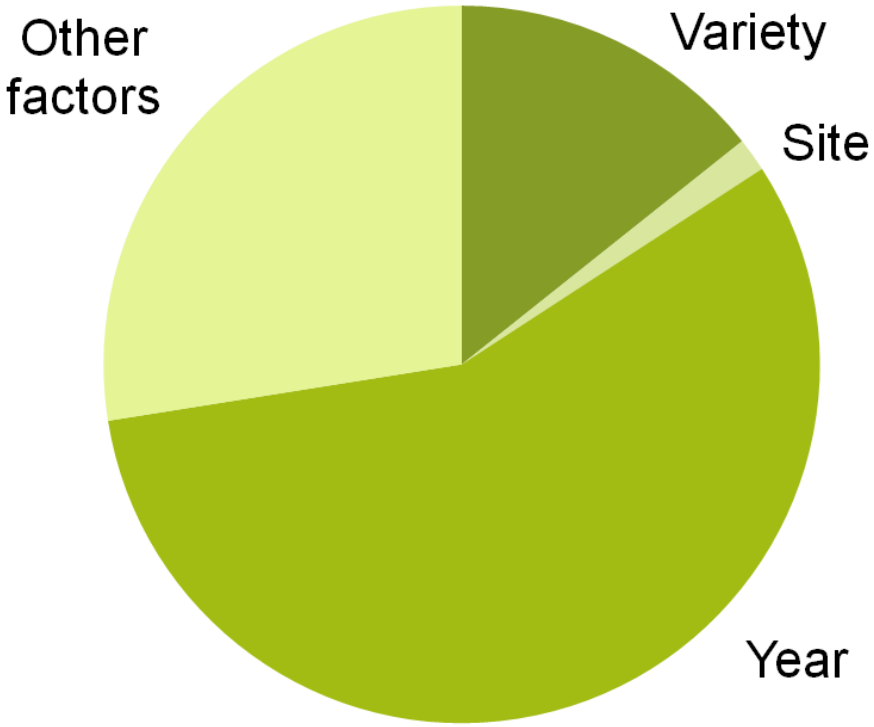
Factors affecting N concentration in most crops:

- Year-to-year variability
- Variety
- Site
- N availability
- Availability of other nutrients

# Source of variability – California wheat

- Data from variety trials (irrigated wheat)
- 4 Central Valley locations
- 3 years (2013-15)
- 5 varieties

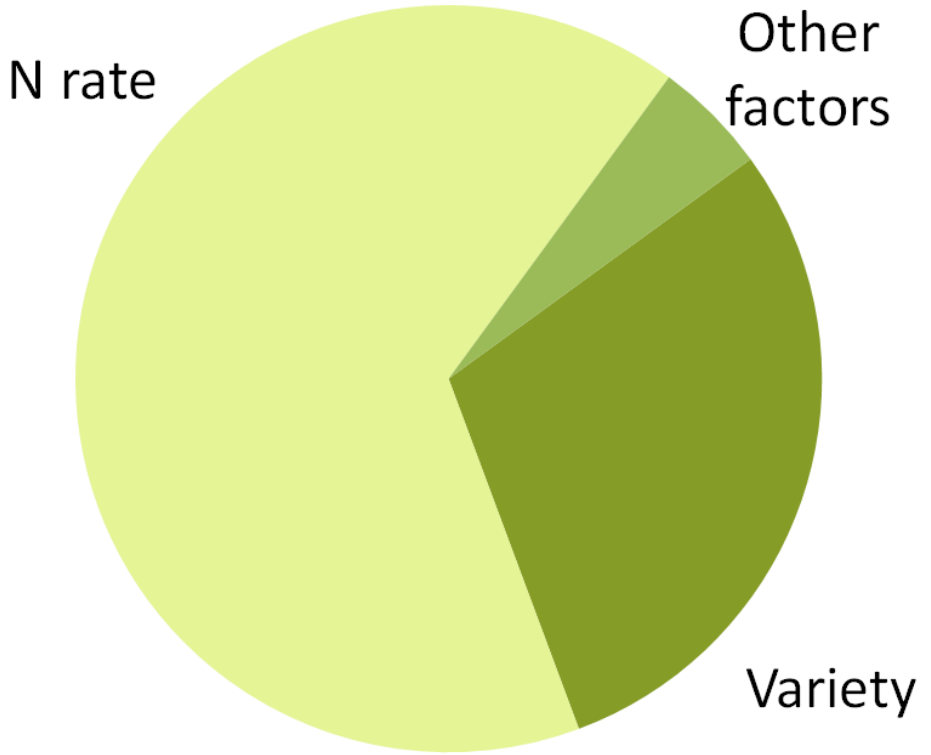
  ⇨ 60 data points




Wheat variety trials: http://smallgrains.ucanr.edu/

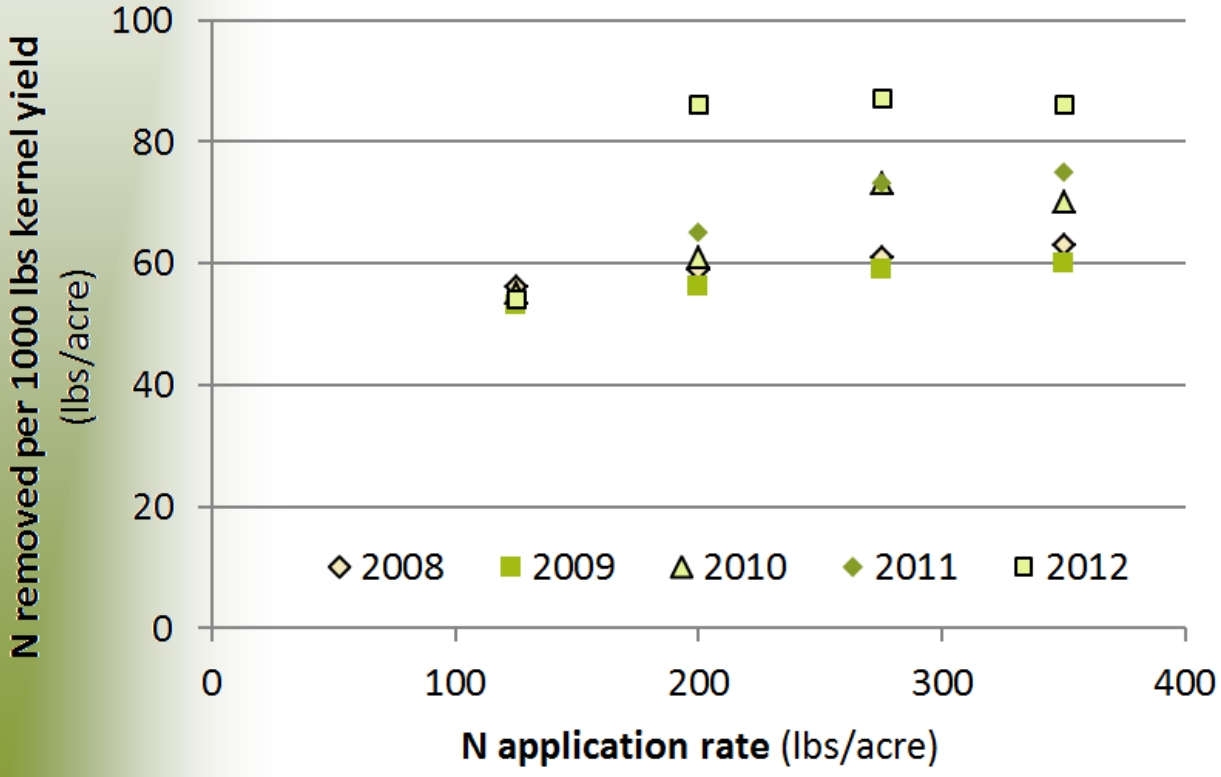
# Source of variability – California nectarines

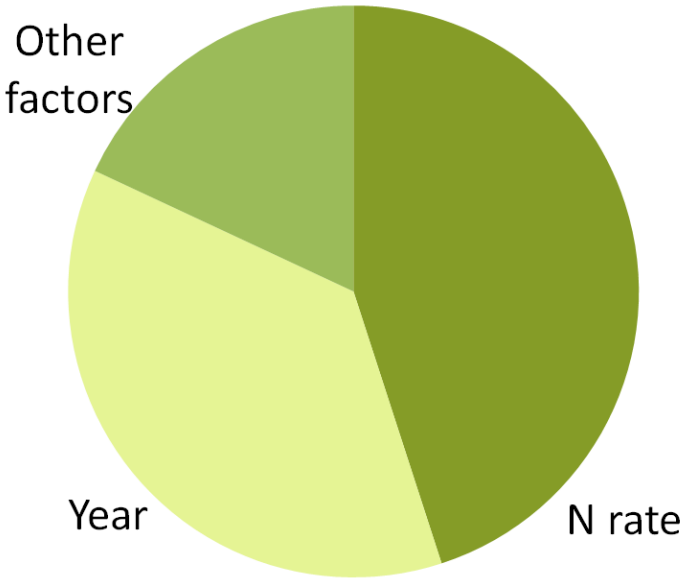
- 2 varieties:
  - Flavortop, Fantasia
- 5 N rates:
  - 0-325 lbs/acre




Weinbaum et al., 1992

# Source of variability – California almonds




Brown et al., 2012; Brown, 2013

# Key findings – N concentrations are highly variable I

Factors affecting N concentration in most crops:

- Year-to-year variability
- Variety
- Site
- N availability
- Availability of other nutrients

# Key findings – N concentrations are highly variable II

Factors affecting N concentration:

- Dry matter content
  - Silage, onions
- Fruit size
  - Stone fruits
- Growth stage and season when harvested
  - Forage crops
- Rootstock
  - Trees and vines
- Percent marketable yield
  - When total yield is removed and cull or trash is not returned

# N concentrations in nuts and N removed

| Commodity | lbs N/ton | tons/acre [1)] | lbs/acre |
|---|---|---|---|
| Almonds | 136 | 1.11 | 151 |
| Pistachios | 56.1 | 1.20 | 67 |
| Walnuts | 31.9 | 1.98 | 63 |

[1)] Yield based on state average values from USDA survey; yield for shelled almonds and in-shell postachios and walnuts

**In addition, 15-40 lbs/acre accumulate each year in permanent tissues**

# N concentrations in citrus and N removed

| Commodity | lbs N/ton | tons/acre [1)] | lbs/acre |
|---|---|---|---|
| Grapefruit | 2.96 | 17.33 | 51 |
| Lemons | 2.58 | 17.50 | 45 |
| Oranges | 2.96 | 12.58 | 37 |
| Tangerines | 2.54 | 13.71 | 35 |

[1)] Yield based on state average values from USDA survey

**In addition, 15-40 lbs/acre accumulate each year in permanent tissues**

# N concentrations in wine grapes and N removed

- Nitrogen concentration in wine grapes averages 3.6 lbs/ton

| County | tons/acre [1)] | lbs/acre |
|---|---|---|
| **California** | **7.2** | **26** |
| San Luis Obispo | 2.5 | 9 |
| Napa | 3.4 | 12 |
| Fresno | 10.0 | 36 |
| Tulare | 15.3 | 55 |

[1)] State average yield from USDA survey, county yields from county crop reports

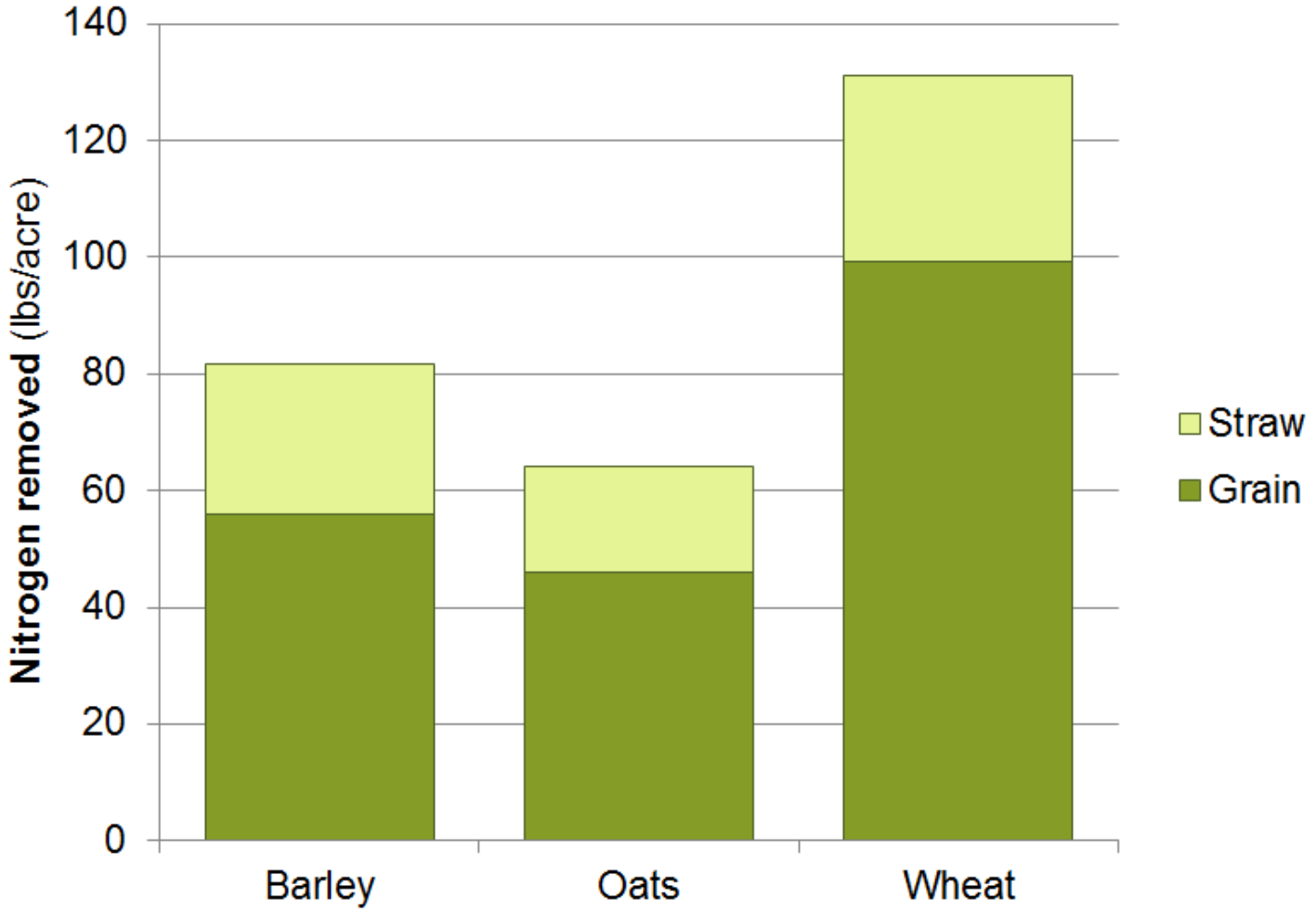
Nitrogen accumulation in the vines not included

# N concentrations in grains and N removed

| Commodity | lbs N/ton | tons/acre [1)] | lbs/acre |
|---|---|---|---|
| Barley | 33.6 | 1.67 | 56 |
| Corn | 24.0 | 4.89 | 117 |
| Oats | 37.7 | 1.22 | 46 |
| Sorghum | 33.0 | 2.63 | 87 |
| Winter Wheat | 43.0 | 2.31 | 99 |
| Durum Wheat | 42.1 | 2.96 | 124 |

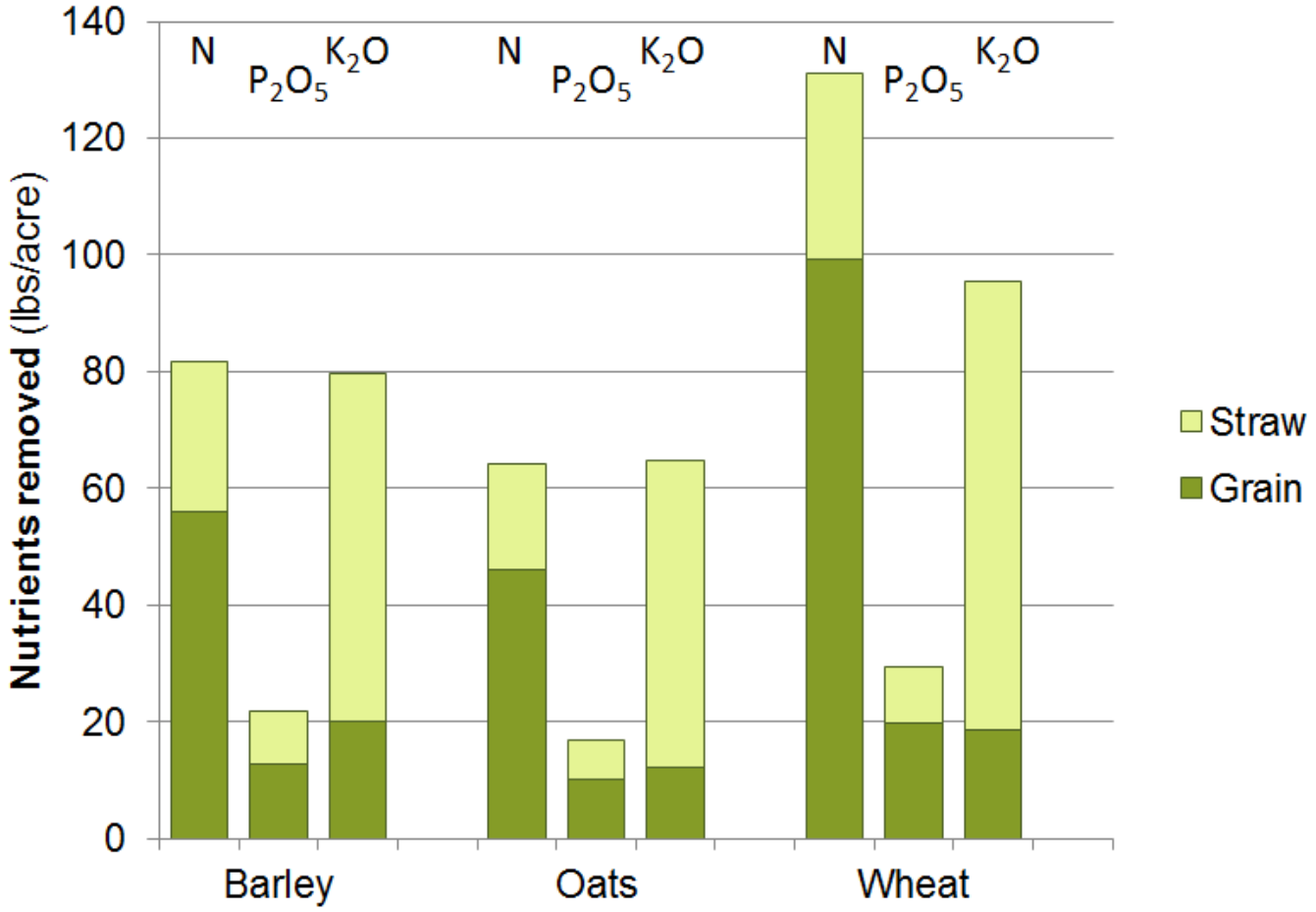
[1)] Yield based on state average values from USDA survey

# Distribution of N in grain and straw



# For comparison: N, P, K in grains and straw

- For comparison NPK in grains and straw



# Conclusions

- For many crops, little data available from California
  - ⇨ Samples need to be collected and analyzed
  - ⇨ FREP just awarded a grant to the Southern San Joaquin Valley Management Practices Evaluation Program to improve the dataset
- N concentration can be highly variable; many factors contribute to variability

# Alternative to using average values

Taking samples from each field by growers

- Costly
- Time consuming
- Logistics may be challenging
- Samples need to be representative of the field

# Challenges of taking a representative sample


# Conclusions

- For many crops, little data available from California
- N concentration can be highly variable; many factors contribute to variability
- Despite variability, using average values may not be less accurate than asking growers to take and analyze their own samples
  - ⇨ Ratio N applied/N removed can be inaccurate for a specific field in a certain year
  - ⇨ Ratio should only be used across multiple years and fields

# Can N removed be used for N agronomic N budgets?

- Yes, but additional information is needed:
  - Harvest index (N removed/total N in biomass)
  - N use efficiency
- More common for tree crops
- N requirement may be overestimated

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- Comparison of N applied/N removed across many fields in the area allows evaluating a nutrient program

# Acknowledgement


- Kings River Watershed Coalition
- John Dickey, PlanTierra
- Reviewers
- Irfan Ainuddin, Patricia Lazicki