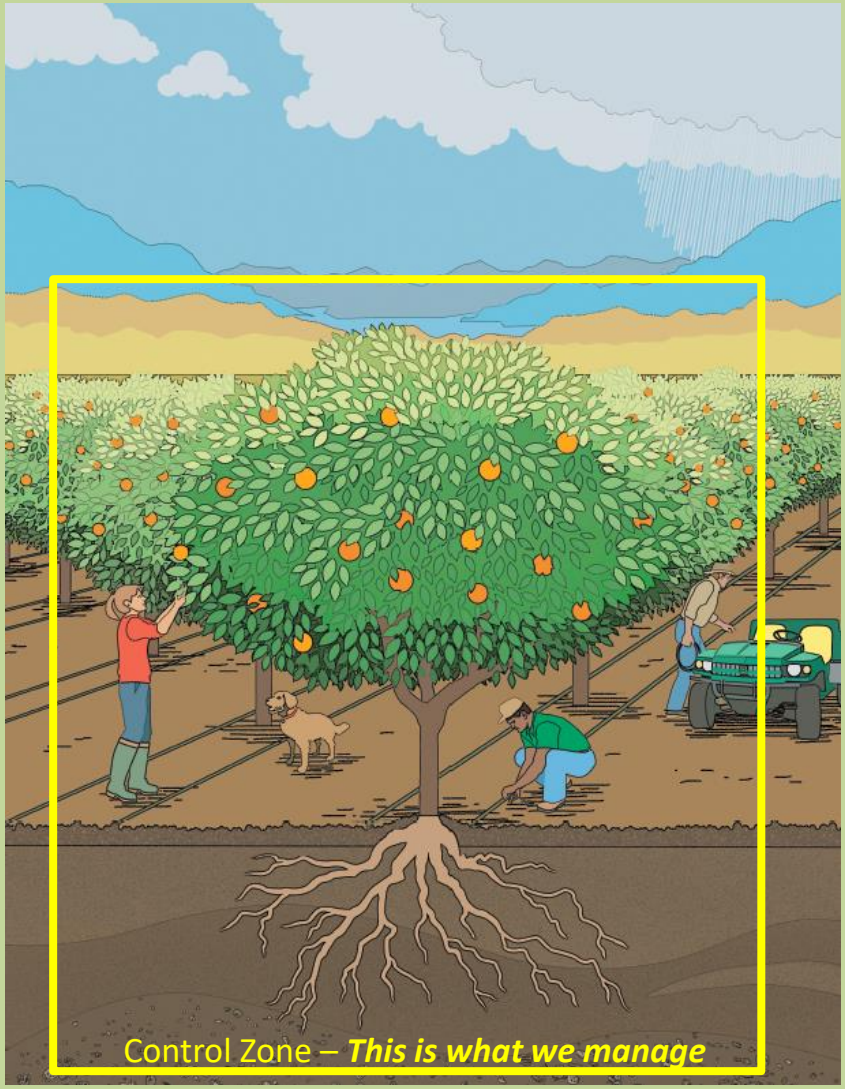

Reminders from Our Nitrogen Management Planning Reports

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Kings River Water Quality Coalition, Grower Re-Certification Course

Kearney Ag Research & Extension Center

March 29, 2018

Southern San Joaquin Valley Management Practices Evaluation Program Committee

USDA United States Department of Agriculture

Natural Resources Conservation Service

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Outline of Discussion

- NMP's & tax returns: How they are alike, how they differ
- Variability and uncertainty in NMP data affect their interpretation
- Measures of performance, of benefits & risks
- How benefits & risks change as we add more fertilizer to each of several crops
- Crop-specific summaries to consider when making N management decisions
- Take-home lessons from year-1 NMP

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NMP and the 1040, similarities

They both Contain:

- **Business information reported to a government agency**
- **Contain information on investments and production (inputs and outputs)**

We need to:

- **Consider from perspective of agency**
- **Find the most productive ways to invest**

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NMP and the 1040, differences

- **Investments & production are either in terms of cash (tax returns), or material quantities (NMP report)**
- **Tax returns contain *lots* of information about *one* business, but NMP reports contain *a little* information about *many* fields**
  - **2846 reports for 16 crops, 2661 for the top 12**
  - **Remove outliers for N applied and Yield → 2510**
  - **Crop, yield, N applied, acreage (only *4* items)**
  - **Analogous to only knowing Type of Business, Gross Income, Business Expenses for each of many tax returns**

What if an accountant studied Gross Income and Business Expenses for hundreds of returns, without knowing much else?

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Reported Yield: Inherent Causes of Variability

- **Actual**
  - **Includes moisture for fresh weight crops**
  - **Percent non-crop materials (trash, branches, hulls)**
  - **Percent pack-out**
- **Measurement error (there is always some)**
- **Reporting/interpretation**
  - **Moisture content for dried (standard moisture content) crops**
  - **Units mismatch**
  - **Data entry errors**

Relationship of Yield, N Applied and Removed: External Causes of Variability

Many non-fertilizer factors affect reported yield & N. Examples:

- **Permanent crop acreage is rapidly expanding; young vines and orchards yield nothing or have small yields compared to mature orchards**
- **Alternate bearing, particularly in pistachio, makes for erratic yields**
- **N applied to permanent crops contributes to perennial structures (roots, trunk, branches, flower buds) & future-years' production**
- **N applied to annual crops and not taken up in current year may be recovered in subsequent years, especially by deeper rooted annuals**

Relationship of Yield, N Applied and Removed: External Causes of Variability (continued)

Many non-fertilizer factors affect reported yield & N. More examples:

- **2016 crops were affected by limited water, salinity, and specific ions (boron, sodium, and chloride), all resulting from prolonged drought**
- **2017 was a brutal year for lygus in cotton**
- **Early bloom in 2018 → tree crop vulnerability to spring storms**
- **Crop may be left in the field due to poor market conditions**
- **Some sources of N (e.g., N carryover, cover crops) are not reflected in NMP**
- **Elevated groundwater N might boost N applied in lightly fertilized crops**

While informative, the NMP data are affected by many factors

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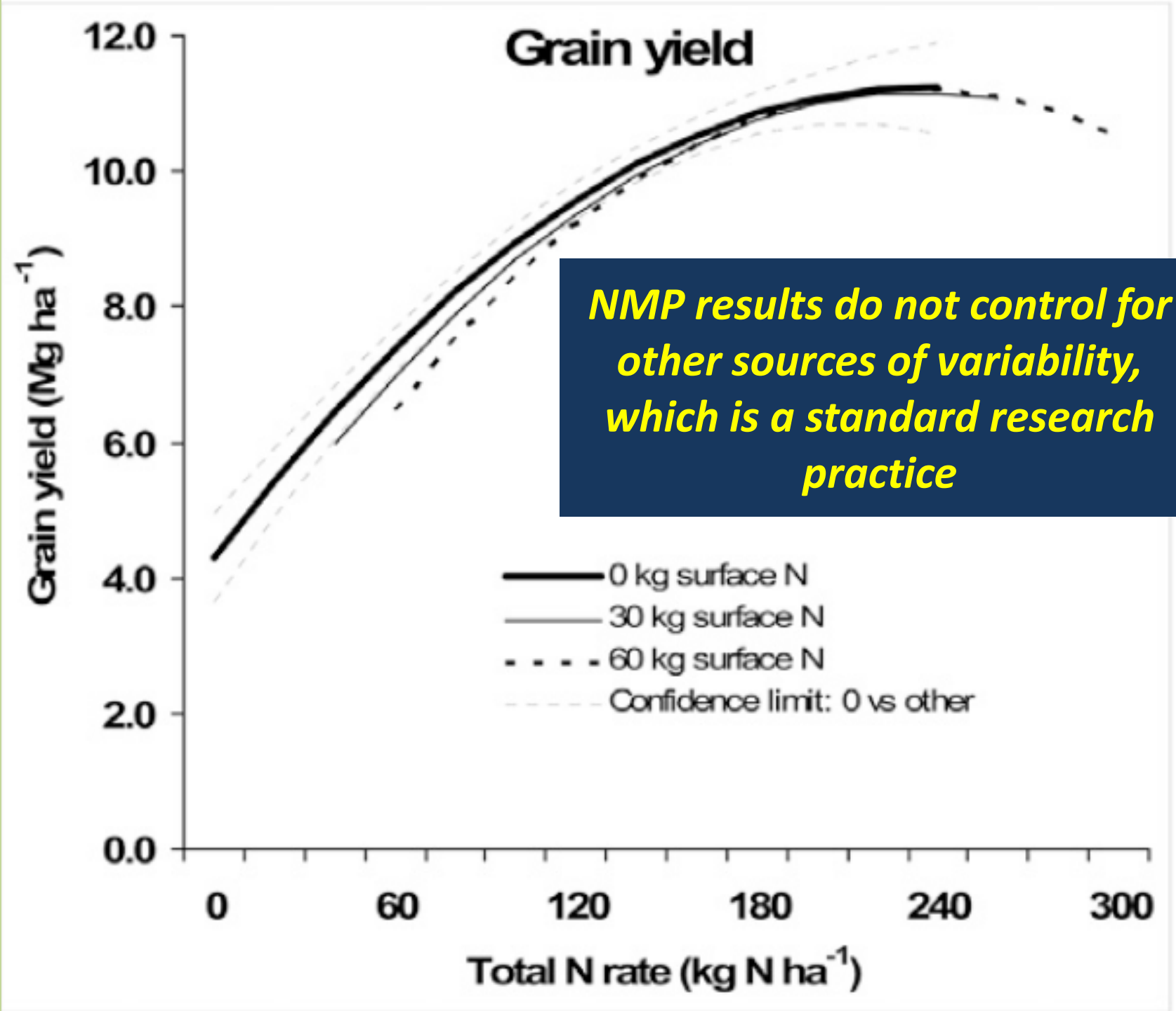
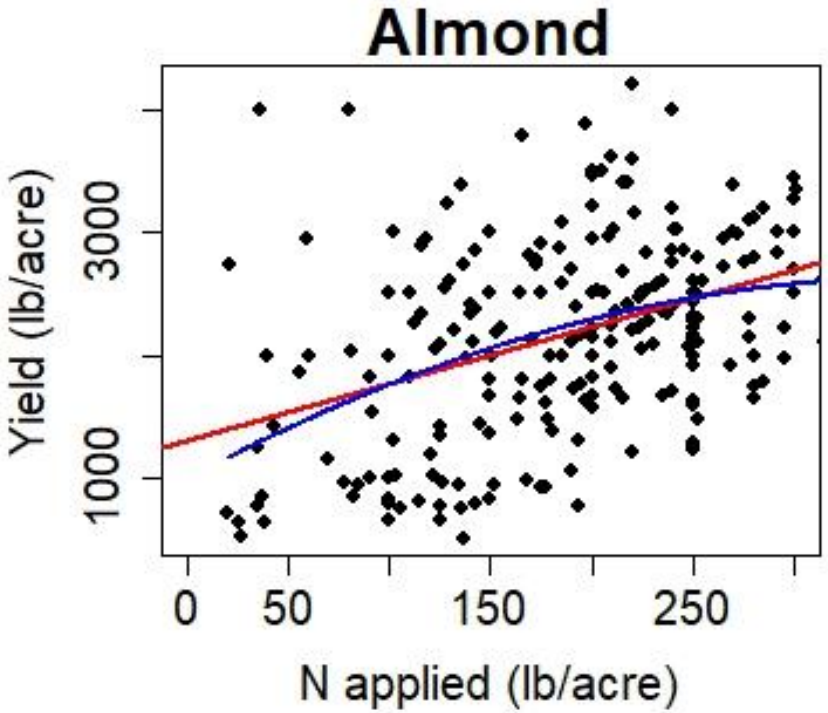
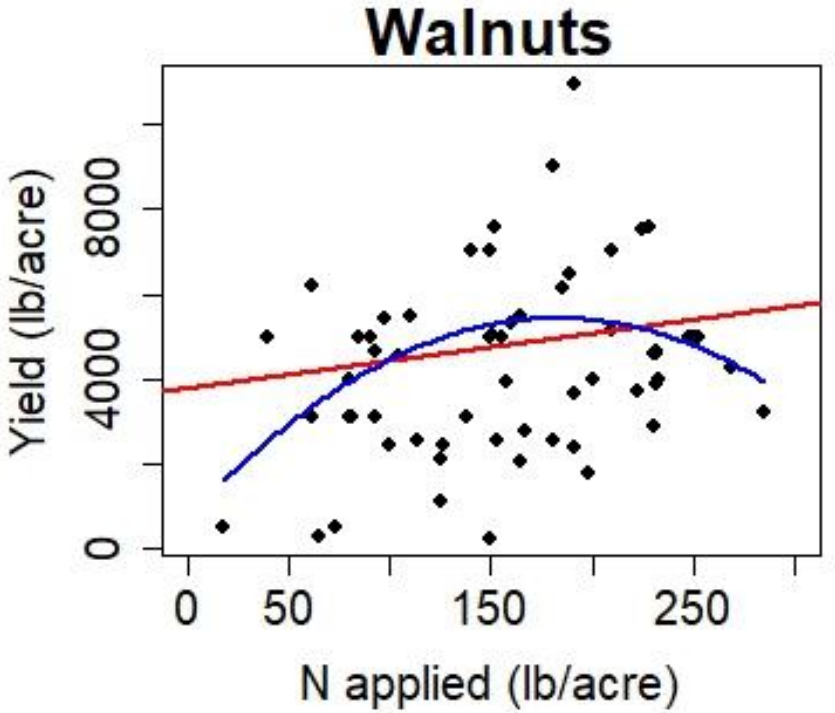

Grain yield
12.0
10.0
8.0
6.0
4.0
2.0
0.0
Grain yield (Mg ha-1)
0
60
120
180
240
300
Total N rate (kg N ha-1)
0 kg surface N
30 kg surface N
60 kg surface N
Confidence limit: 0 vs other
NMP results do not control for other sources of variability, which is a standard research practice

Classical Treatment of Report Results, with No Consideration of Area Represented





Crop	R^2 Linear	R^2 Quadratic
Almond	16%**	17%**
Walnuts	2%	9%**
Pistachios	No relationship	

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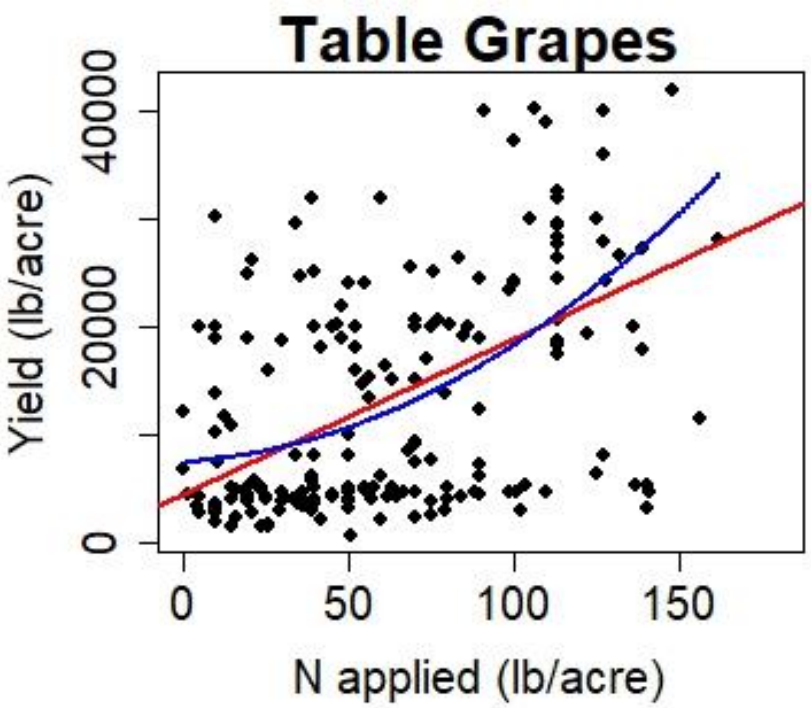
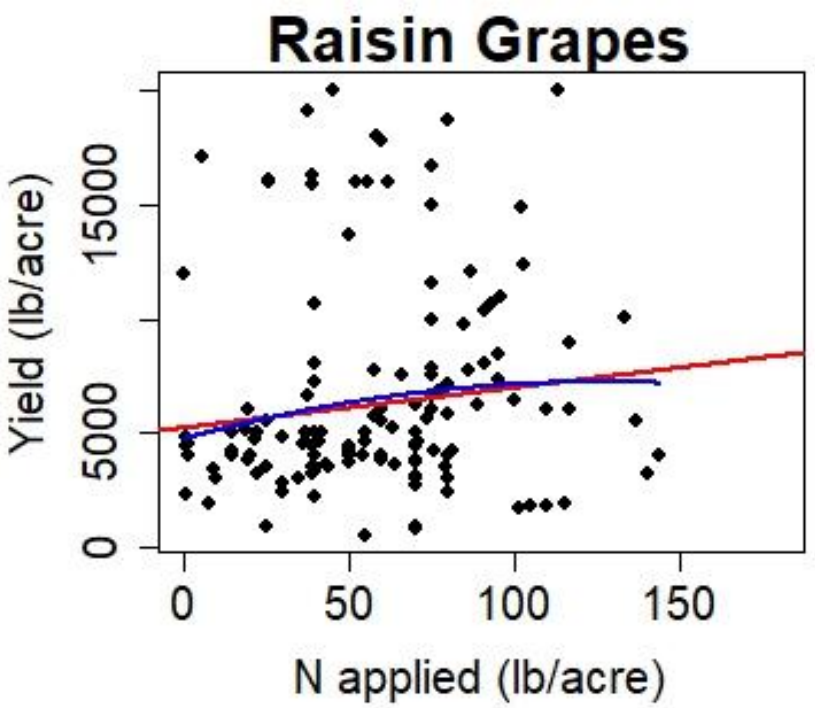
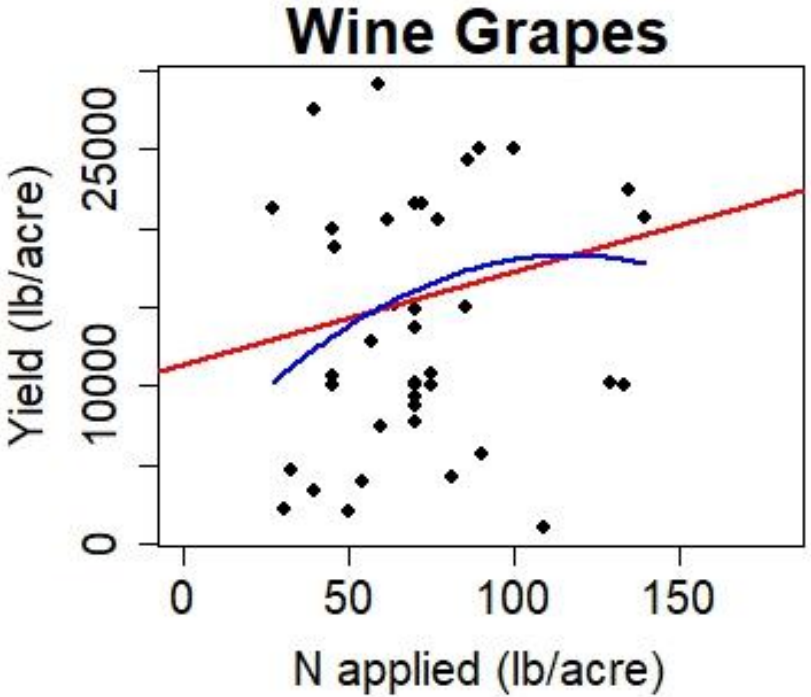
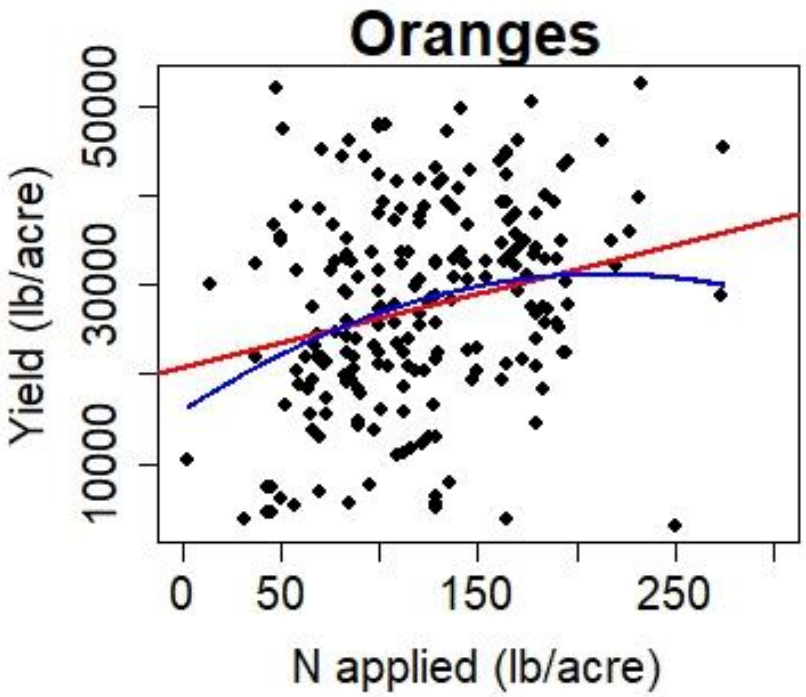
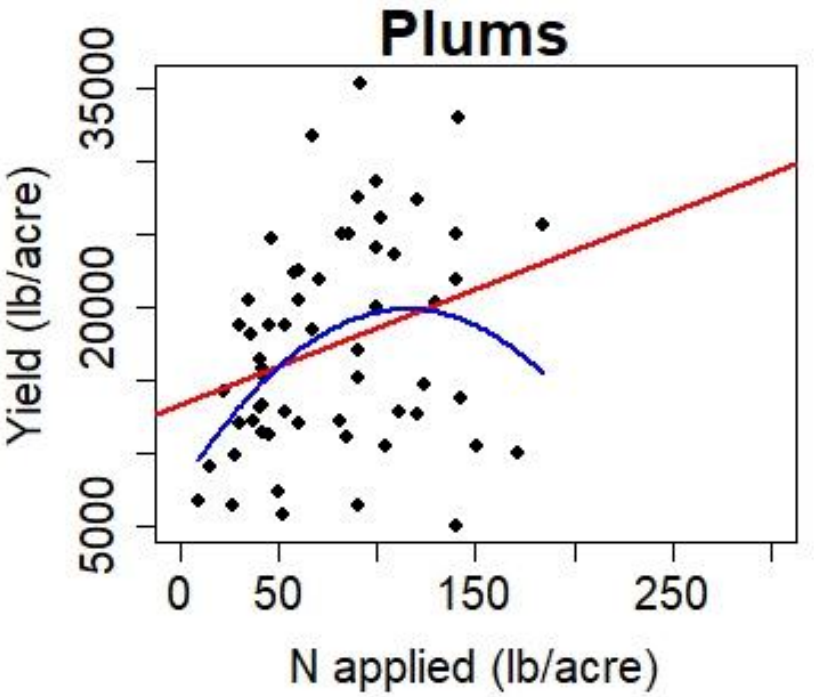


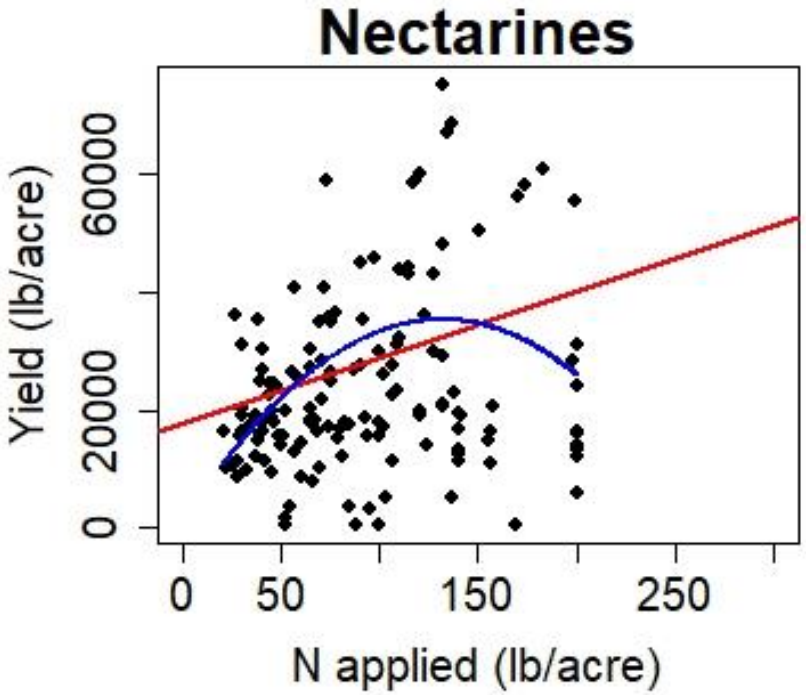




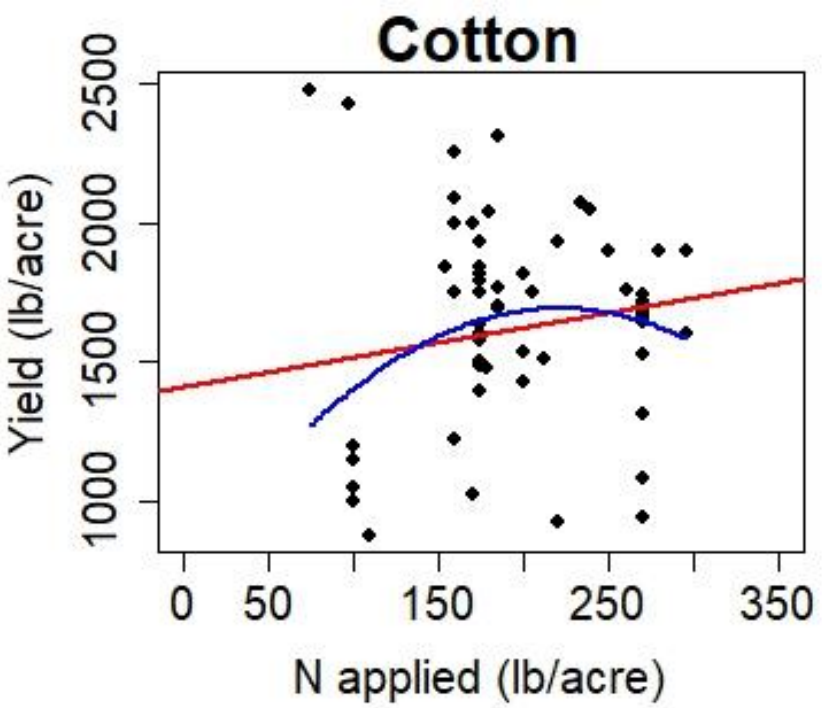
Crop	*R^2 Linear*	*R^2 Quadratic*
Table Grapes	*25%***	*27%***
Raisin Grapes	*2%**	*2%**
Wine Grapes	*Weaker relationship*	

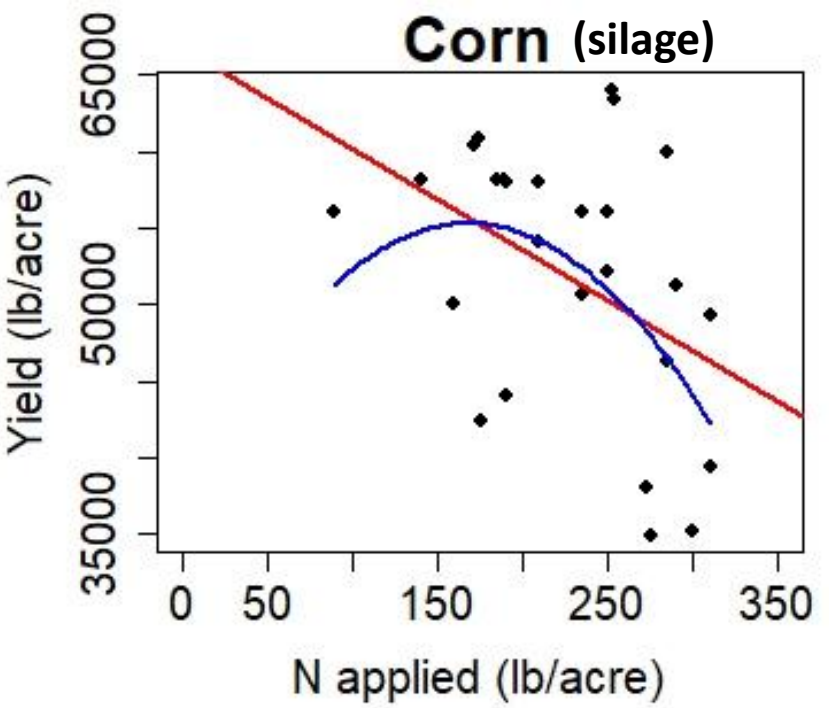


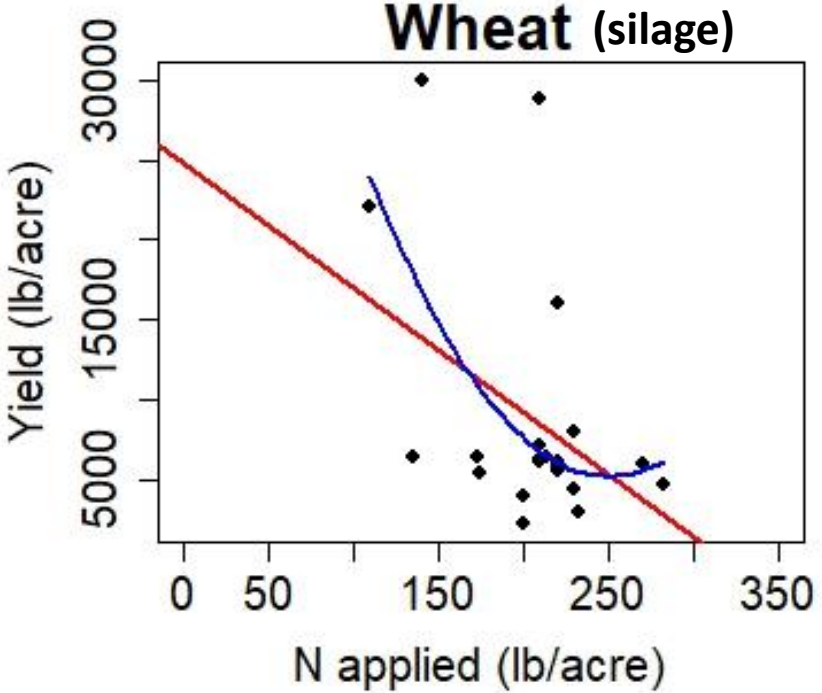




Crop	*R^2 Linear*	*R^2 Quadratic*
Oranges	***7%*****	***7%*****
Plums	***7%*****	***12%*****
Nectarines	***11%*****	***21%*****







Crop	*R^2 Linear*	*R^2 Quadratic*
Cotton	***Weak***	***4%****
Corn	***13%*****	***17%*****
Wheat	***19%*****	***27%*****

Other Distinctive NMP Features & Implications

Another difference:

- **NMP data are like a census (reports obtained for *ALL* irrigated fields) taken each year; we are used to working with *sample data* (just a few measurements to represent all)**

Therefore, NMP results:

- **Are more like sociological or ecological results, where the effect of one factor can be masked by the effects of many others**
- **Don't by themselves tell us how any particular field should be managed**
- **Due to their great number, can inform us about the general N productivity relationships in fields we manage**

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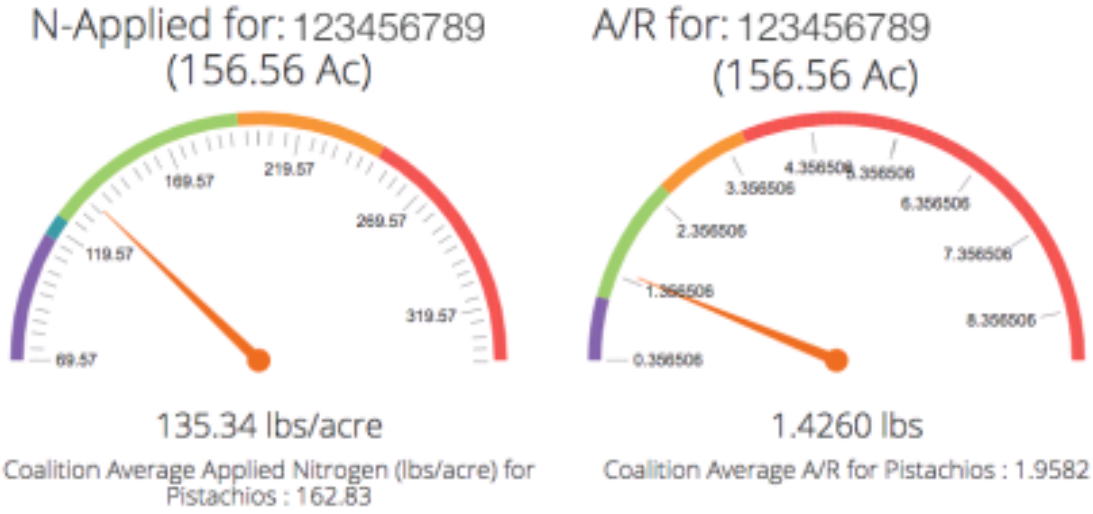
The NMP Report Card Allows Growers to View Site-specific Information in Broader Context

N-Applied and A/R dials show your how your field's numbers stack up within your coalition.



Dials show your field's N-Applied and A/R for the selected field. Colors show percentile ranges.

NMP Summary Feedback Legend

- : Greater than 90th percentile, **Outlier**
- : 75th to 90th percentile
- : 25th to 75th percentile
- : 10th to 25th Percentile
- : 10th percentile and below, **Outlier**

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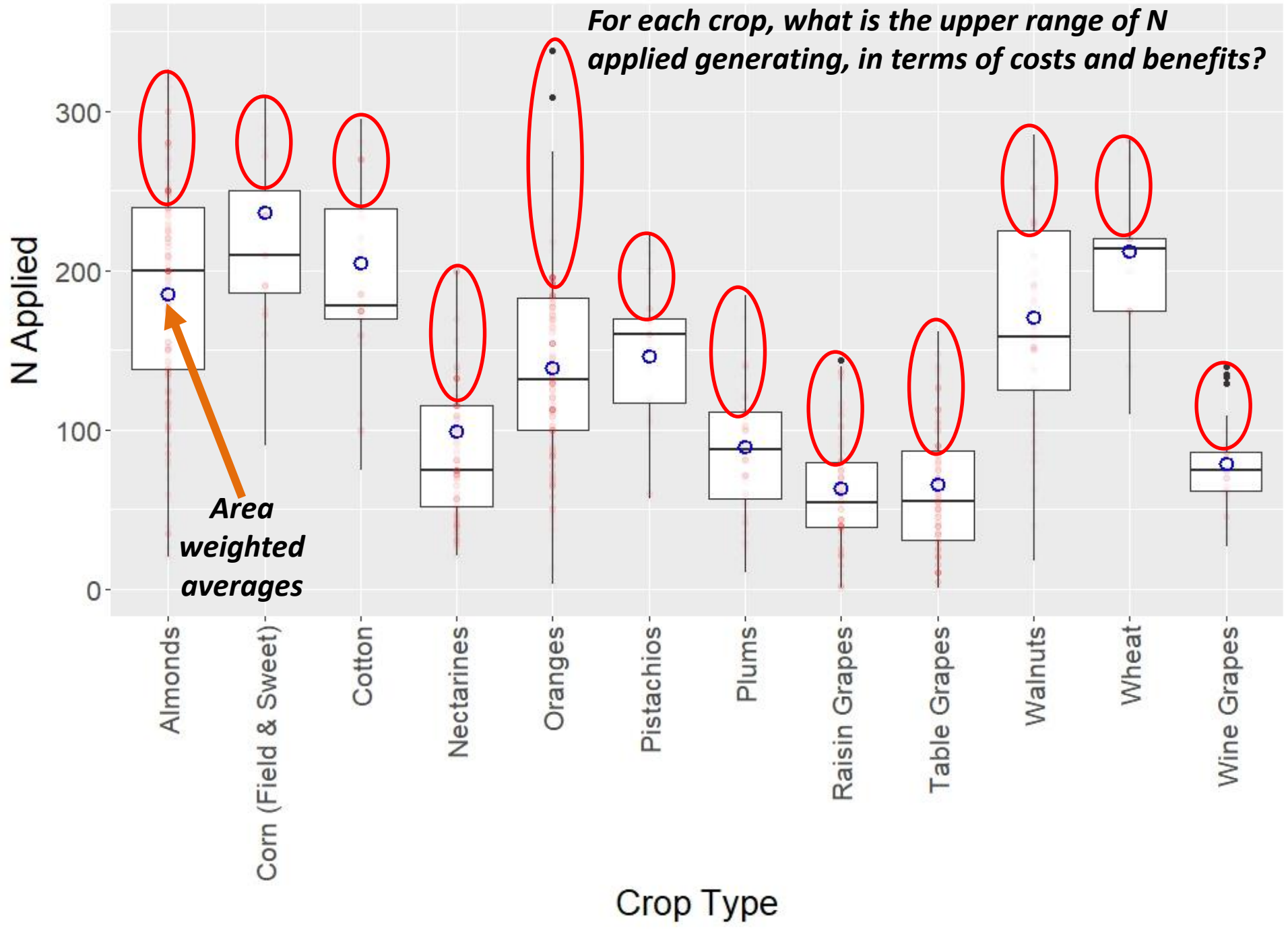
For each crop, what is the upper range of N applied generating, in terms of costs and benefits?
N Applied
300
200
100
0
Area weighted averages
Almonds
Corn (Field & Sweet)
Cotton
Nectarines
Oranges
Pistachios
Plums
Raisin Grapes
Table Grapes
Walnuts
Wheat
Wine Grapes
Crop Type

Further Information Extracted from KRWQC NMP Reports

- **Levels of production**
  - **Gross income**
  - ***Yield***
- **Levels of input productivity**
  - **ADDITIONAL Income/ADDITIONAL Cost**
  - ***ADDITIONAL Yield/ADDITIONAL N applied***
- **Levels of investment**
  - **Business expenses**
  - ***N applied***
- **Level of risk ("residual" N, an index of environmental stewardship)**
  - ***N applied – N removed***
- ***N recommended for the yield achieved (nut crops)***
- ***Distribution of acreage***

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Approach to Cleaning and Smoothing NMP Data

- **Removed outliers. These are being addressed by coalitions with individual growers.**
- **Removed the upper and lower 5% of the acreage in the N applied range**
- **Divided remaining N applied range into 20 classes**
- **Plotted moving, *acreage-weighted* averages for production, risk, marginal return, and in some cases recommended N rate**
  - **As moving averages**
  - **Against N applied**
- **Plotted acreage distribution across N applied for 20 classes**

A lot to absorb, but also illustrated on the next few slides

Note: doing this cleaning sometimes allows us to "see" trends that are masked by poor-quality data". If data quality improves, no need for such

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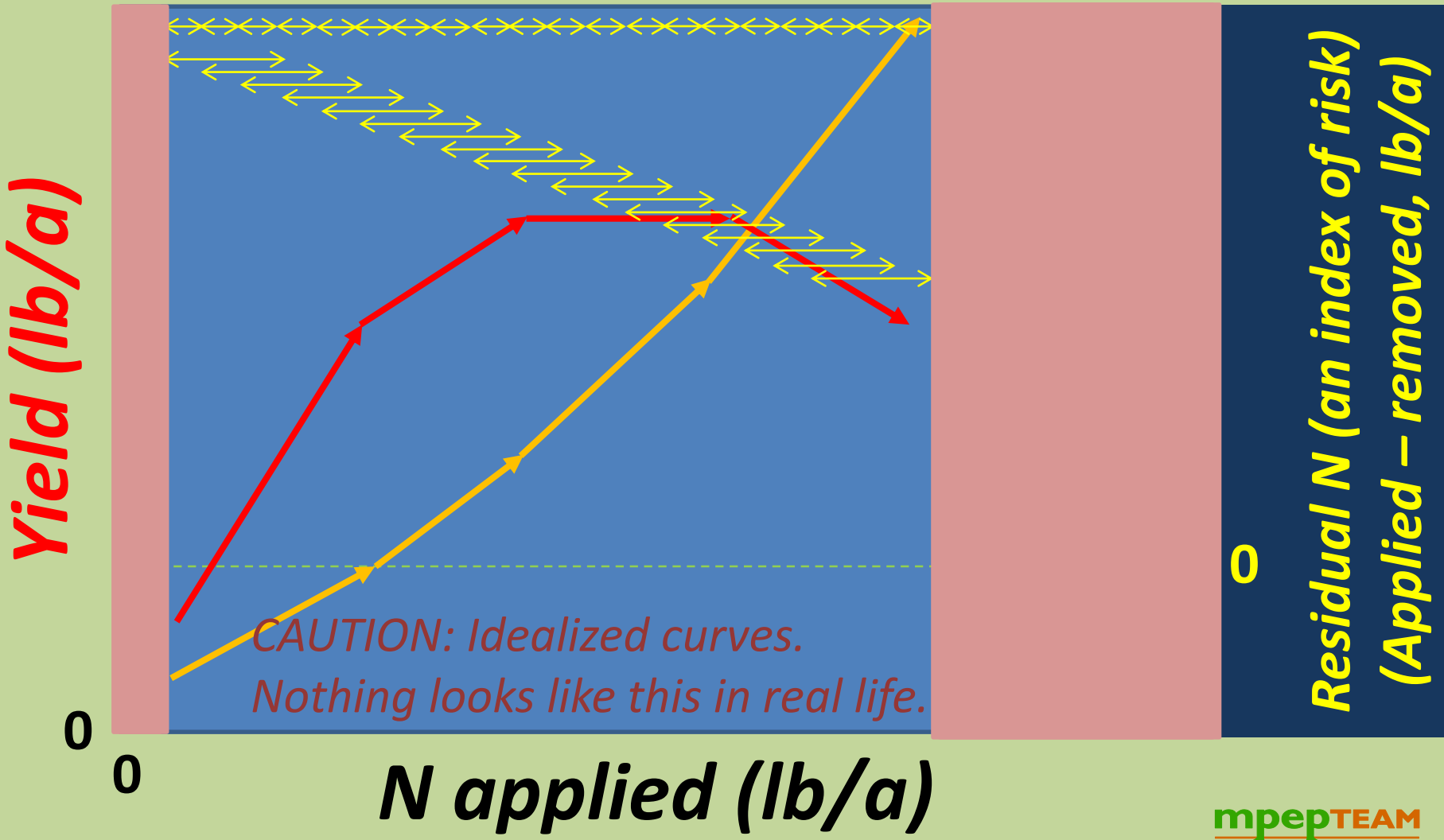
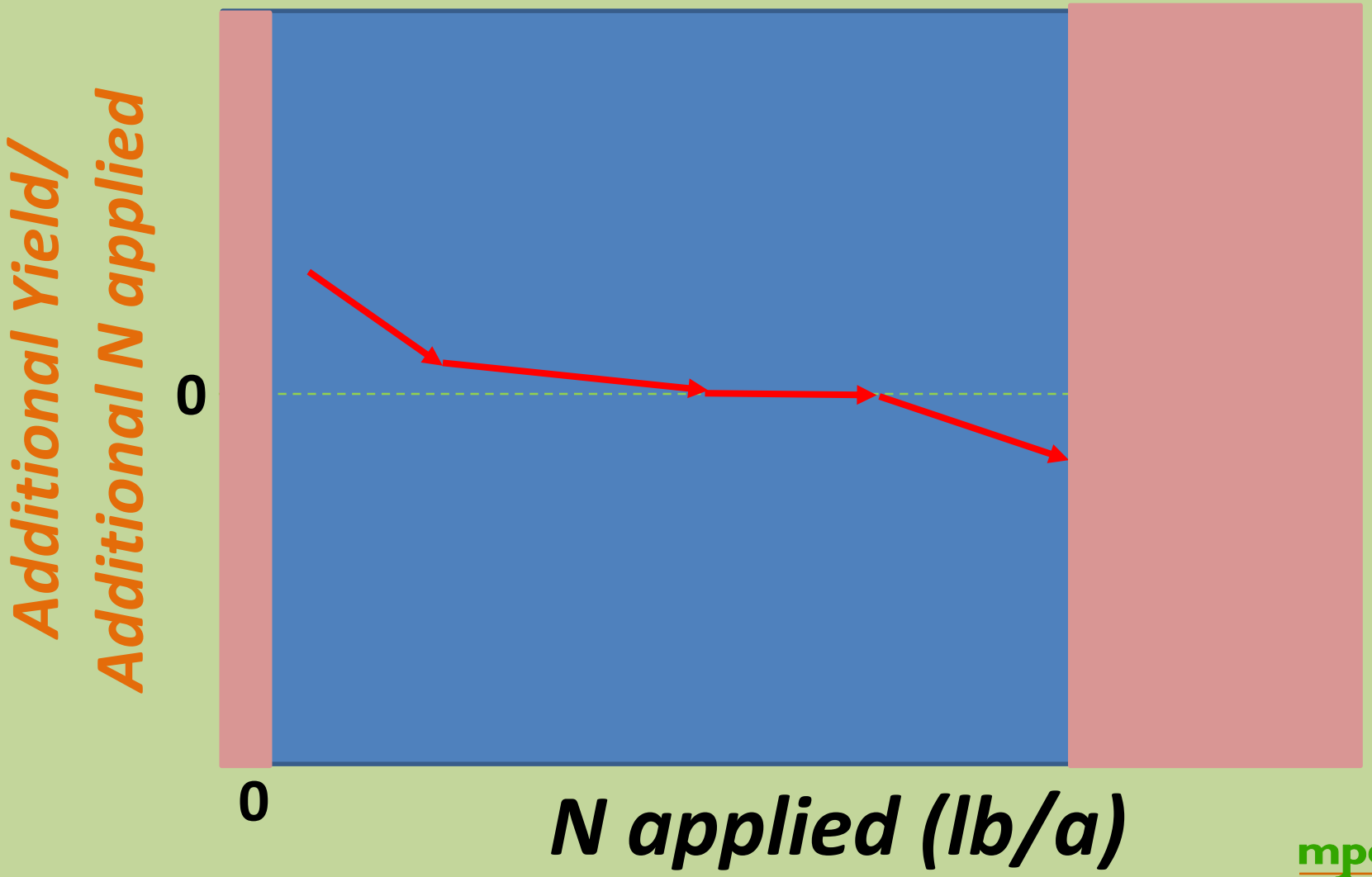
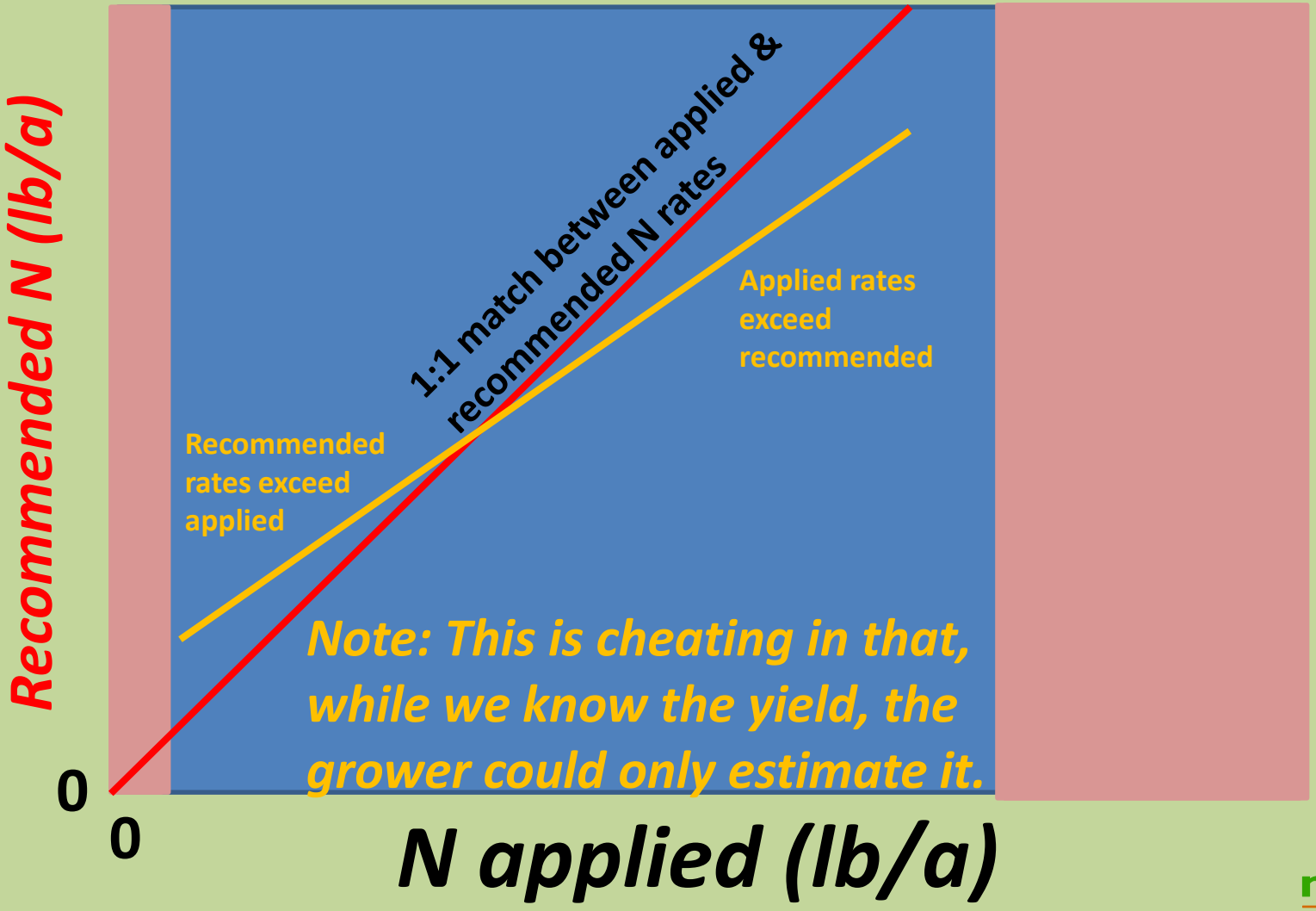
What Yield, at What Risk?



Additional Productivity of More N



Recommended N Application for Yield Achieved



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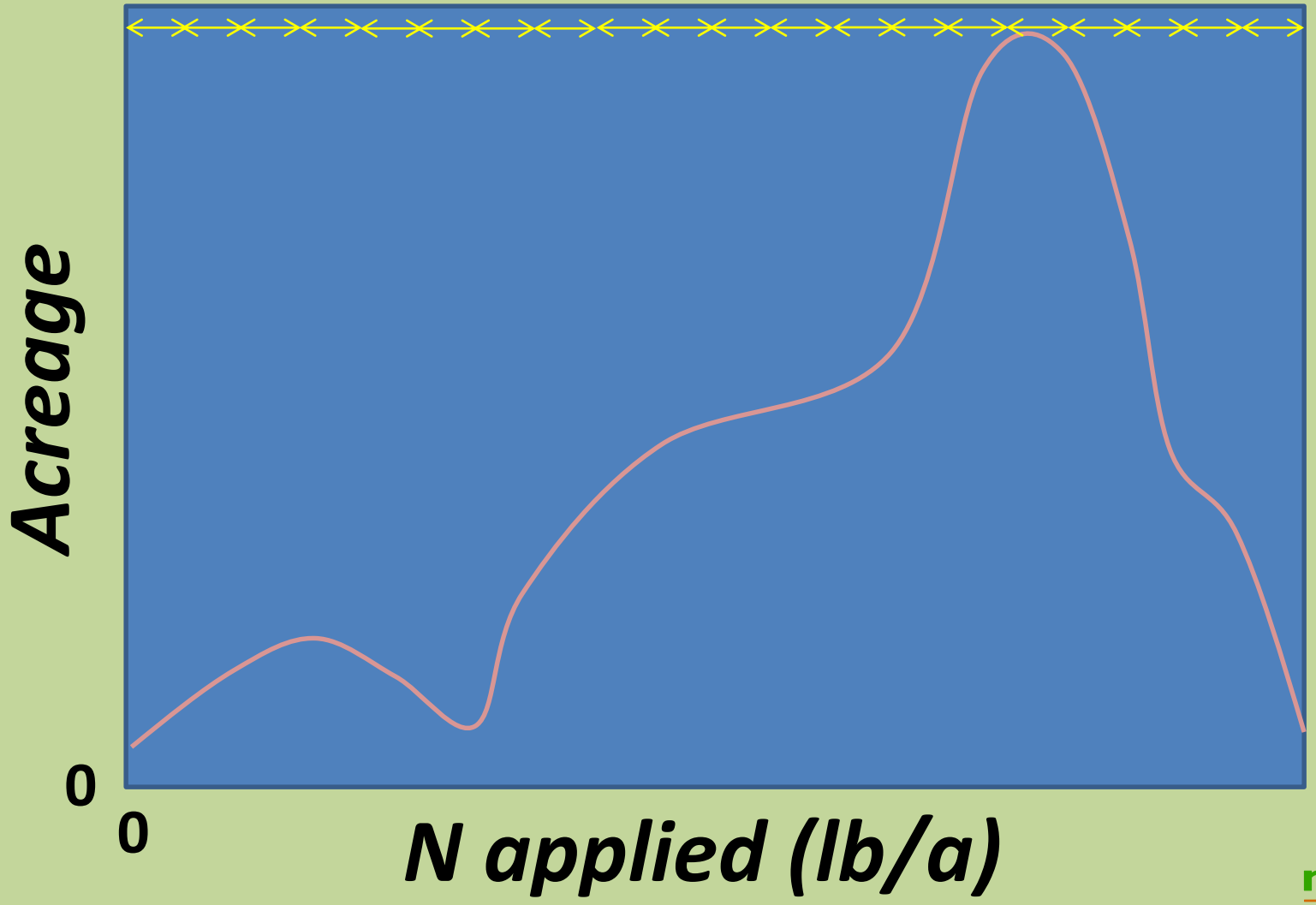
Acreage Distribution – What is common, what is rare?



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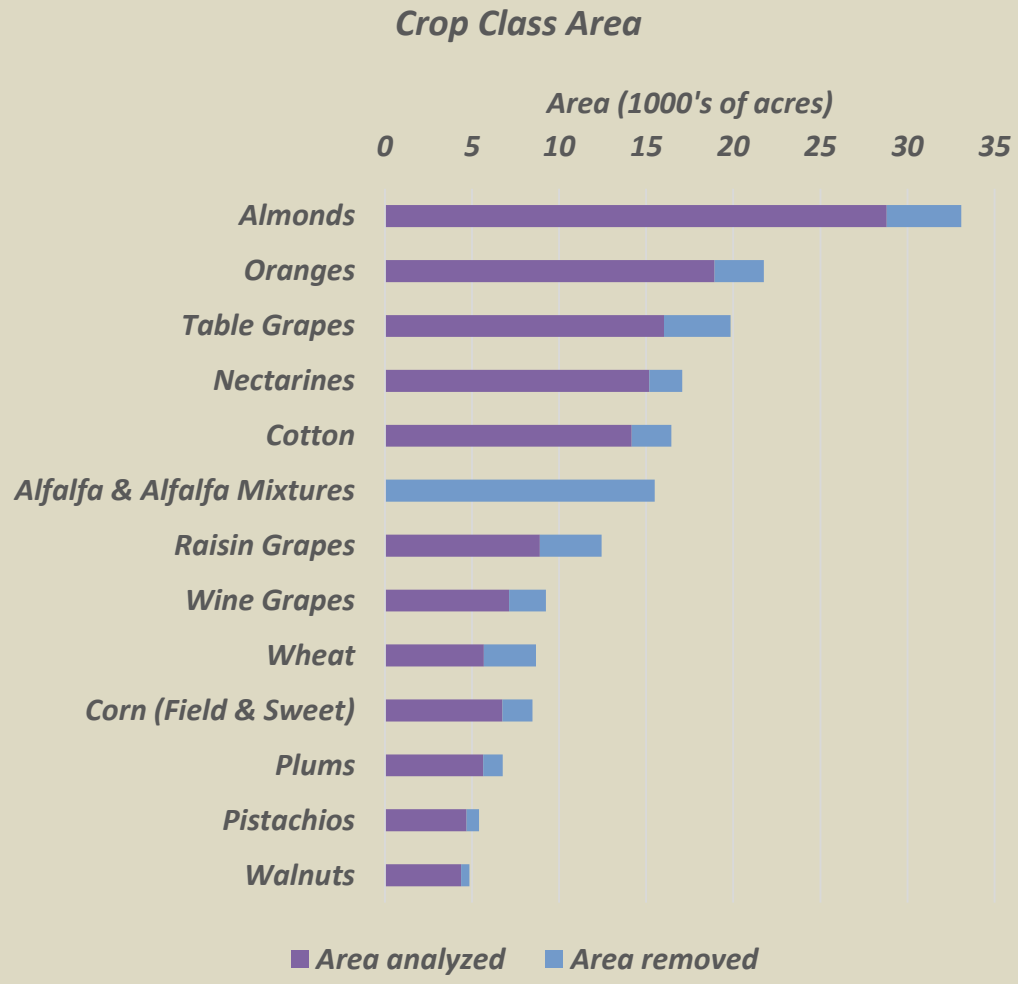
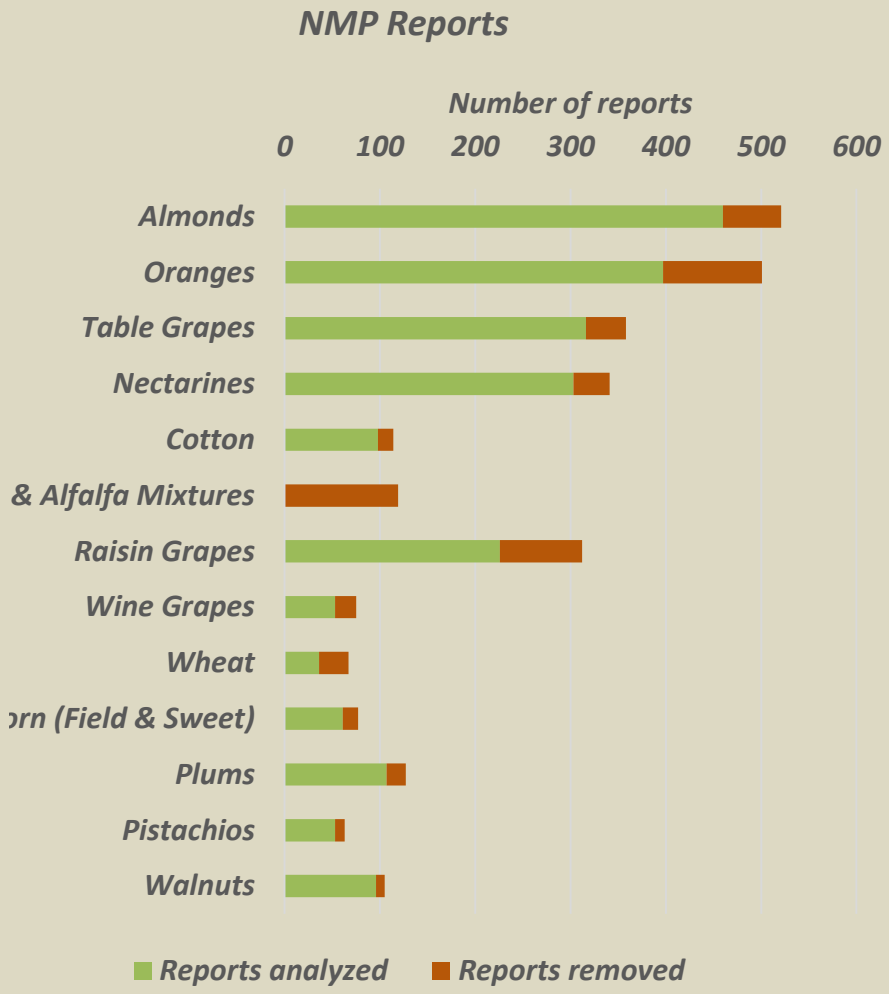
Number and Acreage of Kings NMP Reports





- Total reports = 2,846
- Crops with > 4500 acres analyzed, representing ~180,000 acres
- For crops with > 300 reports, 20 intervals used
- For crops with <100 reports, 10 intervals used

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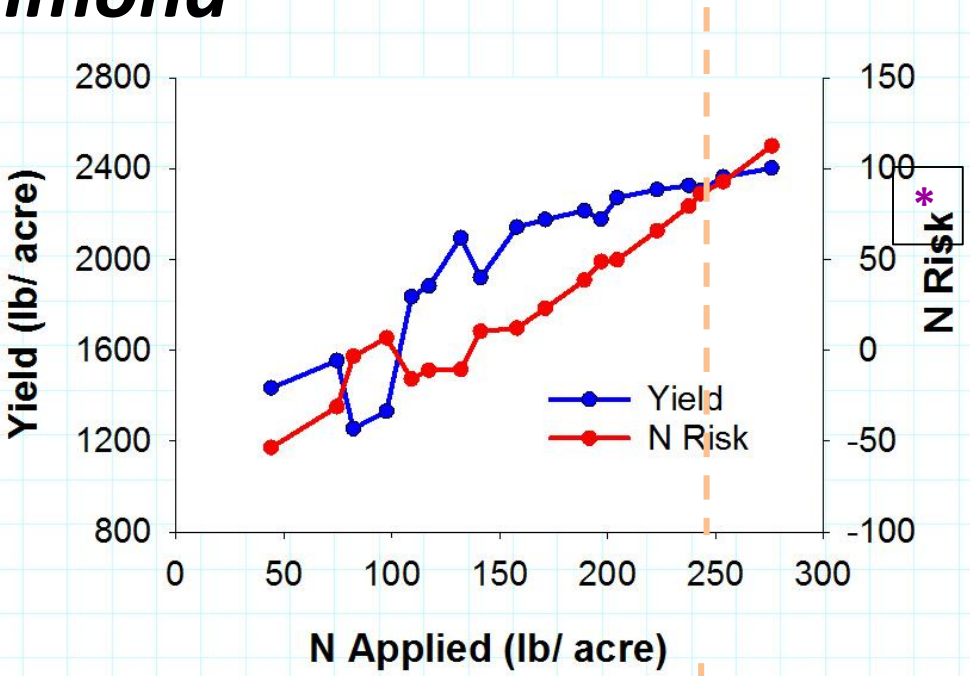
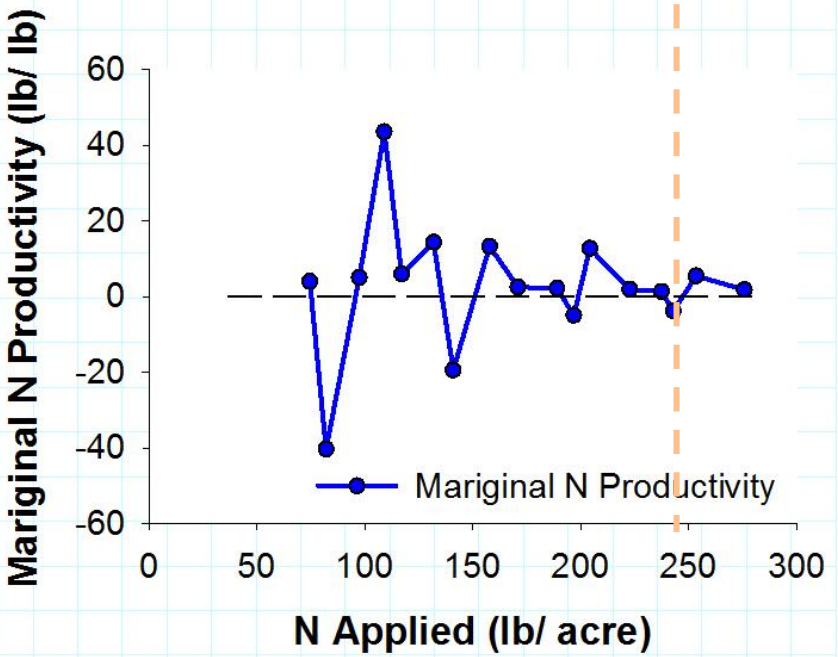
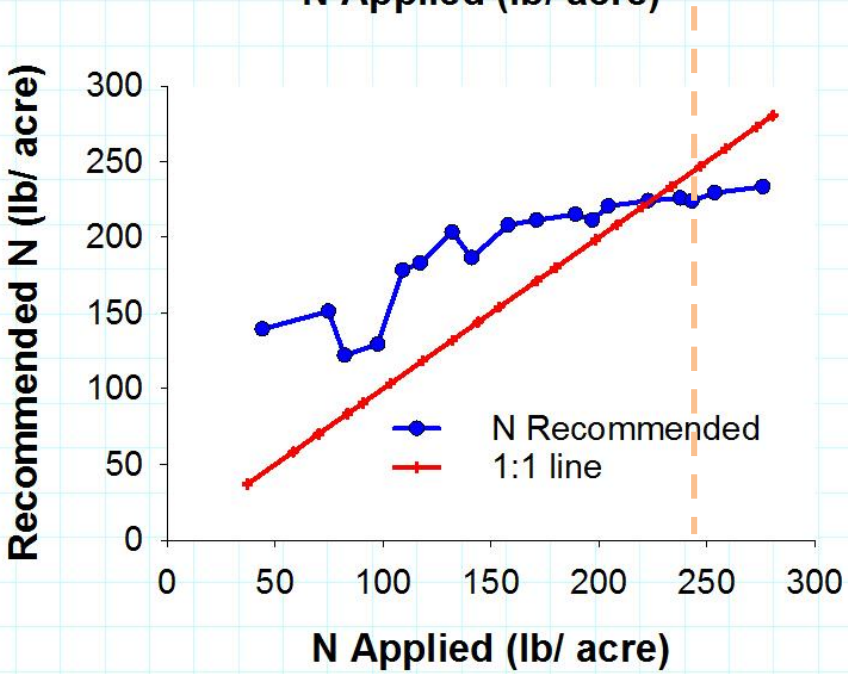
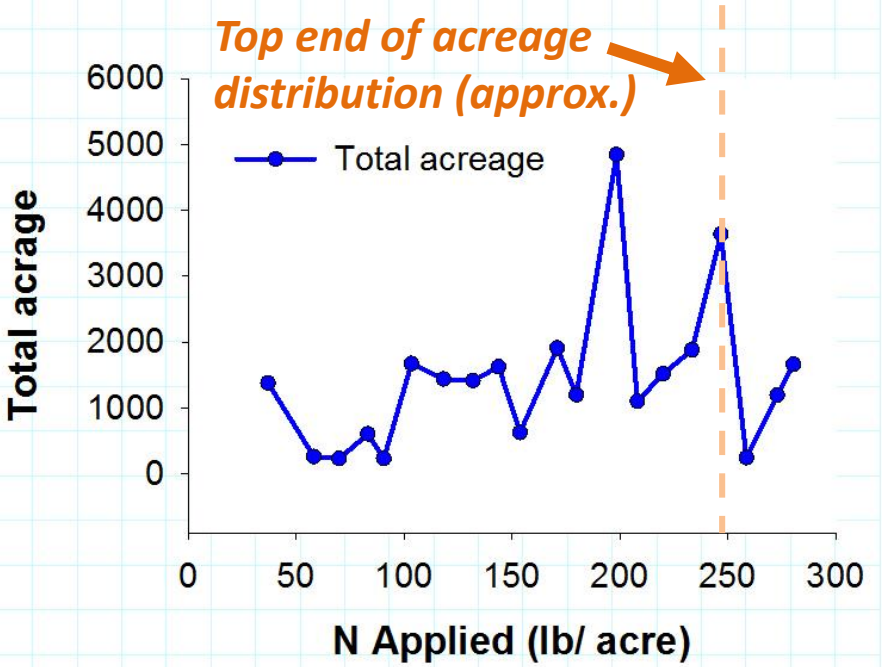
Almond

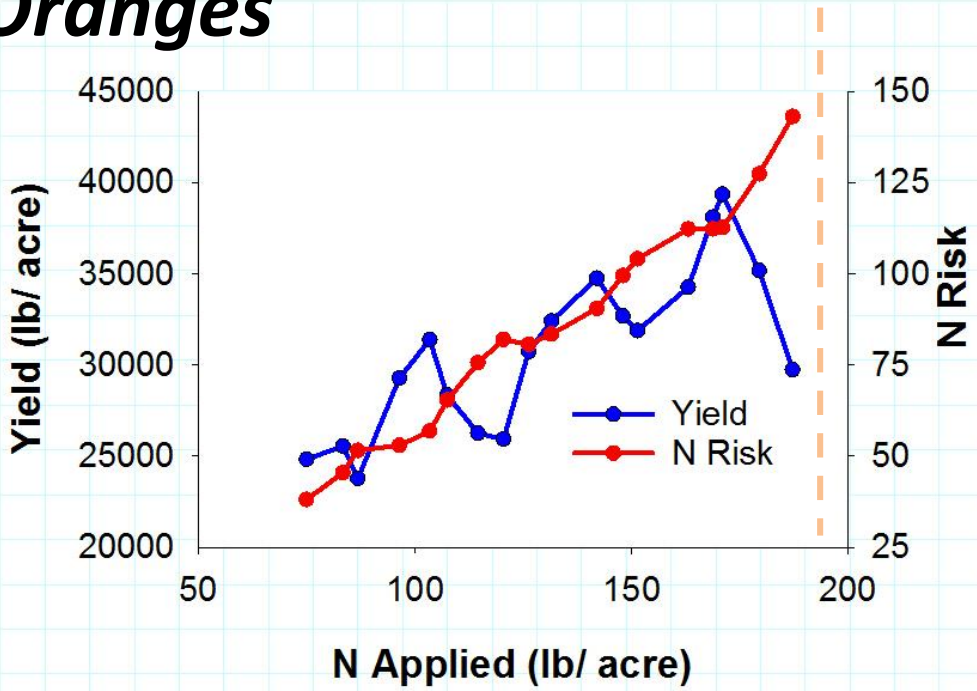

Yield (lb/ acre)
2800
2400
2000
1600
1200
800
150
100
50
0
-50
-100
N Risk
*
Yield
N Risk
0
50
100
150
200
250
300
N Applied (lb/ acre)

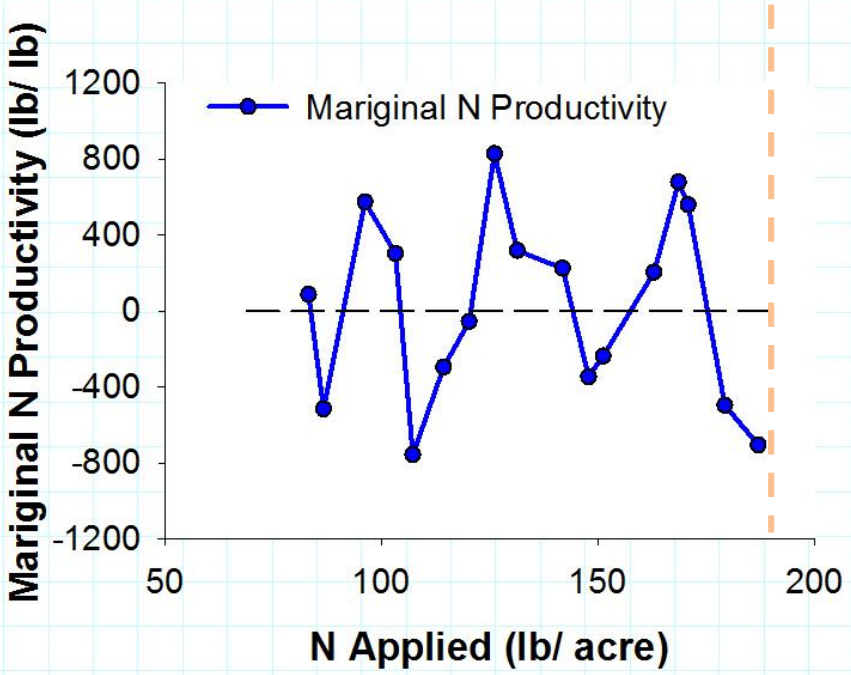

Mariginal N Productivity (lb/ lb)
60
40
20
0
-20
-40
-60
Mariginal N Productivity
0
50
100
150
200
250
300
N Applied (lb/ acre)


Recommended N (lb/ acre)
300
250
200
150
100
50
0
N Recommended
1:1 line
0
50
100
150
200
250
300
N Applied (lb/ acre)


Top end of acreage distribution (approx.)
Total acrage
6000
5000
4000
3000
2000
1000
0
Total acreage
0
50
100
150
200
250
300
N Applied (lb/ acre)

Oranges





What is "N risk"? Needs a footnote in font that can be read by audience.

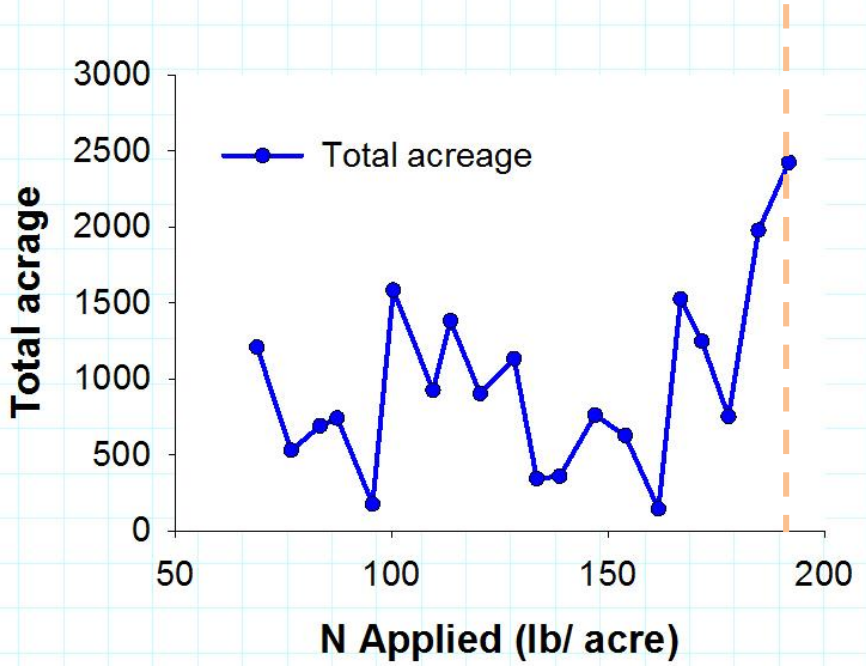
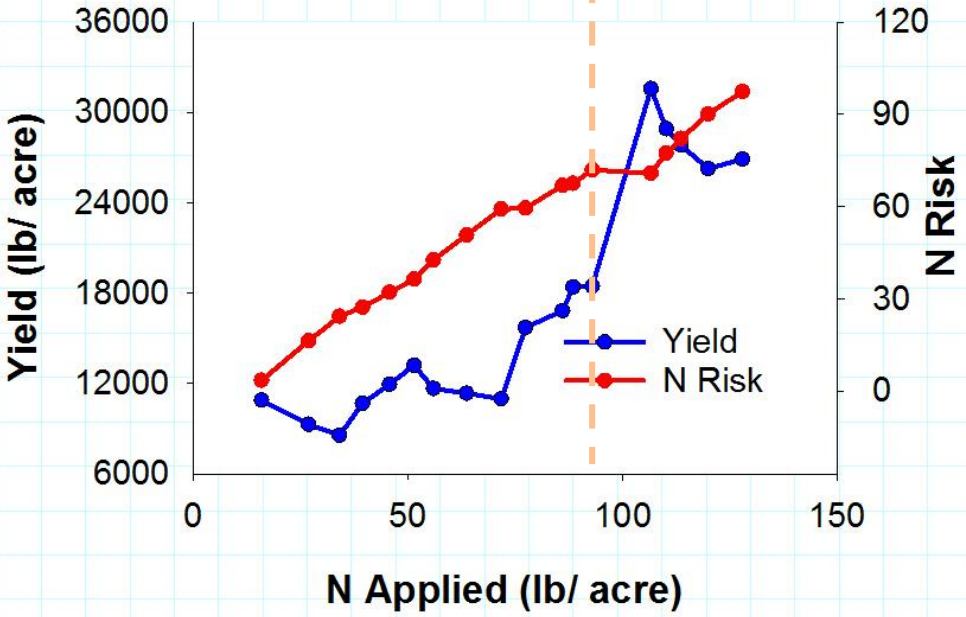
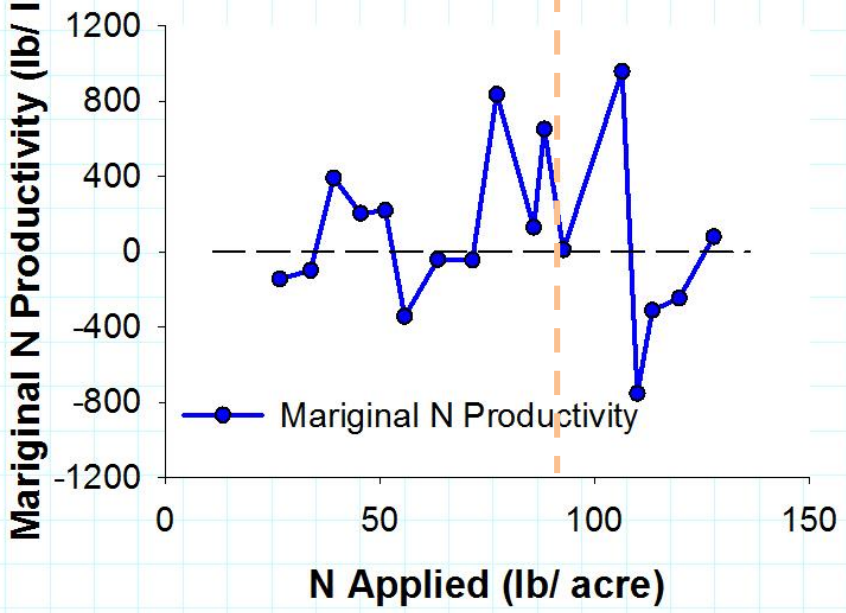
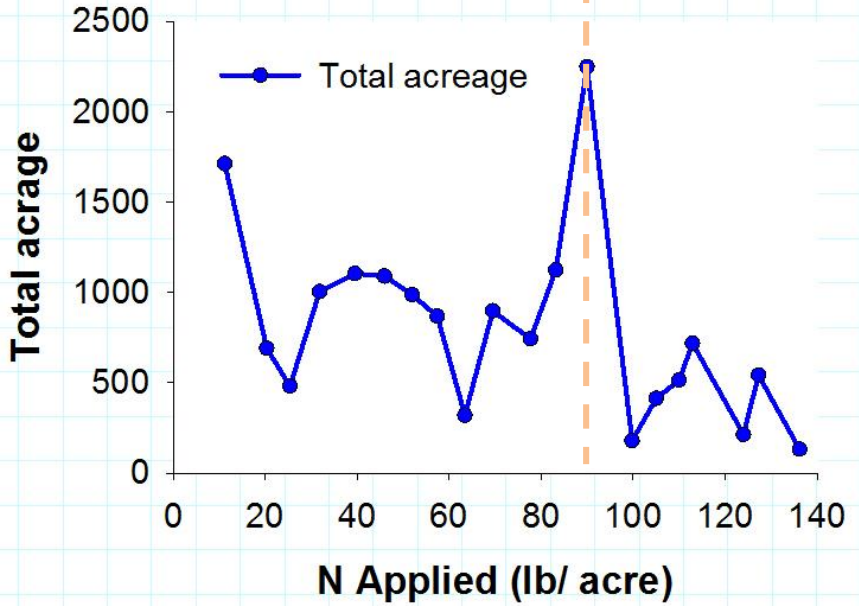


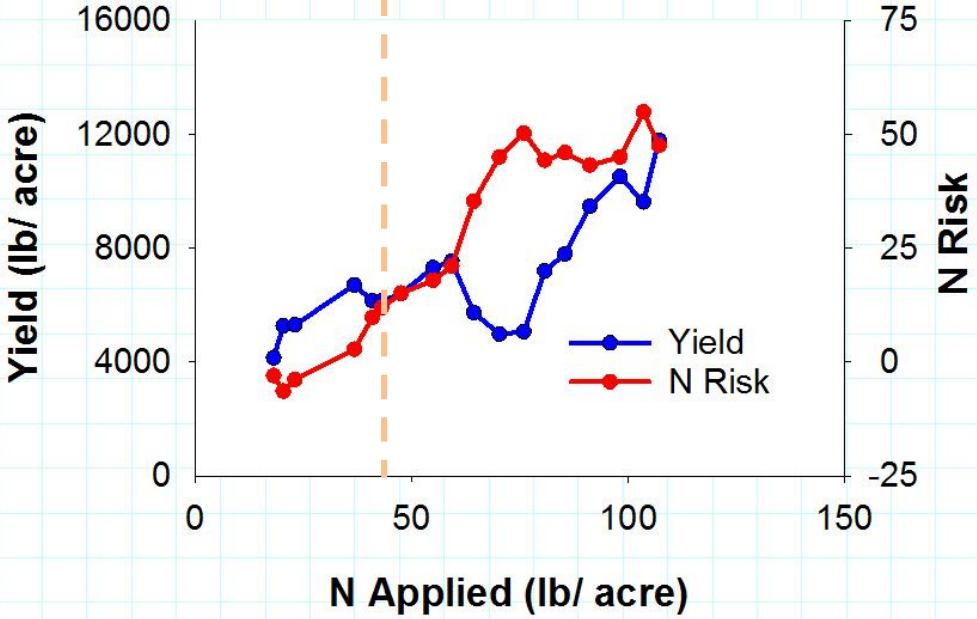
Table Grapes

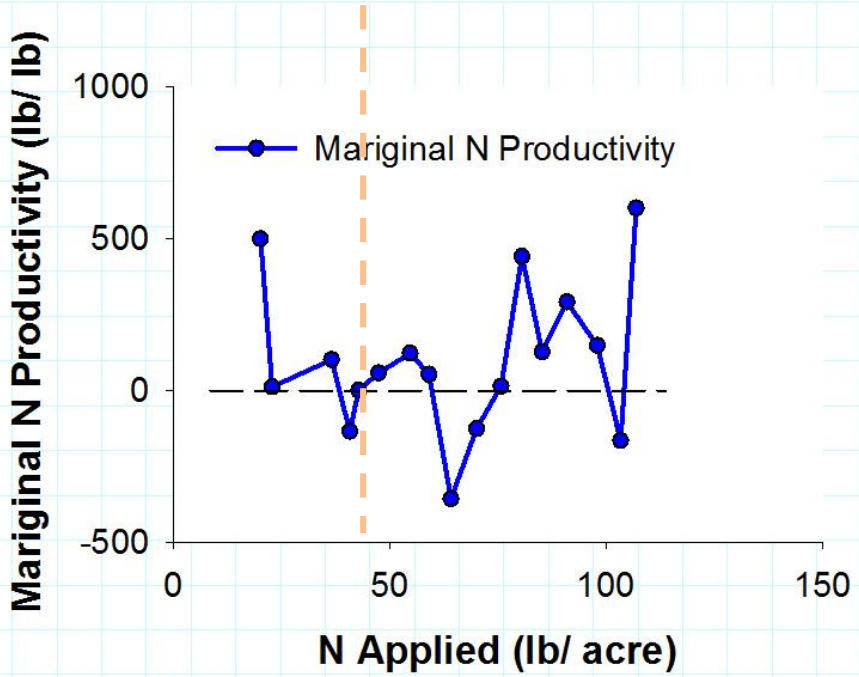


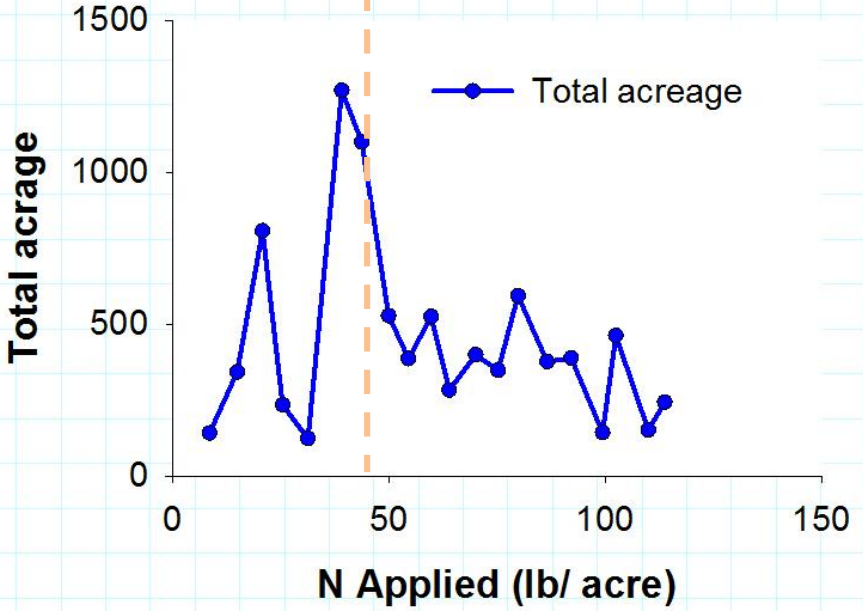




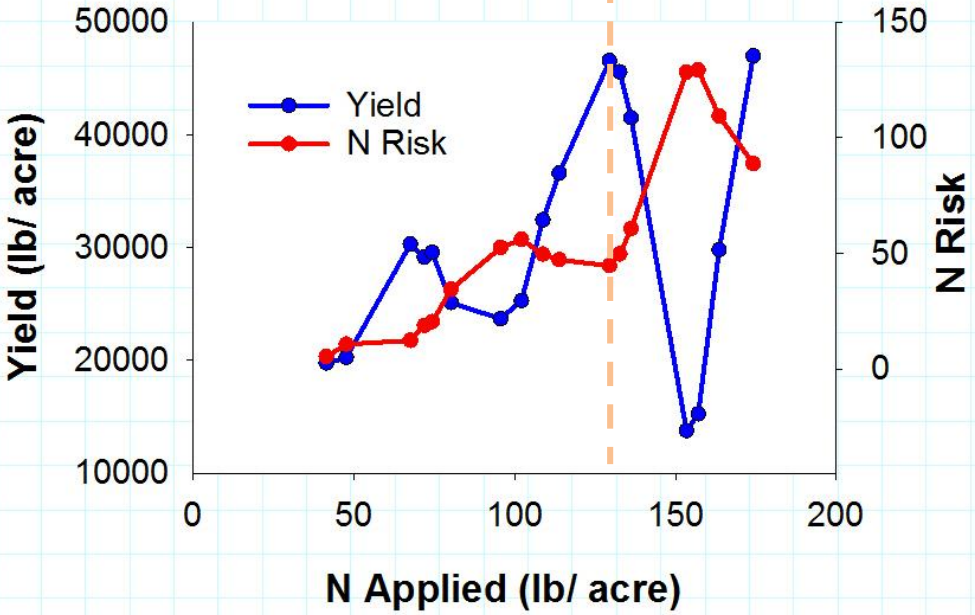
Raisin Grapes

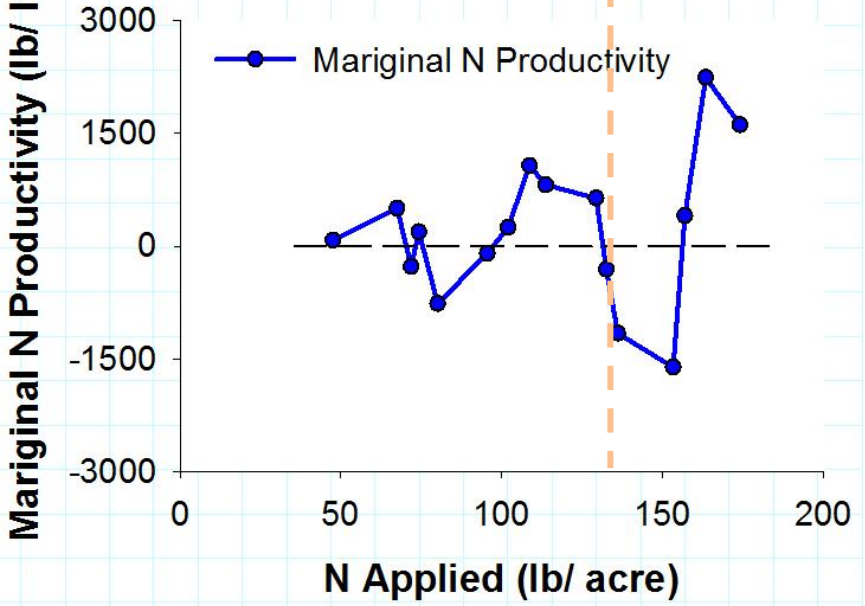


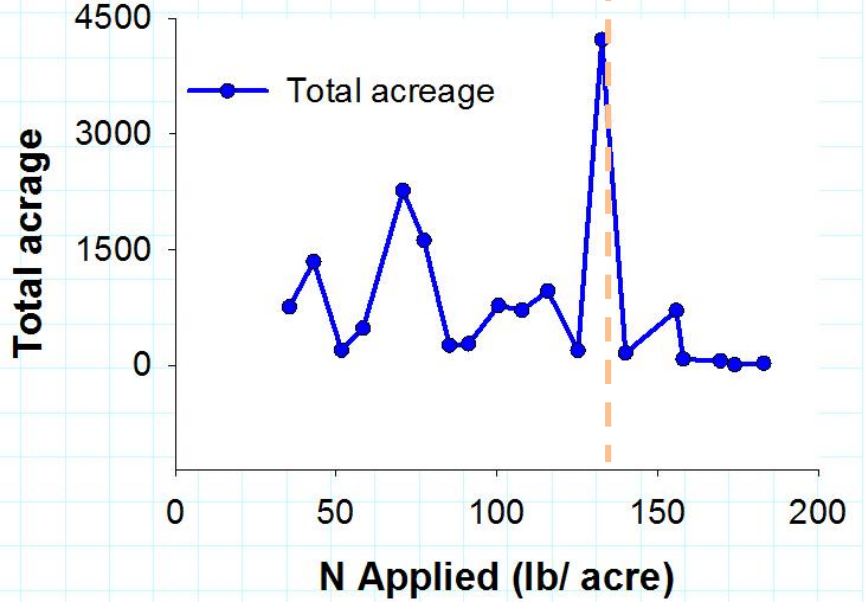




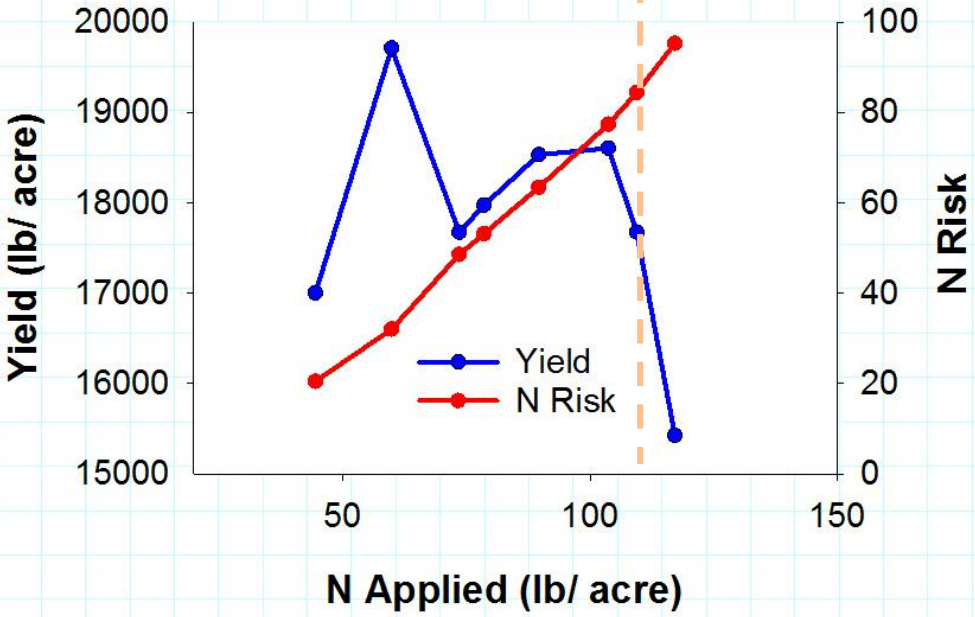
Nectarines

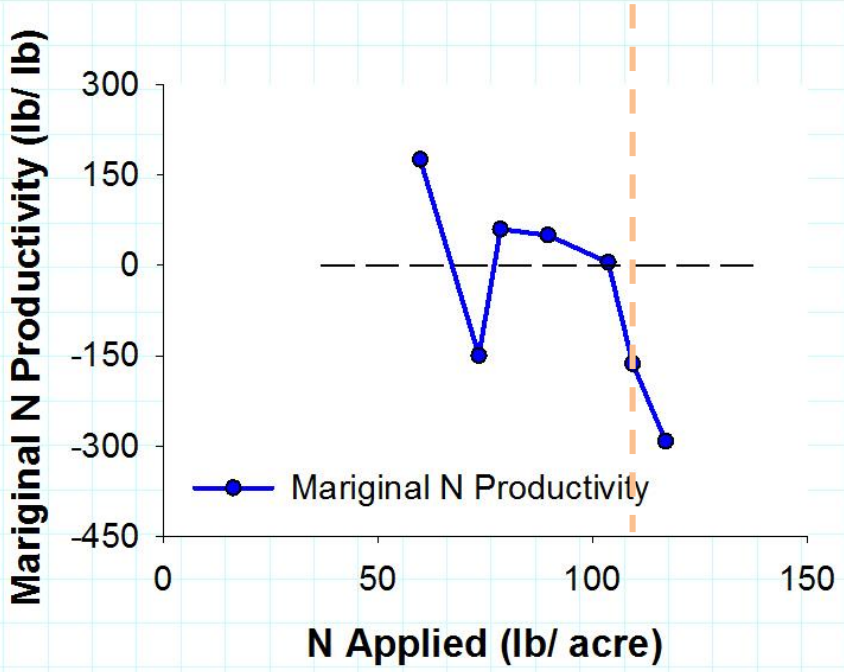

Yield
N Risk
Yield (lb/ acre)
N Risk
N Applied (lb/ acre)
50000
40000
30000
20000
10000
150
100
50
0
0
50
100
150
200

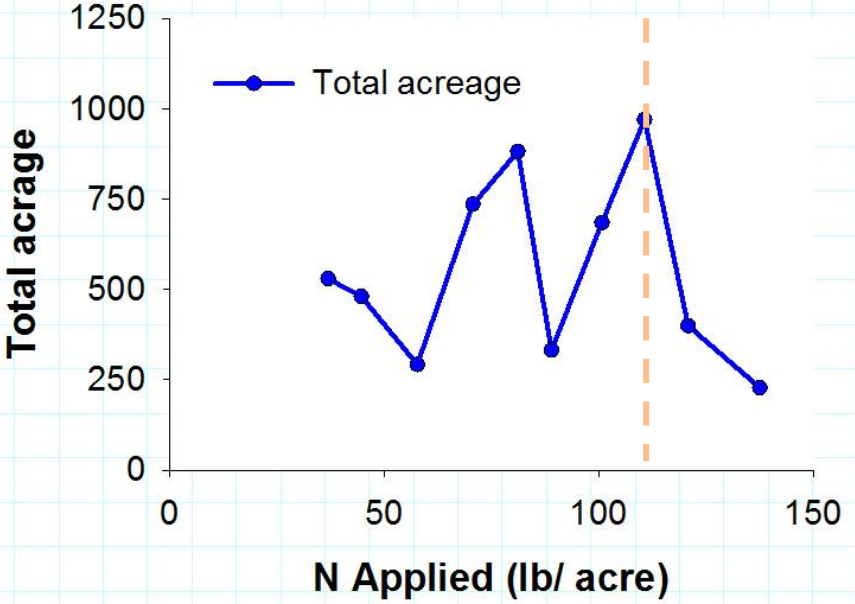

Mariginal N Productivity
Mariginal N Productivity (lb/ lb)
N Applied (lb/ acre)
3000
1500
0
-1500
-3000
0
50
100
150
200


Total acreage
Total acrage
N Applied (lb/ acre)
4500
3000
1500
0
0
50
100
150
200

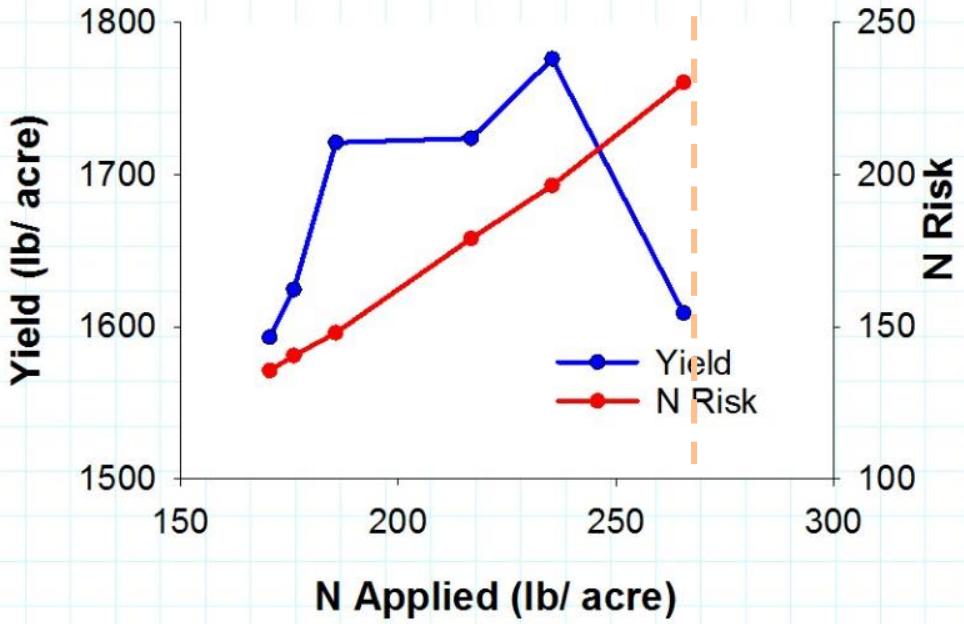
Plums

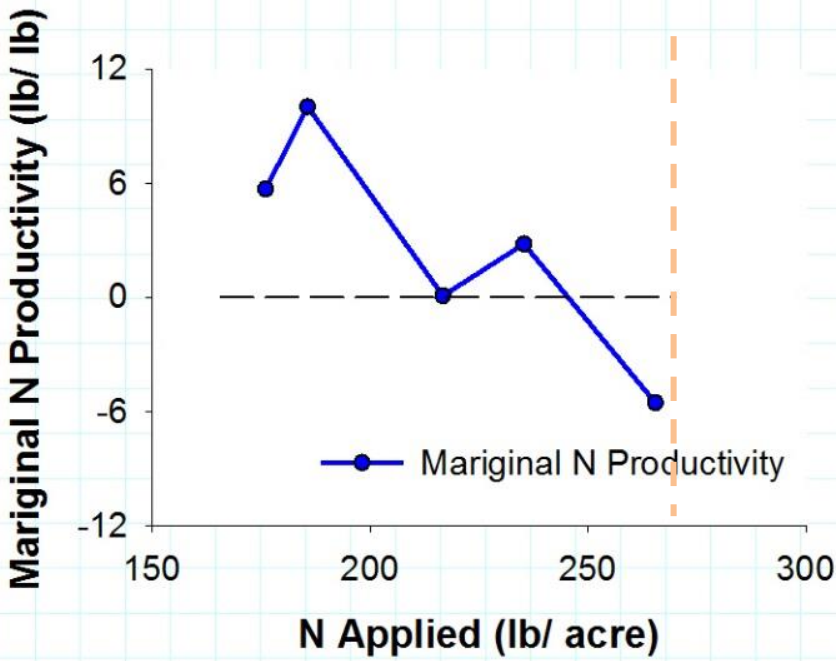

Yield (lb/ acre)
N Risk
20000
19000
18000
17000
16000
15000
100
80
60
40
20
0
50
100
150
Yield
N Risk
N Applied (lb/ acre)

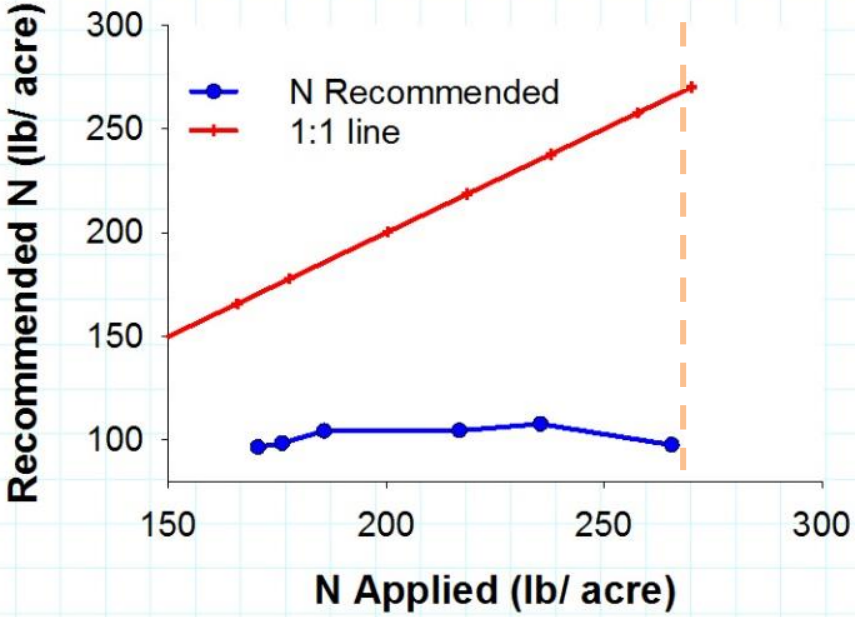

Mariginal N Productivity (lb/ lb)
300
150
0
-150
-300
-450
0
50
100
150
Mariginal N Productivity
N Applied (lb/ acre)

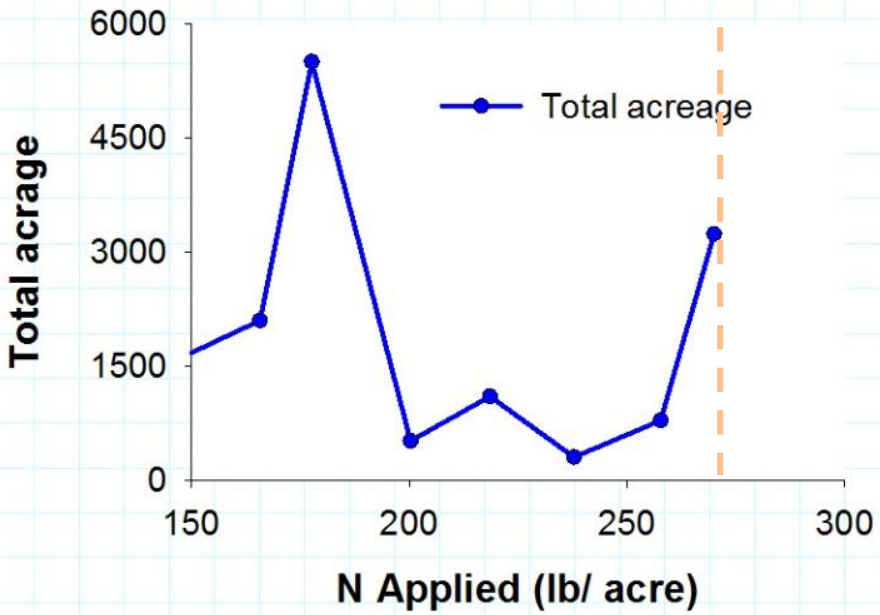

Total acrage
1250
1000
750
500
250
0
0
50
100
150
Total acreage
N Applied (lb/ acre)

Cotton

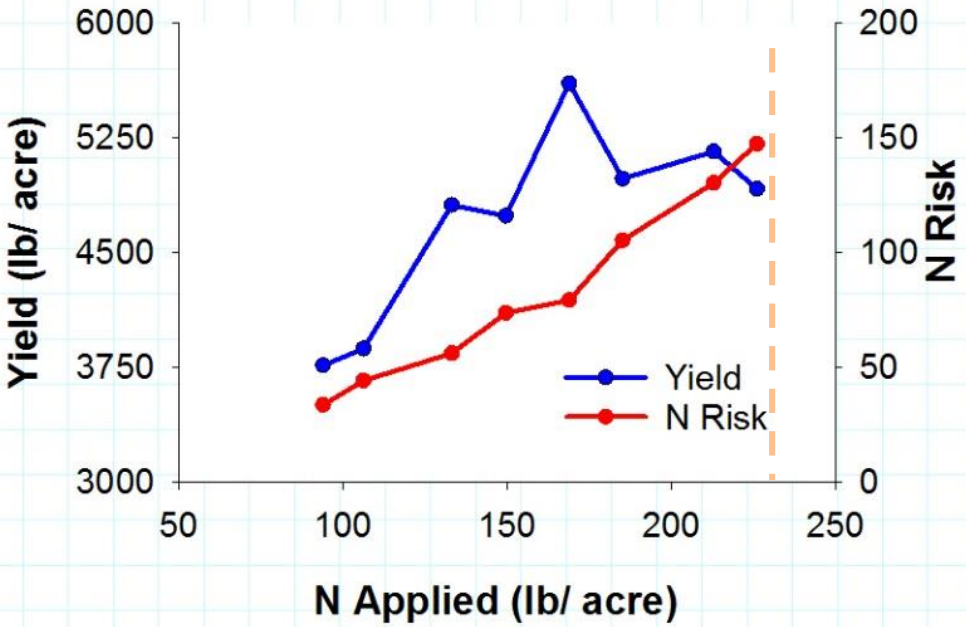

1800
1700
1600
1500
250
200
150
100
150
200
250
300
Yield (lb/ acre)
N Risk
N Applied (lb/ acre)
Yield
N Risk

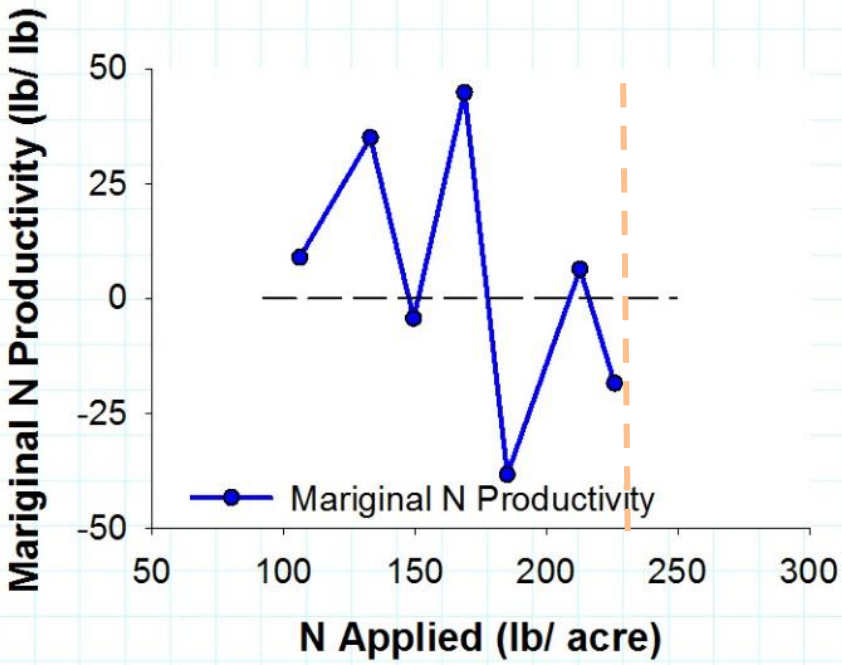

12
6
0
-6
-12
150
200
250
300
Mariginal N Productivity (lb/ lb)
N Applied (lb/ acre)
Mariginal N Productivity

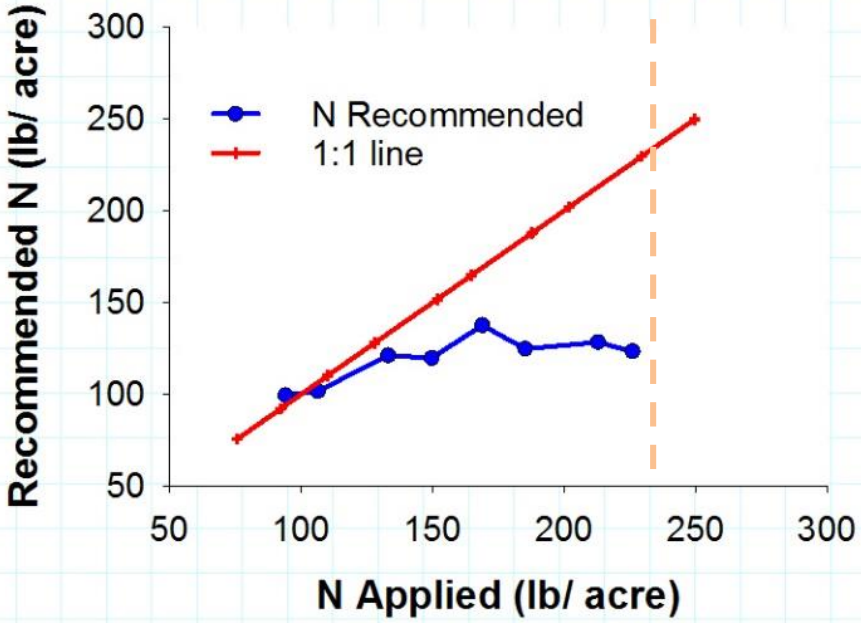

300
250
200
150
100
150
200
250
300
Recommended N (lb/ acre)
N Applied (lb/ acre)
N Recommended
1:1 line

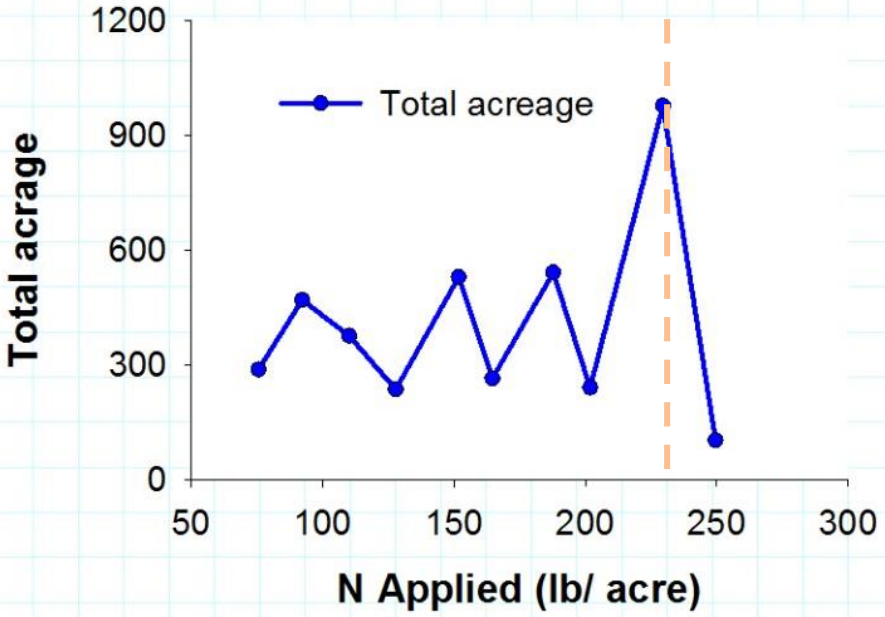

6000
4500
3000
1500
0
150
200
250
300
Total acrage
N Applied (lb/ acre)
Total acreage

Walnuts

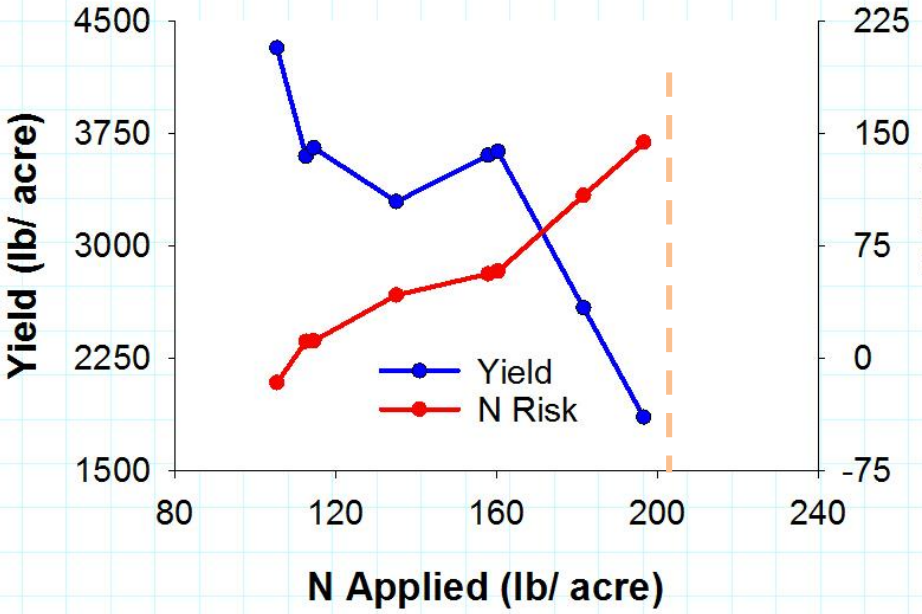

Yield (lb/ acre)
N Risk
N Applied (lb/ acre)
Yield
N Risk
6000
5250
4500
3750
3000
200
150
100
50
0
50
100
150
200
250

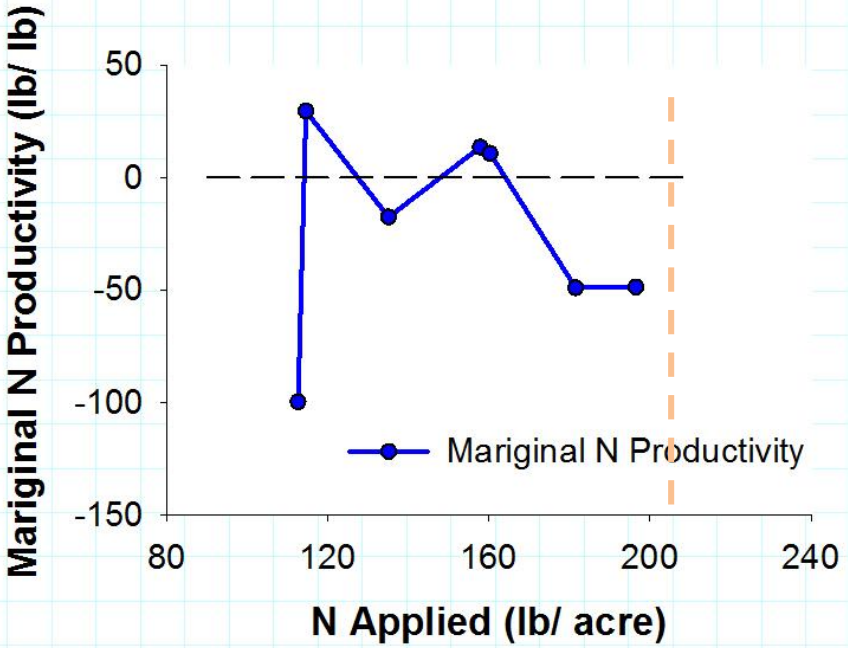

Mariginal N Productivity (lb/ lb)
N Applied (lb/ acre)
Mariginal N Productivity
50
25
0
-25
-50
50
100
150
200
250
300

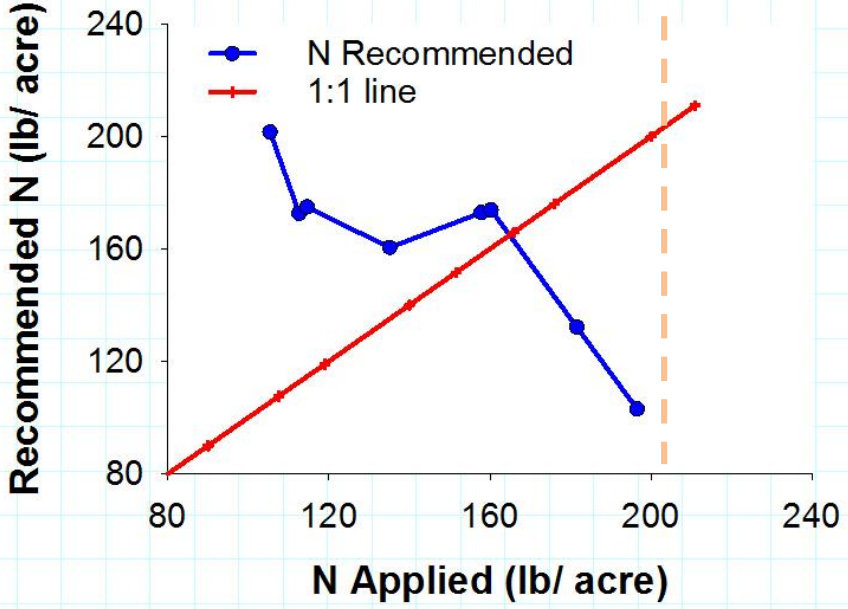

Recommended N (lb/ acre)
N Applied (lb/ acre)
N Recommended
1:1 line
300
250
200
150
100
50
50
100
150
200
250
300

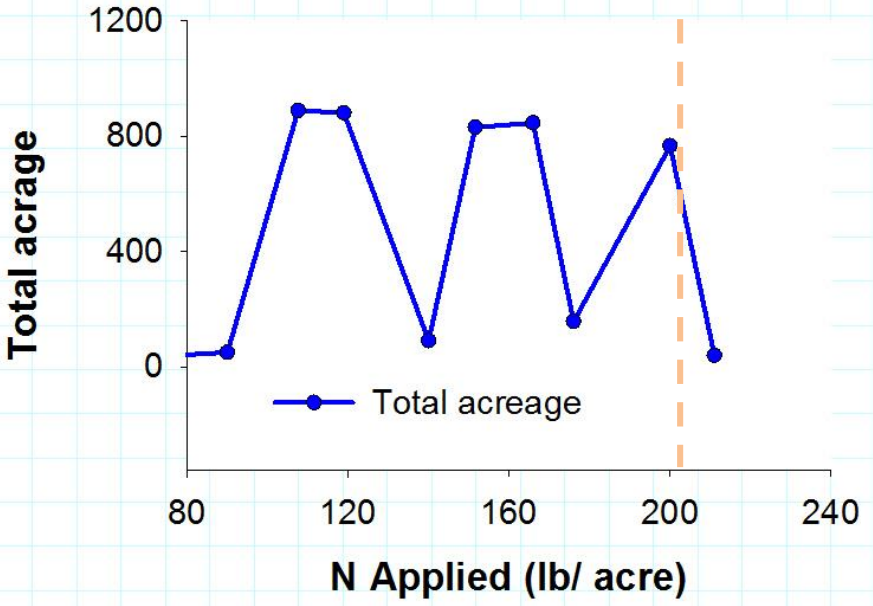

Total acrage
N Applied (lb/ acre)
Total acreage
1200
900
600
300
0
50
100
150
200
250
300

Pistachio

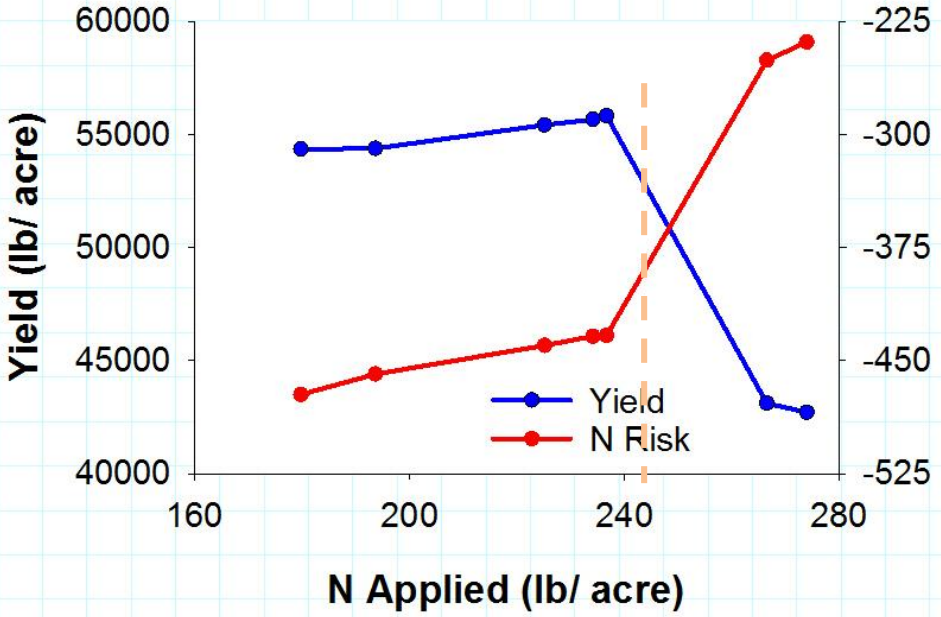

Yield (lb/ acre)
N Risk
4500
3750
3000
2250
1500
225
150
75
0
-75
Yield
N Risk
80
120
160
200
240
N Applied (lb/ acre)

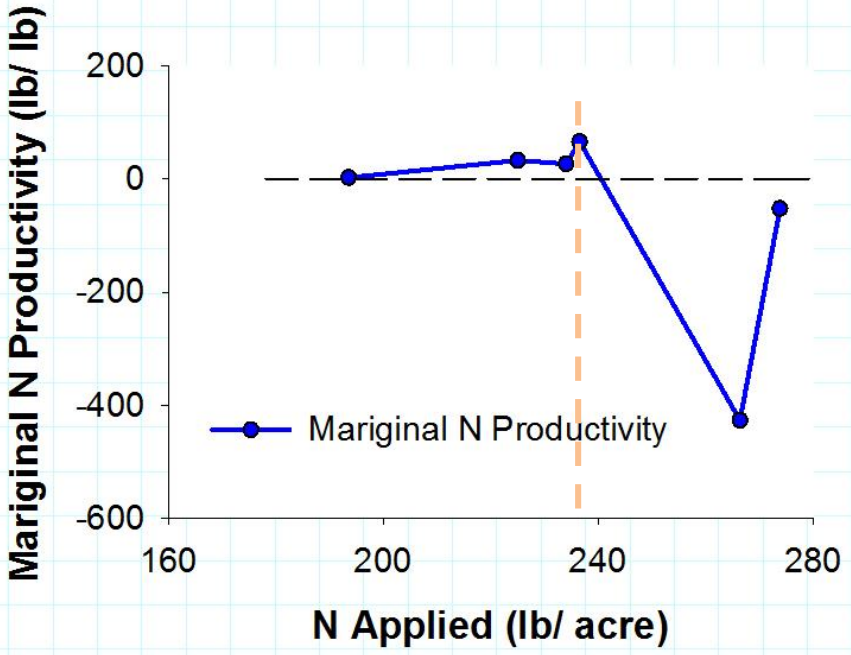

Mariginal N Productivity (lb/ lb)
50
0
-50
-100
-150
Mariginal N Productivity
80
120
160
200
240
N Applied (lb/ acre)

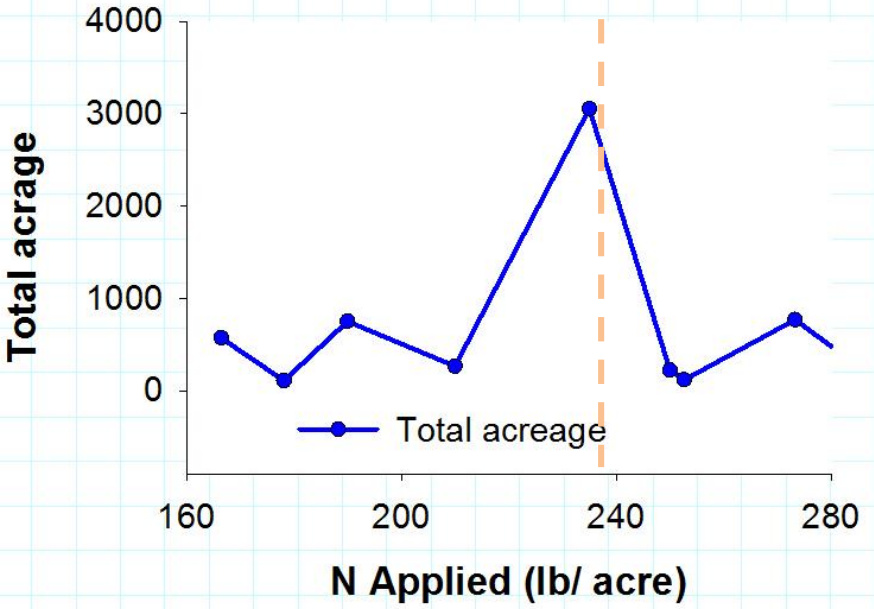

Recommended N (lb/ acre)
240
200
160
120
80
N Recommended
1:1 line
80
120
160
200
240
N Applied (lb/ acre)


Total acrage
1200
800
400
0
Total acreage
80
120
160
200
240
N Applied (lb/ acre)

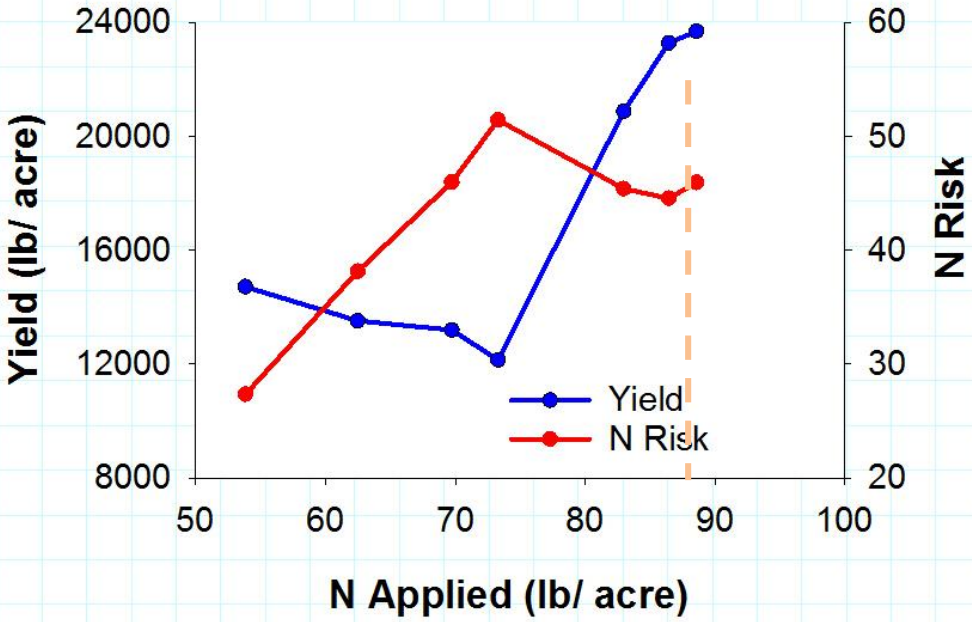
Corn (silage)

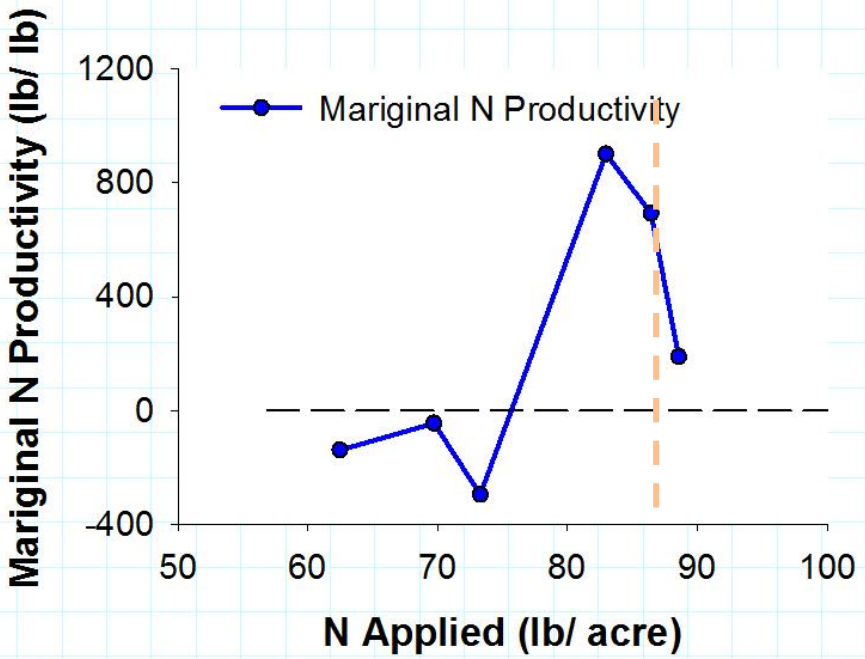

60000
55000
50000
45000
40000
-225
-300
-375
-450
-525
160
200
240
280
Yield (lb/ acre)
N Risk
N Applied (lb/ acre)
Yield
N Risk

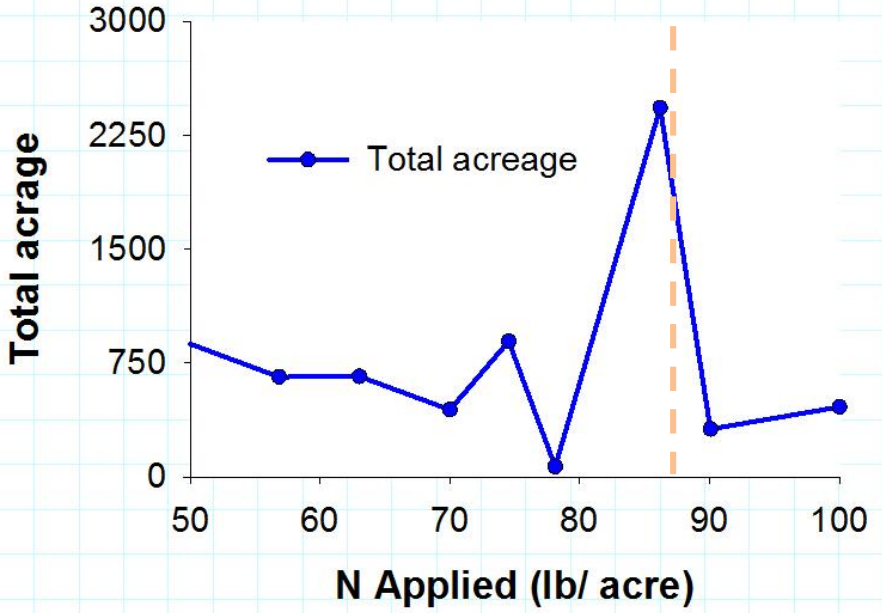

200
0
-200
-400
-600
160
200
240
280
Mariginal N Productivity (lb/ lb)
N Applied (lb/ acre)
Mariginal N Productivity


4000
3000
2000
1000
0
160
200
240
280
Total acrage
N Applied (lb/ acre)
Total acreage

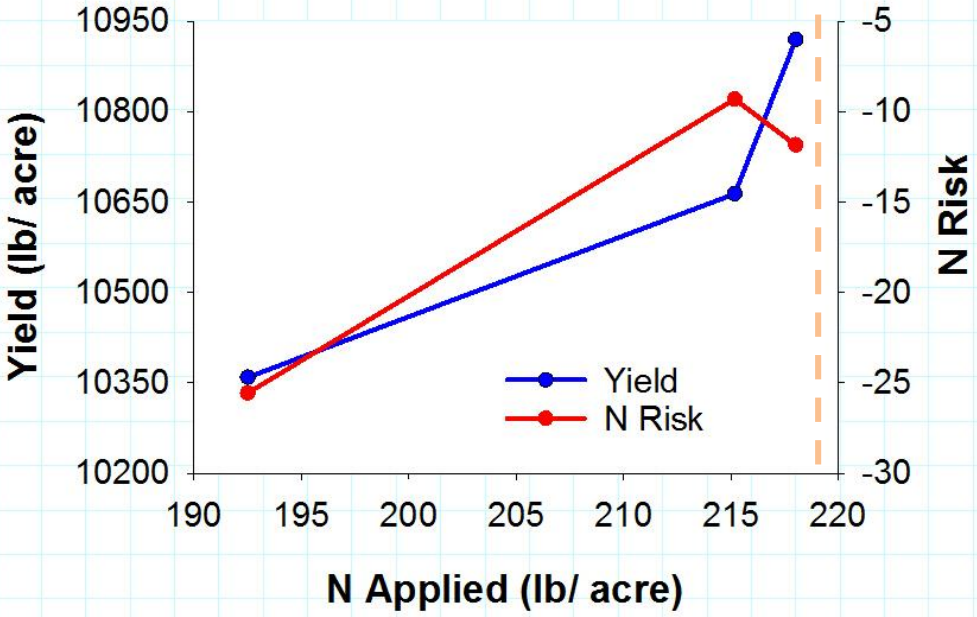
Wine Grapes

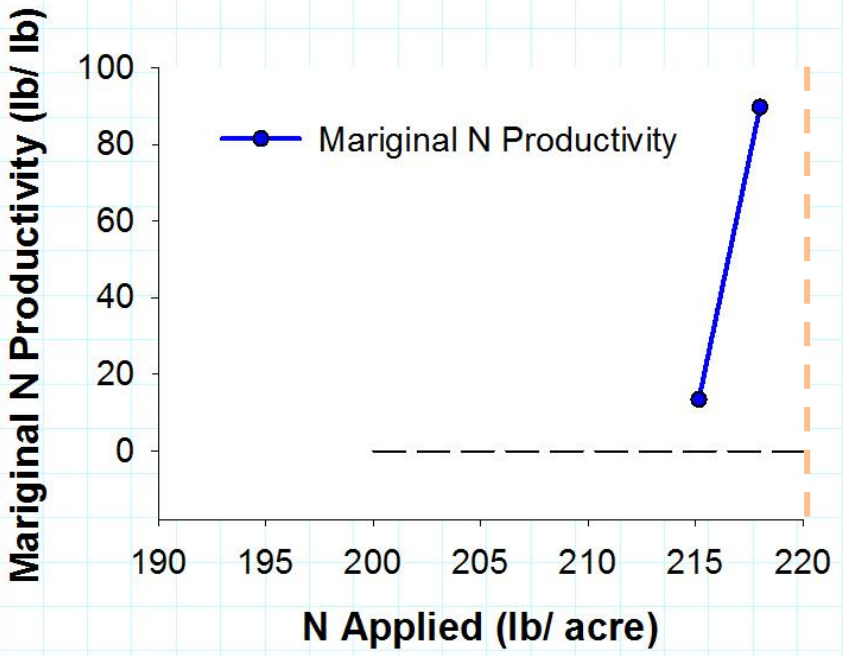

24000
20000
16000
12000
8000
60
50
40
30
20
50
60
70
80
90
100
Yield (lb/ acre)
N Risk
N Applied (lb/ acre)
Yield
N Risk

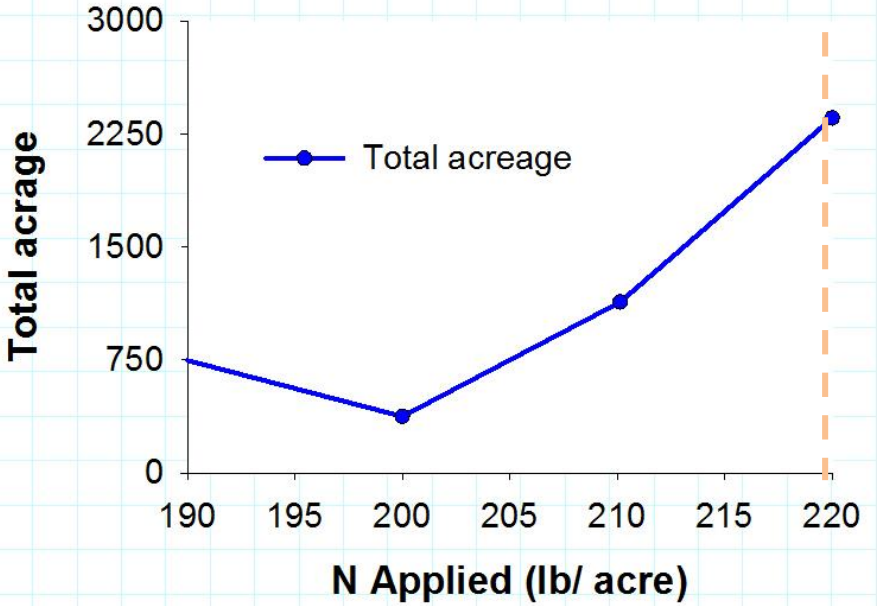

1200
800
400
0
-400
50
60
70
80
90
100
Mariginal N Productivity (lb/ lb)
N Applied (lb/ acre)
Mariginal N Productivity


3000
2250
1500
750
0
50
60
70
80
90
100
Total acrage
N Applied (lb/ acre)
Total acreage

Wheat (silage)







Take-home Messages

- **Rates of N applied in the high range can be:**
  - **Inefficient, since little yield is gained**
  - **Risky, since the amount of N left in the soil increases rapidly**
- **The proportion of acreage in this high range varies among crops**
  - **Almonds, oranges, plums, cotton, walnuts, and pistachio have relatively more**
  - **Nectarines and all grapes have relatively less**
  - **Corn and wheat are intermediate**

Take-home Messages

- **Many factors contribute to NMP data variability (see previous slides)**
- **Despite uncertainty, *Obtain and use the most accurate possible yield expectation, and use it to inform the amount of N applied.***
- **This is still *year 1* of the NMP!**
  - **Multiple years will add breadth & clarity**
  - **Data quality improving**
  - **Nutrient management knowledge & practices are evolving**

mpepTEAM

Acknowledgements: Member Coalitions, Team, Funding Partners

- **South San Joaquin Valley Coalitions**
  - **Kings River Watershed Coalition Authority (http://kingsriverwqc.org/)**
  - **Tule Basin Water Quality Coalition (http://tbwqc.com/)**
  - **Kaweah Basin Water Quality Association (http://www.kaweahbasin.org/)**
  - **Kern River Watershed Coalition Authority (http://www.krwca.org/)**
  - **Cawelo Water District Coalition (http://www.cawelowd.org/ILRP.html)**
  - **Westside Water Quality Coalition (http://www.wwqc.org/)**
  - **Buena Vista Coalition**
- George Paul, Andrea Schmid, Ryan Byrnes, Clint Kellar, Mary Reed, Seanain Snow, Mary Hall

USDA United States Department of Agriculture
Natural Resources Conservation Service

cdfa CALIFORNIA DEPARTMENT OF FOOD & AGRICULTURE
Karen Ross, Secretary

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Acknowledgements: Friends & Supporters

Questions, comments?

MPEP Website: Agmpep.com

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A Recognized Limitation in N Management: Uncertainty About Crop Yield

Example:

- **Pointless to apply enough N for 3 tons in a field that only has 2-ton potential due to other factors**
- **But if a field has 3-ton potential, it may make sense to give it enough N to make that yield**
- **If growers commonly achieve 3 tons with x lb/a N, then applying way more than x may increase the chances that applied N will be wasted and lost**

Obtain and use the most accurate possible yield expectation, and use it to inform the amount of N applied.

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