University of California

Nitrogen Management Training

for Certified Crop Advisers

Nitrogen Management in Corn

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Tulare, CA
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University of California
Agriculture and Natural Resources

HEALTHY FOOD SYSTEMS • HEALTHY ENVIRONMENTS • HEALTHY COMMUNITIES • HEALTHY CALIFORNIANS

This training covers grain and silage corn production on fields that are not part of a dairy operation. Dairy farming systems, which rely more heavily on manure N sources than non-dairy systems, must meet a more stringent N target.

To start off, ,a quick review of corn growth and development.

Images presented here are from.....

Corn Growth & Development

L.J. Abendroth, R.W. Elmore, M.J. Boyer & S.K. Marlay

Iowa Stat University Extension PMR 1009

https://store.extension.iastate.edu/ItemDetail.aspx?ProductID=6065

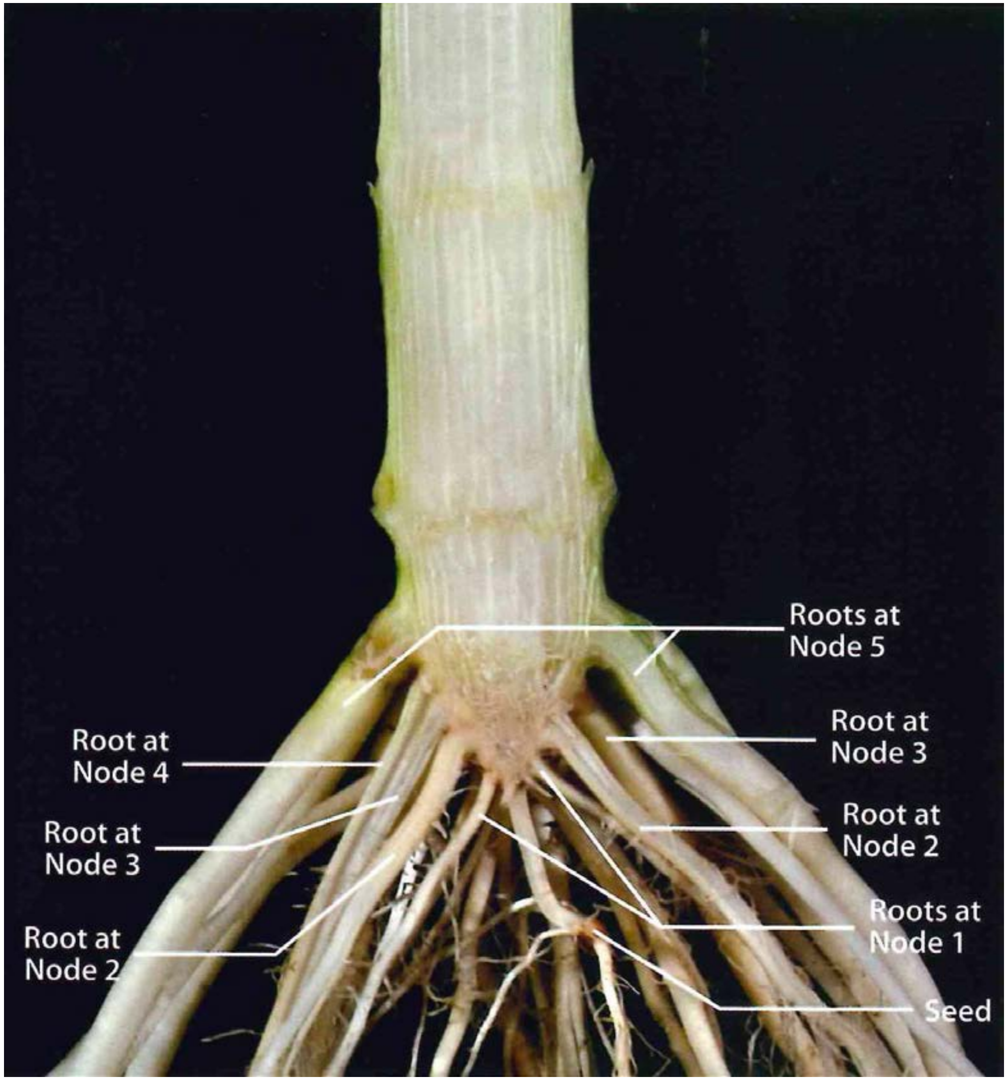
$15 for publication

$5 for Kindle or iPad/iPhone

Growth Stages of Corn

Vegetative Stages
VE emergence
V1 first leaf
V2 second leaf
V3 third leaf
V(n) nth leaf
VT tasseling

A leaf is counted once the blade is expanded and the collar is visible.

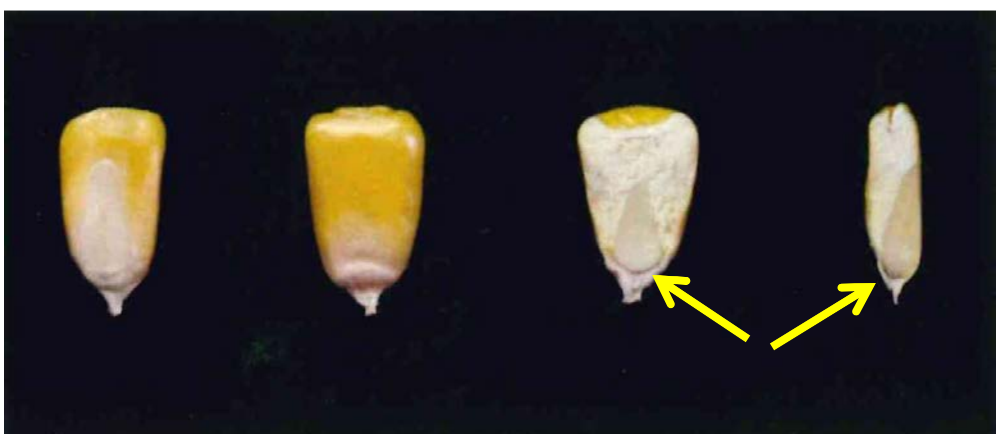


The "sneaky" part is that as the corn plant matures, we "lose" 5 - 6 nodes & their leaves to the developing root system

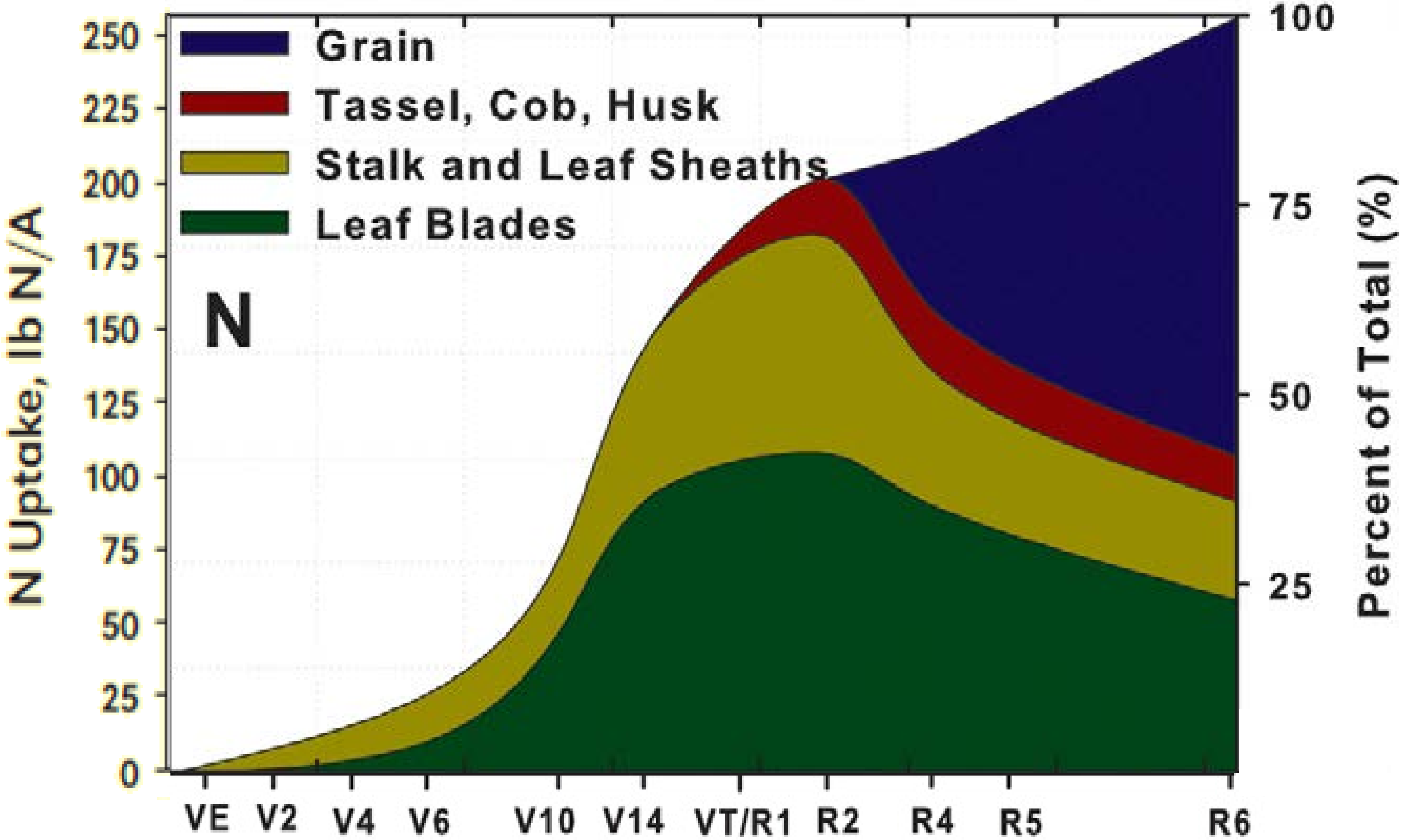
With the appearance of the silks, the plant switches from vegetative to reproductive growth

Growth Stages of Corn

Vegetative Stages	Reproductive Stages
VE emergence	R1 silking
V1 first leaf	R2 blister
V2 second leaf	R3 milk
V3 third leaf	R4 dough
V(n) nth leaf	R5 dent milk line progresses toward kernel base
VT tasseling	R6 physiological maturity



The "black layer" or "black line" is a good indicator of physiological maturity.



Corn Dry Matter: about 51% grain vs 49% stover

Corn Nitrogen: 50 - 60% grain vs 40% - 50% stover

Grain draws from both soil and remobilization from stalk and lower leaves

Ross R. Bender, Jason W. Haegele, Matias L. Ruffo, and Fred E. Below, Agronomy Journal • Volume 105, Issue 1 • 2013

N in grain comes from:

2/3 new N from soil

1/3 remobilized from leaves & stalks

32 - 34% of total N uptake occurs during grain fill.

Two approaches for N fertilization

Typical fertilizer rates

What's "typical?"

Wide range of scenarios

Impossible to make a "one size fits all" recommendation

Not a lot of studies on corn & forages

Rate trials without knowing if leaching was significant may not be helpful

Typical corn grain fertilization, Yolo area

Brittan recommended total application rates of 200 to 275 lbs N/acre on mineral soils, depending on plant population and previous crop.

This is in line with a trial carried out at Davis, where an average grain yield of 6.4 tons/acre) was produced with 200 lbs N/acre.

Doubling the N rate had no effect on yield or grain protein content.

Typical corn grain fertilization, Yolo area

N in P fertilizer (10-34-0 or 11-52-0) is often sufficient for a starter

10 to 15 lbs total at planting

Concentrated salts can be toxic to seedlings…band several inches below and to the side of seed row

Typical corn grain fertilization, Yolo area

Single large sidedress application 150 to 170 lbs N IF low leaching risk

Sidedress around 1 ft high and stay 8 to 15 inches away from the plants to avoid root pruning and injury from ammonia.

Banded fertilizer depending on placement in bed in furrow-irrigated corn may move sideways with water and be less subject to leaching than with basin irrigation.

Typical corn silage/grain fertilization, Tulare area

Total application rates of 200 to 275 lbs N/acre depending on plant population and previous crop.

N in P fertilizer (10-34-0 or 11-52-0) is often sufficient for a starter, 10 to 15 lbs total at planting

(Banded fertilizer depending on placement in bed in furrow-irrigated corn may move sideways with water and be less subject to leaching than with basin irrigation. Concentrated salts can be toxic to seedlings…band several inches below and to the side of seed row)

Typical silage/grain corn fertilization, Tulare area

Common: sidedress of 100-150 lbs followed by one or more water-run applications of 35-50 lb N

(Sidedress around 1 ft high and stay 8 to 15 inches away from the plants to avoid root pruning and injury from ammonia.)

Less common: preplant with one large sidedress of 170-200 + lbs N

Typical corn silage fertilization, Turlock/Hilmar area

Total application rates of 250 to 300 lbs N/acre depending expected yield and N removal, and amount of N that is in manure form.

P starter is common, especially in colder soils. Minimal N (10 to 15 lbs total) at planting, may or may not be needed depending on temperature and manure history. Sometimes ammonium sulfate is spread prior to planting to provide both N and S

Typical corn silage fertilization, Turlock/Hilmar area

Water run N in 4 to 6 split applications depending on total number of expected irrigations

Typical is 50 units of anhydrous or UN32 in each of first 5 crop irrigations

No more than 20 - 30 units on very small corn

No more than 80 units in any one irrigation.

Shanked UN32 sometimes used on heavier soils

Time so there is sufficient N for rapid growth prior to tasselling. Reserve some N for grain fill.

corn N fertilization strategies

1. <u>Typical fertilizer rates</u>
   typical is relative
   affected by leaching

2. <u>N budget</u>
   now need to consider also
   potential yield (N removal)
   previous crop residue/soil organic N
   irrigation water nitrate
   in addition to
   applied N commercial and manure

Nitrogen budget

N removal/crop uptake as starting point

adjust for N additions from irrigation and soil N

compensate for expected losses & inefficiencies

Corn N Budgets

1. How much nitrogen does the crop need?

Nitrogen required for the crop – silage corn

For silage and hay crops, the N removed is similar to N "utilized"

SILAGE CORN

From the harvested portion (IPNI)

1 ton corn silage (67%) – 9.7 lbs N

30 T would be 291 lbs N

From Western Fertilizer Handbook, 8th ed.)

"utilized" by the crop

1 ton silage corn– "utilizes" 8.3 lb N

30 T would be 250 lb N

Or you can calculate uptake after the fact to use in the future.

Silage Total Removal

Lbs dry matter/A x % N

Lbs dry matter/A x % protein/6.25

Tons/A @ 70% x % protein x .96

30 Tons/A x 8.5% x .96 = 245 lbs N/acre

Adequate sampling for moisture and nutrients is critical.

Hay Total Removal

Lbs dry matter/A x % N

Lbs dry matter/A x % protein/6.25

Tons/A @ 10% x % protein x 2.88

Nitrogen required for the crop – grain corn

How much is needed for the crop as a starting point before subtracting various sources of N? **Removal in grain is less than utilized by crop.**

Expected N removal – grain is only about 50-60% the N utilized by the crop

GRAIN CORN

From the harvested portion (IPNI)

1 ton corn grain – 25 lbs N

6 T would be 150 lbs N

From Western Fertilizer Handbook, 8th ed.)

"utilized " by the crop

1 ton grain corn – "utilizes" 48 lb N

6 T would be 288 lb N

Karlen paper: 42 lbs per ton @ 15.5 % moisture

Nitrogen removal – grain corn

Lbs dry matter/acre x % N

Lbs dry matter/acre x % protein/6.25

1. calculate dry matter factor

15.5% moisture
100 – 15.5 = 84.5% dry matter
84.5/100 = .845

2. calculate pounds/acre dry matter

6.5 Tons/A x 2000 = 13,000 lbs/acre
13,000 x .845 = 10,985 lbs/acre dry matter

3. calculate % N from % protein

9% protein = 9 ÷ 6.25 = 1.44% N

4. calculate lbs/acre N removal in grain

10,985 x .0144 = 159 lbs N/acre removed

Nitrogen removal – grain corn

Lbs dry matter/acre x % N

Lbs dry matter/acre x % protein/6.25

Shortcut for 15.5 % moisture grain:

Tons/acre @ 15.5% moisture x % protein x 1.13
= lbs N/acre removed

6.5 tons/acre x 9% protein x 1.13
= 159 lbs N/acre removed

Nitrogen removed by crop – grain corn

Tons/acre @ 15.5% moisture x % protein x 1.13

Lbs dry matter/acre x % protein/6.25

Lbs dry matter/acre x % N

10,985 x .0144 = 159 lbs N/acre removed

Nitrogen required for the crop – grain corn

grain is about 50-60% the N utilized by the crop

Divide by .6 to .5 to get N utilized by the crop

159 ÷ .6 = 264 lbs N/acre for crop

159 ÷ .5 = 316 lbs N/acre for crop

Nitrogen budget

N removal/crop uptake as starting point

adjust for N additions from irrigation and soil N

compensate for expected losses & inefficiencies

highly dependent on soil type, irrigation, etc.

because knowing if leaching of N is significant is critical in a tightly managed system

Corn N Budget

Silage Corn N uptake – 250 lbs N uptake

Assets

Starting N in soil	soil test	41
From irrigation water	calculate from ET	48
From applied manure	table value	23
From background soil organic	table value	
	total assets	112

Losses

Leaching etc.	Expected losses	50

Total N uptake	250
Add extra for losses	+ 50
Total needed	**300**

Total N needed	300
Subtract assets	-112
Total to apply	**188**

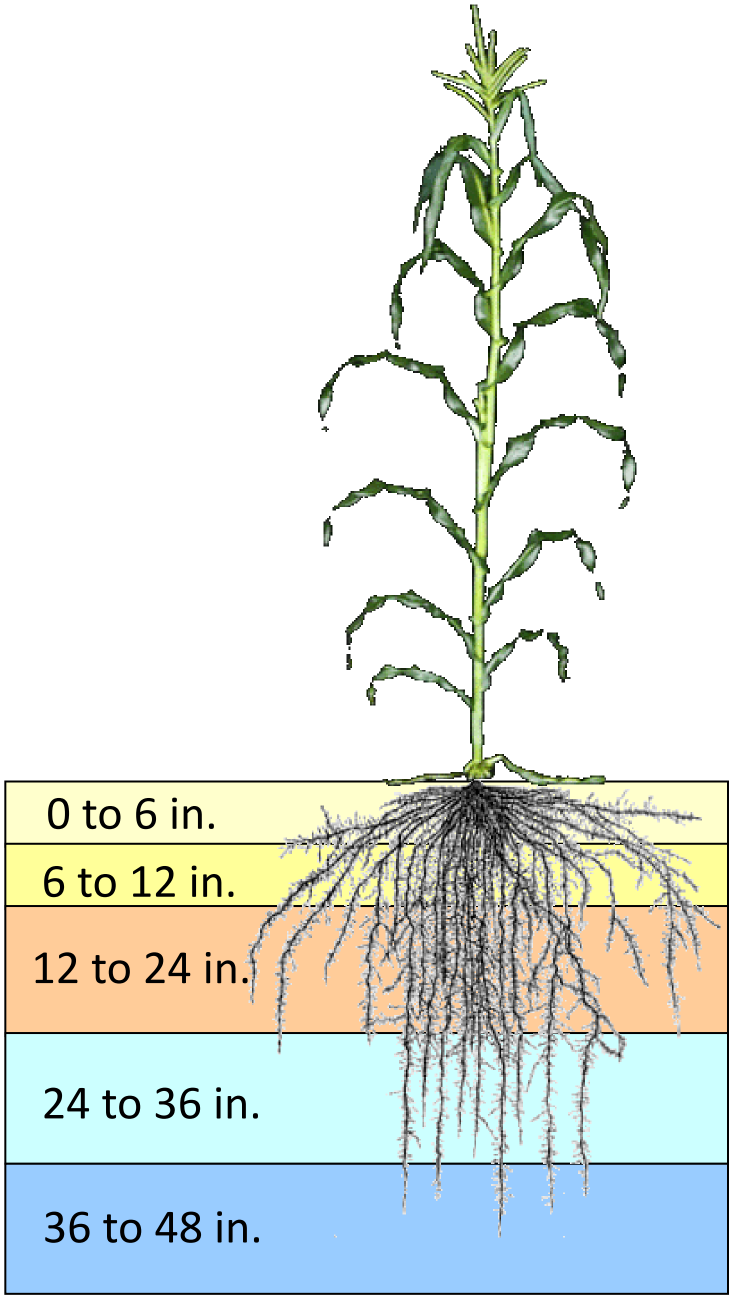
Simple nitrogen budgets don’t consider timing

Corn & Forage N Budgets

1. How much nitrogen does the crop need?
2. **What losses are expected?**

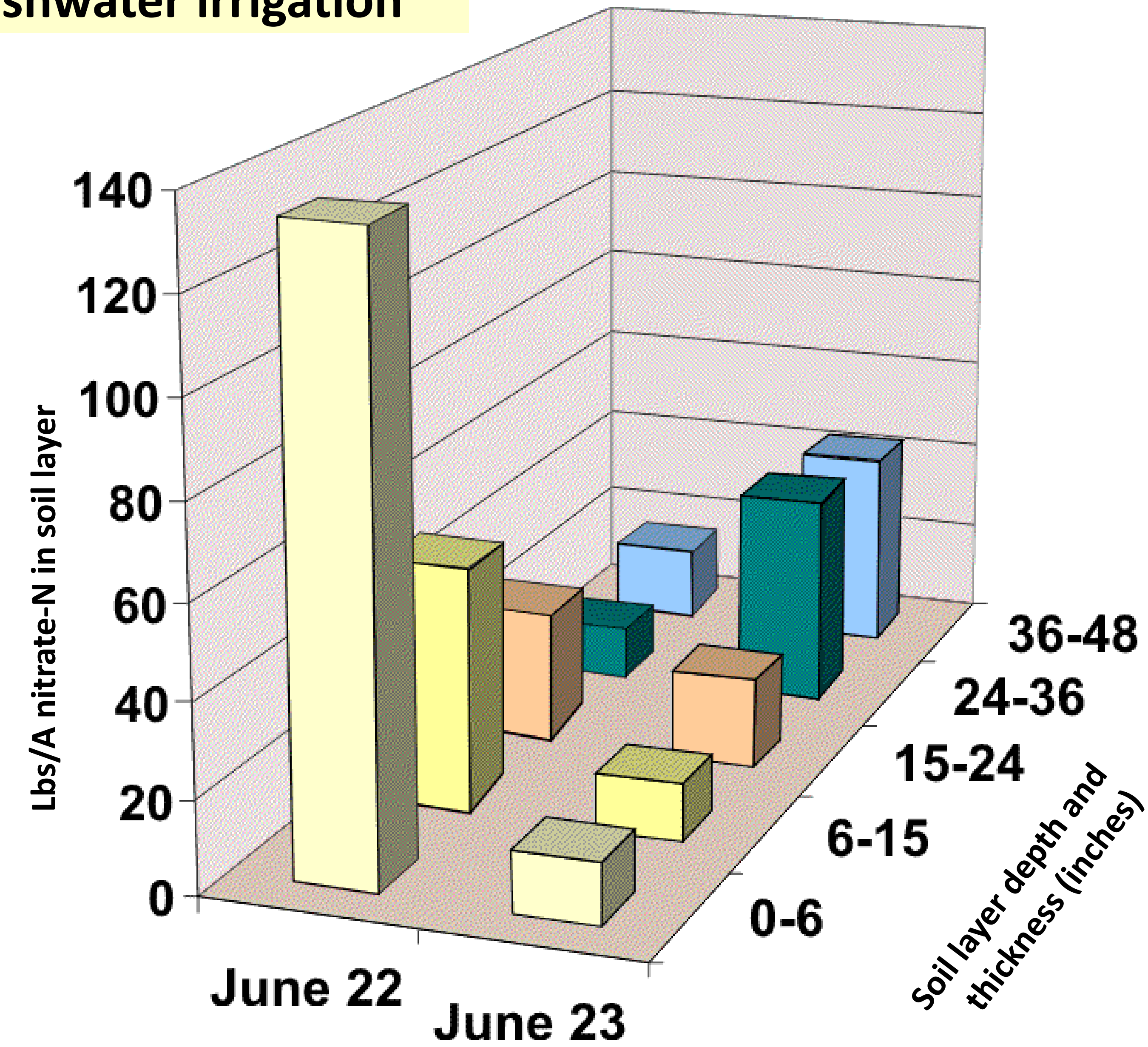
Nitrate Leaching
San Joaquin Valley

- 12 sampling events
- mainly light soils:
  sand (6)
  loamy sand (2)
  sandy loam (3)
  loam (1)
- soil sampled to
  3 or 4 feet
  just prior to and
  just after a
  freshwater irrigation



Nitrate-N losses (lbs/acre) from a single freshwater irrigation

N. San Joaquin Valley
silage corn
1st irrigation
6.7 ac-in
fine sandy loam



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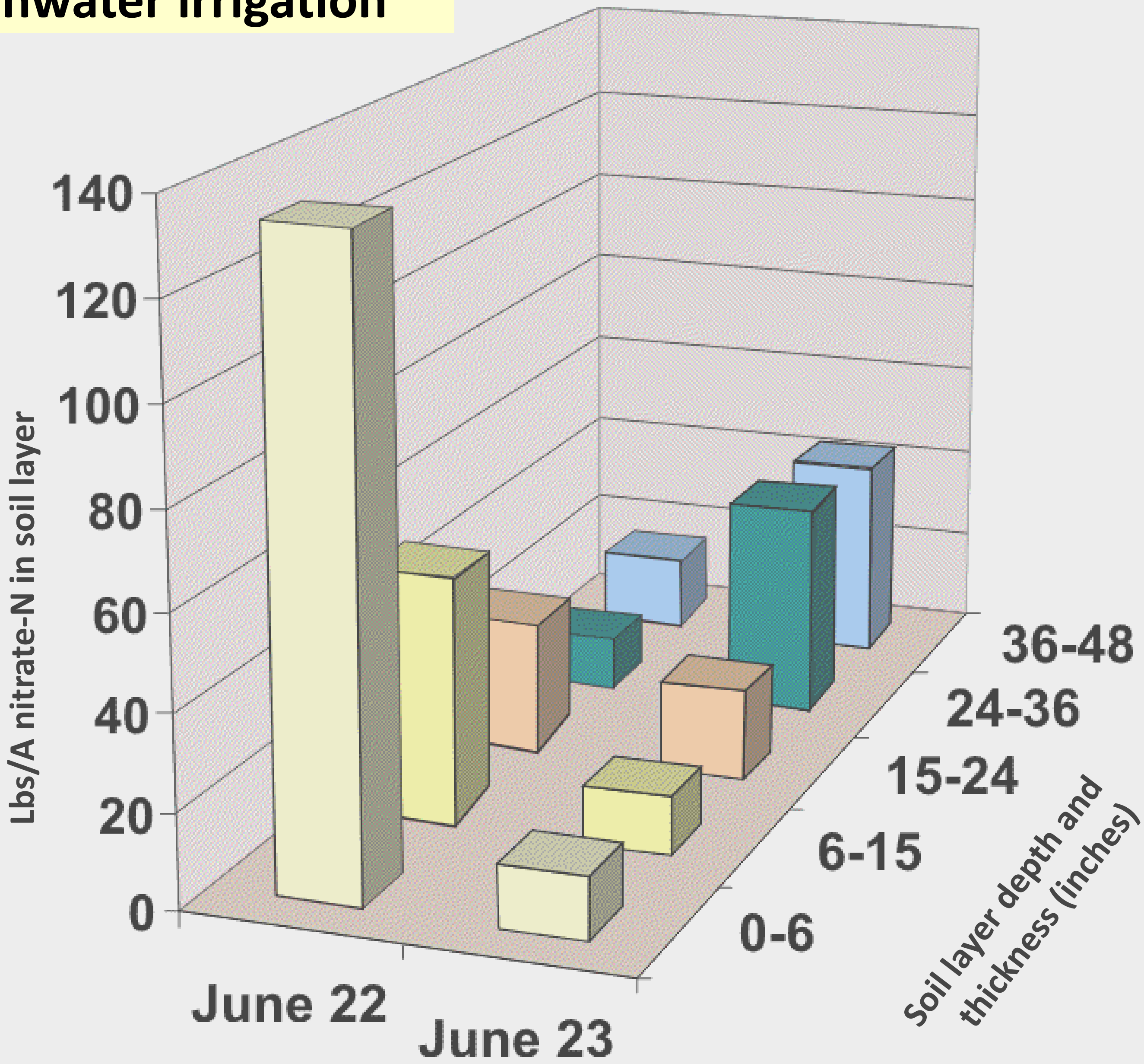


12 sites
loam, sandy loam & sand

Avg. over 50% loss of N from top 2 ft of soil

5 to 7 inch irrigations

Typical scenarios:

Minimal leaching

Leaching pre and first irrigations

Leaching all or most irrigations

Estimating leaching potential

Online tools

NLEAP

ENVIRO-GRO

ET based irrigation scheduling

Rough estimate

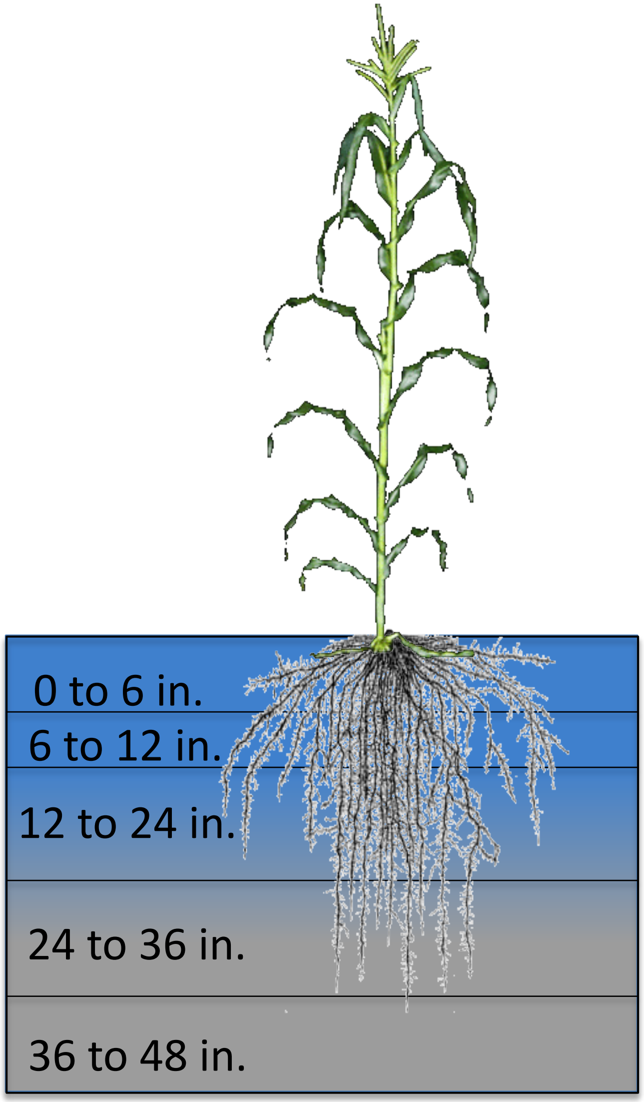
ET ac-inches vs total amount applied

- For a quick evaluation of how much leaching potential, compare total water applied to the ET needs of the crop

Estimating leaching and irrigation N contribution

- Most of N and water uptake is in the top 2 ft. for corn. Roots may be found deeper but usually are not doing much

- Depending on location, time of planting, corn variety, and weather, ET of corn can range from 21-27 in.



Information on corn ET can be found at:

http://ucmanagedrought.ucdavis.edu/Agriculture/Crop_Irrigation_Strategies/Corn/

Estimating leaching and irrigation N contribution

1^{st} step: compare ET crop to applied water

ET **corn**: 21
Irrig ac-in: 34

If leaching is not a huge issue can credit all or most of the irrigation water nitrate.

If applied is greater than ET, credit only ET ac-in

N concentration (mg/L) x 1000 gals x .008345 = lbs N/acre
N concentration (mg/L) x ac-in x .22625 = lbs N/acre

21 ac-in x 10 mg/L x .22625 = 47.5 lbs N from irrigation N

- For a quick evaluation of how much leaching potential, compare total water applied to the ET needs of the crop

- Or compare the amount of water applied in an individual irrigation with the amount of available water that that soil can hold when the irrigation is applied

- *If water applied greatly exceeds the holding capacity of that soil, consider the impact of N leaching!*

	ac-inches per foot of soil	ac-inches in 30" root zone
Sand	0.5 - 0.7	1.3 - 1.8
Fine sand	0.7 - 0.9	1.8 - 2.3
Loamy sand	0.7 - 1.1	1.8 - 2.8
Loamy fine sand	0.8 - 1.2	2.0 - 3.0
Sandy loam	0.8 - 1.4	2.0 - 3.5
Loam	1 - 1.8	2.5 - 4.5
Silt loam	1.2 - 1.8	3.0 - 4.5
Clay loam	1.3 - 2.1	3.3 - 5.3
Silty clay	1.4 - 2.5	3.5 - 6.3
Clay	1.4 - 2.4	3.5 - 6.0

More than maximum: definitely suspect leaching

In between: might have leaching

Less than: need more information to determine leaching

Typical leaching scenarios:

Minimal leaching

Leaching pre and first irrigations

Leaching all or most irrigations

Typical scenarios:

Minimal leaching

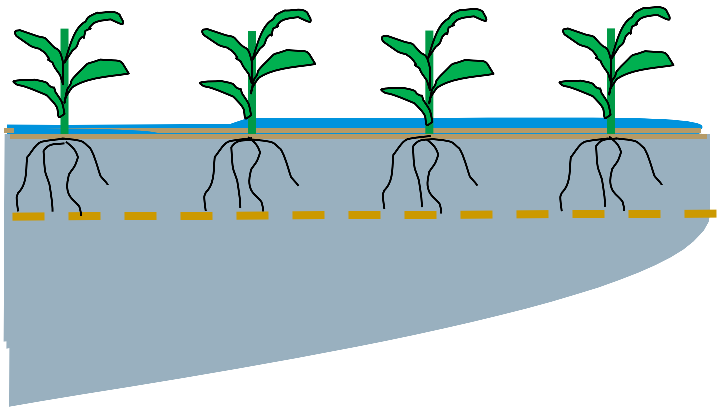
- Good flexibility in N application timing
- Movement of N from surface to roots when using manures
- Utilization of filtered solids when using pressurized systems
- Salt build up
- Concentration of N in leachate

Typical scenarios:

Leaching pre and first irrigations only

- N banking possible part of the year
- One or two higher dose applications are feasible
- Easier to utilize manures effectively
- Accounting for previous crop residues can be important
- Soil and/or tissue tests more useful

Early season shanked/injected application
vs.
water-run applications later



Potential leaching losses
balanced with
application non-uniformity

Typical leaching scenarios:

Minimal leaching

Leaching pre and first irrigations

Leaching all or most irrigations

Obvious approach to reducing N leaching:

Improve irrigation efficiency so water doesn’t move past roots

Obvious approach to reducing N leaching:

Increase irrigation efficiency so water doesn’t move past roots

This may be the preferred approach for some operators

Pressurized systems

High capitol costs

Long term/whole farm use on dairies may need to be in conjunction with new solids & salt management technologies

Parcel size and shape limits use of sprinklers in N. SJV

Ways to minimize deep percolation with surface irrigation

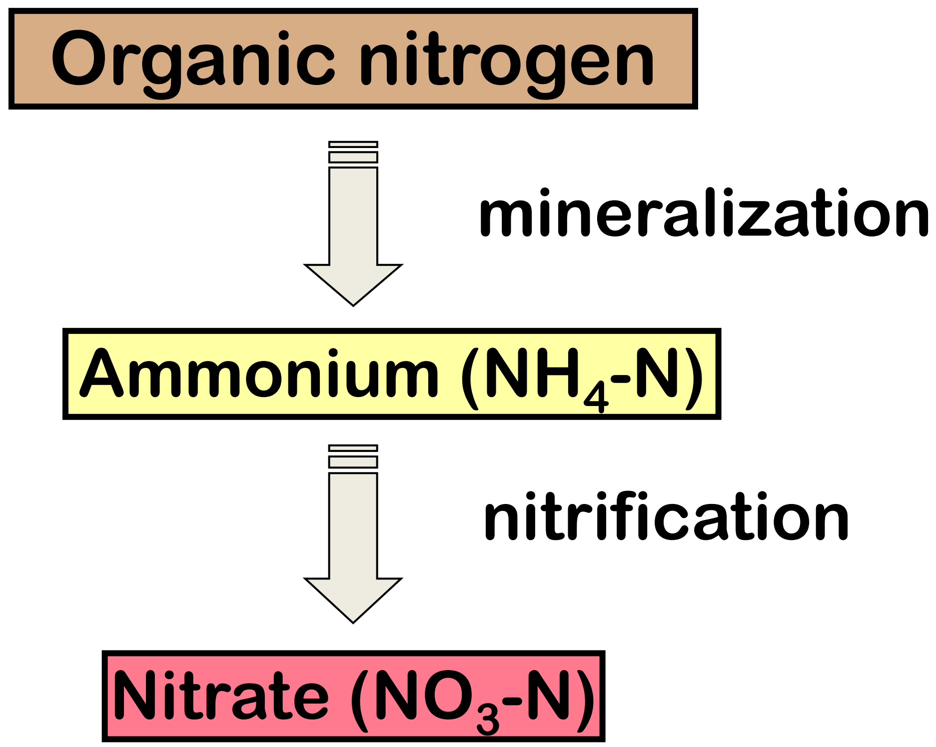
- Reduce field length
- Increase the flow rate so water moves faster
- Increase slope
- Make the soil surface smoother
- Use pulsed, or surge irrigation

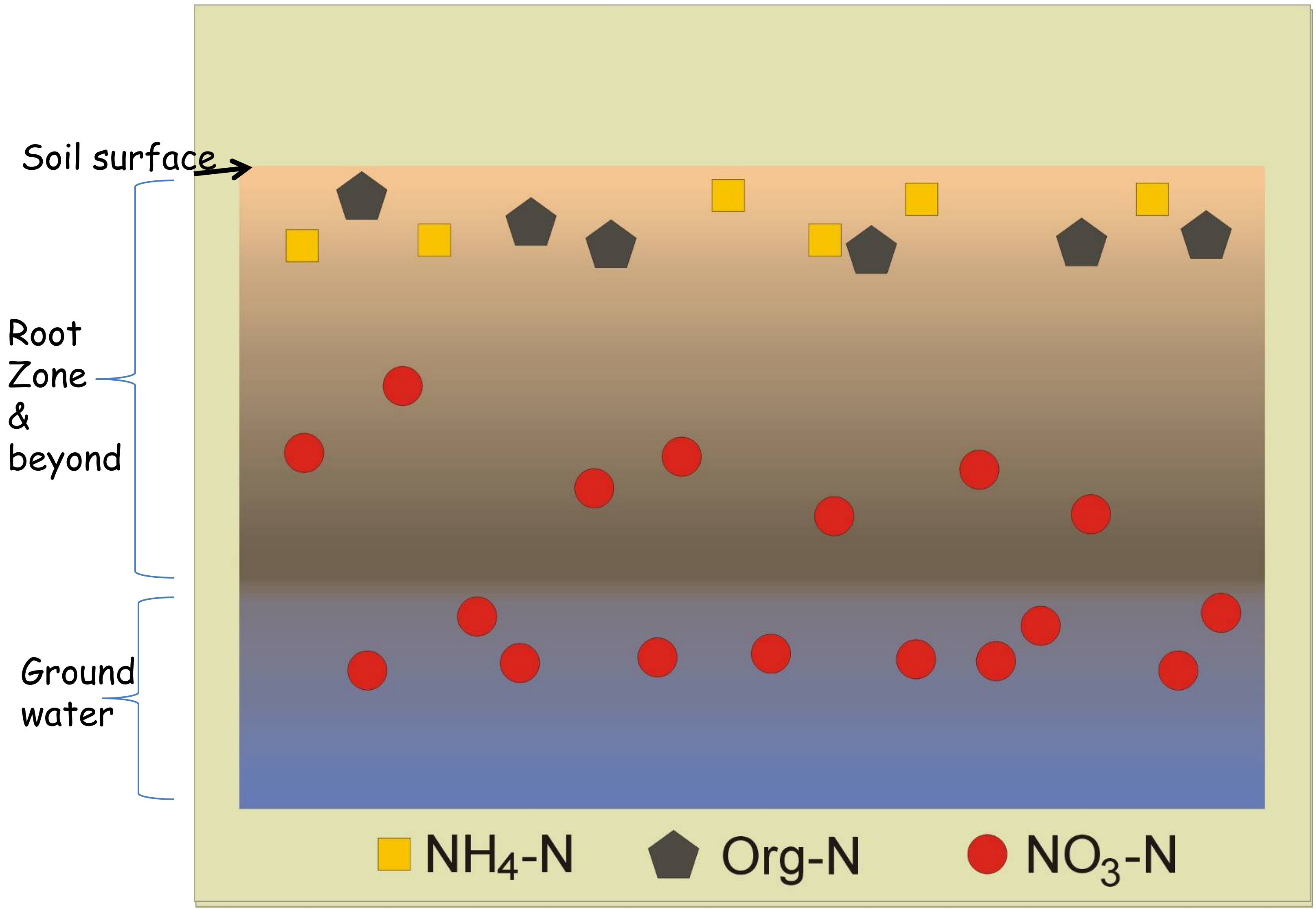
Two basic approaches to reducing N leaching:

1. Improve irrigation efficiency so water doesn't move past roots

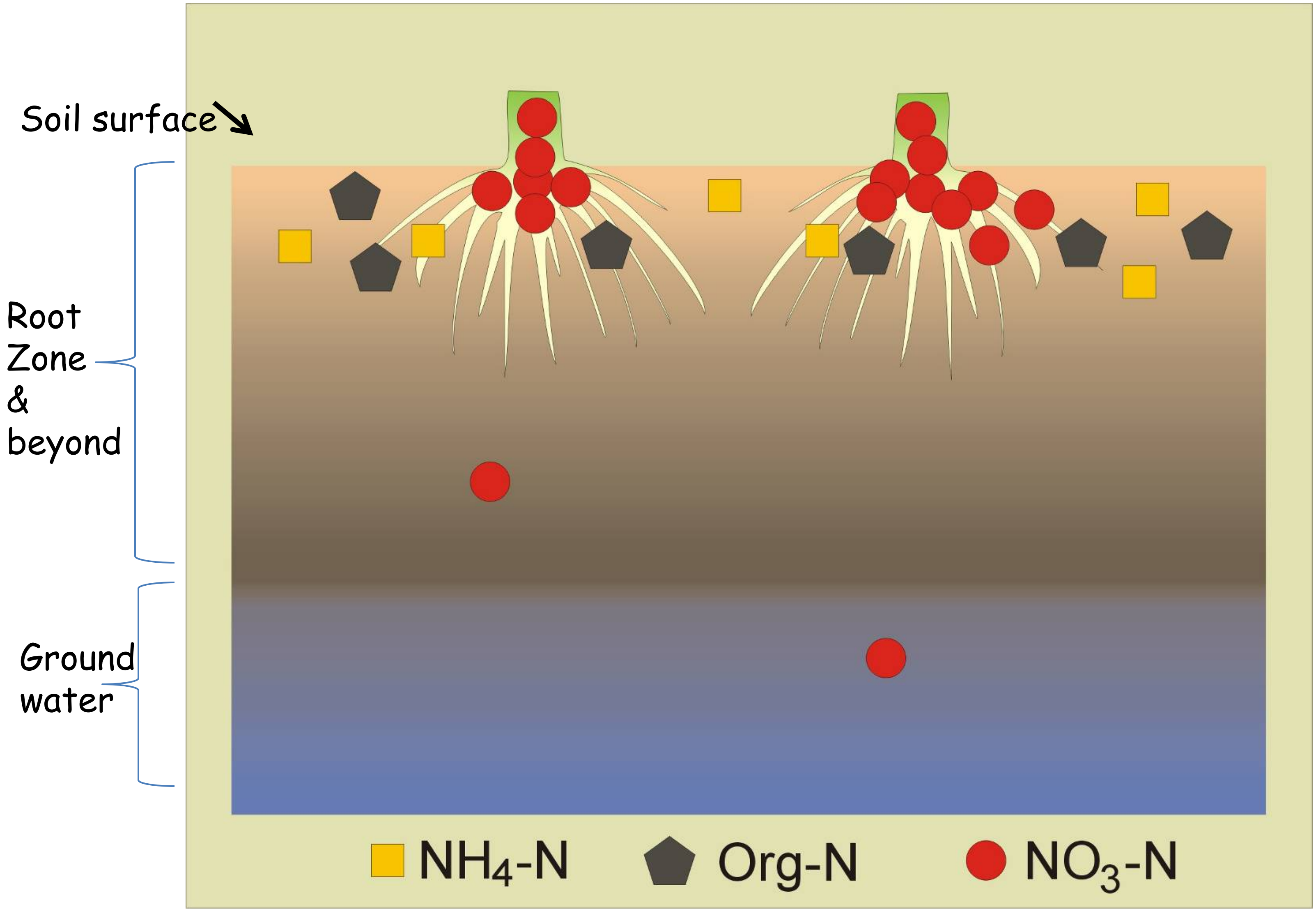
2. Strategic timing of applications so there is a minimal amount of nitrate in the soil during leaching events

Nitrogen Transformations in the Soil





Slide source: Marsha Campbell Mathews University of California Agronomy Farm Advisor



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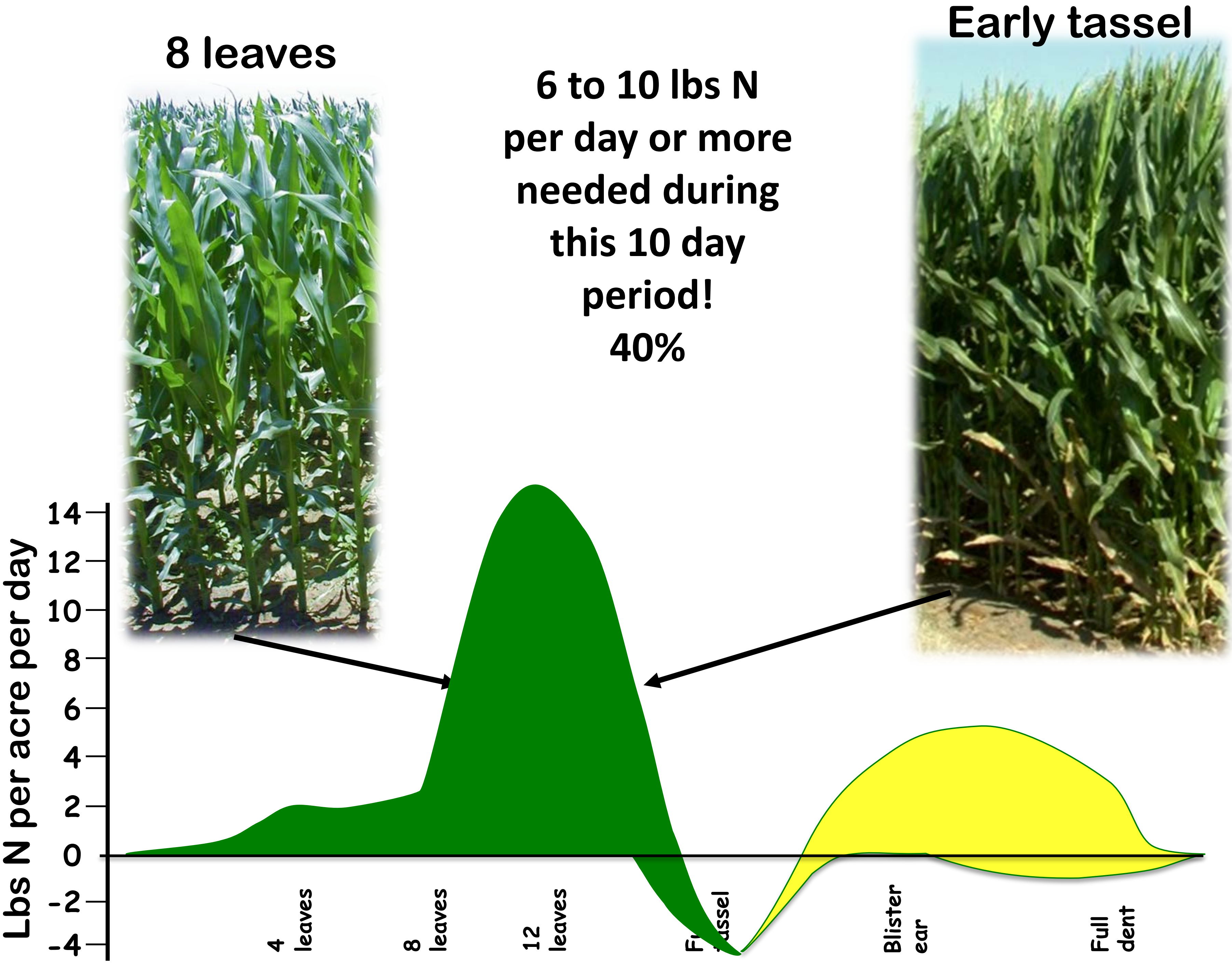
Two basic approaches to reducing N leaching:

A. Improve irrigation efficiency so water doesn’t move past roots

B. Strategic timing of applications so there is a minimal amount of nitrate in the soil during leaching events

Corn & Forage N Budgets

1. How much nitrogen does the crop need?
2. What losses are expected?
3. **When does the crop need the nitrogen?**

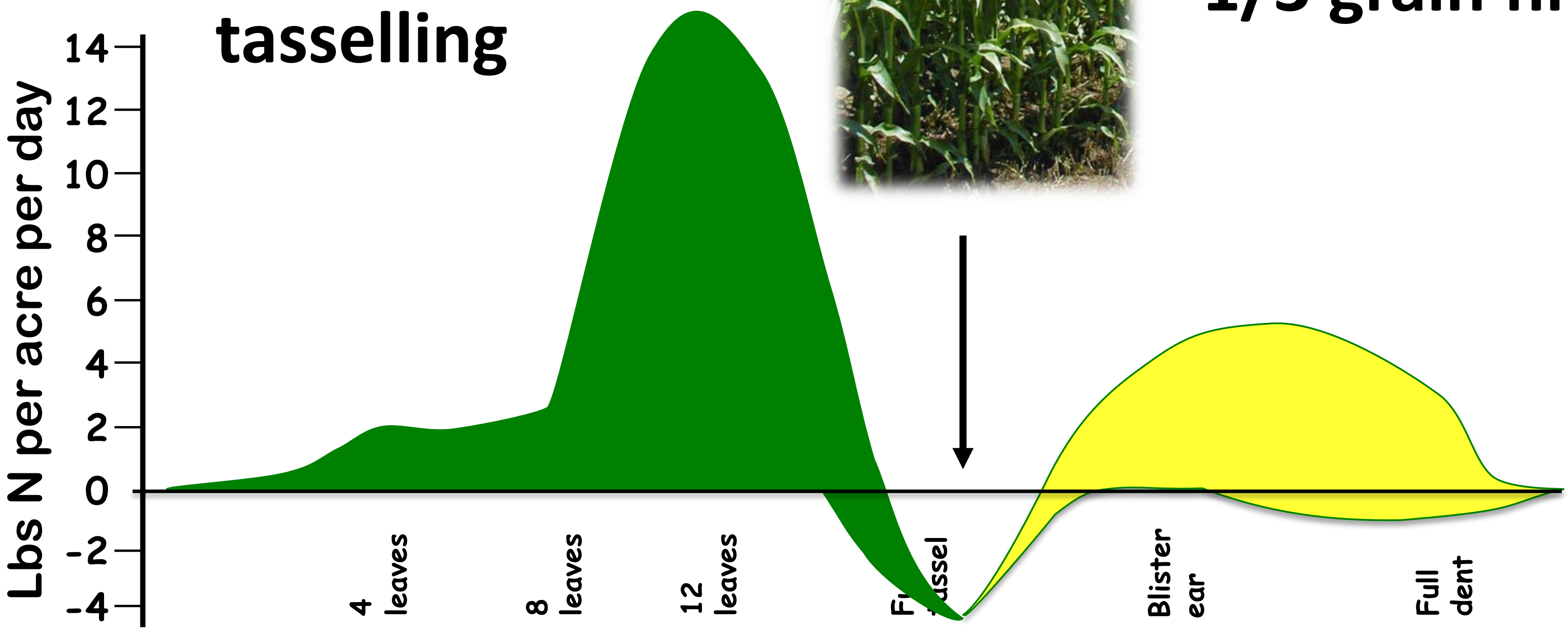


8 leaves
Early tassel
6 to 10 lbs N
per day or more
needed during
this 10 day
period!
40%
Lbs N per acre per day
14
12
10
8
6
4
2
0
-2
-4
4 leaves
8 leaves
12 leaves
Blister ear
Full dent

When is N taken up?

2/3 before tasselling

1/3 grain fill



Nitrogen uptake by corn grown for silage
(above ground portions only, 8.5% protein at harvest)

				30 tons/acre			
stage	GDU		% total N uptake per period	lbs N/acre used each	lbs N/acre used before		
V4	305	4 leaves fully emerged	3%	9		257 x .03 =	9
V8	422	8 leaves fully emerged	5%	14		257 x .05 =	14
V12	571	12 leaves fully emerged	14%	36		257 x .14 =	36
VT	753	tassel fully emerged	40%	102	161	257 x .40 =	102
R1	909	silks emerging				257 x 0 =	
R2	1140	blister stage	5%	13		257 x .05 =	13
R5	1490	early dent	32%	83		257 x .32 =	83
R6	1598	physiological maturity	0.2%	0.6	96	257 x .002 =	1
		total	100%	257			257

Rutgers, N.J. 1985. Adapted from Karlen, et.al., Agronomy Journal, 1988 by M. Campbell Mathews

32 - 34% of total N uptake occurs during grain fill.

Typical scenarios:

Leaching all or most irrigations

- Multiple low dose applications are necessary
- System must allow for low N application rates through irrigation system (important if using lagoon water)
- Good irrigation uniformity is necessary
- Difficult to utilize organic N
- May need to consider N needed for root growth
- Use soil and/or tissue test results cautiously

Keys to N Fertilization of Corn

Goal: have nitrogen available in soil when the crop needs it & avoid having too much if leaching is likely

- Know the potential to leach N
- Understand uptake patterns
- Strategically time N applications

Corn & Forage N Budgets

1. How much nitrogen does the crop need?
2. What losses are expected?
3. When does the crop need the nitrogen?
4. **What form(s) is the nitrogen in?**

Forms of nitrogen

commercial

Irrigation water

Calculate amount from concentration and volume

Some may move past roots

Nitrogen in Irrigation water

10 mg/L x 34 acre-inches x .226 = 77 lbs/A

30% of a 250 lb/acre removal

Organic form nitrogen

Releases slowly over years

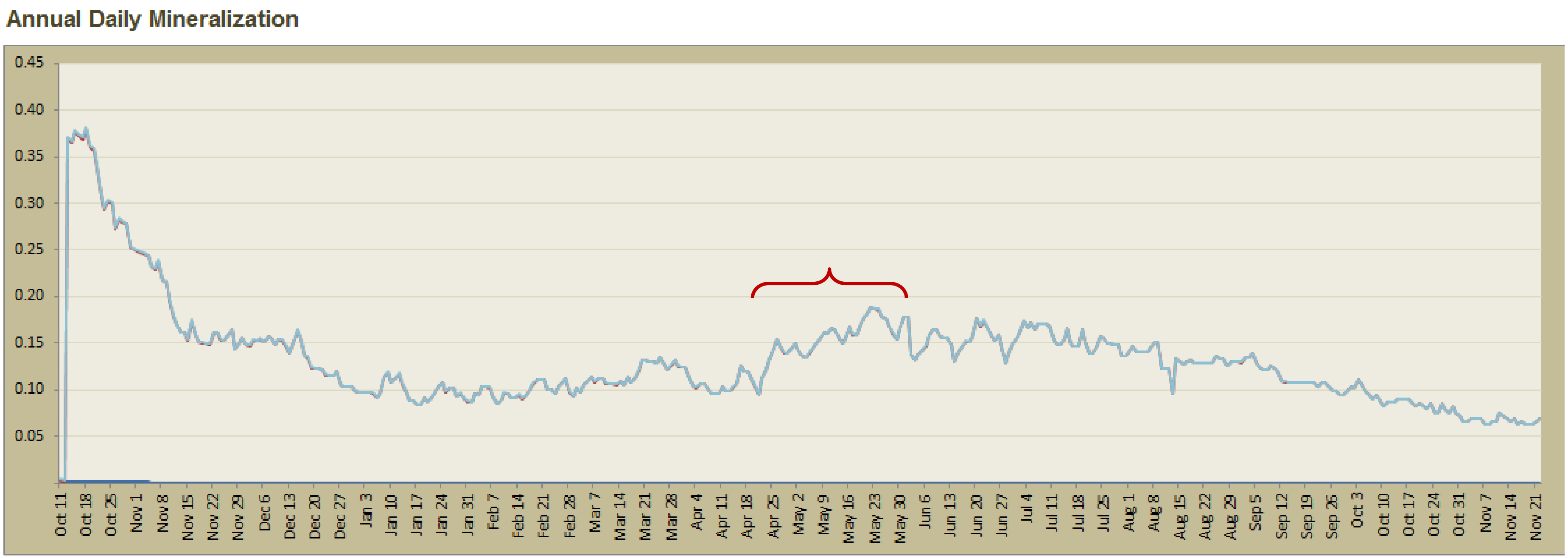
Table values (% per year)

more than one crop per year

carry over from one year to the next

multiple applications

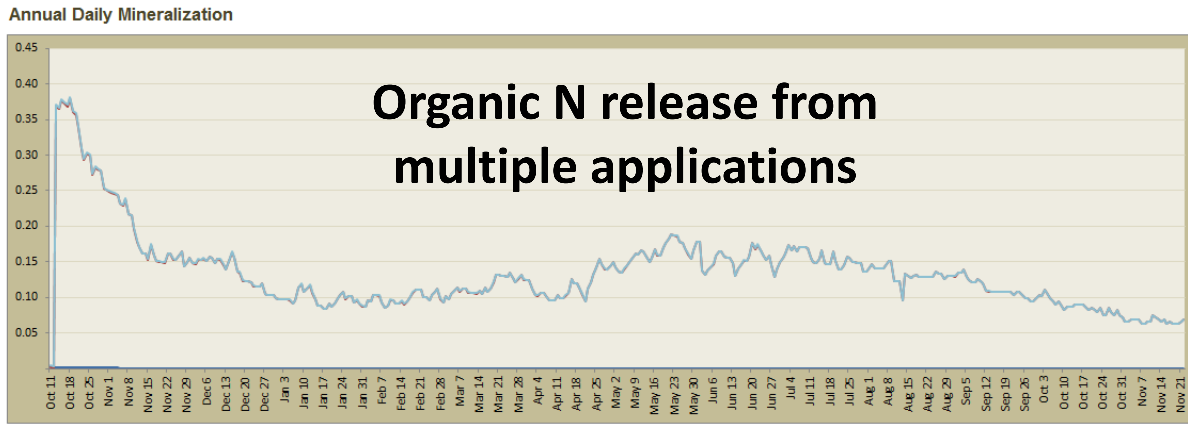
Rate depends on temperature and material type



Corn & Forage N Budgets

1. How much nitrogen does the crop need?
2. What losses are expected?
3. When does the crop need the nitrogen?
4. What form(s) is the nitrogen in?
5. **Will the proposed budget meet the N needs of the crop throughout the season?**

Major considerations:



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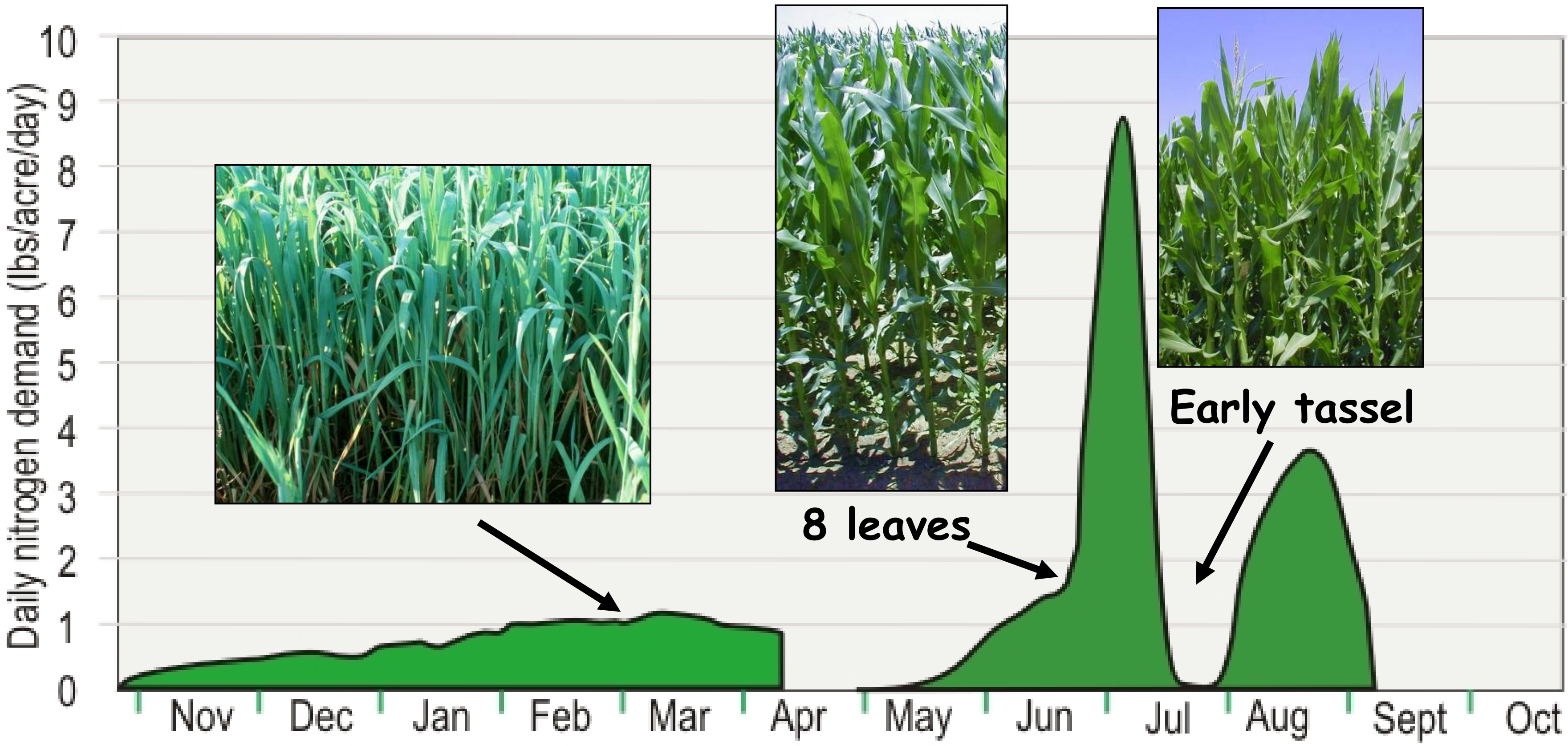
Forage systems may need to consider both crops



Goal: have nitrogen available in soil when the crop needs it & avoid having too much if leaching is likely

Nitrogen Ledger Calculator

Event	Event date	material type	ammon N lbs/A	organic N lbs/A	nitrate N lbs/A	irrig ac-inches
initiation date	3 May 14					
s pplnt 1	5 May 14	Dairy Cow Manure		180		
s pre irrig	10 May 14				18	8.0
summer planting	*20 May 14*					
s 1st irrig	19 Jun 14				11	5.0
s 2nd irrig	29 Jun 14				7	3.0
s 3rd irrig	9 Jul 14				7	3.0
s 4th irrig	19 Jul 14				7	3.0
s 5th irrig	29 Jul 14				7	3.0
s 6th irrig	9 Aug 14				7	3.0
s 7th irrig	19 Aug 14				7	3.0
s 8th irrig	29 Aug 14				7	3.0
summer harvest	*10 Sep 14*					
	totals	**258**	**0**	**180**	**78**	**34.0**

Create irrigation schedule for entire season

UCCE Nitrogen Ledger Calculator

Event	Event date	material mineralization type	ammon N lbs/A	organic N lbs/A	irrig nitrate N lbs/A	irrig ac-inches
date 1	3 May 14					
s pplnt 1	4 May 14	Dairy Cow Manure		180		
s pre irrig	6 May 14				18	8.0
summer planting	*16 May 14*					
s 1st irrig	12 Jun 14				11	5.0
s 2nd irrig	22 Jun 14				7	3.0
s 3rd irrig	2 Jul 14				7	3.0
s 4th irrig	12 Jul 14				7	3.0
s 5th irrig	22 Jul 14				7	3.0
s 6th irrig	1 Aug 14				7	3.0
s 7th irrig	11 Aug 14				7	3.0
s 8th irrig	21 Aug 14				7	3.0
summer harvest	*29 Aug 14*					
	totals	258	0	180	78	34.0

10 mg/L x .226 x 8 ac-in

N removal = 250

250 lbs/A expected crop uptake

Nitrogen Ledger Calculator

Event	Event date	material type	ammon N lbs/A	organic N lbs/A	nitrate N lbs/A	irrig ac-inches
initiation date	3 May 14					
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s 7th irrig	19 Aug 14				7	3.0
s 8th irrig	29 Aug 14				7	3.0
summer harvest	*10 Sep 14*					
	totals	258	0	180	78	34.0

Estimate water and nitrate amounts

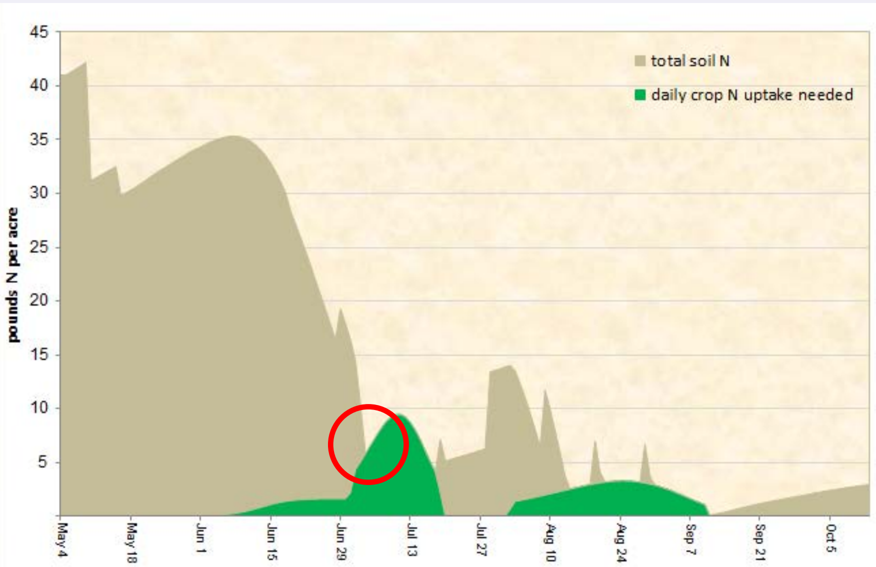
250 lbs/A expected crop uptake

Nitrogen Ledger Calculator

Event	Event date	material type	ammon N lbs/A	organic N lbs/A	nitrate N lbs/A	irrig ac-inches	lbs/A soil N leached	crop N this period	avail N this period	soil test soil N	mineralized N this period
initiation date	3 May 14								41	**41**	**0**
s pplnt 1	5 May 14	Dairy Cow Manure		180					42		**1**
s pre irrig	10 May 14				18	8.0	**29**	**0**	34		**3**
summer planting	*20 May 14*						**3**	**11**	39		**8**
s 1st irrig	19 Jun 14				11	5.0	**12**	**16**	29		**2**
s 2nd irrig	29 Jun 14				7	3.0	**3**	**59**	19		**2**
s 3rd irrig	9 Jul 14				7	3.0		**69**	2		**2**
s 4th irrig	19 Jul 14				7	3.0			6		**1**
s 5th irrig	29 Jul 14				7	3.0	**0**	**12**	15		**2**
s 6th irrig	9 Aug 14				7	3.0	**0**	**26**	11		**1**
s 7th irrig	19 Aug 14				7	3.0	**0**	**32**	5		**1**
s 8th irrig	29 Aug 14				7	3.0	**0**	**25**	5		**1**
summer harvest	*10 Sep 14*						**0**				
	totals	**258**	**0**	**180**	**78**	**34.0**	**47**	**250**			**24**

Calculates organic N mineralization,
N lost to leaching,
and compares crop need with N remaining in soil

Event	Event date	material type	ammon N lbs/A	organic N lbs/A	nitrate N lbs/A	irrig ac-inches	lbs/A soil N leached	crop N this period	avail N this period	mineralized N this period
initiation date	3 May 14								41	0
s pplnt 1	5 May 14	Dairy Cow Manure		180					42	1
s pre irrig	10 May 14				18	8.0	29	0	34	3
summer planting	*20 May 14*						3	11	39	8
s 1st irrig	19 Jun 14				11	5.0	12	16	29	2
s 2nd irrig	29 Jun 14				7	3.0	3	59	19	2
s 3rd irrig	9 Jul 14				7	3.0		69	2	2
s 4th irrig	19 Jul 14				7	3.0			6	1
s 5th irrig	29 Jul 14				7	3.0	0	12	15	2
s 6th irrig	9 Aug 14				7	3.0	0	26	11	1
s 7th irrig	19 Aug 14				7	3.0	0	32	5	1
s 8th irrig	29 Aug 14				7	3.0	0	25	5	1
summer harvest	*10 Sep 14*						0			
	totals	258	0	180	78	34.0	47	250		24



Crop	Exp'd Removal	Total Avail	Total Applied	Cmplnc Ratio	crop nitrogen deficiancy first deficit		total deficit
none		**0**	0				
silage corn	250	**102**	258	**1.0**	107	7/4/14	169
none		**3**	0				
Annual	250		258	**1.0**	lbs/A nitrate leached: **47**		

N Summary | Field Info | N detail

Brown shading is lbs available N/acre in soil & the green is **daily** corn N uptake

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s pre irrig	10 May 14				18	8.0				
summer planting	*20 May 14*									
s 1st irrig	19 Jun 14				11	5.0	12	16	29	2
s 2nd irrig	29 Jun 14	Lagoon Water	100	50	7	3.0	3	59	120	3
s 3rd irrig	9 Jul 14				7	3.0		69	71	3
s 4th irrig	19 Jul 14				7	3.0	0		11	2
s 5th irrig	29 Jul 14				7	3.0	0	12	20	2
s 6th irrig	9 Aug 14				7	3.0	0	26	16	2
s 7th irrig	19 Aug 14				7	3.0	0	32	5	1
s 8th irrig	29 Aug 14				7	3.0	0	25	5	1
summer harvest	*10 Sep 14*						0			
	totals	408	100	230	78	34.0	48	250		28

N Ledger Toolbox

pick date | Expand | update calculations | Go To

fields | events | irrig defaults | fixed losses | view

Crop	Exp'd Removal	Total Avail	Total Applied	Cmplnc Ratio	crop nitrogen deficiancy	first deficit	total deficit
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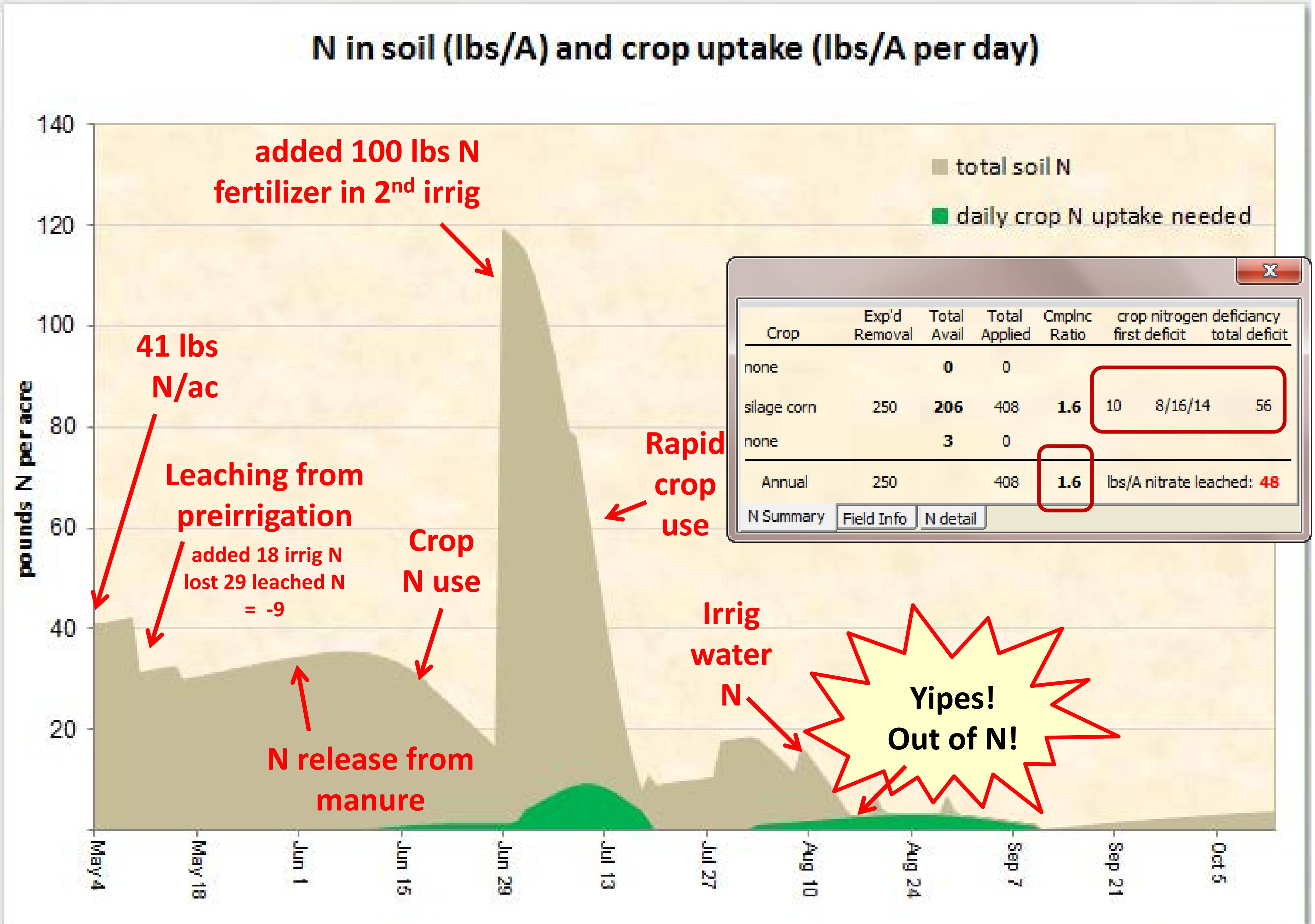
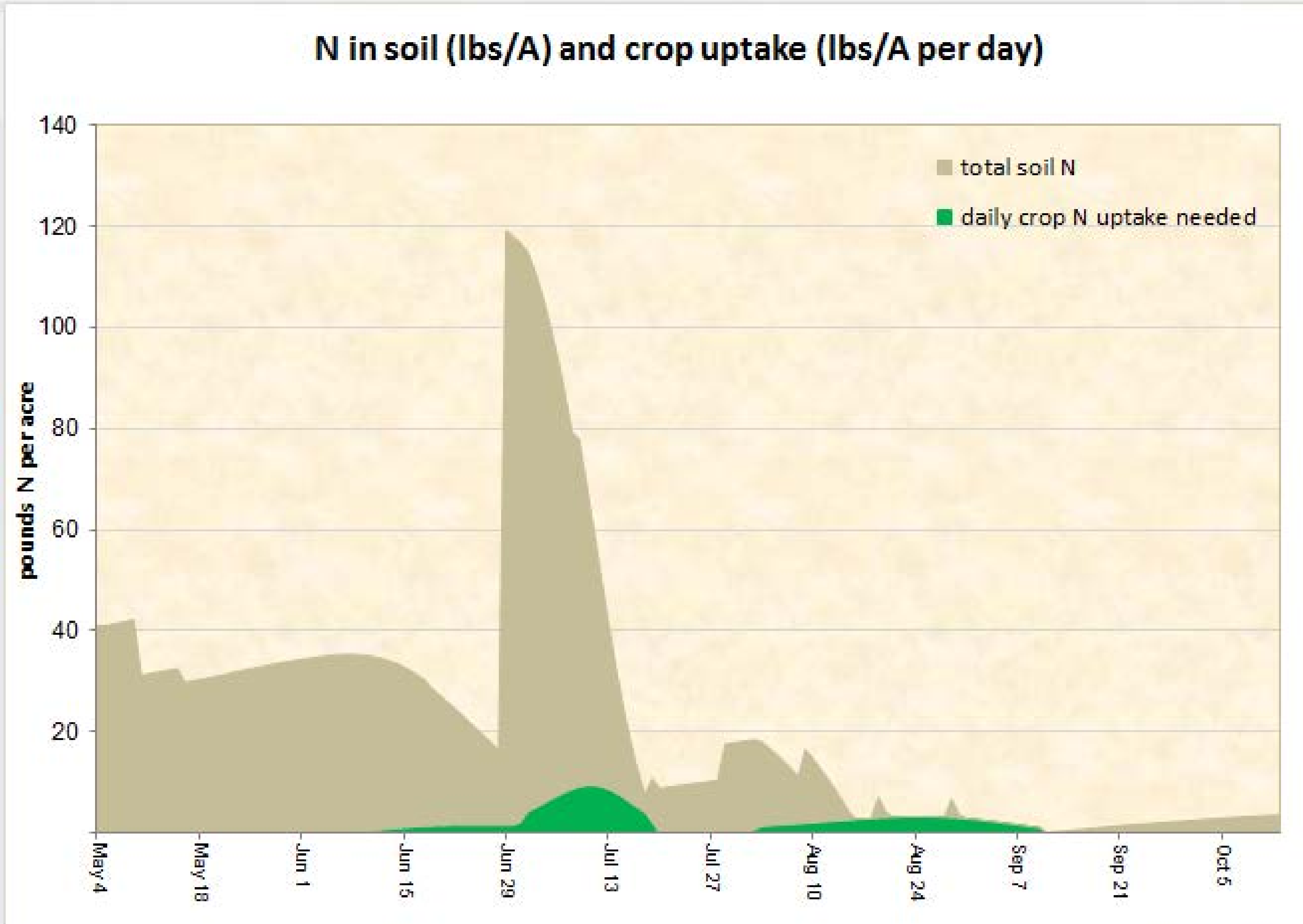
N Summary | Field Info | N detail



Brown shading is lbs available N/acre in soil & the green is **daily** corn N uptake



Use in-season monitoring to confirm results

Soil & Tissue Testing for Corn Nitrogen Management

Little work has been conducted in CA on soil and tissue testing for nitrogen management in corn.

Information to be presented is based on work primarily from the mid-west and has not been evaluated in UC trials to evaluate their usefulness under CA conditions and management.

The tests have limitations that must be considered

Soil Analyses

Pre-Plant nitrate test (PPNT)
Pre-Sidedress nitrate test (PSNT)

Challenges in using these tests:

- Spatial variability – need representative samples
- Turn around time from the lab (there are some quick tests)
- Will the nitrate be there after an irrigation?
- If nitrate is coming from mineralization of an organic source, how much and how quickly will more nitrate be available?

Details on these tests can be found at http://apps.cdfa.ca.gov/frep/docs/Corn.html

Plant Tissue Analysis Guidelines for Nitrogen in Corn

Growth Stage	Plant Part to Sample	Sufficiency Range %
Early Season (6-16 inches)	Whole plant	3.5 – 5.0
Midgrowth (3-6 ft)	First fully developed leaf: third leaf from top	3.5 – 4.0
Tasseling	Leaf opposite and below the primary ear	2.8 – 3.8
Silking	Leaf opposite and below the primary ear	2.0 – 3.0

Challenges:

- Provide current status and may not be very predictive
- Getting samples back in time to correct a problem

Details on these tests can be found at http://apps.cdfa.ca.gov/frep/docs/Corn.html

Leaf Greenness Tests

Chlorophyll meter

Canopy reflectance meters

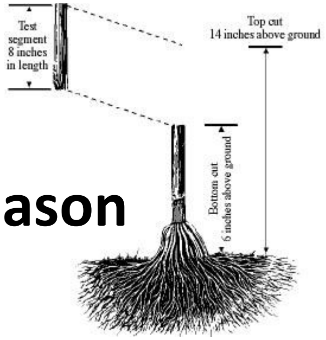
Challenges

- Corn varieties don't have the same greenness levels
- Need a well fertilized strip in the field for comparison
- A lot of leaves may need to be sampled

Details on these tests can be found at http://apps.cdfa.ca.gov/frep/docs/Corn.html

For end of season evaluation of corn program:

<u>Corn Stalk Nitrate Test</u> at end of season



Take samples from ¼ milk line to 3 weeks post black layer

Samples are 8 inch portion of the stalks (from 8-16 inches above soil surface)

Analyze for nitrate

Guidelines can indicate if there was excess nitrogen at the end of the season

Can help in planning in the next year

Doesn’t measure how much nitrate might have leached past the root zone. Might indicate the potential for residual N that could be leached or could provide N for subsequent crop.

Details on these tests can be found at http://apps.cdfa.ca.gov/frep/docs/Corn.html

Corn N management

1. How much nitrogen does the crop need?
2. What losses are expected?
3. When does the crop need the nitrogen?
4. What form(s) is the nitrogen in?
5. Will the proposed budget meet the N needs of the crop throughout the season?

6. Use in-season monitoring to confirm results

Assets:

- Nitrate in irrigation water
- Mineralized N from organic sources this year & previous
- N fertilizer residual from previous crop

Losses:

- leaching with rainfall or irrigation
- denitrification

Goal:

- have N in soil when crop needs it
- don't have N in soil when it can be lost

Keys to N Fertilization of Corn

- Not enough to know total amount of N but must have N when the crop needs it.

- Timing of N applications must consider leaching

Questions?