

Nitrogen management strategies to comply with water quality regulation



Regional Board draft waiver considers both the nitrogen load and the nitrate concentration

- Load = amount of N released to the environment
- Concentration = amount of N per unit of water released

$$45 \text{ PPM NO}_3^- = 10 \text{ PPM NO}_3\text{-N}$$

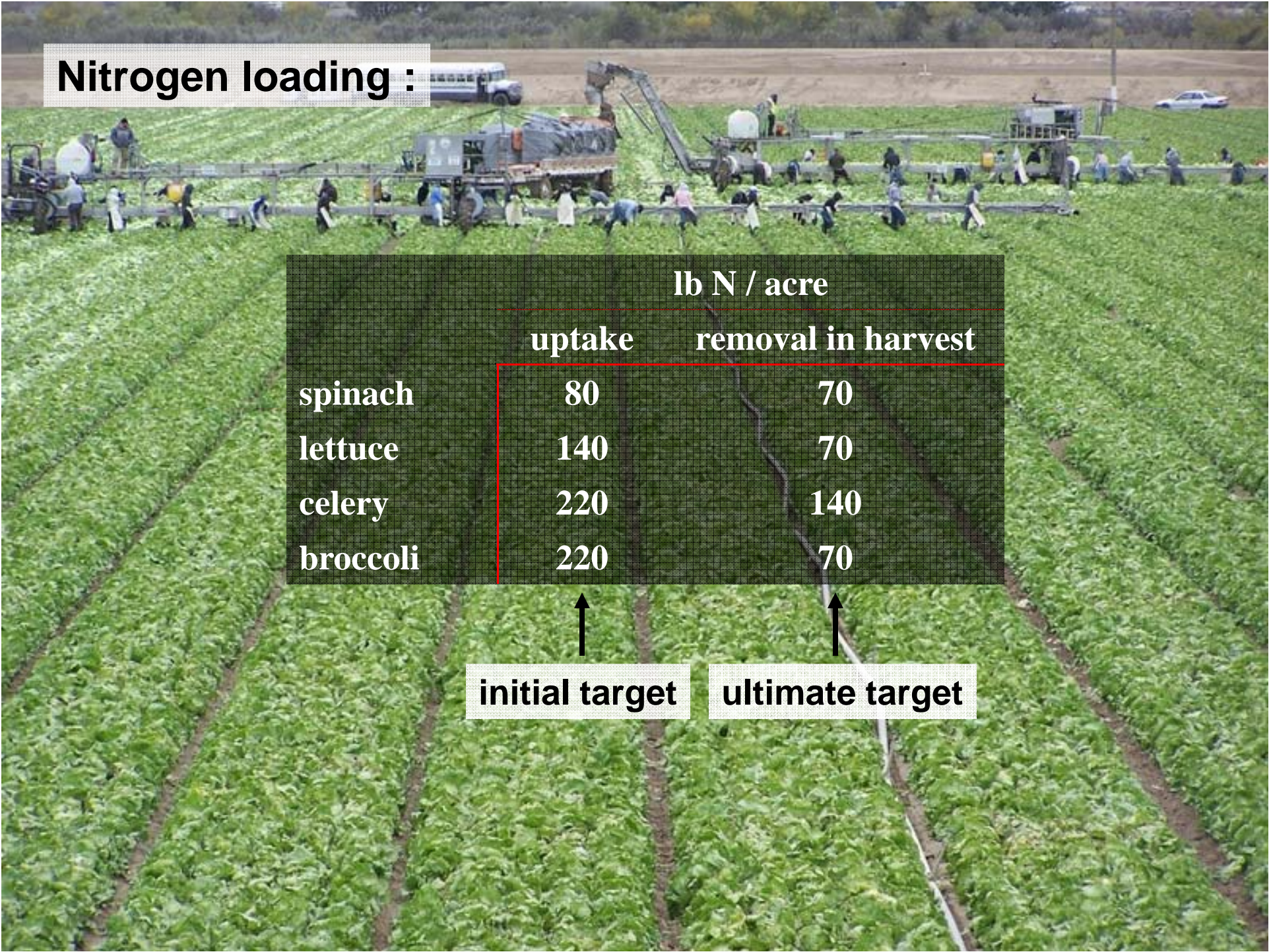


Nitrogen loading :

	lb N / acre	
	uptake	removal in harvest
spinach	80	70
lettuce	140	70
celery	220	140
broccoli	220	70

↑
initial target

↑
ultimate target





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A photograph of a drainage ditch with a pipe, showing soil erosion and water flow. The ditch is dug into brown soil, and a black pipe is visible. Water is flowing through the pipe and into the ditch. The background shows more soil and some dry sticks.

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(possible short term, not likely long term)
- lost through leaching or runoff
(the fate of much of the N 'not removed')

Nitrate concentration standard is very tough :



Federal drinking water standard of 10 PPM $\text{NO}_3\text{-N}$ is applied to all groundwater, and most surface water



How tough is the 10 PPM $\text{NO}_3\text{-N}$ standard?

- for every 10 lb $\text{NO}_3\text{-N}$ released to the environment, more than 4 acre inches of clean water would be needed to dilute it
- for soil leachate to average 10 PPM $\text{NO}_3\text{-N}$, soil would need to average < 3 PPM $\text{NO}_3\text{-N}$



Can surface runoff meet this standard ?

- **Field monitoring shows that runoff tends to be a few PPM greater than the irrigation water $\text{NO}_3\text{-N}$**



Can leachate or tile drain effluent meet this standard ?

Relationship between soil NO₃-N and leachate NO₃-N :

- all NO₃-N is in the soil solution, not attached to soil particles
- soil solution only 20-30% the weight of soil

**Soil NO₃-N
(PPM)**

10-20

NO₃-N in soil solution (PPM)

Sandy loam

50-100

Clay

30-60



Bottom line :

- water leaving vegetable fields will likely exceed 10 PPM $\text{NO}_3\text{-N}$
- regulatory compliance will require management changes
 - less fertilizer applied
 - better control of irrigation
 - nutrient trapping where possible
 - treatment of discharged water

How can fertilizer application be *safely* reduced ?
✓ modify preplant application
- fall N application is highly inefficient



How can fertilizer application be *safely* reduced ?

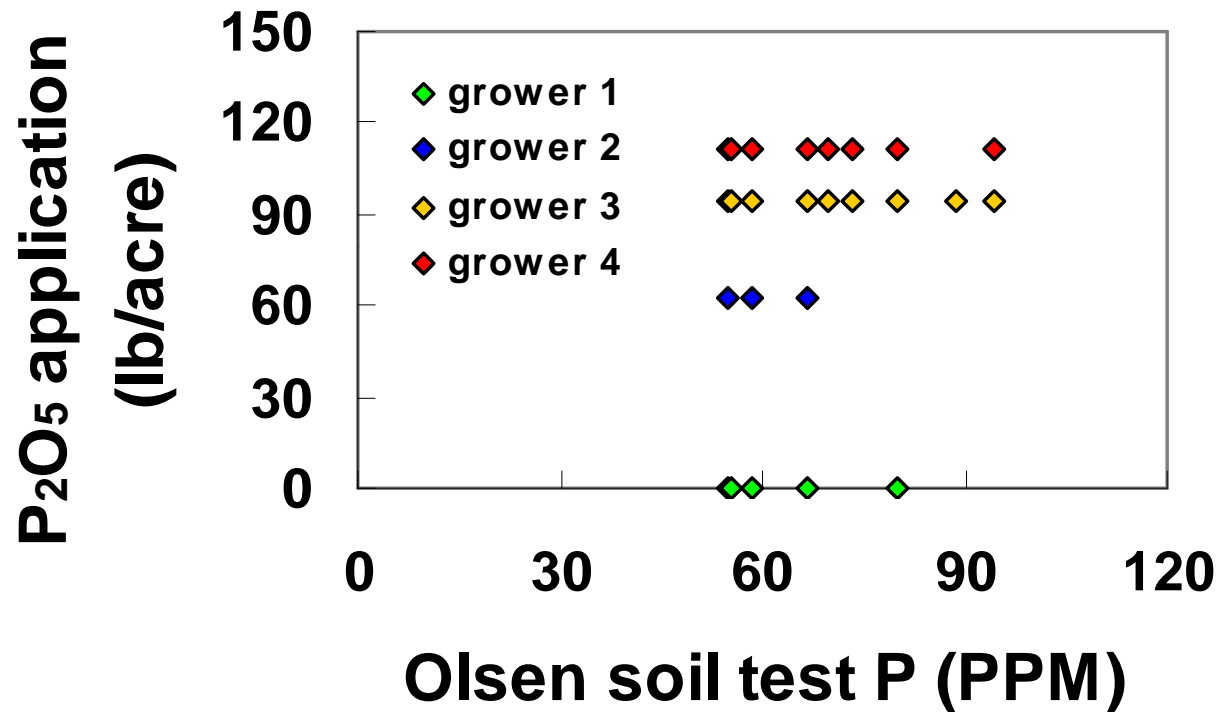
✓ modify preplant application

- fall N application is highly inefficient

- **do not apply preplant where it is not needed**



Preplant applications should be field-specific :



Many coastal vegetable fields require no P or K

Summer plantings unlikely to require preplant N :



Of 14 summer lettuce fields sampled at thinning in 2009 :

- **average $\text{NO}_3\text{-N}$ was > 100 lb N/acre in top foot**
- **minimum was > 60 lb $\text{NO}_3\text{-N}$ /acre in top foot**

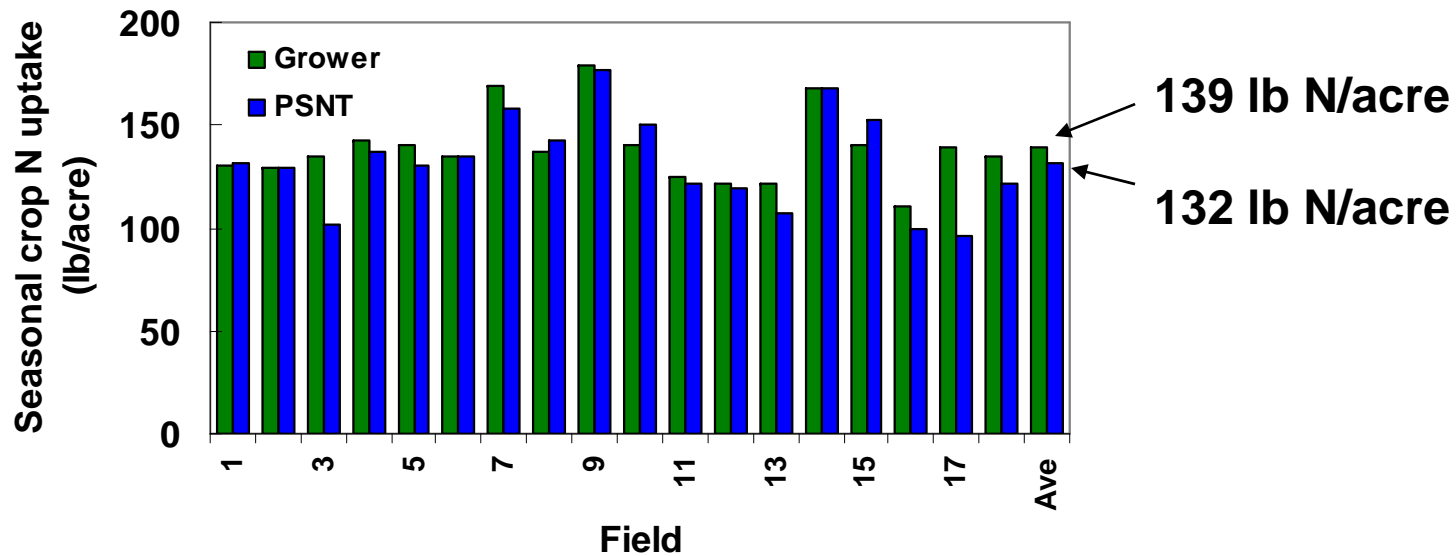
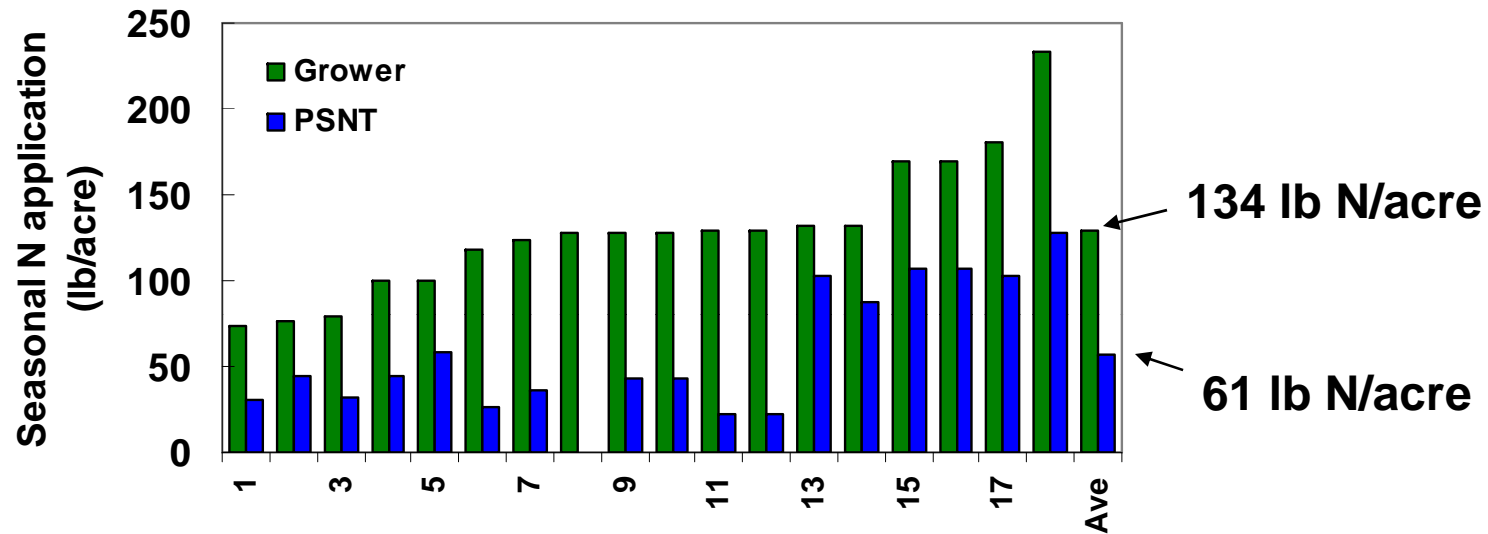
Is your N application program reasonable ?

In more than 100 lettuce fields monitored over the past decade ...

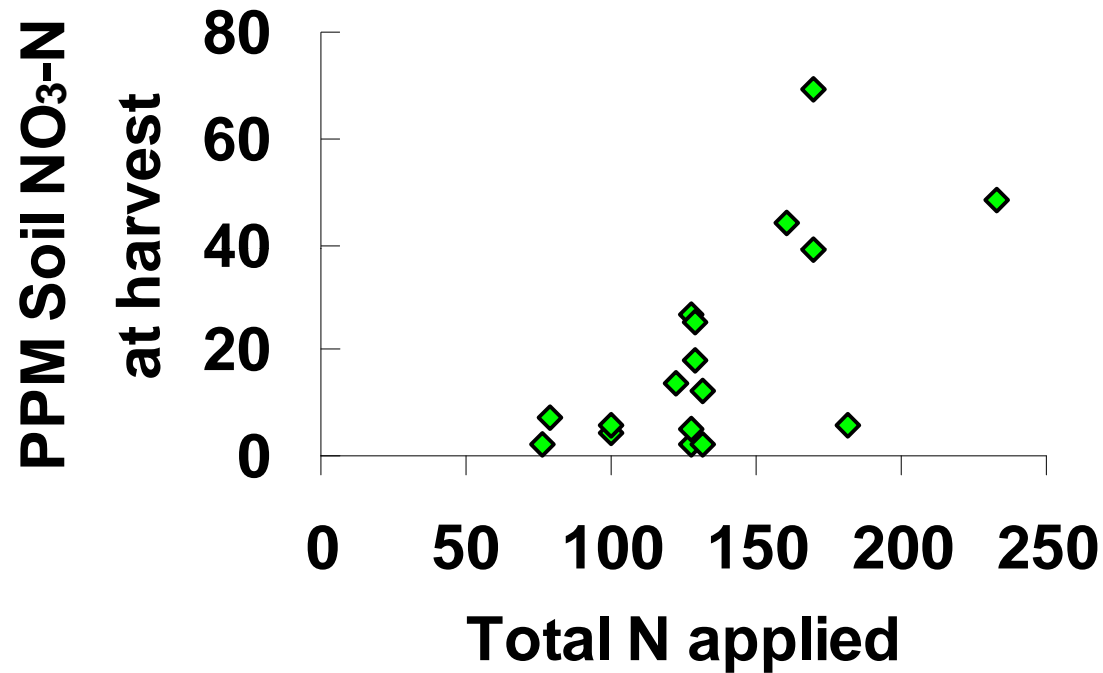
	Seasonal N application (lb /acre)	
	Spring planting	Summer planting
High	392	306
Low	70	27
Average	215	152
Average of lowest 50% of fields	149	106
Average of highest 50% of fields	281	198

N uptake efficiency declines as fertilizer rate increases ...

2009 lettuce N trials :



2009 lettuce N trials :



- ✓ Higher N application leads to higher residual soil NO₃-N

To help reduce N fertilizer application, consider the fertilizer value of irrigation water $\text{NO}_3\text{-N}$:

- ✓ Any applied water that is transpired by the plant leaves its $\text{NO}_3\text{-N}$ at the root surface**



Example : Coastal lettuce

- Irrigation water contains 20 PPM $\text{NO}_3\text{-N}$:
 $20 \times 0.23 = 4.6 \text{ lb NO}_3\text{-N per acre} \cdot \text{inch}$
- Seasonal transpiration by the crop = 8 inches

Therefore :

$4.6 \text{ lb NO}_3\text{-N / acre} \cdot \text{inch} \times 8 \text{ inches} = 37 \text{ lb NO}_3\text{-N /acre for the season}$



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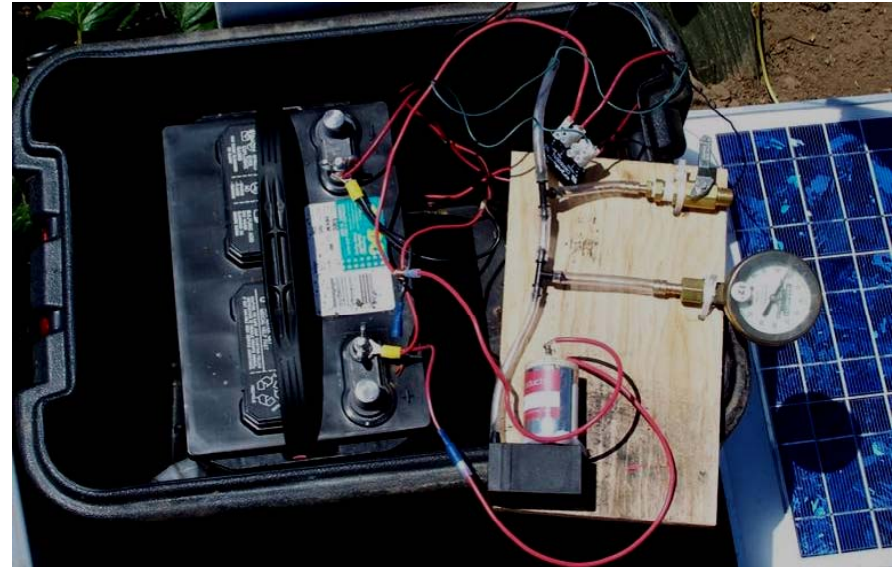
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Caution:
excessive irrigation will leach more nitrate than the well water provides

Effect of irrigation efficiency on nitrate loss :



Automated suction lysimeters

	Applied water (in.)	Percolation (in.)	NO ₃ -N loss (lb/acre)
Grower irrigation	1.4	0.9	37
Efficient irrigation	0.8	0.3	11

Nitrogen trapping :

Cover crops can scavenge soil $\text{NO}_3\text{-N}$, but ...



... N uptake is proportional to growth, and growth must occur before nitrate is leached

Can water be treated to remove nitrate ?

- Common conservation practices generally ineffective in removing $\text{NO}_3\text{-N}$ from surface runoff



Can water be treated to remove nitrate ?

- Denitrification beds an interesting technology



What will the conditional waiver renewal bring ?



It will not be easy, but it is possible to make significant progress toward water quality standards

