# Practical ways to improve water quality

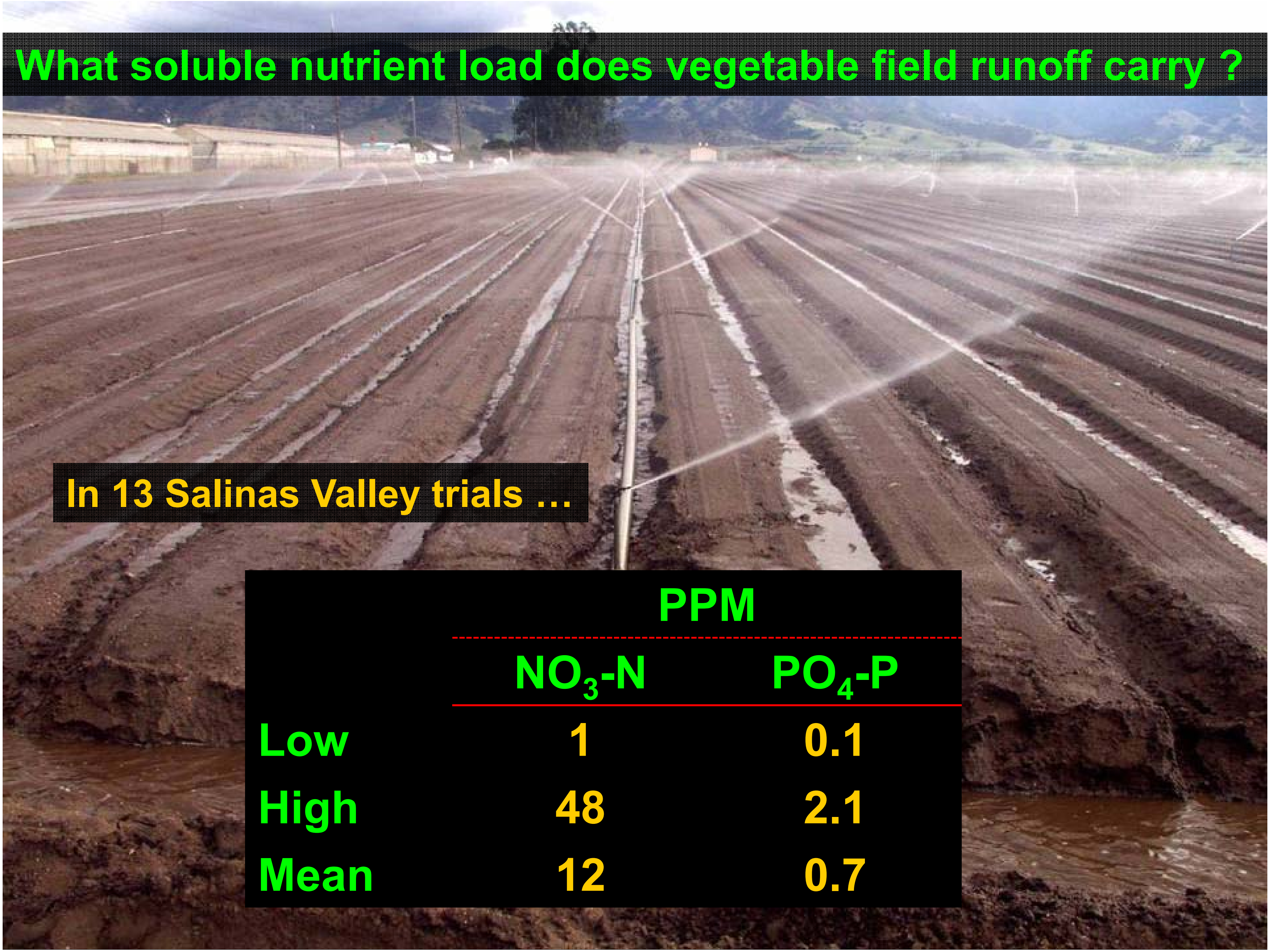
## Salinas/Castroville area ditches, creeks and sloughs

### Average of 2005-07 monthly sampling of 11 sites

| Water quality parameter | Measurement unit | Exceedance threshold | 2005-2007 monthly average |
|---|---|---|---|
| $NO_3$-N | PPM | > 10 | 25 |
| $PO_4$-P | PPM | > 0.5 | 0.63 |
| Algae | % survival | > 110 | 228 |
| | | | |
| Turbidity | NTU | > 50 | 587 |
| Water toxicity | % survival | < 80 | 27 |
| Sediment toxicity | % survival | < 80 | 24 |


Source of nutrients ?
✓ Fertilizer
✓ Well water

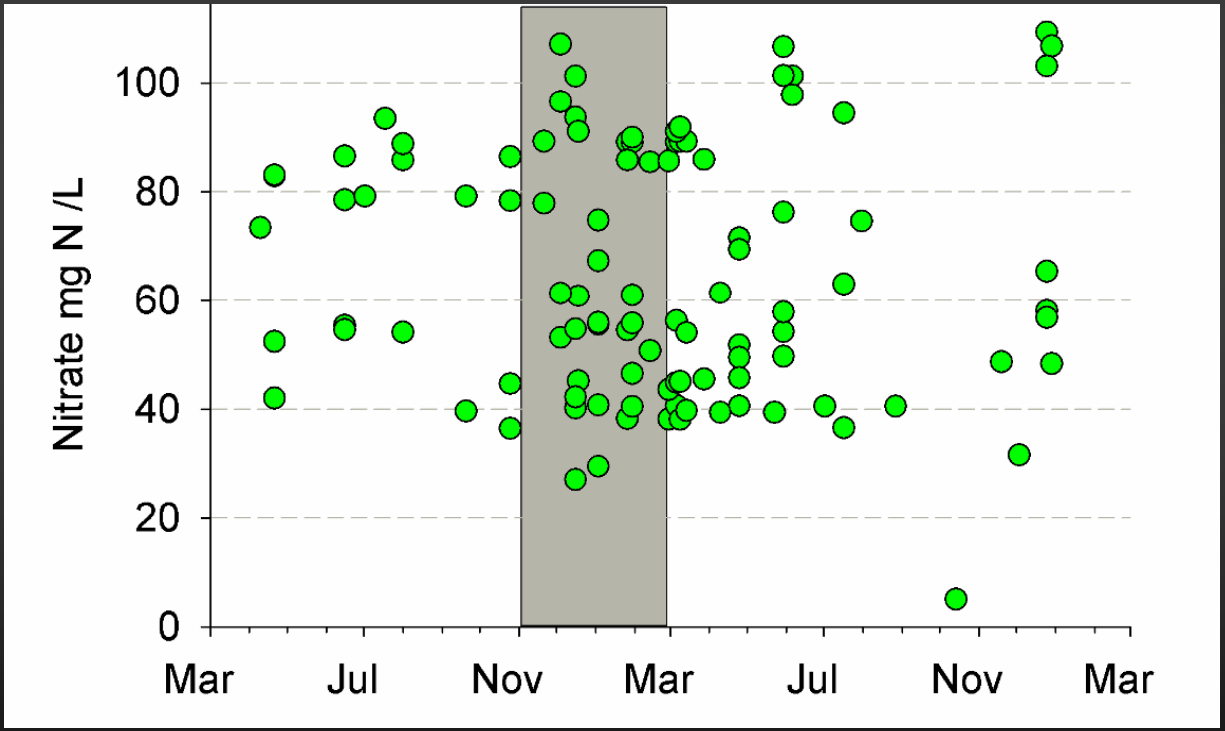
# What soluble nutrient load does vegetable field runoff carry ?



In 13 Salinas Valley trials …

| | PPM | |
|---|---|---|
| | $NO_3$-N | $PO_4$-P |
| Low | 1 | 0.1 |
| High | 48 | 2.1 |
| Mean | 12 | 0.7 |

## How about drain tile effluent ?




2002-04 drain tile sampling in the Salinas Valley

Why is drain tile effluent so high in $NO_3$-N?

- all $NO_3$-N is in the soil solution

Relationship of soil $NO_3$-N to soil solution $NO_3$-N :

| Soil $NO_3$-N (PPM) | $NO_3$-N in soil solution (PPM) | |
|---|---|---|
| | Sandy loam | Clay |
| 10 | 50 | 30 |

**In 13 Salinas Valley field trials runoff turbidity ranged from 200 - 4,600 NTU**

## Bottom line :

**Any water escaping from a vegetable field is likely to exceed water quality standards for one or more pollutants**

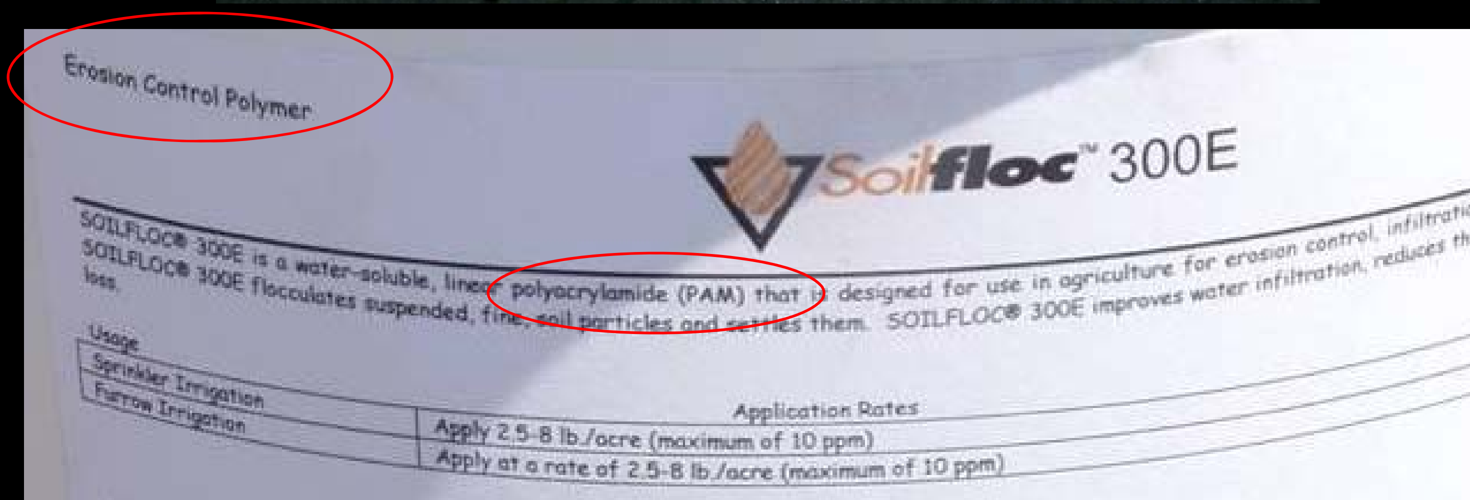
## What can be done ?

- ✓ Treat the water to remove pollutants
- ✓ Reduce the application of materials that can move in water
- ✓ Reduce the volume of water that leaves the field

# Water treatment :

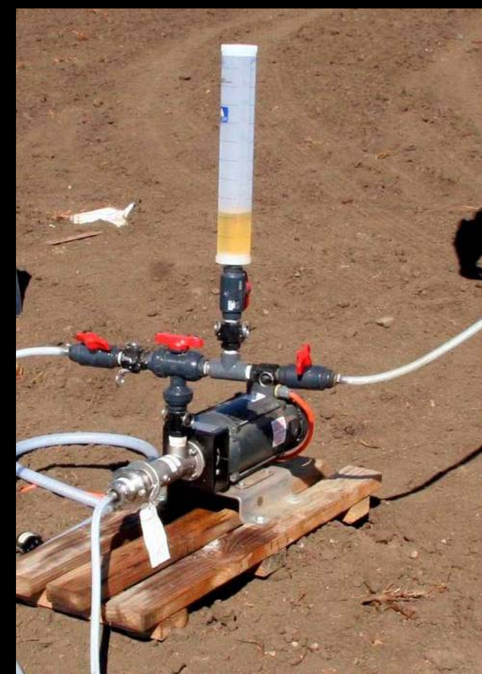
- Consistently reduce sediment loss
- Minimally effective for soluble nutrients
- May conflict with microbial food safety practices

# Water treatment :

# Water treatment :

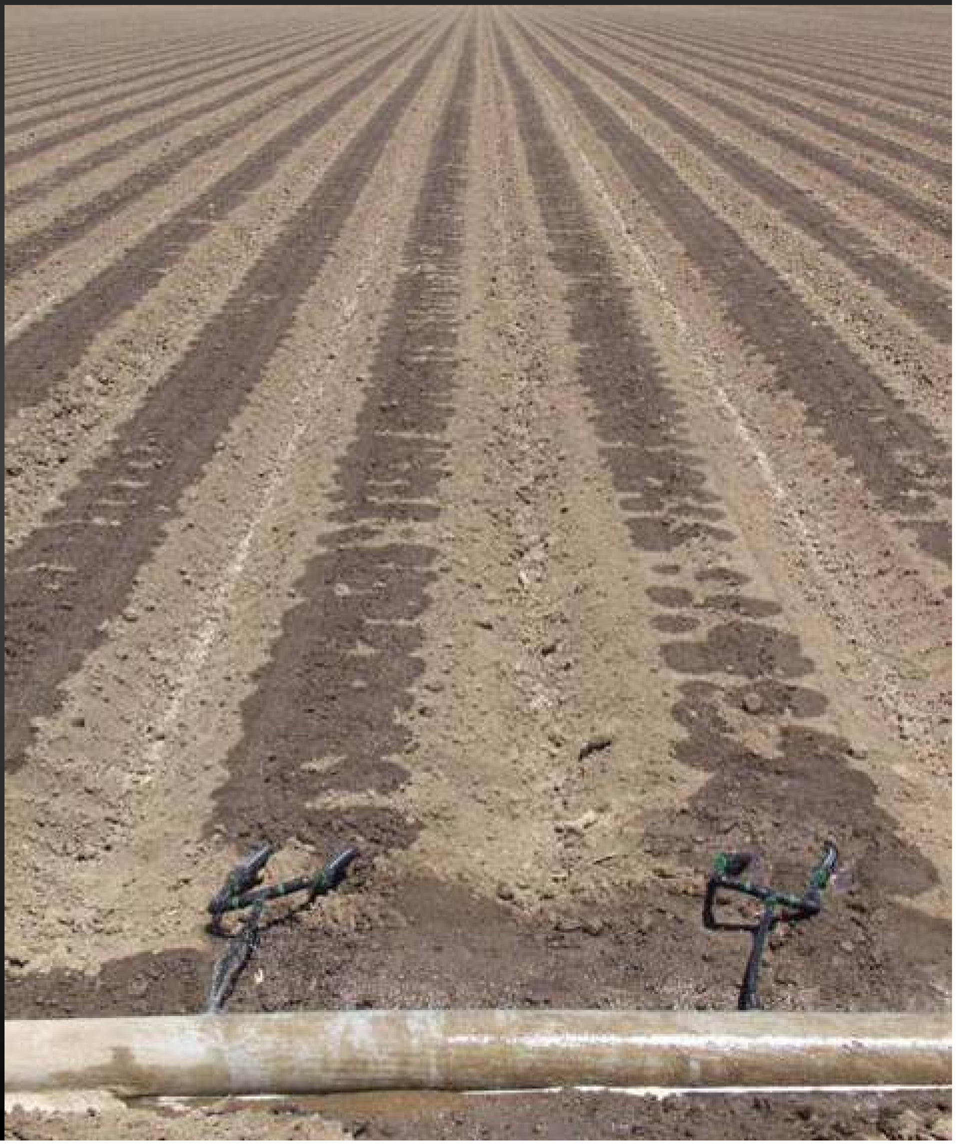
PAM



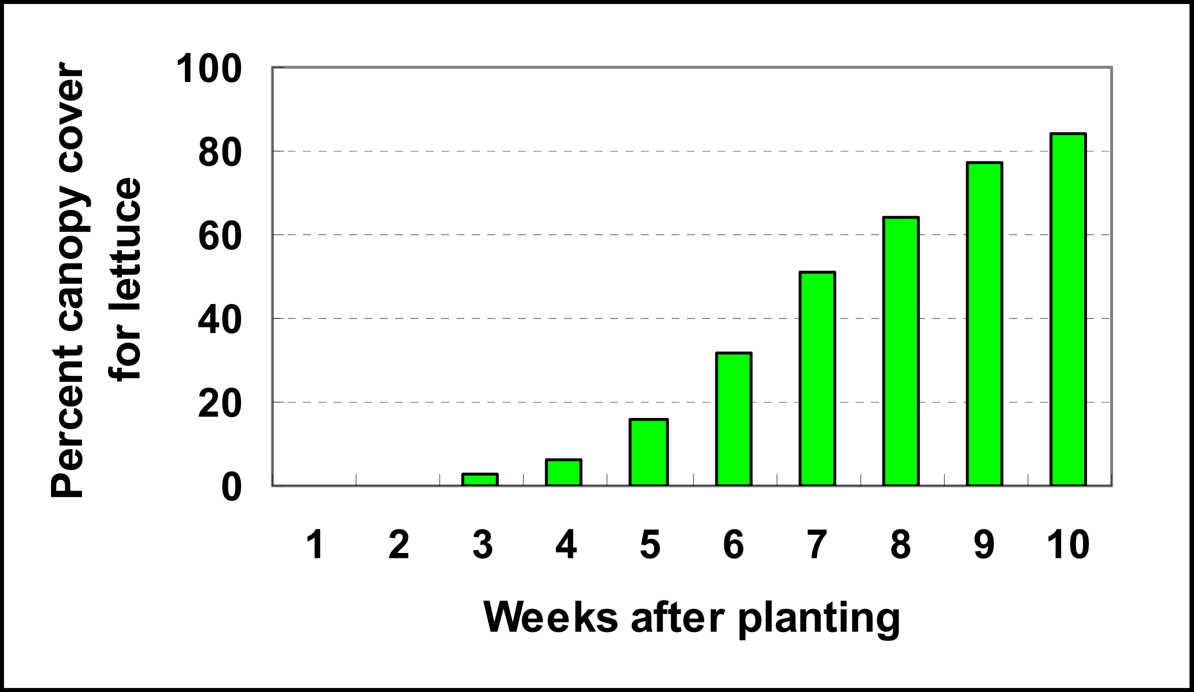
- ✓ Highly effective for sediment removal
- ✓Relatively inexpensive, can be automated
- ✓ Inconsistently effective at reducing soluble nutrients

Most practical solution is to limit the volume of runoff or leachate …

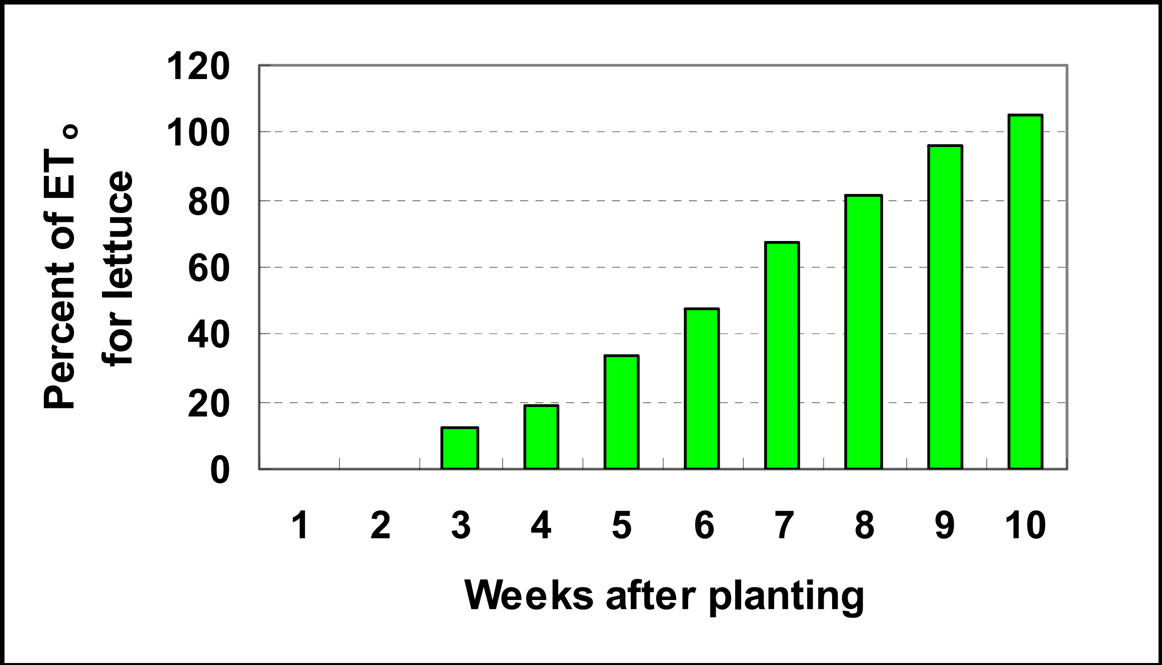
… and drip irrigation is the ideal tool

# Crop water use can be predicted by canopy size and $ET_o$ :

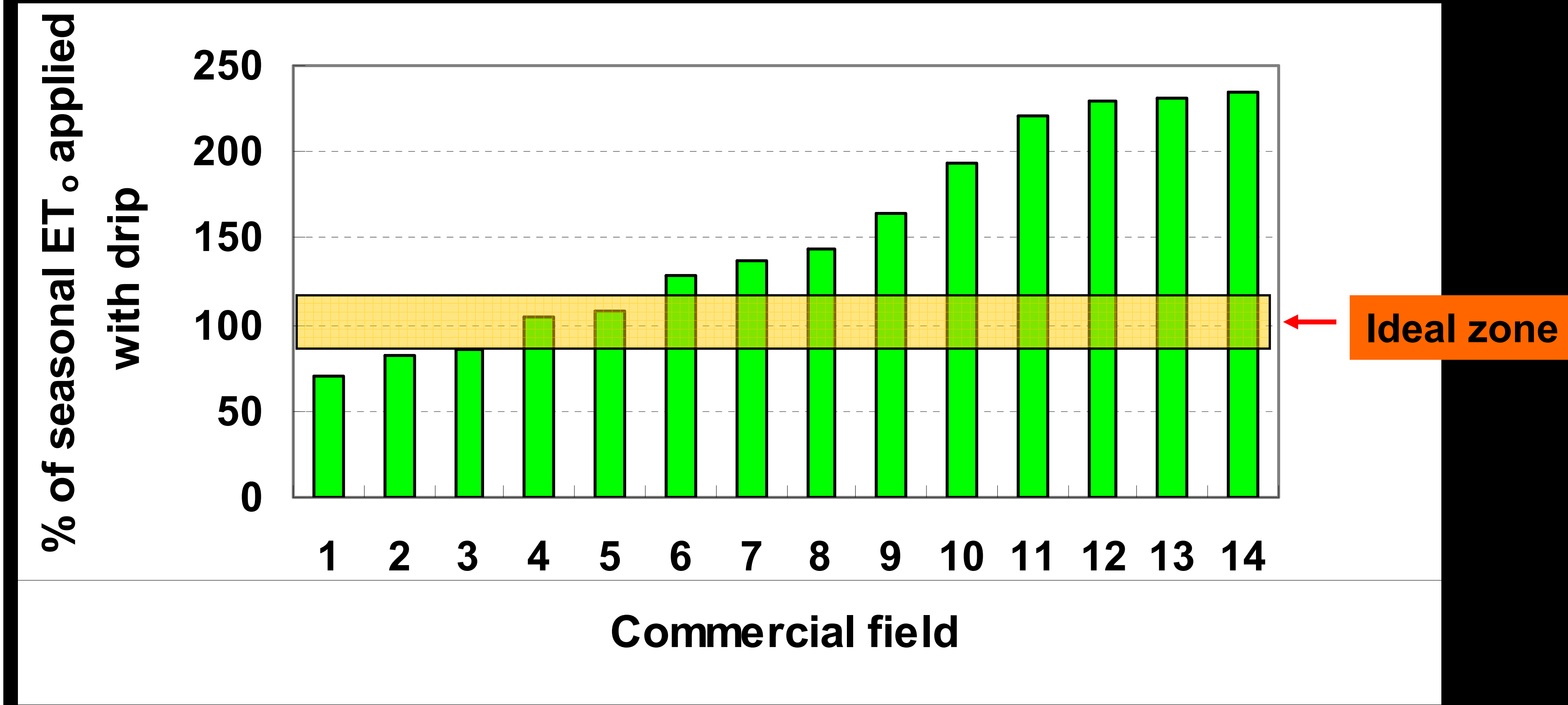


## *Irrigation requirement* can be predicted by canopy size and $ET_o$ :



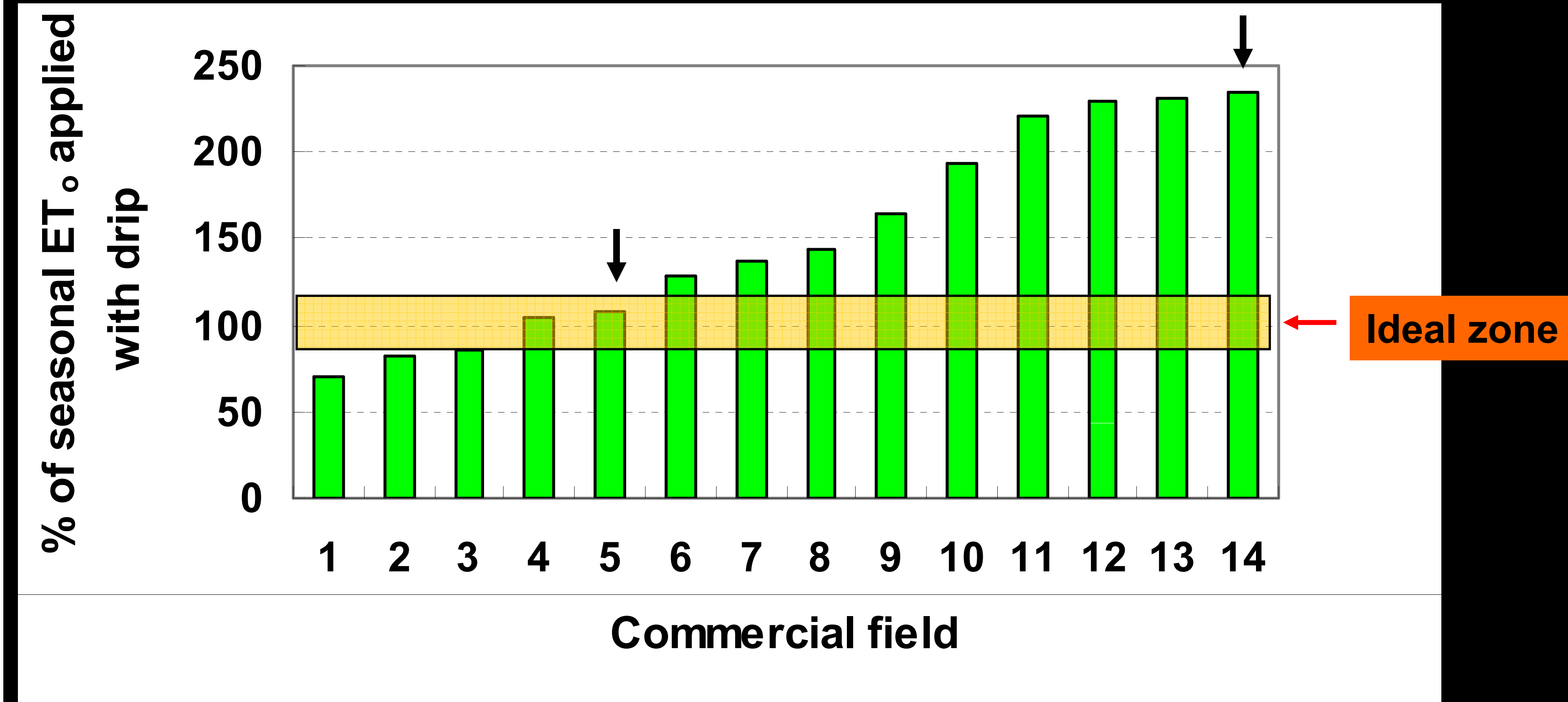

**Efficient seasonal drip irrigation volume ≈ 80 – 120 % of $ET_o$**

# Drip irrigation management varies greatly among growers :




Drip-irrigated lettuce fields in the Salinas Valley

# Consequences of excessive irrigation :



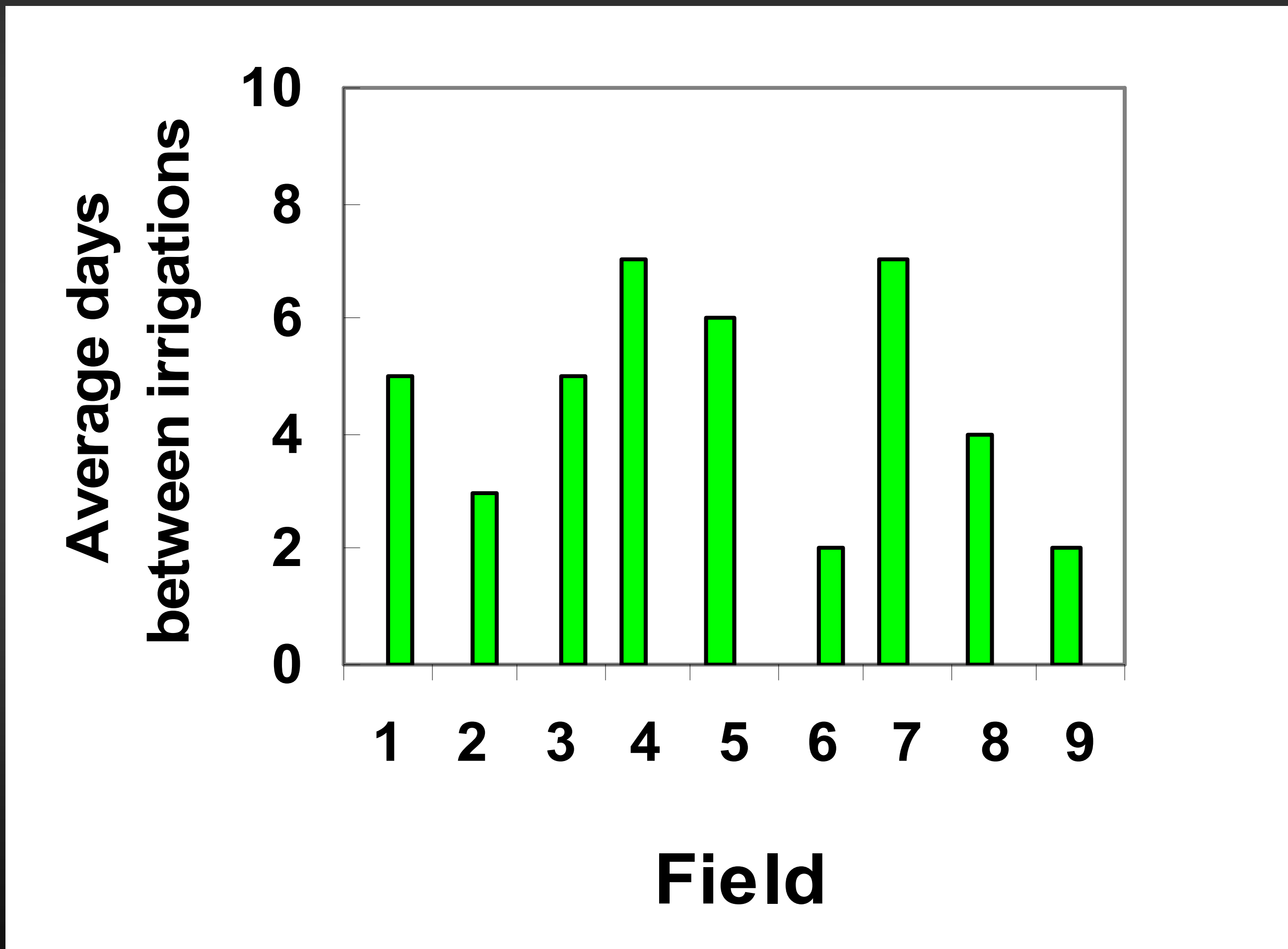

Assume early summer conditions, northern Salinas Valley location, sandy loam soil :

If field 5 applied 5 inches of water with drip, then field 14 applied 10 inches

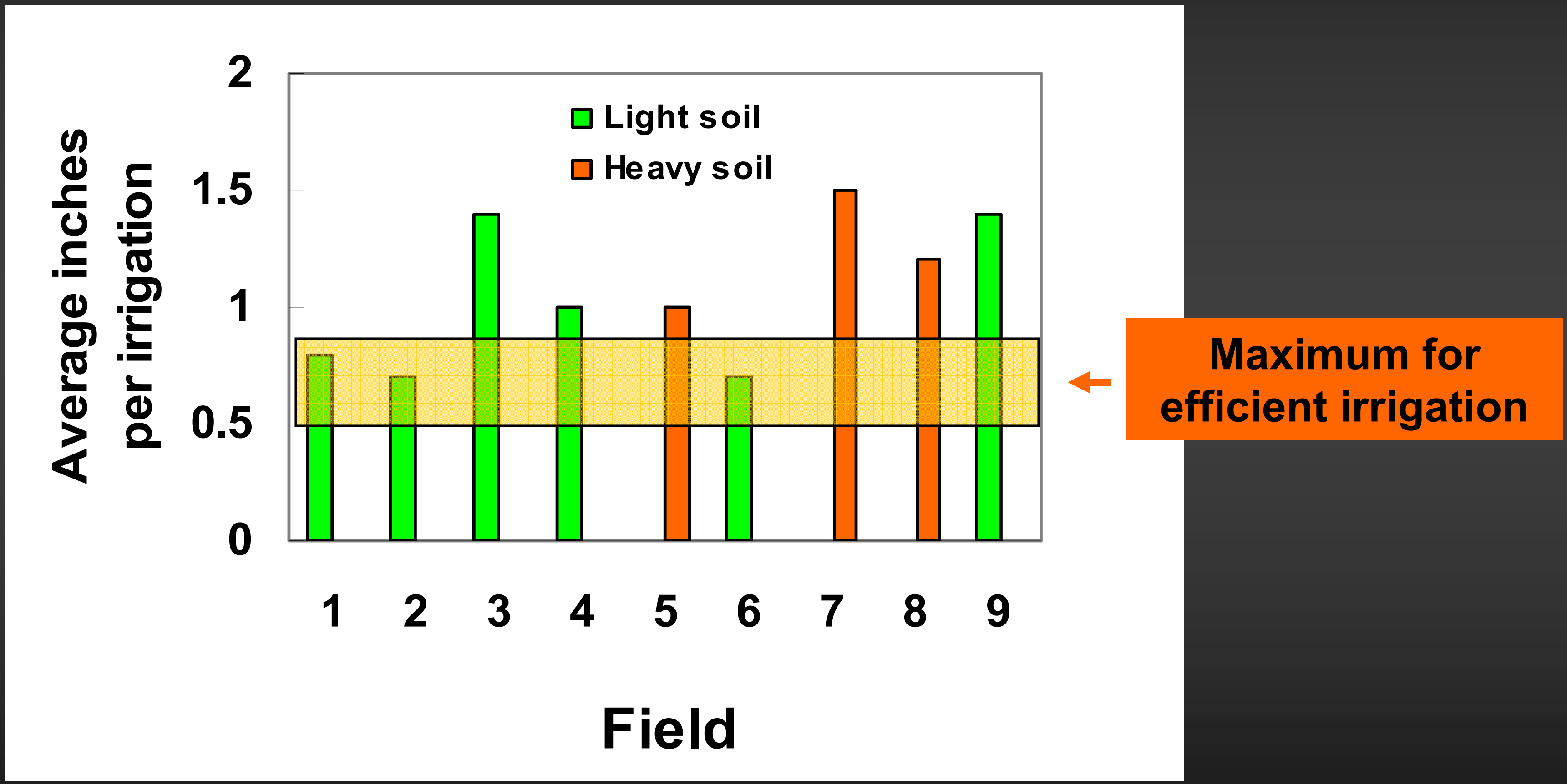
If soil is 10 PPM $NO_3$-N, field 14 lost > 50 lb N/acre in leaching !

## Long irrigation intervals ruin drip irrigation efficiency :

## In drip-irrigated celery fields …

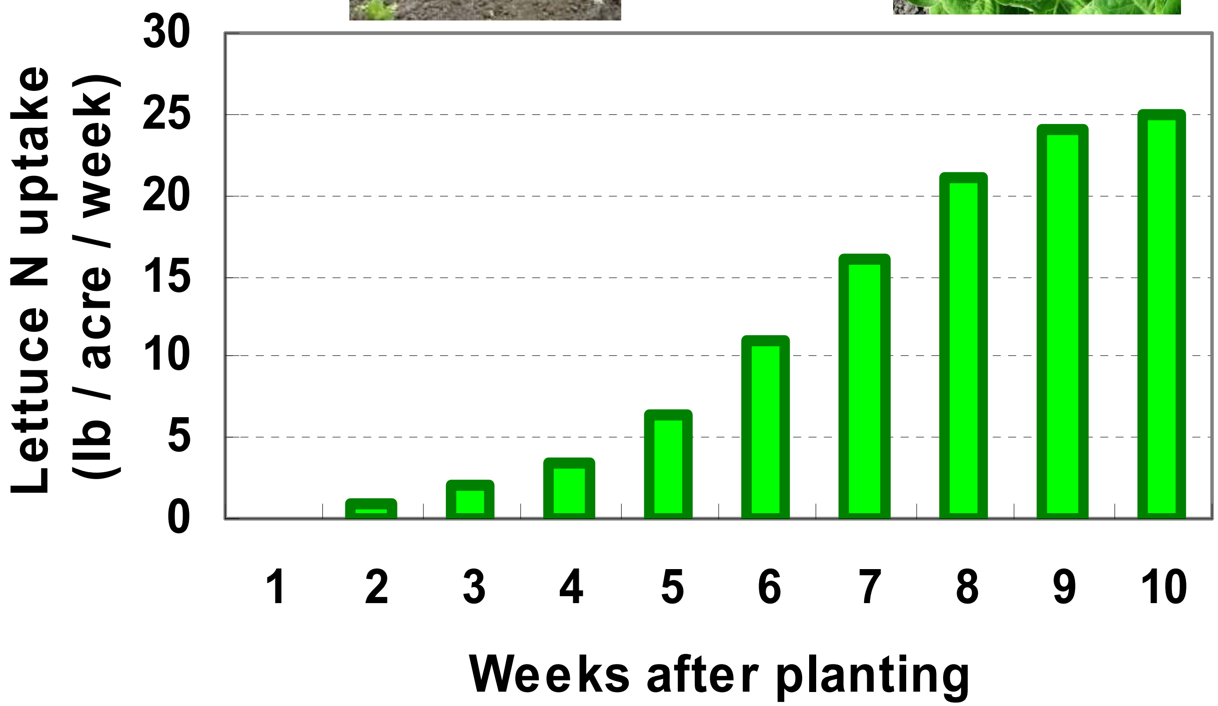


# Long irrigation intervals lead to heavy individual applications :

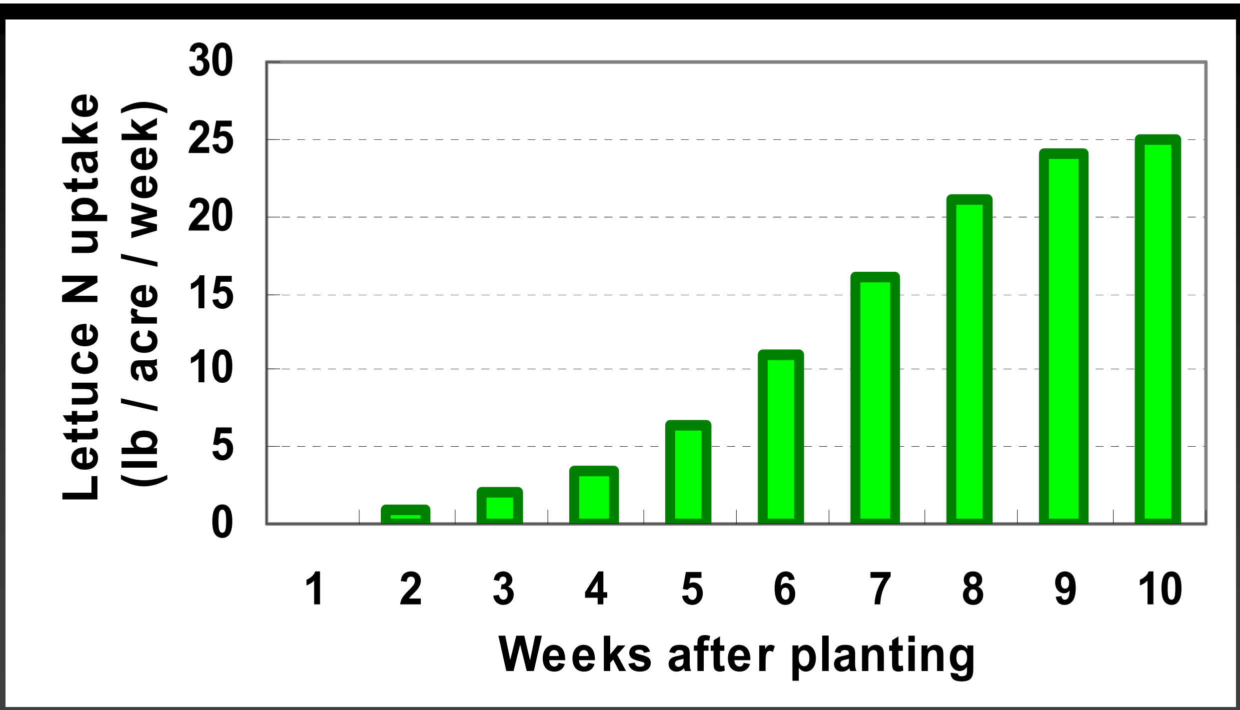



Above this maximum range the leaching fraction becomes significant !

# What constitutes efficient fertigation ?




**90 - 120 lb N/acre at harvest**

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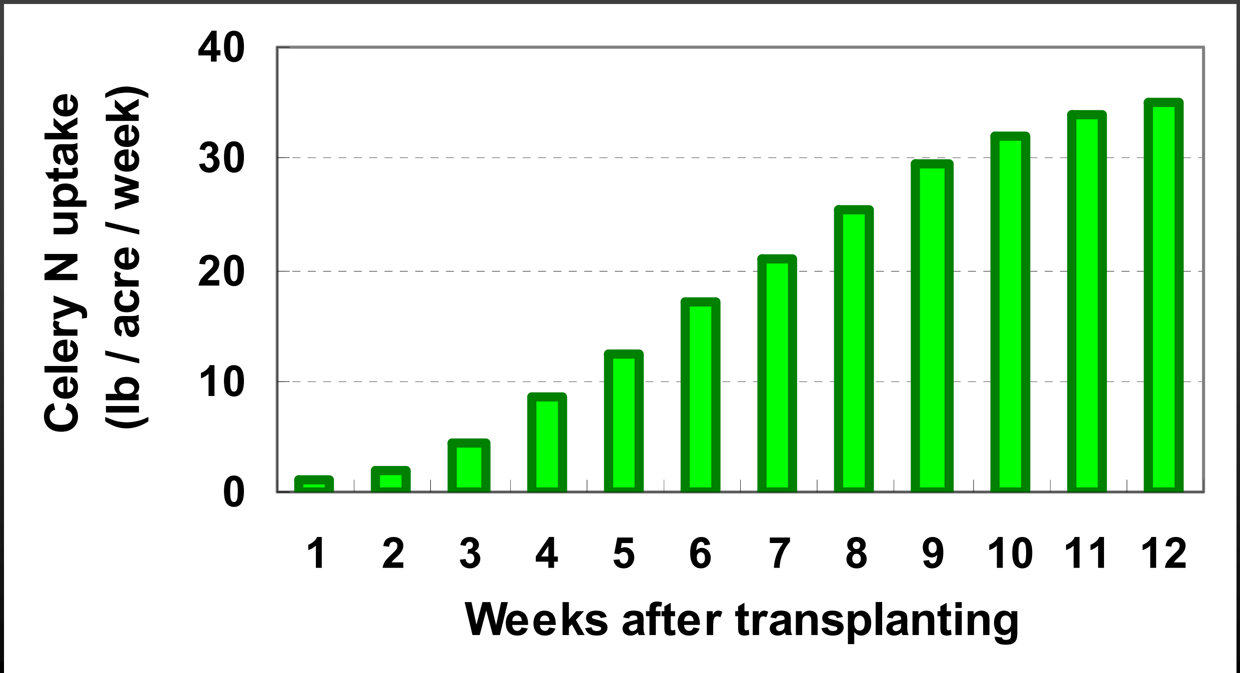
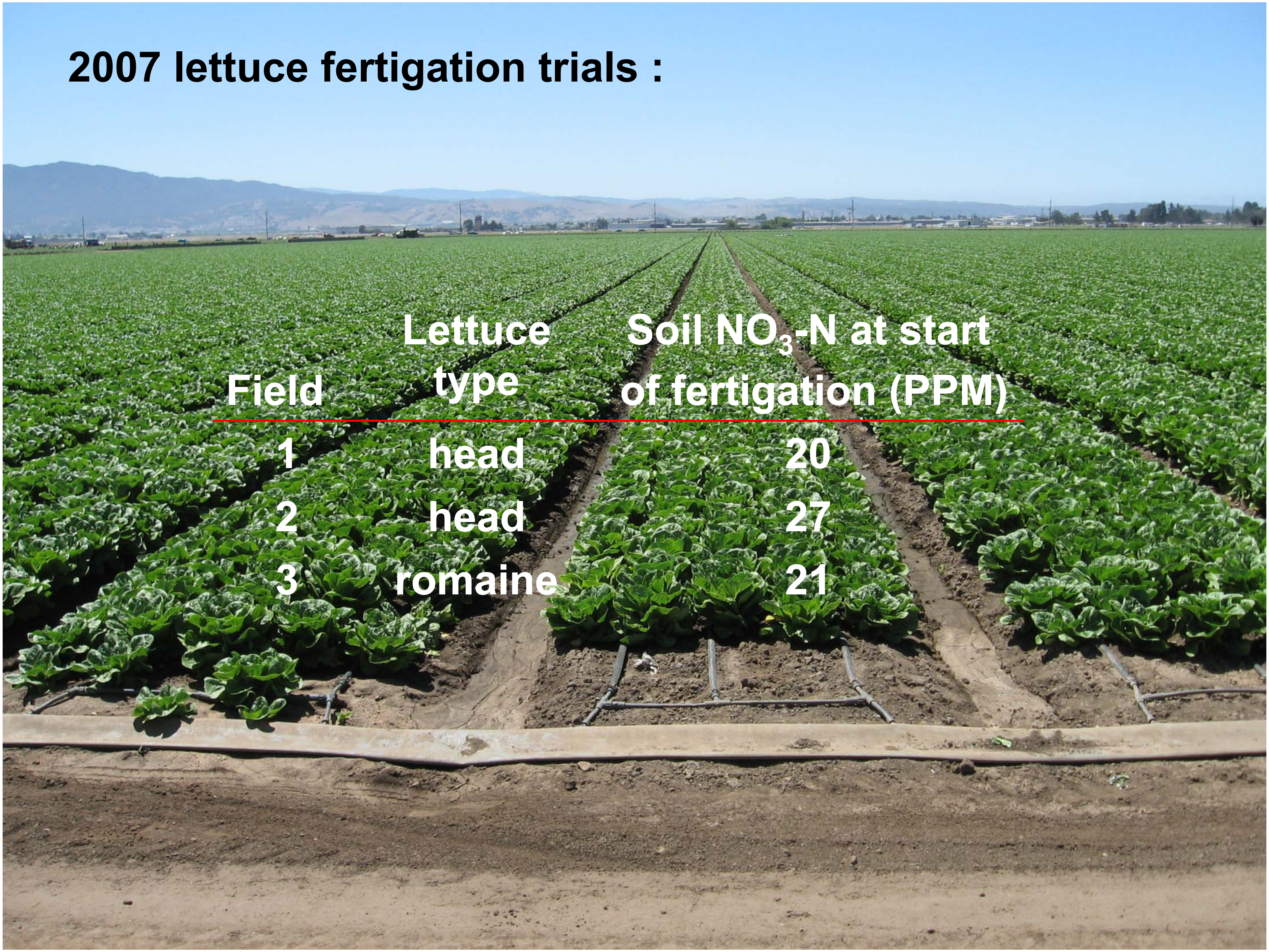



**180 - 220 lb N/acre at harvest**

# 2007 lettuce fertigation trials :



| Field | Lettuce type | Soil $NO_3$-N at start of fertigation (PPM) |
|---|---|---|
| 1 | head | 20 |
| 2 | head | 27 |
| 3 | romaine | 21 |

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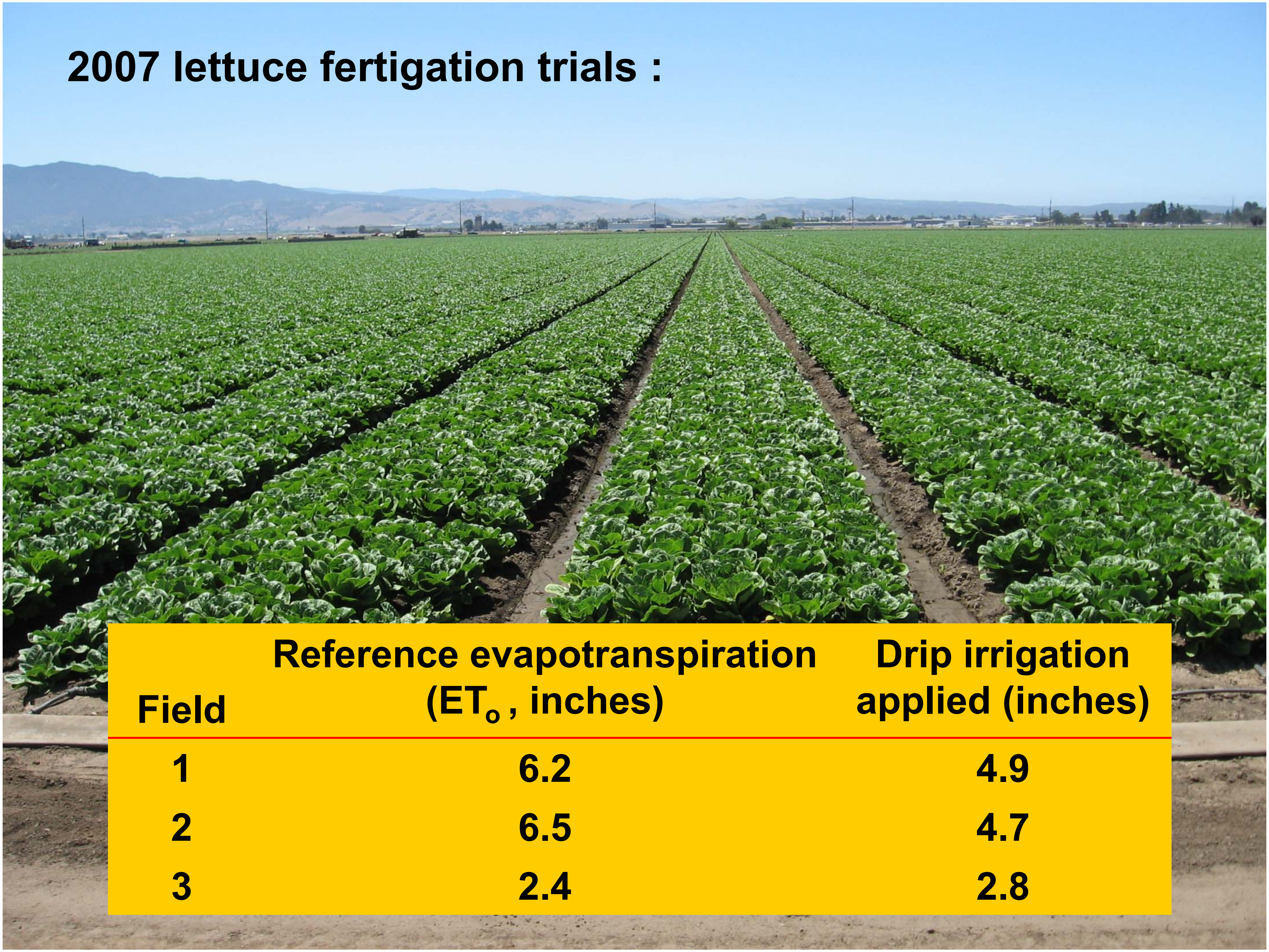
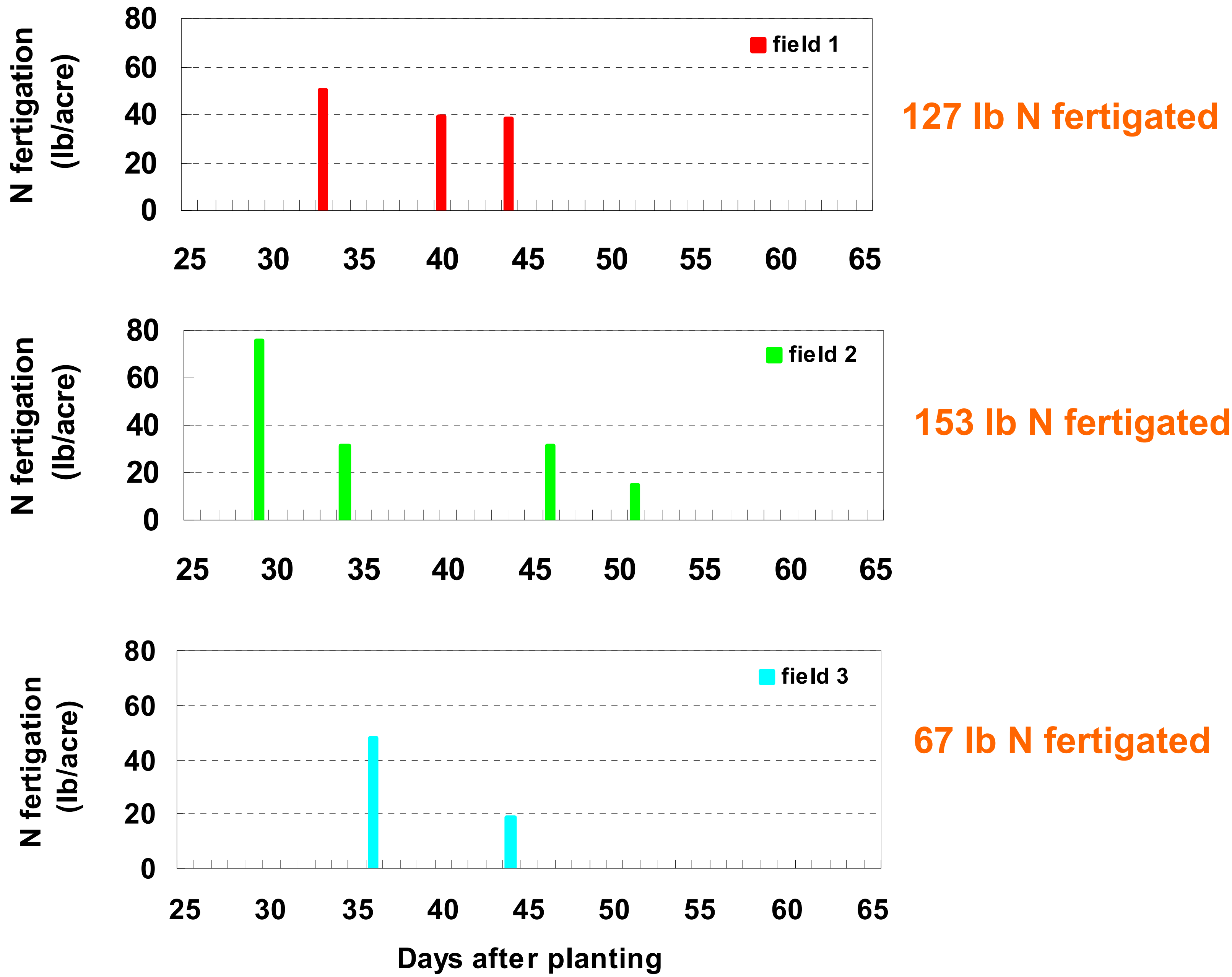
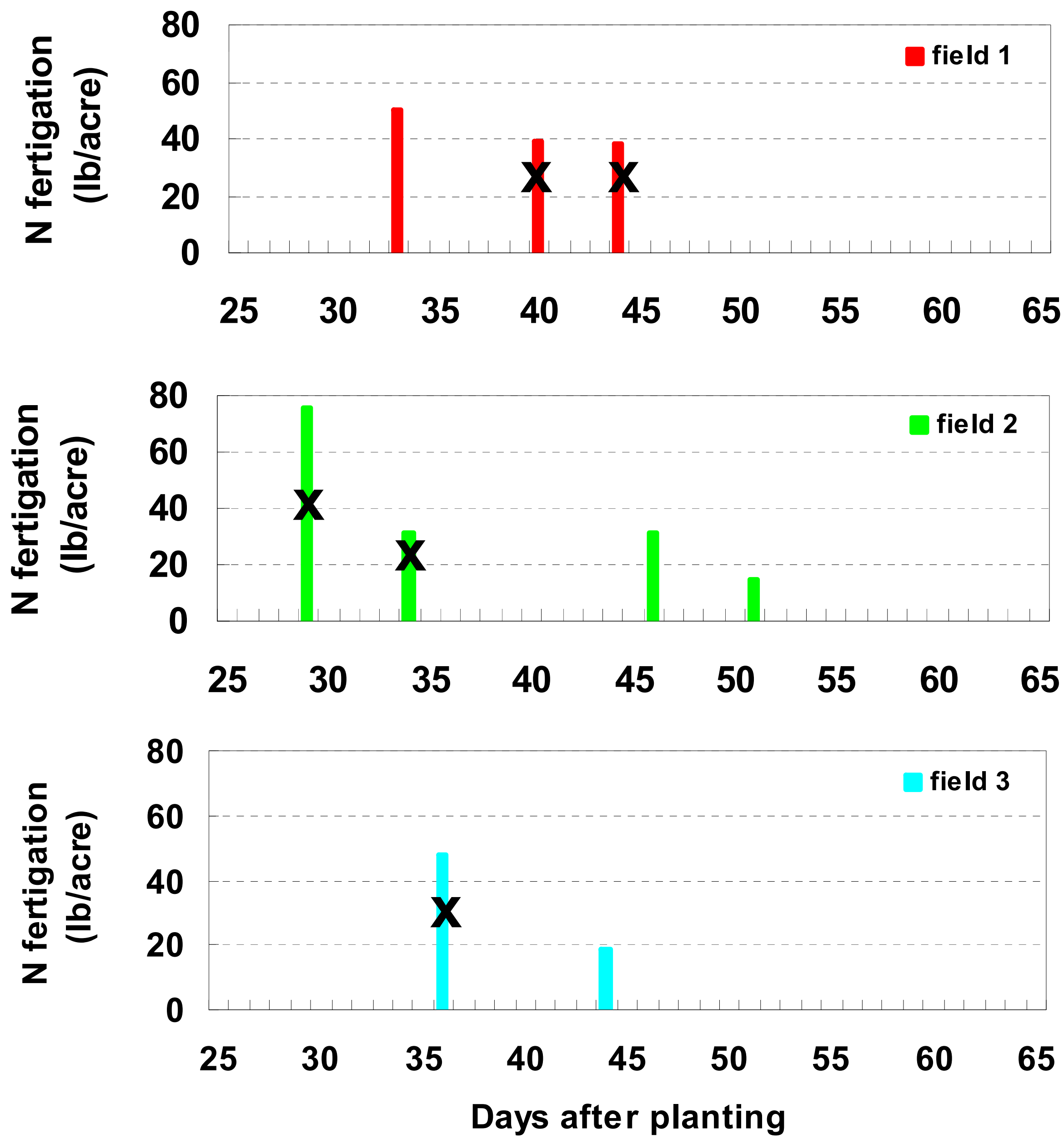


| Field | Reference evapotranspiration ($ET_o$ , inches) | Drip irrigation applied (inches) |
|---|---|---|
| 1 | 6.2 | 4.9 |
| 2 | 6.5 | 4.7 |
| 3 | 2.4 | 2.8 |



N fertigation (lb/acre)
80
60
40
20
0
field 1
25
30
35
40
45
50
55
60
65
127 lb N fertigated
field 2
153 lb N fertigated
field 3
67 lb N fertigated
Days after planting

# Reduced N treatment created by eliminating some N fertigation :



# Results :

| | | lb N / acre | | Mean plant wt | Crop N uptake |
|---|---|---|---|---|---|
| Field | Treatment | total | fertigated | (lb) | (lb / acre) |
| 1 | Grower | 169 | 127 | 2.29 | 98 |
| | Reduced N | 92 | 50 | 2.31 | 91 |

# Results :

| Field | Treatment | lb N / acre total | lb N / acre fertigated | Mean plant wt (lb) | Crop N uptake (lb / acre) |
|---|---|---|---|---|---|
| 1 | Grower | 169 | 127 | 2.29 | 98 |
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| 2 | Grower | 171 | 153 | 2.16 | 103 |
| | Reduced N | 64 | 46 | 2.27 | 101 |

## Results :

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|---|---|---|---|---|---|
| Field | Treatment | total | fertigated | (lb) | (lb / acre) |
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| 2 | Grower | 171 | 153 | 2.16 | 103 |
| | Reduced N | 64 | 46 | 2.27 | 101 |
| 3 | Grower | 115 | 67 | 1.92 | 102 |
| | Reduced N | 67 | 19 | 1.81 | 87 |

**Conclusion :**

✓ given careful irrigation, a modest level of N fertigation is sufficient

## What will efficient fertilization do to water quality ?

- Reduced N application limits potential N loss

## What will efficient irrigation do to water quality ?

- N *concentration* of runoff or leachate might increase, but environmental *load* will decrease substantially

**concentration x volume = load**

**What will efficient irrigation do to water quality ?**

- **N *concentration* of runoff or leachate might increase, but environmental *load* will decrease substantially**

**concentration x volume = load**

**Example : lettuce field 14 – 230% of $ET_o$ applied**

**50 PPM soil solution $NO_3$-N in 5 inches of leaching = 57 lb N/acre**

**Example 2: lettuce field 5 – 110% of $ET_o$ applied**

**100 PPM soil solution $NO_3$-N in 0.5 inches of water loss = 11 lb N/acre**


Putting it together:
✓ Minimize and/or treat sprinkler irrigation during crop establishment
✓ Drip irrigate based on ET, with irrigation frequent enough to be efficient
✓ Fertigate modestly, timing N application to meet crop uptake

**What about winter ?**

- ✓ **Leave as little $NO_3$-N in the profile as possible after fall crop**
- ✓ **Employ winter cover where practical**