Nitrogen management and water quality regulation
Surface runoff and tile drainage can degrade surface water quality
- Pesticide residues
- Sediment
- Nutrients
Conversion to drip solves the surface runoff problem ...

... but not the groundwater problem
Nitrate leaching to groundwater has become a hot issue:

Federal drinking water standard is 10 PPM NO$_3$-N (= 45 PPM NO$_3^-$)
Groundwater NO$_3$-N:
Regulatory action on nitrogen management:

- Region 5 Board imposed an N balance restriction on dairies, and is now focusing on other cropping systems.
Central Valley dairy:
- Annual N application target of 1.4 times forage crop N uptake

Coastal vegetable crops:
- Proposed annual N application targets of 1.0 for vegetable crops

First target:
  (N application = crop N uptake)

Ultimate target:
  (N application = harvest N removal)
What comes next?

- Region 5 wants data on potential groundwater loading from the major Central Valley crops
- Processing tomato not in the immediate line of fire, but future scrutiny is likely
Nitrogen balance for processing tomato:

<table>
<thead>
<tr>
<th>Description</th>
<th>Ib N/acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seasonal fertilizer application</td>
<td>190</td>
</tr>
<tr>
<td>Crop N uptake</td>
<td>240</td>
</tr>
<tr>
<td>N removed with harvest</td>
<td>150</td>
</tr>
<tr>
<td>Application - crop uptake</td>
<td>-50</td>
</tr>
<tr>
<td>Application - harvest removal</td>
<td>+40</td>
</tr>
</tbody>
</table>

Based on a 50 ton crop

Why focus on harvest removal?
- N applied to the field but not removed in harvested product is viewed as at risk for eventual loss to the environment
Steps to more efficient N management:

- Evaluate residual soil NO$_3$-N
- Credit N contribution from organic amendments
- Control in-season leaching
Evaluate residual soil NO$_3$-N:

- Tomato fields differ widely

29 fields were monitored:

How to use residual soil NO$_3$-N to modify N application program:

- Each PPM NO$_3$-N represents about 4 lb N/acre in the top foot
- Therefore, N credit could be as much as 4 lb N/acre for each PPM NO$_3$-N above 5 PPM
How to sample for soil NO$_3$-N:

- Sample in the drip wetted zone
- Eliminate bed shoulders, surface 2-3 inches
Credit N contribution from organic amendments:

Percent of original N content likely to mineralize over the tomato growing season:

<table>
<thead>
<tr>
<th></th>
<th>&lt; 2% N</th>
<th>&gt; 2% N</th>
</tr>
</thead>
<tbody>
<tr>
<td>fall applied compost*</td>
<td>0</td>
<td>0-5%</td>
</tr>
<tr>
<td>spring applied compost</td>
<td>0-5%</td>
<td>5-10%</td>
</tr>
</tbody>
</table>

* N mineralization from fall to spring already represented by post-transplanting soil NO₃-N test
Control in-season leaching:

- To estimate $\text{NO}_3$-N concentration in leachate, multiply soil $\text{NO}_3$-N by 3 or 4.
  Example: If root zone soil $\text{NO}_3$-N is 15 PPM, leachate is likely to be 40-60 PPM.
- Leachate $\text{NO}_3$-N x 0.23 = lb N per acre-inch of leaching.

In processing tomato production, $\text{NO}_3$-N loss is likely to be in the range of 5-15 lb N/acre inch of leaching.
Can tissue analysis improve N efficiency?

- As currently used, tissue analysis more often leads to increasing a grower’s normal N fertilization program than decreasing it
- Sufficiency level for leaf total N is well established, but petiole NO₃-N sufficiency level needs review
Leaf N data from 20 fields:

- Sufficiency level
- First red fruit
- Full bloom
- Early flowering

The diagram shows a scatter plot with leaf total N (%) on the y-axis and growing degree days on the x-axis. The data is color-coded to indicate sufficient N (green) and deficient N (red). Key points marked are Early flowering, Full bloom, and First red fruit.
Leaf N data from 20 fields:

3-7 weeks post-transplant:
Very low leaf N may indicate limited soil N availability, but plant N uptake is not yet rapid enough to put a strain on soil N supply, so high values do not necessarily indicate high soil N.
7-11 weeks post-transplant:
This is the period of peak N uptake, and leaf N can fall rapidly; by the first red fruit stage leaf N comfortably above the sufficiency level indicates that N fertigation can stop.
Leaf N data from 20 fields:

> 11 weeks post-transplant:
After first red fruit only fields with very low leaf N are candidates for continued fertigation; high leaf N at preharvest indicates excessive N application.
Petiole NO$_3$-N data from 20 fields:
3-7 weeks post-transplant:
Very low petiole NO$_3$-N early in the season indicates limited soil N availability, but in the sufficient range higher values do not necessarily indicate more soil N.
Petiole NO$_3$-N data from 20 fields:

7-11 weeks post-transplant:
Petiole values fall rapidly in this period, and it is difficult to set a sufficiency level; maintaining 4,000 PPM NO$_3$-N through first red fruit is not required.
After first red fruit the only thing that petiole analysis can tell you is whether you have applied excessive N.

Petiole NO$_3$-N data from 20 fields:

- **Sufficiency level**: 
  - After first red fruit, the only thing petiole analysis can tell you is whether you have applied excessive N.
In summary:

- N management may draw regulatory scrutiny in the years ahead.
- Fertilizer N requirement can vary widely depending on residual soil NO₃-N, and on irrigation management.
- Tissue testing can document N sufficiency, but is less useful in identifying when N fertilization can be reduced.