Toward Reducing Groundwater Nitrate Loading on Dairies

Central Valley Dairy Representative Monitoring Program

LUHDORFF & SCALMANINI
CONSULTING ENGINEERS

Till E. Angermann

Dairy General Order requires management practices protective of groundwater quality

Summary Report scheduled for April 2019

- Identify dairy management practices (MPs) that are protective of groundwater quality (<10 mg/L NO_3-N)
- IF not protective THEN 'must propose *solutions and upgrades* that will result in compliance'
- 'Implementation of the identified MPs must be as soon as practicable, supported with appropriate technical or economic justification and in no case may time schedules extend beyond 10 years from the date that the summary report is approved by the Executive Officer'

Improved N management on cropland holds the most promise for decreasing N loading

Mass contribution on a dairy farm scale 2-5%

- CVDRMP investigates MPs and groundwater quality associated with liquid manure lagoons, corrals, and cropland
- Early focus on lagoons shifted to cropland

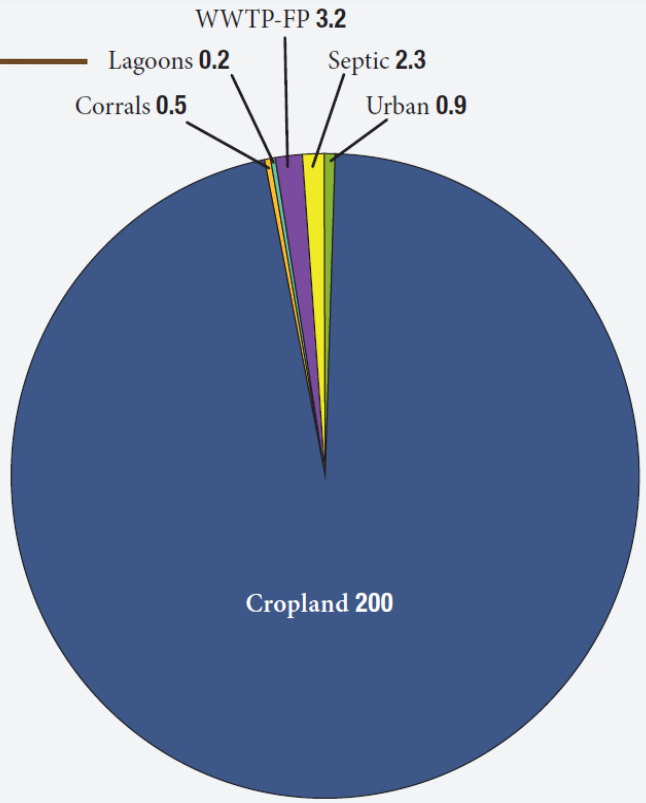

Figure ES-1. Estimated groundwater nitrate loading from major sources within the Tulare Lake Basin and Salinas Valley, in Gg nitrogen per year (1 Gg = 1,100 t).

From: Harter et al. (2012), *Addressing Nitrate in California's Drinking Water*

GW protection cannot be assumed or guaranteed based on implementation of particular MPs

Examples of Management Practices

1. Conduct irrigation system performance evaluation
2. Use weather-based irrigation scheduling
3. Include perennial crop in rotation (e.g., alfalfa)
4. Apply fertilizer N in small multiple doses rather than single large doses

Management Practice: Activity, process, operational range, structure, or use of technology to reduce N leaching

- Carried out at different intensity, frequency, and with various degrees of care (i.e., effectiveness)
  - A single MP has non-unique effects on subsurface mass loading and on groundwater quality
- Confounding factors: Farmers use many MPs at the same time or in sequence, try new things all the time; environmental conditions

CVDRMP's proposed solutions and upgrades will aim to reduce subsurface N loading

Improved N-management manifests itself in reduced N-mass losses to deep percolation NOT necessarily in reduced concentrations in the percolate.

GW monitoring near the water table is not an effective tool for documenting improved site-specific N-management.

Nitrogen use efficiency (NUE) is a direct measure of how well N-applications are matched by crop uptake.

- Same concept as the General Order's application removal ratio (AR ratio)

CVDRMP NUE research studies provide basic information to guide recommendations

- Demonstrate that the *concept* of the AR ratio is universally applicable, while *actions to achieve improvements may differ* from site to site
- Document currently achieved AR ratios under different conditions (as-is conditions)
- Show the extent of improvement under different conditions
- Document the level of effort and challenges associated with improvement under different conditions, including costs

Common components among CVDRMP NUE Research Studies

- Evaluate surface irrigation systems
- Identify if/how existing irrigation systems could be improved; other options
- Track nitrogen inputs, changes in soil storage, and harvest removal to estimate AR Ratios & leaching
- Evaluate current N-application timing with crop need and identify potential for improvements
- Evaluate N-mineralization
- How much on-farm measurement can be expected from a farmer?

Enhanced solid/liquid separation may bear many benefits

- Concentration of organic N and phosphorous in fine solids, reduction of volume, increased transportability and exportability
- Liquid stream lean on organic N, high in ammonium bodes well for improved NUE
- Keeps solids (carbon) out of lagoon
  - Reduces frequency/cost for cleanout
  - Potentially reduces methane emissions
  - Potentially improves flush power due to reduced microbial activity, slime in lagoon

Enhanced solid/liquid separation needs further evaluation

- Can promised results be achieved?
- Capital cost for infrastructure?
- Operation and maintenance needs and costs?
- System reliability?
- Long-term polymer costs?
- Fate of polymers and effect on N mineralization, plant availability?

Internal draft recommendations toward solutions and upgrades and improved groundwater quality are being developed

Examples of Focus Areas

1. Enhanced N mass accounting where needed
2. Enhanced N and irrigation water management where needed
3. Removal of a specific numeric ratio for N management in favor of site-specific benchmarking and incremental improvement over time
4. Development of stronger outreach and education to farm managers to develop specific skills
5. Examine options for implementing a stronger research and development program to support improvements over time
6. Continued use of the CVDRMP well network to document water quality responses to the program over time
7. Use of domestic well testing data to document trends

Scheduled for public release in draft form sometime in 2017

Toward Reducing Groundwater Nitrate Loading on Dairies

Central Valley Dairy Representative Monitoring Program

Thank You