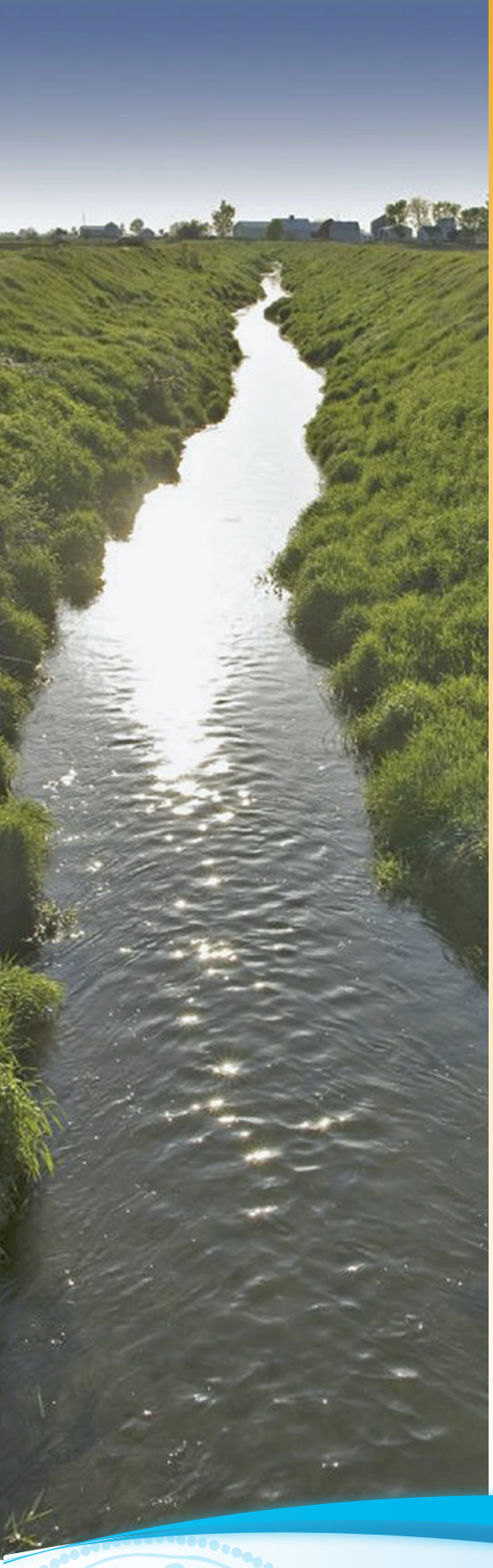

Healthy Crops, Safe Water

ANR Works to Achieve Both

UC Agriculture and Natural Resources is working to ensure that all Californians have access to safe drinking water and to ensure that the state's farmers can grow enough food to help meet the world's increasing demand. Research has shown that nitrogen (N) fertilizer used in agricultural production can over many years move from a plant's root zone into groundwater. UC Cooperative Extension (UCCE) and Agricultural Experiment Station researchers are working with growers with small and large acreage on fertilizer management, irrigation efficiency and other farming practices to provide options for protecting groundwater, which serves as a primary drinking water source for many rural communities.

The following are some specific examples of ANR research and extension projects under way and selected peer-reviewed publications addressing nitrate issues.

Research on nutrient and fertilizer management

Quick nitrate test guides fertilizer management

Michael Cahn and Richard Smith, UC Cooperative Extension advisors in Monterey County, and Tim Hartz, UCCE specialist in the department of Plant Sciences at UC Davis, have developed a quick test to measure soil nitrate in the field so growers can match fertilizer rates with plant needs. The test has reduced nitrogen-loading rates by an average of 70 pounds per acre in lettuce. On-farm demonstration trials have shown that by testing the soil, growers can reduce their fertilizer use by about 30 percent. Major growers in Monterey County, who manage a significant number of vegetable acres in the Salinas Valley, have begun using the quick nitrate test in their operations.

University *of* California
Agriculture and Natural Resources

For more information, see *ucanr.org/hcsw*

Farming practices developed for improving nitrogen use efficiency

Best management practices to minimize nitrate leaching in irrigated crop production have been compiled by UC Cooperative Extension scientists based in the San Joaquin and Salinas valleys and at UC Davis. The project—led by Stuart Pettygrove, UCCE specialist in the department of Land, Air and Water Resources, UC Davis—identifies a wide range of potential techniques for maximizing nitrogen use by vegetables, tree fruits, nuts, vines, field crops, grain, hay, and forage and silage crops, while limiting leaching losses. Many of these practices are already in use by farmers in California, representing a change for the better from historical practices that have contributed to current groundwater nitrate levels.

Nitrogen uptake by crops measured

Aziz Baameur, UC Cooperative Extension advisor in Santa Clara County, and UCCE advisors Mark Bolda and Richard Smith in Santa Cruz County, have been studying the nitrogen use efficiency of lettuce, spinach, broccoli, cabbage, cauliflower, strawberries, raspberries, jalapeños and bell peppers. By identifying the point at which crop quality and yields no longer significantly rise with additional nitrogen, growers can apply fertilizer with more precision to reduce the amount of nitrogen left in the soil. The advisors also show growers how to factor in the nitrogen available in soil and irrigation water.

Assessing plant nutrient status

Leaf sampling is a common method of determining when a nut tree has a nutrient deficiency. Patrick H. Brown, professor in the department of Plant Sciences at UC Davis and Agricultural Experiment Station pomologist, and his colleagues are studying other ways of assessing plant nutrient status to help almond and pistachio growers manage fertilizer applications with more precision.

NBOT aids in dairy nutrient planning

The Nitrogen Budget Optimization Tool (NBOT) is a dairy nutrient planning tool being developed by David Crohn, UC Cooperative Extension specialist in the department of Environmental Sciences at UC Riverside. NBOT is an algorithm that uses a daily time step to represent crop nitrogen demand, nitrogen mineralization and losses from leaching, denitrification and ammonia volatilization. Typical nitrogen application charts tell how much nitrogen a crop needs during the growing season, but they do not say when the crop will need it. With NBOT, dairy operators input information about what crop they are growing, how much they expect to harvest and when they can apply manures. NBOT's output gives an idealized management strategy that helps dairy operators decide what they should do all year round.

Cover crops help trap nitrates

Mark Bolda, UC Cooperative Extension advisor in Santa Cruz County, and Michael Cahn and Richard Smith, UCCE advisors in Monterey County, are studying the ability of cover crops to prevent nitrates from moving out of strawberry and vegetable fields into groundwater. Cover crops can trap mobile nutrients such as nitrate before they can leach below the root zone. Studies in the Salinas Valley have documented that fall-planted non-legume cover crops can take up more than 100 pounds of nitrogen per acre.

UC helps dairy operators understand and comply with regulations

In 2007, the California Regional Water Quality Control Board–Central Valley Region adopted waste discharge requirements that impose stringent nutrient management and monitoring practices on dairies. In the ensuing years, UC Cooperative Extension advisors and specialists, under the leadership of Deanne Meyer, UCCE specialist in the department of Animal Science at UC Davis, have worked with state and local agencies to develop information and resources that enable dairy operators to comply with the regulations. For example, the Water Discharge Requirements General Order Reference Binder is a comprehensive online resource that provides step-by-step instructions written by UC authors for sampling supply wells and subsurface drainage systems, solid manure, liquid manure and soil. Dairy operators can use the resources to create required maps, complete form templates and review an exhaustive list of reference guides.

N-Ledger software addresses nitrogen management

A software program under development by a team headed by Marsha Campbell Mathews, UC Cooperative Extension advisor in Stanislaus County, will help dairy operators and other farmers improve nitrogen management by calculating when nitrogen applied in manure is expected to be released from organic form into a form that the crops can use. Nitrogen applications are tracked, release rates are estimated and adjusted for expected losses, and the calculated total is compared to the expected daily crop need for nitrogen. The program helps the user choose an application strategy that will meet the crop's needs and result in the least possible amount of nitrate in the soil during periods when it is vulnerable to leaching or other losses.

Gene-to-landscape analysis to improve nutrient cycling on organic farms

Organically farmed crops are uniquely susceptible to nitrogen limitations, as well as to pulses of nitrogen into the environment. At 13 field sites, Louise Jackson, UC Cooperative Extension specialist in the department of Land, Air and Water Resources at UC Davis, is examining the potential for a new test—based on plant gene expression—that more accurately reflects the availability of soil nitrogen for particular crops. In addition, researchers are conducting a landscape survey to assess other diagnostic variables that could serve as new plant- and soil-testing approaches for nitrogen management in organic agriculture. In conjunction with this, they are working with farmers and other decision makers on improving nitrogen cycling in organic farming, utilizing participatory stakeholder activities to demonstrate needs, obstacles and time frames for implementation.

Through its *Strategic Vision: 2025*, ANR has funded five multidisciplinary initiatives that seek solutions for issues of importance to California. With respect to nitrogen and water:

- Water Quality, Quantity and Security is focusing on agricultural production, irrigation and nitrogen use;
- Sustainable Food Systems addresses all inputs to production;
- Sustainable Natural Ecosystems looks at the relationship between nitrogen, and rangeland and pasture;
- Endemic and Invasive Pests and Diseases addresses better plant protection, which leads to less plant stress and more efficient fertilizer use; and
- Healthy Families and Communities promotes healthy behaviors and development in young people.

contact Pamela Kan-Rice at 530-754-3912

Peer-reviewed publications

Throughout the history of the University of California, UC scientists have been at the forefront of publishing cutting-edge, peer-reviewed agricultural research as well as user-friendly, science-based materials for growers. The following recent ANR publications and *California Agriculture* journal articles (in quotes) demonstrate some of the breadth of published information about water quality and nutrient management.

Irrigation efficiency, runoff management, soil hydrology

Agricultural Salinity and Drainage

California Dairies: Protecting Water Quality

Dairy Water Compliance: Steps to Take After the Preliminary Assessment

Farm Water Quality Fact Sheet Series

Management Options to Reduce Pollutants in Runoff from Irrigated Pastures

"Monitoring helps reduce water-quality impacts in flood-irrigated pasture"

Salinity Management Under Drip Irrigation of Row Crops

Scheduling Irrigations: When and How Much to Apply

Sprinkle Irrigation of Row and Field Crops

Water Quality Treatment for Livestock Feeding and Exercise Areas on California Coastal Dairy Farms and Ranches

"Water sensors with cellular system eliminate tail water drainage in alfalfa irrigation"

Nutrient management, conservation tillage, cover cropping, manure treatment

Cover Cropping for Vegetable Production

Dairy Manure Treatment Technologies

Dairy Nutritionists' Roles in Nutrient Use

"Deep vadose zone hydrology demonstrates fate of nitrate in eastern San Joaquin Valley"

Fertilizing with Microirrigation

Groundwater Quality Protection: Managing Dairy Manure in the Central Valley of California

Manure Treatment Technologies: Anaerobic Digesters

Production Guide: Nitrogen and Water Management of Coastal Cool-Season Vegetable Production

"Scientists, growers assess trade-offs in use of tillage, cover crops and compost"

Total Mixed Ration (TMR) Sampling Protocol

Using Feed Inventory Records to Reduce Nutrient Loading at Dairy Operations

Vegetative Filter Strips for Nonpoint Source Pollution Control in Agriculture

Watersheds, Groundwater, and Drinking Water: A Practical Guide

For many more titles, see *http://ucanr.org/hcsw*

3/2012

Research on irrigation and farming practices

Water use optimized to limit leaching

To control nitrate leaching in lettuce, spinach, broccoli and strawberry fields, Mark Bolda, UC Cooperative Extension advisor in Santa Cruz County; Michael Cahn and Richard Smith, UCCE advisors in Monterey County; and Tim Hartz, UCCE specialist in the department of Plant Sciences at UC Davis, are studying the amount of irrigation water applied. For each crop, the scientists are trying to determine the optimum amount of water the plants need to grow quality produce while limiting leaching. For lettuce, they are improving irrigation efficiency by using evapotranspiration data and soil water-holding properties to calculate an irrigation schedule that will maintain desirable crop yields yet minimize deep water percolation.

Adjusting field length can reduce irrigation levels

In his research on how dairy operators can reduce water applications to their crops, Larry Schwankl, UC Cooperative Extension specialist at Kearney Agricultural Research and Extension Center, has found that allowing less water to percolate will reduce impacts on groundwater. With furrow irrigation, the part of the field closest to the water source tends to be overirrigated by the time a sufficient amount of water reaches the far end of the field. Since dairy farms are irrigated with a mixture of nutrient-rich manure water and irrigation water, the head of the field also gets disproportionately more nitrogen. Using shorter fields, he found, is by far the best way to reduce the amount of water applied. "It's not inexpensive or easy to make this change," Schwankl said. "Shorter fields make cultural practices more difficult and land is taken out of production." However, this change can have a dramatic impact: With shorter furrows, water applied per acre was cut nearly in half. In addition, manure water is often added to fresh water as part of dairy irrigation and fertigation practices, so being able to reduce the applied water also significantly reduces the amount of nitrogen applied.

Conservation tillage may help farmers use up more nitrogen on dairies

If dairy farmers were able to grow more silage, they might also be able to have more nitrogen in manure and lagoon water taken up and removed in feed materials. Jeff Mitchell, UC Cooperative Extension specialist at Kearney Agricultural Research and Extension Center, and other researchers have been investigating the feasibility of using conservation tillage planting techniques to shorten the intervals between silage crops and to effectively enable triple-cropping as a means to increase annual feed production and nitrogen removal.

UC helps dairy industry manage nitrogen on the farm

It is common practice for dairy operators to use cattle manure as fertilizer for their silage crops. UC Cooperative Extension advisors throughout California routinely provide reliable information to dairy operators and consultants so they can efficiently manage nitrogen on the farm and comply with pending state regulations. This information includes how to install and calibrate flow meters, how to measure nitrogen levels in manure ponds, how much nitrogen crops need and when they need it, and how to properly sample the crops that are harvested to know how much nitrogen is being removed. "We've developed protocols to ensure accurate information gathering, and we can share these with the dairy industry," said Carol Frate, UCCE advisor in Tulare County.