ANNUAL REPORT
FOR 1999

STATUS OF IMPLEMENTATION
OF SENATE BILL 90-126
THE AGRICULTURAL CHEMICALS AND GROUNDWATER PROTECTION ACT

Colorado Department of Agriculture
Colorado State University Cooperative Extension
Colorado Department of Public Health and Environment

AGRICULTURAL CHEMICALS AND GROUNDWATER PROTECTION

www.ag.state.co.us/DPI/programs/groundwater.html

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In the annual report for 1998, several goals for 1999 were identified by the cooperating agencies. The progress made toward each of the goals is detailed in the following pages.

Memoranda of Understanding

Memoranda of Understanding as provided in Section 25-8-205.5 (3)(f) and (g) of the Act have been signed for fiscal year 1999/2000 between the Colorado Department of Agriculture and: 1) Colorado State University Cooperative Extension, and 2) the Colorado Department of Public Health and Environment. The objectives for 2000 for this program are stated on pages 13 and 14.

Education and Communication

Communication is a vital component of the program. Numerous methods are used to provide information to individuals and organizations affected by the program as well as the general public. Fact sheets are prepared to provide information on the program and are being distributed at meetings, conferences, and trade shows. Also, a display board is being utilized at conferences and trade shows to provide information on the program. Videos entitled Protecting Colorado's Groundwater and Best Management Practices for Colorado Agriculture are available to inform the general public on groundwater quality, agricultural chemicals, and the Act. These videos may be borrowed from the Department of Agriculture or copies may be purchased from the CSU bulletin room. Information on the program is continually being presented to the public through radio shows, mass media, press releases, and presentations at meetings throughout the state.

Development pressures, in once rural outlying areas, have heightened public awareness of the potential for impacts to water quality. The Program has responded to these concerns by offering technical assistance to water conservancy districts, groundwater management districts, and other local entities interested in evaluating water quality in their area. Presentations of how the program works, past and present water quality projects, and plans for future projects with request for local input are made at every opportunity. In 1999, presentations were made at several major meetings and small local groups throughout the state. We consider this type of outreach an important part of the customer service component of the program.

The initiation of the National Certified Crop Advisor program in Colorado has dovetailed into this program to provide a mechanism for training and education regarding the correct use of agricultural chemicals. Over 200 crop consultants and advisors have passed the national and state exam and proven sufficient experience to be certified as crop advisors in Colorado. These individuals and others to be certified in the future are required to obtain continuing education credits to maintain their certification. This affords an ideal opportunity to provide information concerning pesticides and fertilizers and groundwater protection to those making recommendations to farmers.

Best Management Practices

Best Management Practices (BMPs) are being developed at the user level through extensive local input. A general BMP notebook for Colorado Agriculture has been completed and consists of eight subject specific BMP chapters and one booklet providing an overview of the BMP process. The notebook has been provided to producers, pesticide and fertilizer dealers, CSU Cooperative Extension offices, and all USDA Natural Resources Conservation Service offices. All of the BMP chapters are available through the CSU Bulletin Room.

In 1996, an economic analysis of the BMPs was performed to determine the cost of implementing the BMPs that required purchasing a service or product to adopt the practice. This information has been condensed into two fact sheets that agricultural chemical users can easily utilize. The two fact sheets are titled, Economic Considerations of Nutrient Management BMPs and Economic Considerations of Pest Management BMPs.

The statewide notebook is being utilized to guide local work groups through the BMP development process for regionally specific BMPs. Localized BMP development is continuing in the San Luis Valley, the South Platte River Basin from Denver to the Nebraska state line, and the Uncompahgre Valley of the western slope.

In the San Luis Valley, booklets entitled Best Management Practices for Nutrient and Irrigation Management in the San Luis Valley, Best Management Practices for Potato Pest Management in the San Luis Valley, and Best Management Practices for Small Grain Pest Management in the San Luis Valley have been published to promote BMPs.

On the west slope, a booklet entitled Best Management Practices for the Uncompahgre Valley has been published for practices appropriate to this area.

Localized BMPs for the Front Range/South Platte Basin have also been completed. A document entitled Best Management Practices for Irrigated Agriculture was published from this group's efforts. In addition, a booklet was developed of BMPs specifically for irrigated barley production. This booklet was published and is entitled Barley Management Practices for Colorado: A Guide for Irrigated Production.

To assess program progress, we surveyed approximately 3500 irrigated crop producers state wide in the winter of 1997. We wanted to learn the status of BMP adoption and possible barriers to change. The confidential survey instrument asked producers questions about what specific BMPs and irrigation management and technology they used, and what information sources they utilized for production decisions. Producers returned more than 1300 surveys for a 40% response. We found that certain BMPs such as soil testing and pest scouting are being used by over two-thirds of Colorado producers. Other BMPs such as record keeping and irrigation water crediting need more emphasis to achieve higher adoption. Two fact sheets, Water Quality Best Management Practices: What Are Colorado Producers Doing? and Irrigation Best Management Practices: What Are Colorado Producers Using?(Appendix I), were produced summarizing the results of the survey. More comprehensive results are provided in the technical report, Irrigation Management in Colorado - Survey Data and Findings. (Appendix I)

In an effort to provide increased access to the BMPs as well as articulate the need for farmers to adopt water quality protection practices, a 20 minute instructional video was produced entitled: "Best Management Practices for Colorado Agriculture". The video shows farmers speaking about why they have adopted practices and the need for continued diligence on their part to protect water quality.

The use of pesticides and commercial fertilizers in urban areas also has the possibility to impact groundwater resources. Five publications describing BMPs for urban pesticide and fertilizer use have been developed and distributed. The five publications are entitled: Homeowner's Guide to Protecting Water Quality and the Environment, Homeowner's Guide to Pesticide Use Around the Home and Garden, Homeowner's Guide Alternative Pest Management for the Lawn and Garden, Homeowner's Guide to Fertilizing your Lawn and Garden, and Pollution Prevention in Colorado Commercial Greenhouses. These publications are available from the CSU Bulletin Room or the Colorado Department of Agriculture.

Demonstration Sites and Field Days

Field demonstrations continue to be an integral part of the program to demonstrate BMPs to farmers. In 1999, work focused on a cooperative effort with the Colorado Corn Growers Association to demonstrate BMPs on crediting nitrogen in irrigation water, nutrient management planning, irrigation scheduling, use of polyacrylamides, and pest scouting. Eight demonstration sites were used to show these practices.

One objective of these demonstration trials was to compare crop yields where the fertilizer rate was reduced by accounting for (or crediting) the NO3-N supplied from irrigation well water and other sources. The irrigation nitrogen credits at the sites ranged from 40 to 100 pounds per acre. Irrigation water quantity was measured at each site to determine if the full amount of the credited nitrogen was applied. Atmometers were installed to demonstrate a simple method of keeping track of crop water use (ET) for more efficient irrigation scheduling. A fact sheet has been developed to explain the demonstrated practice, describe the trial objectives, and provide the results with information on fertilizer cost savings (Appendix I).

A new technology known as in-season nitrate testing was highlighted for demonstration. This tool may help farmers improve nitrogen recommendation accuracy and minimize the use of "insurance" fertilizer. Demonstration plots in the South Platte River Basin in 1999 showed farmers how to use this method to reduce unnecessary nitrogen applications.

Groundwater Monitoring

A long-range sampling plan has been developed for the monitoring program. The plan covers three major types of groundwater monitoring. The first type of monitoring is the initial screening surveys to be conducted on all major aquifers subject to contamination from agricultural chemicals. The screening surveys for the South Platte River alluvial aquifer, San Luis Valley unconfined aquifer, Arkansas River alluvial aquifer, the Front Range Urban Corridor, and the High Plains Ogallala Aquifer are complete. The second type of monitoring is a follow-up sampling program to resample, for confirmation, all wells in which any contaminant was detected at a level of concern. Surrounding wells may also be sampled, if available, to determine if the contamination is widespread or only a localized problem. Follow-up sampling is planned in 1999 for the High Plains and West Slope. The third type of monitoring is the specialized sampling needed for evaluation of Best Management Practices or Agricultural Management Areas when established. This long term monitoring, utilizing special wells such as dedicated monitoring wells, was started in 1995 in the Brighton to Greeley reach of the South Platte. In 1998, we continued this long term monitoring project and in 1999 will begin the initial statistical analysis of the data that has been gathered to date.

Before an area is selected for monitoring, CDPHE will contact interested parties to inform them of the sampling program and SB 90-126, and how we envision its implementation. CDPHE will coordinate closely with federal agencies, county extension agents, conservancy districts, and local health officials in the project area.

West Slope of Colorado

The 1998 monitoring program began a regional groundwater quality baseline study for the western slope of Colorado. The West Slope of Colorado includes all of Colorado west of the continental divide. However, this monitoring program excluded the central core of the Rocky Mountains where the land use is predominately National Forest. The majority of the groundwater sampled on the west slope occurs along stream and river valleys in alluvial deposits with some local aquifers on the larger mesas. No single aquifer underlies this area, therefore this survey differs from past work that tended to focus on a single regional aquifer. The agriculture in this region is dominated by ranching with associated hay production. Dry land wheat in Moffat County, corn in the tri river area, dry beans in Montezuma County, and the fruit and vineyards of Mesa County are the exceptions.

Ninety samples have been collected to date with future additions planned. All samples were collected from existing wells that are privately owned and permitted as domestic wells. The samples were analyzed for nitrate and 45 pesticides (Appendix III). Preliminary analysis of the nitrate and pesticide data indicates that groundwater in the majority of the area sampled has not been adversely impacted by current agricultural practice. The major inorganic contaminant of concern in this area is nitrate. Nitrogen analysis indicated that 36% of the wells tested for a level of nitrate-nitrite as nitrogen below the laboratory detection limit of 0.5 mg/L (parts per million). Sixty-three (63 %) percent of the wells tested in the range of 0.5 to 9.9 mg/L, indicating nitrogen present but below the drinking water standard of 10 mg/L. Only one well exceeded the nitrate drinking water standard of 10 mg/L, with a test result of 32.0 mg/L. This well was located in Moffat County, north of Craig. The drinking water standard is used as a benchmark for nitrate levels in all wells regardless of use. Pesticide data revealed one well testing positive for the pesticide Malathion at 0.23 ug/L (part per billion) with a detection limit of 0.1 ug/L. This well was located in Montrose County, west of Montrose.

Well samples were analyzed for basic water quality constituents, nitrate, and selected pesticides. The basic inorganic analysis was performed by the Soils Laboratory at CSU. The Colorado Department of Agriculture, Standards Laboratory performed the laboratory analysis for nitrate as nitrogen and selected pesticides. Temperature, conductivity, and total dissolved solids were measured in the field.

The monitoring program included sample collection, laboratory analysis, and data analysis and storage. Upon completion of the sampling and a full analysis, which should include integration with previous and current studies by other agencies, the resulting sampling program will provide the basis for determining a groundwater quality baseline for this region.

The results from this sampling program have been entered into the CDPHE Groundwater Quality Data System maintained at CDPHE. A detailed report describing the area sampled, the protocol for sampling and analysis, and the results of the analysis will be provided to the Commissioner of Agriculture upon completion of the analysis.

Weld County Long Term Monitoring

Nineteen ninety eight was the fourth year of a long term monitoring effort initiated in the South Platte alluvial aquifer from Brighton to Greeley. The long term monitoring network was established in 1995 and is a combination of three types of wells previously sampled in the area. The long term monitoring network consists of 19 monitoring wells operated by the Central Colorado Water Conservancy District, 60 irrigation wells sampled in 1989, 1990, 1991, 1994, 1995, 1996, and 1997, and 18 domestic wells sampled in 1992 and 1995.

From June through August, 1998, 94 wells in the long term network were sampled. All wells were analyzed for nitrate-nitrite as nitrogen. The 19 monitoring wells and 18 domestic wells were analyzed for 45 pesticides. The pesticide analysis for the irrigation wells was an immuno assay screen for the triazine herbicides.

Nitrogen analysis indicated that 79% of the monitoring wells, 44% of the domestic wells, and 73% of the irrigation wells exceeded the nitrate drinking water standard of 10 mg/L. In the monitoring wells, nitrate levels ranged from a low of 3.0 mg/L nitrate as nitrogen to a high of 88.0 mg/L. The range of values for the eighteen domestic wells was from a low of 1.0 mg/L to a high of 45.0 mg/L. In the irrigation wells, nitrate levels ranged from below our detection level of 0.5 mg/L nitrate as nitrogen to a high of 33.9 mg/L.

Pesticide data revealed four pesticides, Atrazine, Metolachlor, Metalaxyl, and Prometone present in the monitoring well samples. The breakdown products of Atrazine, Deethyl Atrazine and Deisopropyl Atrazine were also detected. Atrazine was present in 37% of the wells, Deethyl Atrazine in 53% of the wells, Metolachlor in 32% and Prometone in 26%. Metalaxyl was detected in two wells (11%), and the level of Metalaxyl reached 13.6 ug/L (ppb) in one well. The breakdown product Deisopropyl Atrazine was detected in one well. Detection levels for the other pesticides averaged less than 0.5 ug/L (ppb).

The triazine herbicide screen used on the irrigation wells detects any pesticide in this family, which includes Atrazine, Simazine, Cyanazine, Deethyl Atrazine, and Prometone. The results are calibrated in units of Atrazine equivalent but may be actually composed of one or more of the components. In 1998, triazine herbicides were detected in 91% of the irrigation wells. Levels ranged from 0.05 ug/L to 1.18 ug/L (ppb).

The monitoring wells in Weld County were sampled in cooperation with the Central Colorado Water Conservancy District in June 1998 by Randy Ray of Central and Brad Austin of CDPHE. John Colbert, of CDPHE, sampled the irrigation wells in Weld County in July and August 1998. All West Slope sampling was performed by Brad Austin, July through October, 1998. Field sampling procedures followed the protocol developed by the Groundwater Quality Monitoring Working Group of the Colorado Nonpoint Task Force.

Aquifer Vulnerability

In addition to monitoring groundwater for the presence of agricultural chemicals, the Agriculture Chemicals and Groundwater Protection Program is required to determine the likelihood that an agricultural chemical will enter the groundwater. This determination is based upon the chemical properties of the chemical in question, the behavior of a particular chemical in the soil types of the region under study, the depth to groundwater, the farming practices in use, and other factors. This type of determination has been described as a vulnerability analysis.

In the process of writing the generic State Management Plan for Pesticides (SMP), the staff at CDPHE, CDA, and CSU has studied various types of vulnerability analysis. The goal has been to satisfy the requirements of the SMP and SB 90-126, while remaining within the confines of existing staffing, organization, and budget. In early 1996, a project was contracted to conduct a limited test of an aquifer sensitivity method in the northeastern section of the state. The results of this pilot project were evaluated by CDPHE, CDA, CSU, and USEPA and approved for use throughout the state. The Program expanded this effort statewide in 1997 to produce a vulnerability analysis for Colorado. The project was completed in June 1998. This final mapping product will provide a standard method to determine aquifer sensitivity. Upon completion of the next phase, the addition of the vulnerability factors, the program will be able to determine groundwater vulnerability to agricultural chemicals statewide. Results will be evaluated and incorporated into a standard method to delineate those areas of the state where groundwater is vulnerable to contamination from agricultural chemicals. The monitoring program can then target resources to those areas where attention is most needed. This effort will become a key element of the State Management Plan for pesticides implemented under the Federal Insecticide, Fungicide, and Rodenticide Act.

Groundwater Quality Data

In the FY-99 Memorandum of Understanding, the Agricultural Chemicals and Groundwater Protection Program agreed to pursue collecting, evaluating, and entering into a database all existing groundwater quality data available. Groundwater quality data from various regions of the state has been entered as it becomes available. Recently this includes, CDPHE data collected as part of Super Fund preliminary assessment studies by the Haz. Mat. Division, and recently published U. S. Geological Survey data. As the data from these studies is received, it is entered into a database specifically designed for this purpose. In addition, collection and entry of historical data from the U. S. Geological Survey and U. S. EPA is an ongoing process.

The U. S. Geological Survey (USGS) is now wrapping up monitoring in the Upper Colorado Basin area under the National Water Quality Assessment (NAWQA) program. As this data becomes available it will be incorporated into the final analysis for water quality on the west slope. Several water conservancy districts are also actively engaged in collecting groundwater quality data. Unfortunately, this data is not always readily available due to concerns about privacy and future use of the data. The program hopes that as the monitoring effort continues and the agricultural community grows comfortable with our goals and intent, this valuable source of data will become available and enhance our understanding of the overall groundwater quality of the state.

Advisory Committee

The advisory committee continues to be an integral part of the implementation of this program by providing input from the many facets of the agricultural community and the general public that they represent (Appendix V). The committee met two times during 1999. All major program activities are discussed with the committee prior to implementation. The committee has been essential in providing input on program strategy by helping to determine which issues to address first, where geographically to focus efforts, critiquing drafted documents, providing ideas about the most effective means of distributing materials, and giving comments on how the information will be received, in addition to many other items.

Coordination

Coordination with other projects and programs relating to agricultural chemicals and groundwater is an essential part of the implementation of the program. All three agencies work continually to keep abreast of other programs both, governmental and private, so information can be incorporated into the implementation of the Act as well this program's information passed on to other agencies and organizations. Input is sought in all phases of the implementation of this program to avoid duplication of efforts, costs, conflict or duplication of regulation and to insure decisions are made with the most complete knowledge available.

Storage Regulations

Section 25-8-205.5 (3)(b) of the Agricultural Chemicals and Groundwater Protection Act requires the Commissioner of Agriculture to develop regulations where pesticides and fertilizers are stored or handled in quantities that exceed the established thresholds. These regulations were adopted in July 1994 and became effective September 30, 1994. The law mandated at least a three-year phase-in period for the regulations. As a result of comments prior to and at the public hearings, a graduated phase-in schedule was adopted.

Regulation of pesticide secondary containment/storage facilities, mixing and loading pads, and liquid fertilizer tanks greater than 100,000 gallons began on September 30, 1997. For these large liquid fertilizer tanks one of the three prescribed methods of leak detection is required unless secondary containment is in place. Regulation of fertilizer secondary containment/storage facilities (storing between 5,000 and 100,000 gallons) and mixing and loading pads began on September 30, 1999.

Compliance for liquid fertilizer is required by:

- **September 30, 2004** for secondary containment for fertilizer storage tanks with a capacity greater than 100,000 gallons.

Pesticide facility inspections continued in 1999. A total of 23 secondary containment facilities and 35 mixing and loading pads were inspected. Fertilizer facility inspections began on September 30, 1999 and a total of 39 containment and mixing/loading facilities were inspected. In addition, four leak detection inspections were conducted for facilities storing fertilizer in tanks larger than 100,000 gallons. Six Cease and Desist Orders and one Violation Notice were issued during 1999; modifications were needed at some sites. A database of inspection sites continues to be developed to track inspections. Inspection of pesticide and fertilizer facilities will be ongoing during 2000.

State Management Plan for Pesticides

EPA is developing a program that would require states to produce management plans for pesticides thought to be a significant groundwater hazard. If a state wants to allow continued use of any of the pesticides identified, it must produce an EPA-approved management plan specific to that pesticide.

In 1996, a complete draft of the generic state management plan was finished and provided to EPA for their informal review. If Colorado can complete and receive concurrence from EPA on a generic plan, it should be much easier for a pesticide specific plan to be approved once the proposed rule is finalized. A redrafted, general state management plan based on EPA's comments on previous versions was submitted in January 1998. Comments on this version were received from EPA in April 1998, and Colorado then submitted a document final in August 1998 for formal review and concurrence. Two subsequent documents were submitted to EPA based on comments received, the last being in January of 2000. We are currently waiting for EPA's response to the Colorado plan.

As discussed in last year's report, one of the more significant issues involves EPA's demand for a sensitivity analysis/vulnerability assessment map of the state in a Geographic Information System (GIS) format by which to determine where to focus education and monitoring activities. In late 1995, a small EPA grant was obtained to perform a sensitivity analysis pilot project for the northeastern part of the state. This work was completed in 1996 and provided to EPA. EPA reacted favorably to the project and provided funding for a statewide sensitivity analysis, which was completed in 1998. This information has been published in an eight page fact sheet titled Relative Sensitivity of Colorado Groundwater to Pesticide Impact. This publication assesses aquifer sensitivity based on four primary factors: conductivity of exposed aquifers; depth to water table; permeability of materials overlaying aquifers; and availability of recharge for the transport of contaminants. These factors were selected because they incorporate the best data currently available for the entire state and incorporate important aspects of Colorado's unique climate and geology.

In 1999, the SB 90-126 program was given spending authority to begin an aquifer vulnerability project to compliment and improve the existing aquifer sensitivity map. Work has begun on this project and completion will be June 30, 2001.

Pesticide use data at the county level is another requirement of the SMP. In addition, with the passage of the Food Quality Protection Act by Congress, accurate pesticide use information has become more critical. To try and provide this data, CDA along with CSU Cooperative Extension contracted with the Colorado Agricultural Statistics Service to perform a statewide pesticide use survey. All commercial pesticide applicators were surveyed during the winter of 1997/98. In addition, farmers who responded to a pre-survey that they apply some portion of their own pesticides were surveyed. Data is currently being sorted and transformed into a useable format and will then be analyzed and a report generated.

Waste Pesticide Disposal

A statewide pesticide collection program was conducted in 1999 by MSE Environmental, Inc. A total of 19,792 lbs of pesticides from 47 participants was collected during this program. MSE is scheduled to conduct another program in the spring of 2000.

Objectives for 2000 Determined

The following objectives for 2000 have been established:

- Begin development of a report on water quality status in Colorado based on data collected in previous years;
- Continue the development and implementation of localized BMPs for irrigated crops in the South Platte River Basin;
- Continue demonstration plots in the South Platte River area for displaying improved nitrogen and water management to farmers;
- Coordinate with other agencies and non-governmental organizations to deal with water quality issues in the South Platte River Basin an throughout the state.
- Continue BMP education work in the San Luis Valley;
- Continue the distribution of the BMP video;
- Continue distribution of the fact sheets on the economic considerations of BMP adoption for nutrient and pest management;
- Continue developing educational resource materials for groundwater education;
- Continue distribution of urban BMPs to encourage improved agricultural chemical and water management in urban areas;
- Continue to hold in-service training for chemical applicators, agency personnel, etc.;
- Participate in the Certified Crop Advisor program;
- Continue performing inspections of facilities requiring compliance with the containment regulations;

- Continue to provide information and enforcement on the containment rules and regulations;
- Continue collection and analysis of groundwater samples in western Colorado for pesticides and nitrates;
- Continue the long term monitoring program in Weld County by collecting and analyzing groundwater samples for pesticides and nitrates;
- Continue to refine the sensitivity analysis and begin vulnerability determination of groundwater for all of Colorado;
- Complete the pesticide use survey for Colorado;
- Obtain concurrence from EPA on the generic Pestidice Management Plan for pesticides;
- Obtain and input results of other groundwater monitoring for agricultural chemicals into the Agricultural Chemicals and Groundwater database;
- Integrate results of other projects to achieve goals in the Act;
- Continue disseminating information on the Act and groundwater protection to special interest groups in Colorado;
- Continue publishing and distributing fact sheets; and
- Continue using the display board to provide information on the program at trade shows and professional meetings.

APPENDICES

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APPENDIX I

Documents Produced and Disseminated for the Agricultural Chemicals and Groundwater Protection Program

Program Information

- ☐ Agricultural Chemicals and Groundwater Protection Program Brochure
- ☐ Annual Report - Status of Implementation of Senate Bill 90-126, The Agricultural Chemicals and Groundwater Protection Act
- ☐ Rules and Regulations Pertaining to Commercial Fertilizers and Pesticides at Storage Facilities and Mixing and Loading Areas and Related Sections of the Colorado Water Quality Control Act - Effective September 30, 1994
- ☐ Summary of Rules and Regulations for Bulk Storage Facilities and Mixing and Loading Areas for Fertilizers and Pesticides - Fact Sheet #8
- ☐ Agricultural Chemical Bulk Storage and Mix/Load Facility Plans for Small to Medium-Sized Facilities
- ☐ Web sites:
  www.ag.state.co.us/DPI/programs/groundwater.html
  www.ColoState.EDU/Depts/SoilCrop/extension/WQ

General Best Management Practices for Agriculture

- ☐ Best Management Practices for Colorado Agriculture: An Overview #XCM-171
- ☐ Best Management Practices for Nitrogen Fertilization #XCM-172
- ☐ Best Management Practices for Irrigation Management #XCM-173
- ☐ Best Management Practices for Manure Utilization Bulletin 568A
- ☐ Best Management Practices for Phosphorus Fertilization #XCM-175
- ☐ Best Management Practices for Crop Pests #XCM-176
- ☐ Best Management Practices for Agricultural Pesticide Use #XCM-177
- ☐ Best Management Practices for Pesticide and Fertilizer Storage and Handling #XCM-178
- ☐ Best Management Practices for Private Well Protection #XCM-179
- ☐ Best Management Practices for Water Quality - Fact Sheet, January 1993
- ☐ Best Management Practices for Turfgrass Production - Fact Sheet, June 1993
- ☐ Best Management Practices for Agricultural Chemical Handling, Mixing and Storage - Fact Sheet #7, April 1994
- ☐ Soil, Plant, and Water Testing
  Fact Sheet #11, April 1997
- ☐ Economic Considerations of Nutrient Management BMPs
  Fact Sheet #13, July 1997
- ☐ Economic Considerations of Pest Management BMPs
  Fact Sheet #14, July 1997
- ☐ Reducing Fertilizer Costs by Crediting Irrigation Water Nitrogen
  (Results from 1997 Trials)
  Fact Sheet #15, April 1998
- ☐ Improving Profitability and Water Quality: Irrigation Water Nitrate Crediting
  Fact Sheet #17, March 1999
- ☐ Water Quality Best Management Practices: What Are Colorado Producers Doing?
  Fact Sheet #18, April 1999
- ☐ Irrigation Best Management Practices: What Are Colorado Producers Using?
  Fact Sheet #19, August 1999
- ☐ Pesticide Record Book for Private Applicators

Local Best Management Practices

- ☐ Best Management Practices for Nutrient and Irrigation Management in the San Luis Valley - March 1994
- ☐ Best Management Practices for Irrigated Agriculture: A Guide for Colorado Producers - August 1994
- ☐ Best Management Practices for Integrated Pest Management in the San Luis Valley: Small Grains #XCM-195
- ☐ Best Management Practices for Integrated Pest Management in the San Luis Valley: Potato #XCM-196
- ☐ Best Management Practices in the Uncompahgre Valley: Making Vital Decisions
- ☐ Barley Management Practices for Colorado: A Guide for Irrigated Production

Best Management Practices for Industry

- ☐ Pollution Prevention in Colorado Commercial Greenhouses #XCM-206

Homeowner's Guides

- ☐ Homeowner's Guide to Protecting Water Quality and the Environment
- ☐ Homeowner's Guide: Alternative Pest Management for the Lawn and Garden
- ☐ Homeowner's Guide to Fertilizing Your Lawn and Garden
- ☐ Homeowner's Guide to Pesticide Use Around the Home and Garden

Groundwater Monitoring

- ☐ Ground Water Monitoring Activities South Platte River Alluvial Aquifer 1992-1993 Report
- ☐ Ground Water Monitoring Activities San Luis Valley Unconfined Aquifer 1993 Report
- ☐ Ground Water Monitoring Activities Arkansas River Valley Alluvial Aquifer 1994-1995 Report
- ☐ Ground Water Monitoring Activities High Plains Ogallala Aquifer 1997-1998 Report
- ☐ Ground Water Monitoring Activities West Slope of Colorado 1998 Report
- ☐ San Luis Valley Fact Sheet #9, February 1995
- ☐ South Platte Valley Fact Sheet #10, March 1995
- ☐ Arkansas Valley Fact Sheet #12, April 1997

Groundwater Vulnerability

- ☐ Relative Sensitivity of Colorado Groundwater to Pesticide Impact Fact Sheet #16, October 1998

Videos

- ☐ Protecting Colorado's Groundwater
- ☐ Best Management Practices for Colorado's Agriculture

To request any of these educational materials please call the Colorado Department of Agriculture at (303) 239-4180 or the CSU Bulletin Room at (970) 491-6198.

AGRICULTURAL CHEMICALS AND GROUNDWATER PROTECTION

Fact sheet #17

Improving Profitability and Water Quality: Irrigation Water Nitrate Crediting

Low commodity prices combined with higher input costs made 1998 a marginal year for many crop producers. Faced with these realities, crop producers must tighten their operations to remain in business. Unfortunately, many costs in agriculture today (land, water, equipment, labor) are fixed, and cutbacks are hard to find. However, for some producers in Colorado a potential means to reduce fertilizer inputs does exist. This strategy involves taking advantage of the "free fertilizer" supplied as nitrate in irrigation water. CSU Cooperative Extension conducted trials in 1997 and 1998 to help producers understand how to take advantage of this potential cost cutting measure.

Groundwater monitoring in irrigated areas along the S. Platte River, the Arkansas River, and the San Luis Valley has revealed several locations where enough nitrogen (N) as nitrate has accumulated over time in the groundwater to benefit crop production. Producers using this nitrate-enriched groundwater to supply a major portion of a field's water will profit by crediting this N source when determining their fertilizer rate.

Soil testing to determine correct fertilizer rates and to ensure top yields is an accepted practice for many producers, but testing irrigation wells as a source of N is less common. However, irrigation water containing nitrate can supply considerable amounts of N because it is applied during the growing season and is immediately available for crop uptake, thus potentially reducing the amount of fertilizer required. Situations where fields are irrigated with more than 50% well water that has nitrate concentrations greater than 10 ppm are most likely to benefit. Ditch water nitrate is usually low, unpredictable, and consequently not worth crediting.

Crediting the N received in irrigation water is a recommended Best Management Practice (BMP) for N management. Growers that use this BMP are improving water quality by removing nitrate from the groundwater through crop uptake while reducing their fertilizer needs.

This fact sheet was written by Troy Bauder and Reagan Waskom at Colorado State University in cooperation with the Colorado Department of Agriculture and the Colorado Department of Public Health and Environment. 3/99.

For more information contact the authors at 970/491-4923.

Protecting Colorado's groundwater and supporting agriculture

Trial Descriptions

During the 1997 and 1998 growing seasons, 11 trials were held in several locations in the alluvial portion of the S. Platte River valley in Weld County (Table 2). The objective of these trials was to compare crop yields where the fertilizer rate has been reduced by accounting for (or crediting) the nitrate supplied from the irrigation groundwater.

To accurately develop N fertilizer recommendations, all field sites were soil sampled to a depth of two to four feet depending upon the crop and situation. The irrigation well was sampled and analyzed for nitrate prior to and throughout the growing season at each site. The soils were analyzed using field kits or by the CSU testing lab. The soil and water test results were used to develop N fertilizer recommendations according to each field's yield goal with and without an irrigation water N credit. At some sites an additional N rate was included to evaluate a partial water credit.

The amount of irrigation water applied was measured using furrow flumes and rain gauges to determine cumulative water and nitrogen additions.

Table 1. Nitrogen credited and received from

	Max Projected N Credit	Actual N Received	Projected N Credit Achieved?
1997 Site	----------------	lb N/Acre	----------------
Moser	40	120	Yes
Fritzler Silage	45	45	Yes
DHAg Wheat	30	40	Yes
LaSalle Corn	50	18	No
1998 Site	----------------	lb N/Acre	----------------
DHAg Wheat	30	70	Yes
Fritzler Wheat	40	100	Yes
Fritzler Silage	50	135	Yes
Wiedeman	75	158	Yes
Eckhardt	100	200	Yes
Moser	100	220	Yes
Koehn	40	30	No

Table 1 provides the projected N credits, the amount actually received from the irrigation water, and whether or not the projected credit was made.

Trial Results

Grain and silage yields were obtained from both hand and mechanical harvesting methods. Weigh wagons and portable load scales were used to weigh grain harvested from trials.

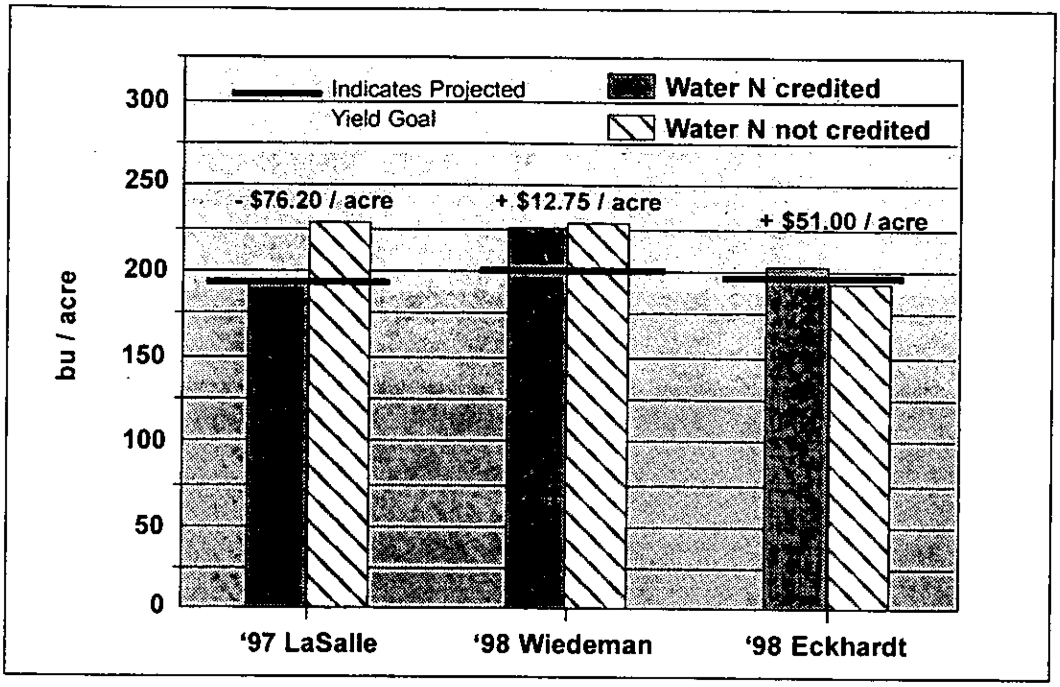
The figures on the next two pages illustrate the results broken down by crop type and location. Two years of trials have shown that irrigation nitrate crediting is a sound economic and agronomic practice. Significant yield loss from reducing N fertilizer applied occurred only when the expected water nitrate credit was not actually received from the applied irrigation water (Table 1). When properly used, growers can maintain yields, reduce fertilizer costs and help clean up groundwater by crediting nitrate in irrigation water. However, the trial results also show that growers should be cautious when crediting N from wells that supplement ditch water. Wells that are only used in dry years should not be counted upon to supply N to a crop.

Because profit margins in irrigated agriculture continue to shrink, growers using groundwater containing nitrate should seriously consider implementing this BMP to improve their bottom line. The final page of this document provides detailed information on how to start using this BMP.

Graph Interpretation

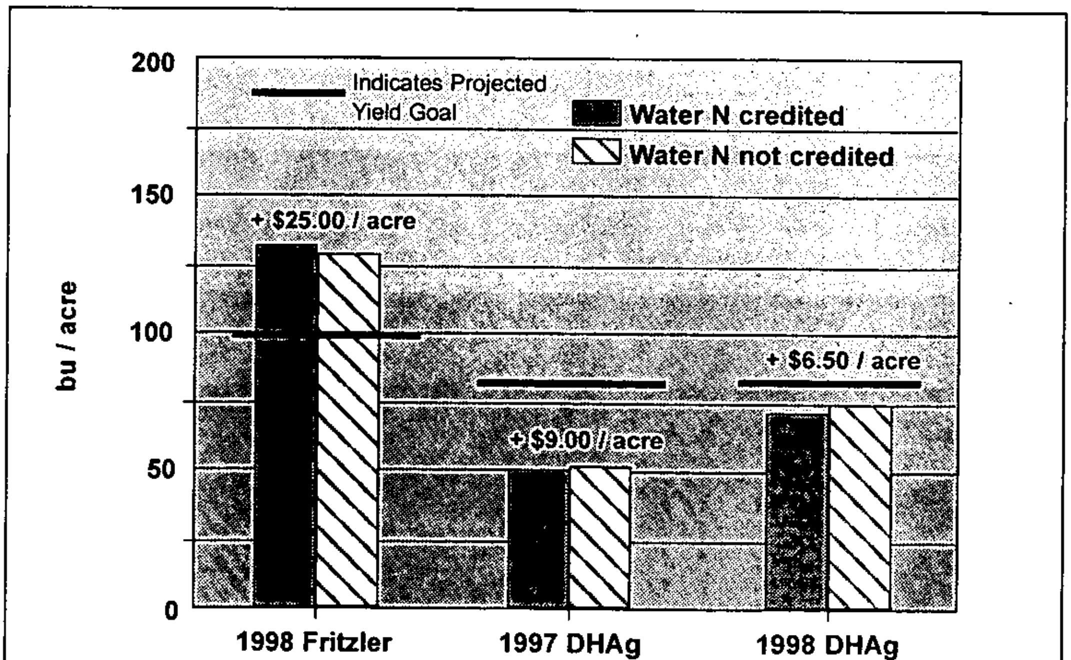
The following graphs compare the recommended fertilizer rate without an N credit to the recommended fertilizer rate with the highest N credit tested. The positive or negative dollar amount provided above each set of bars is the per acre return on crediting the N from irrigation water. Commodity and fertilizer prices on the date of this writing were used for 1998 trials. Differences in yield were used to make economic comparisons whether or not the yields were statistically significant.

Figure 1. Trial Results at Gilcrest and LaSalle Corn Grain Sites



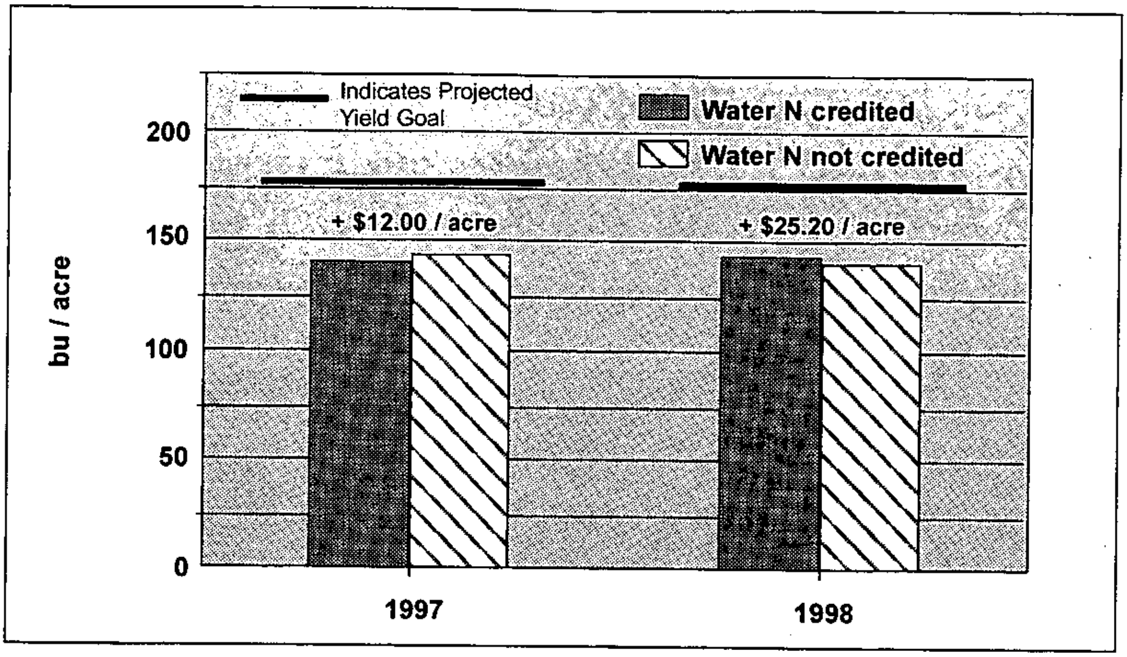
- The dollar amount provided above each set of bars indicates the economic gain or loss from crediting irrigation water nitrate.
- When irrigation N credit was received, no yield loss was measured and an economic benefit resulted. Note: Yield decrease at '97 LaSalle resulted partially from estimated irrigation N credit not being met due to type of water received. Only ditch water was applied, no groundwater (see Table 2.)
- Economic analysis for 1997 computed using $2.70/bu corn price and $0.28/unit N and for 1998 computed using $1.95/bu corn price and $0.28/unit N.

Figure 2. Trial Results at Gilcrest Wheat Sites



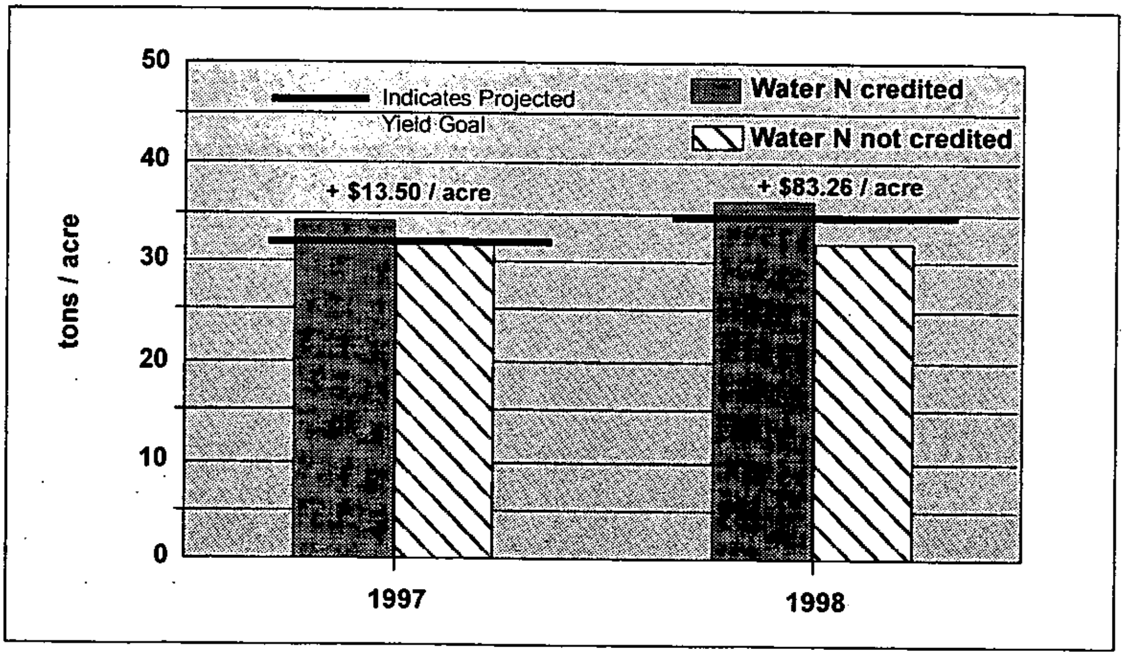
- The dollar amount provided above each set of bars indicates the economic gain or loss from crediting irrigation water nitrate.
- Higher N rate at the 1998 Fritzler produced more lodging reducing yield.
- 1998 economic analysis computed using $2.80/bu wheat price and $0.30/unit N + $4.00/acre application cost (1998 DHAg). 1997 used $3.50/bu wheat.

Figure 3. Trial Results at Moser Corn Grain Sites



- The dollar amount provided above each set of bars indicates the economic gain or loss from crediting irrigation water nitrate.
- Yield on this field is limited by highly saline irrigation water.
- Economic analysis computed using $1.95/bu corn price and $0.28/unit N for 1998 and $2.70/bu corn for 1997.

Figure 4. Trial Results at Fritzler Corn Silage Sites



- The dollar amount provided above each set of bars indicates the economic gain or loss from crediting irrigation water nitrate.
- Yield goal was met by all but one treatment.
- Economic analysis computed using $57.12/dry ton silage price and $0.30/unit N.

Table 2. Summary of practices and results for 1997 and 1998 trials.

1997 Cooperators	Location	Crop	Water Source	Fertilizer Rates (lb N/acre)	Yield
Wes Moser & Sons	Platteville	Grain Corn	100% groundwater	0 + Ami*	140 bu
				40-no Ami	147 bu
				40 + Ami	146 bu
				80 + Ami	140 bu
				TC** + Ami	144 bu
Diamond Hill Ag.	Gilcrest	Winter Wheat	100% groundwater	60	53 bu
				30	51 bu
Glen Fritzler	Gilcrest	Silage Corn	50% groundwater	0	27 ton
				90	34 ton
				180	32 ton
LaSalle Producer	LaSalle	Grain Corn	70% groundwater	90	192 bu
			(Assumed)	160	228 bu
1998 Cooperators					
Diamond Hill Ag.	Gilcrest	Winter Wheat	100% groundwater	0	72 bu
				30	75 bu
Glen Fritzler	Gilcrest	Winter Wheat	60% groundwater	105	132 bu
				150	129 bu
				190	114 bu
Glen Fritzler	Gilcrest	Silage Corn	50% groundwater	140	36 ton
				190	32 ton
Terry Wiedeman	Gilcrest	Grain Corn	100% groundwater	100	224 bu
				125	227 bu
				175	229 bu
Steve Eckhardt	Gilcrest	Grain Corn	100% groundwater	55	203 bu
				135	190 bu
				195	192 bu
Wes Moser & Sons	Platteville	Grain Corn	100% groundwater	0	143 bu
				TC**	140 bu
				TC + 25 lb	134 bu
				TC + 65 lb	135 bu
				TC + 105 lb	141 bu
Orlan Koehn	Lucerne	Grain Corn	70% groundwater	100	NA
				140	NA

*Amisorb is a nutrient uptake enhancement product
**TC = Turkey compost applied at approximately 15 tons/A suppling an estimated 70-80 lb N/A
*** 110 rate = CSU recommendation with 25 lb water credit
150 rate = Western lab recommendation with 40 lb water credit
190 rate = Western lab recommendation with no water credit

We greatly appreciate the help, input, and generosity of all our cooperators. Without their assistance these results would not be available to help other producers make sound decisions regarding this practice.

Using Irrigation Nitrate Crediting on Your Farm

Implementing this BMP on your farm requires two important pieces of information:

1. *The nitrate-nitrogen content of the irrigation well water (reported as ppm NO_3-N):*
   Direct analysis of well water by field test kits or laboratories is the only reliable way to accurately determine nitrate content. A nitrate test from a commercial lab generally costs about $10 to $20. Sample the well twice during the first year to account for possible seasonal variability. In subsequent years a single sample should be sufficient.

2. *An estimate of the amount of water to credit:*
   Because crops take up the majority of the N required during the vegetative growth stages, only water applied during the early part of the growing season can be credited. Consumptive use during this time period, often referred to as evapotranspiration (ET), can be used to estimate the amount of water to credit. You should only credit about 60% to 70% of seasonal ET for most crops (no more than 15 inches for corn). Local NRCS personnel, water districts, or Cooperative Extension offices can provide local values for crop water use (ET) for your area. With this information, multiply the NO_3-N content of the water by 0.23 (an acre-inch of water contains 0.23 lbs of N for each ppm of NO_3-N) by the inches of water to obtain the amount of N to credit.

Remember that reducing a fertilizer rate by crediting irrigation water N should not be practiced without using soil testing to initially determine a crop's N needs. We advise testing this practice on only a small portion of a field before cutting back N fertilizer applied over a large acreage. For more information contact Troy Bauder with CSU Cooperative Extension at (970) 491-4923.

AN EXAMPLE SITUATION:

Crop: corn
Water supply: 60% well (groundwater), 40% ditch
Well test results: 18 ppm NO_3-N
Seasonal consumptive use for area: 21 inches of water
Inches of water to credit = 21 inches ET x 70% of seasonal (.70) x 60% by well (.60) = 9 inches
Water Credit = 18 ppm x 0.23 x 9 inches/acre = 37 lb N /acre

Table to determine irrigation nitrate credit (equation is provided below).

Well Water NO_3-N (ppm)	Inches of Water to Credit: 5	7.5	10	12.5	15
	lb N/Acre				
10	11	17	22	28	34
15	17	25	34	42	51
20	22	34	45	56	70
25	28	42	56	70	84
30	34	51	67	84	101
35	39	59	79	98	118

Calculation: ***lbs N/acre = NO_3 - N (ppm) x 0.23 x Inches Applied Water/acre***

AGRICULTURAL CHEMICALS AND GROUNDWATER PROTECTION

Fact sheet #18

Water Quality Best Management Practices: What Are Colorado Producers Doing?

Public concern regarding drinking water quality and the environment has increased the need for urban and rural agricultural chemical users to take a larger role in protecting groundwater. Rather than legislate overly restrictive measure on farmers and related industries, Colorado has elected to encourage the voluntary adoption of Best Management Practices (BMPs). These guidelines allow for continued use of agricultural chemicals with some managerial constraints, while still meeting environmental quality goals. Colorado State University Cooperative Extension and the Colorado Department of Agriculture developed BMPs with significant input from local producers and chemical applicators in several watersheds throughout the state. The goal of this program is to prevent degradation of water quality through voluntary adoption of BMPs by Colorado farmers.

Until now, there has been little quantified information on what BMPs Colorado producers are actually using, how many producers are using them, and where the BMPs are being used. This information is necessary to conduct relevant educational programming and training in the areas and topics where it is most needed. The data is also helpful in documenting progress Colorado producers are making in protecting water quality and to identify where more effort is needed.

This fact sheet was written by Troy Bauder, Reagan Waskom, Marshall Frasier, and Dana Hoag at Colorado State University in cooperation with the Colorado Department of Agriculture and the Colorado Department of Public Health and Environment. 4/99.

For more information contact the authors at 970/491-6102.

Protecting Colorado's groundwater and supporting agriculture

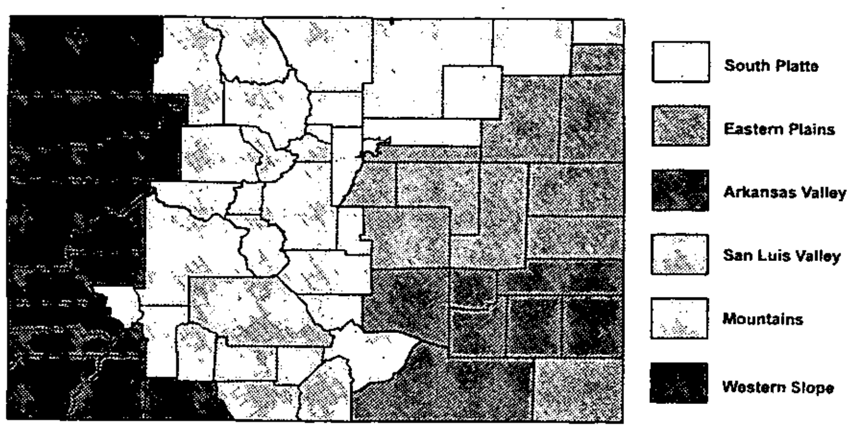


Figure 1. Regional grouping of survey responses by county given.

To obtain this information, a written survey was conducted in February 1997. The survey was mailed to 3,281 producers who had at least 40 acres of cropland and irrigated any of their crops. The confidential survey asked producers about irrigation management and technology used in their operations and included questions about specific fertilizer and pesticide BMPs. Producers returned 1319 usable surveys for a 40% response rate.

The survey consisted of 50 questions in five sections. Part of the survey asked about practices used anywhere on the farm, and in two sections producers were asked questions about a specific *Representative Field*. This report provides some results of the survey, specifically on BMPs for groundwater quality. More comprehensive results are provided in the technical report, "Irrigation Management in Colorado - Survey Data and Findings" (Colo. Ag. Expt. Station TR-99-5).

To control for the variety of irrigation practices in Colorado, six geographic regions were identified for summarizing responses. The six regions identified are the South Platte, the Eastern Plains, the Arkansas Valley, the San Luis Valley, the Mountains, and the Western Slope (Figure 1). These regions were selected based on known differences in water sources and cropping opportunities.

Survey Results

Figure 2 provides the results for fertilizer management BMPs averaged across the state. Table 1 gives further delineation of the responses by region. Other than experience, Colorado producers rely upon soil test analysis more than any other method to determine their fertilizer rate. In some regions (S. Platte and Plains) a large majority of irrigated producers are using this practice. Soil testing is the basis for a sound fertilizer management program and producers have recognized the positive economic and agronomic benefits of this practice.

We found that the majority (69%) of producers using manure on their *Representative Field* reported taking manure fertilizer credits on their farm. Although we cannot quantify how many pounds of nutrients these producers credit toward manure applications, these results suggest a general awareness of manure as a nutrient source.

However, crediting nitrogen received from previous legume crops or from nitrate in groundwater is a less accepted practice. Only about one quarter of the producers statewide growing alfalfa reported using a legume credit when determining their fertilizer rate. This is surprising given that the nitrogen fixing capabilities of legume crops, especially alfalfa, should be well known.

Figure 2. Results of the following question:
Check all techniques that you use in determining fertilizer application rates.

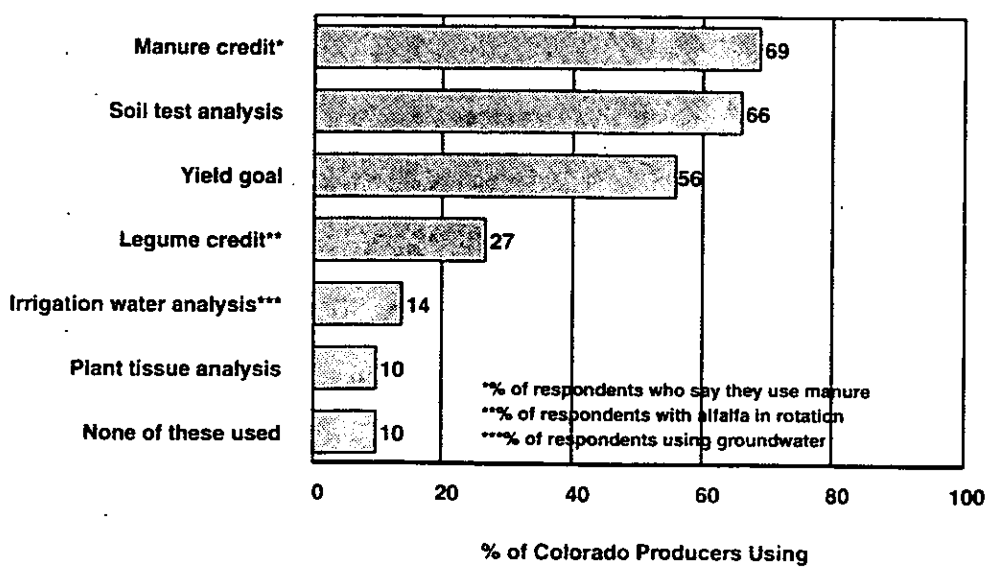


Table 1. Regional differences in fertilizer BMPs used by Colorado irrigated farms.

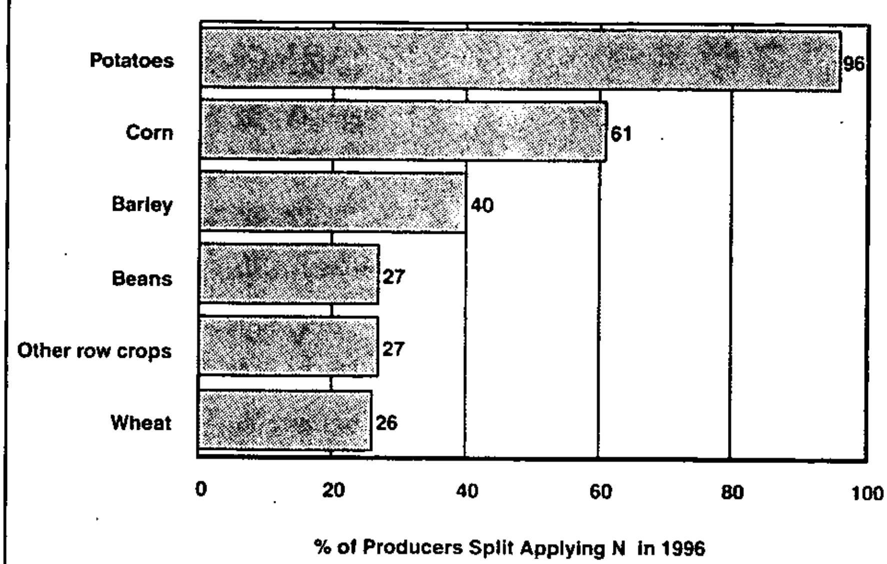
	Region						
	South Platte	Eastern Plains	Arkansas Valley	San Luis Valley	Mountains	Western Slope	Colorado
Fertilizer Practices (% using)							
Soil test analysis	82	90	59	56	44	49	66
% irrigated acres sampled in 1996	53	82	24	52	23	29	50
Plant tissue analysis	10	12	4	22	2	8	10
Irrigation water analysis*	15	10	0	28	--	--	14
Manure credit**	78	86	75	--	33	57	69
Legume credit***	34	25	34	19	15	16	27
Yield goal	71	67	60	51	36	43	56
Past experience	77	67	77	67	55	74	71
Consultant	33	45	16	28	5	9	23
None of these used	2	4	11	18	30	9	10

--Fewer than five responses
*% Of respondents using groundwater.
**% Of respondents using manure on representative field.
***% Of respondents with alfalfa in rotation.

Only a few producers credit their water as a nutrient source. Crediting nitrate-nitrogen from irrigation water is primarily practiced by producers using groundwater in the San Luis Valley (SLV) and the S. Platte. Both regions have wide spread geographic areas with higher concentrations of nitrate-nitrogen in groundwater that can be used by crops when this water is used for irrigation. The SLV and the S. Platte have water quality demonstrations that have promoted water credits for several years.

While the majority of Colorado producers use soil test analysis in their fertilizer decision making, the acreage sampled in 1996 varied greatly between regions. This variation between regions seems to follow the same general trend between regions as consultant use (Table 1). Another BMP that is widely used among producers is split nitrogen application (Figure 3). These results were obtained from questions regarding the *Representative Field*, therefore the practice could be linked to a particular crop. Nearly all the respondents growing potatoes reported applying their nitrogen in increments, as did a majority of corn growers. Split application was used with less frequency with small grains, beans, and other row crops (sugar beets and vegetables for example).

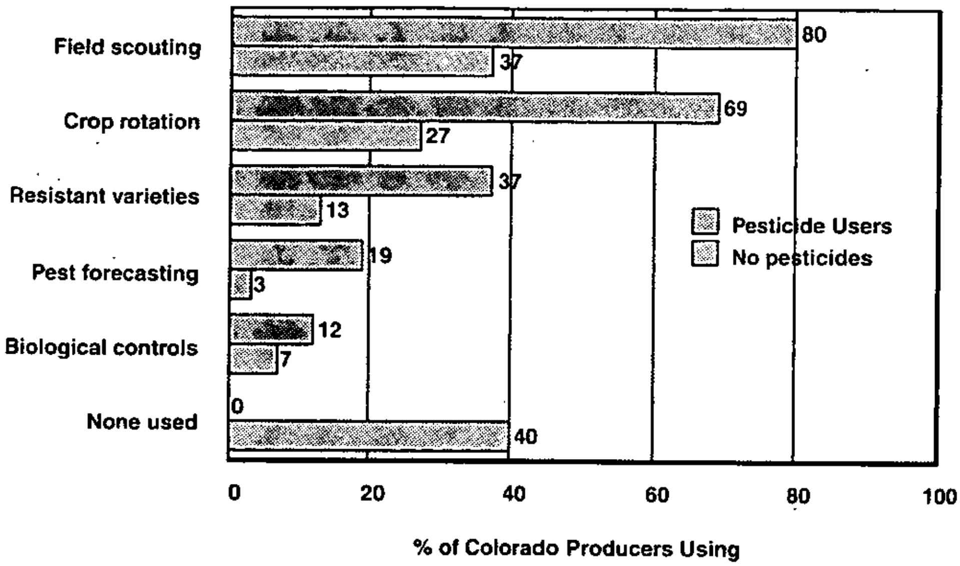
Figure 3. Use of split nitrogen application on major relevant crops by Colorado producers.



The results for pest management practices show that field scouting was the most widely used pest management technique (Figure 4). On average, more producers reported using field scouting than pesticides (Table 2). Determining the need for pesticide applications by field scouting is widely considered a base practice for integrated pest management (IPM). When using IPM, producers may reduce their reliance on pesticides by applying

Figure 4. Results of the following question:

Check all pest management practices that you routinely use. (Include all weed, insect, and disease controls)



only when potential crop damage exceeds the cost of application. Again the frequency of use varies greatly among regions, with higher adoption in regions with more intensive row crop production.

Producers did not select crop rotation, tillage, and/or resistant varieties as frequently; suggesting they do not consider these cultural practices as effective pest management techniques. For example, variety selection is often based upon yield, with disease or insect resistance a secondary consideration. Likewise, only small minorities of producers use intensive management techniques such as pest forecasting and biological controls. These practices require more time, locally adapted information, and do not apply to most crops.

The second pest management BMP question asked about decisions that were related to pesticide applications (Figure 5). Therefore, the results provided in Figure 5 and Table 3 are only for respondents that indicated pesticide use in the previous question.

As shown in Table 3, one practice that varied significantly by region, but was lower than expected statewide was pest and pesticide record keeping. Only half of all pesticide users statewide reported

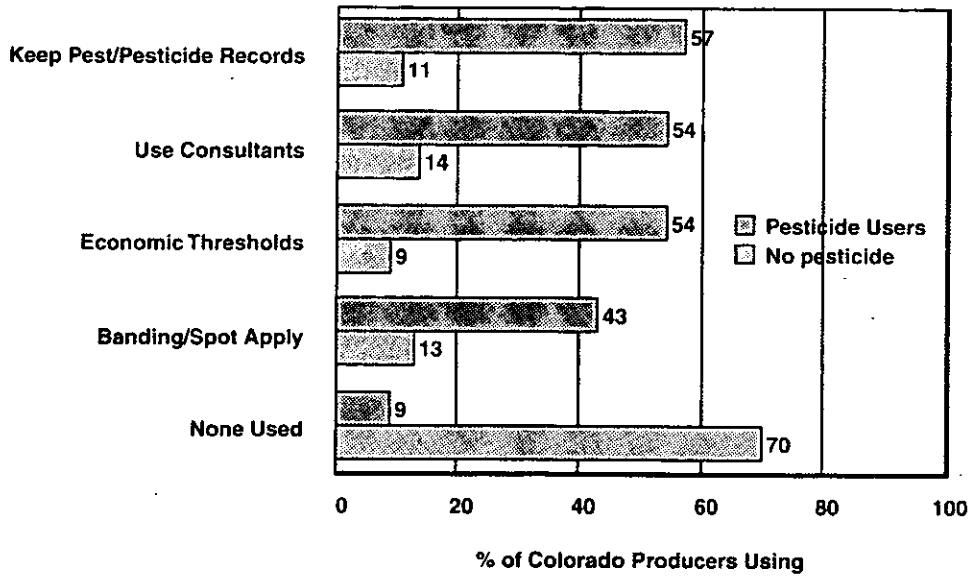
Table 2. Regional differences in pest management BMPs used by Colorado irrigated farms.*

	Region						
	South Platte	Eastern Plains	Arkansas Valley	San Luis Valley	Mountains	Western Slope	Colorado
Practices (% using)							
Field Scouting	81	81	70	59	29	50	64
Pesticides	84	80	74	49	17	50	63
Resistant varieties	34	35	36	19	8	26	28
Crop rotation	70	64	77	52	6	40	53
Tillage	63	63	61	49	8	35	48
Biological controls	9	13	7	4	7	15	10
Pest forecasting	15	25	13	18	1	6	13
None of these used	4	4	6	23	62	15	15

*Average of pesticide users and nonusers.

Figure 5. Results of the following question:

With respect to your pest management program do you... (check all that apply)



keeping records. These records are important for monitoring pests, keeping track of plant back restrictions, and are required by law for restricted use pesticides.

Economic thresholds were used by slightly more than 50% of all pesticide users. However, these thresholds are not available for all crops and areas of the state. The use of economic thresholds tends to follow consultant use, suggesting that many producers rely upon consultants for pesticide timing decisions according to these thresholds. More producers reported using consultants for pest and pesticide recommendations than for fertilizer and irrigation management advice. This finding is readily explained by the higher cost of pesticides and the labor needed for good pest control.

Banding and spot application are also utilized by less than half of all pesticide users. Banding and spot application for weed and insect control reduces how much pesticide is required. Still, these practices require more management and are often not available when using commercial applicators.

The question "Are there any concerns about the quality of your water for crop production?" was included to assess the perception among irrigating producers about water quality as it relates to crop production. Fifteen-percent of producers statewide affirmed concerns about their irrigation water quality. As shown in Figure 6, the categories of impairment concerns are as diverse as the different regions of Colorado. The most common concern statewide and particularly in the Arkansas and W.

Table 3. Regional differences in pesticide BMPs used by Colorado irrigated farms (among pesticide users).

	Region						
	South Platte	Eastern Plains	Arkansas Valley	San Luis Valley	Mountains	Western Slope	Colorado
Practices (% using)							
Keep pest & pesticide records	63	62	39	54	36	41	54
Use crop consultants	67	73	39	72	32	30	57
Use economic thresholds	58	74	52	56	32	32	54
Use banding or spot applic.	57	48	14	24	55	34	43
None of these used	3	3	20	9	5	19	9

Figure 6. Results of the following question:

Are there any concerns about the quality of your water for crop production? Please briefly describe these water quality concerns:

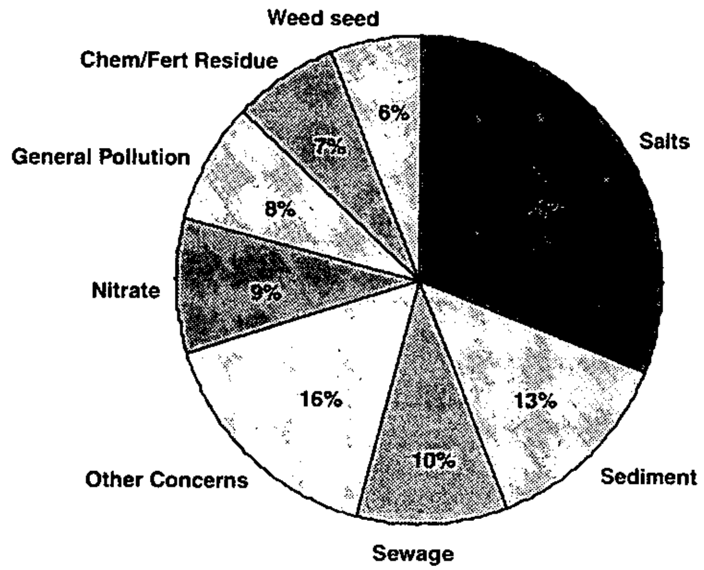


Table 4. Respondents indicating water quality concern in different regions.

	Region						
	South Platte	Eastern Plains	Arkansas Valley	San Luis Valley	Mountains	Western Slope	Colorado
Portion of Respondents Concerned	--------------------	--------------------	--------------------	%	--------------------	--------------------	--------------------
	19	11	35	12	5	12	15

Slope region is salinity. These are legitimate concerns with high soluble salt content reported by several studies in surface and groundwater within these basins. Sediment, sewage, and nitrate contamination also have producers' interest in several basins. Other water quality issues ranged from heavy metals from mining to pesticides from other farms. The results suggest that some producers do believe that poor water quality can also impact their crop production as well as the environment.

Overall, the survey results suggest that producers are accepting many of the fertilizer and pesticide BMPs that protect water quality, although considerable differences exist between practices, regions, and producer demographic group. Practices that have an obvious economic benefit seem to be used more often than those where the return from increased managerial input is less obvious. The survey also identified some areas and topics where more extension work is necessary for improved water quality protection in Colorado.

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AGRICULTURAL CHEMICALS AND GROUNDWATER PROTECTION

BEST MANAGEMENT PRACTICES

Fact sheet #19

Irrigation Best Management Practices: What Are Colorado Producers Using?

Irrigation for crop production diverts a large majority of all water used in Colorado. Coloradoans have a long history of irrigation innovation, but little is known about what updated practices producers are implementing. These innovations in irrigation practices may include new equipment, information systems, or management techniques designed to improve water distribution, uniformity, and efficiency. Collectively, these practices may be considered Best Management Practices (BMPs) because of their potential to improve water use efficiency and sustain water quality.

Colorado State University Cooperative Extension and the Colorado Department of Agriculture developed these BMPs with significant input from local producers and chemical applicators in several watersheds throughout the state. The goal of this work is to prevent degradation of water quality through voluntary adoption of BMPs by Colorado farmers. Colorado has elected to encourage the voluntary adoption of these BMPs rather than legislate overly restrictive measures on farmers and related industries.

This fact sheet was written by Troy Bauder, Reagan Waskom, Marshall Frasier, and Dana Hoag at Colorado State University in cooperation with the Colorado Department of Agriculture and the Colorado Department of Public Health and Environment. 8/99.

For more information contact the authors at 970/491-6102.

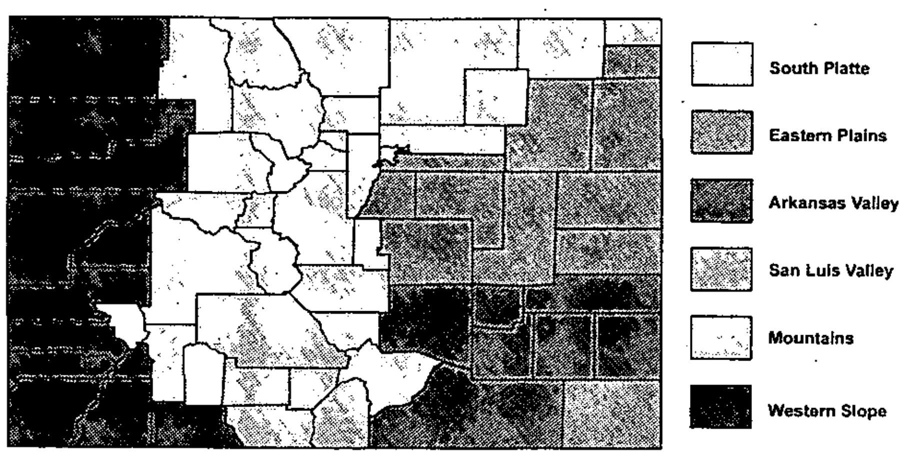


Figure 1. Regional grouping of survey responses by county given.

Protecting Colorado's groundwater and supporting agriculture

Table 1. Selected characteristics of responding farms.

Characteristic	Units	
Farm size	Average acres*	2009
	Median acres	480
Irrigated acres	Average	387
Irrigated area rented	Average %	29
Water Source:		
Ground water	Average % of acres irrigated	72
Surface water		28

*Average farm size was much larger than the median due to responses from a few very large operations.

Until now, there has been little quantified information on what irrigation BMPs Colorado producers are using and where they are being used. This information is necessary to conduct relevant educational programming and training in the areas and topics where it is most beneficial. The data is also helpful in documenting progress that Colorado producers are making in protecting water quality by improving their irrigation and to identify where more effort is needed.

To obtain information about BMP adoption, a written survey was conducted in February 1997. The survey was mailed to 3,281 producers who had at least 40 acres of cropland and irrigated at least one crop. The confidential survey asked producers about irrigation management and technology used in their operations and included questions about specific fertilizer and pesticide BMPs. Producers returned 1,319 usable surveys for a 40% response rate.

The survey consisted of 50 questions in five sections. Part of the survey asked about practices used anywhere on the farm, and part asked about a specific *Representative Field*. This report provides results of the survey related to irrigation BMPs for groundwater quality. More comprehensive results are provided in the technical report, "Irrigation Management in Colorado - Survey Data and Findings" (Colo. Ag. Expt. Station TR-99-5).

The results were grouped into six geographic regions for summarizing responses. (Figure 1). These regions were delineated based on known differences in water sources and cropping opportunities. General characteristics of the responding farms are provided in Table 1.

Survey Results

Properly timing water applications to fulfill crop demand is a basic irrigation BMP that greatly improves overall seasonal efficiency and eliminates unnecessary applications. The most reliable way to closely time water applications to crop demand is to schedule according to accumulated crop evapotranspiration (ET) and/or soil moisture depletion. Less than one-third of all the respondents indicated they used accumulated ET or depleted soil moisture to time their water applications. Figure 2 shows that "crop appearance" is the most popular determination of when to irrigate. Judging water stress through crop appearance usually is an inaccurate method of irrigation scheduling and can be deceiving even for experienced irrigators. Respondents choosing "other" often listed tradition and experience as their guiding mechanism.

These application-timing results vary considerably with the water source (Table 2). Producers with more control over when they can irrigate (groundwater pumpers) use ET and soil moisture more often and irrigated less by "fixed number of days" than surface water users. Groundwater users also tend to use a consultant more often to help schedule irrigation. Differences in timing water applications are also found between regions and irrigation systems as would be expected given the diversity of water sources and systems found across the state.

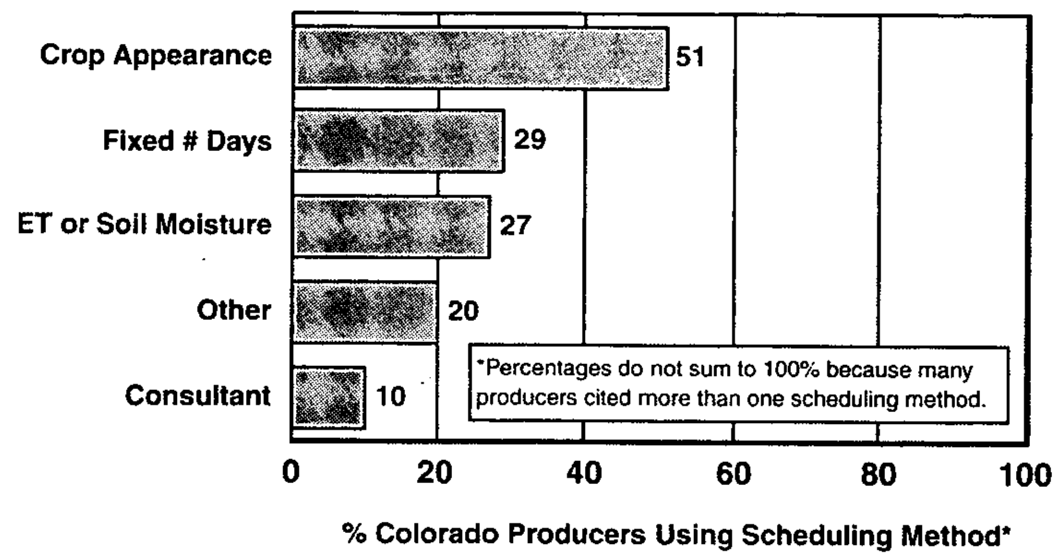


Figure 2. Results of the following question:
Check the ONE primary method that you used in 1996 to decide WHEN to irrigate.

Table 2. Differences in scheduling water application as affected by water source.

Water Source	Crop Appearance	Fixed Number of Days	Accumulated ET or Soil Moisture*	Other Method	Consultant Determines
	Irrigation Timing Criteria				
	----------------------% Respondents Using Scheduling Method**----------------------				
Groundwater	41	24	38	10	29
Ditch Company	58	33	24	20	4
Direct Diversion	48	25	19	34	0

* Accumulated ET and soil moisture depletion was offered as two separate responses. However, most respondents indicating the use of one also indicated use of the other; therefore both practices are presented together.

** Percentages do not sum to 100% because many producers cited more than one scheduling method.

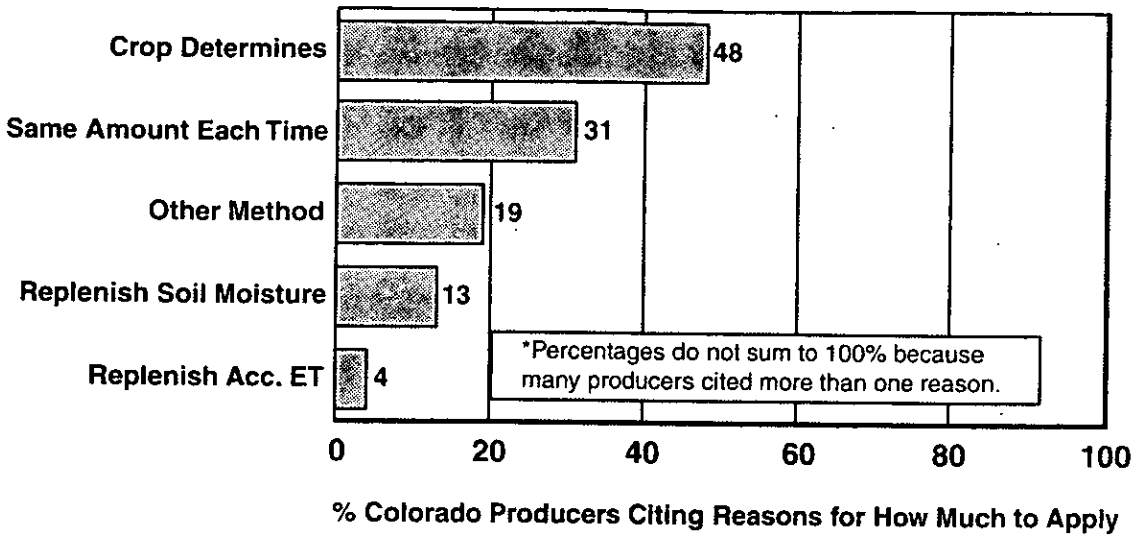


Figure 3. Results of the following question:
Check the ONE primary method used in 1996 to decide HOW MUCH water to apply for each irrigation application.

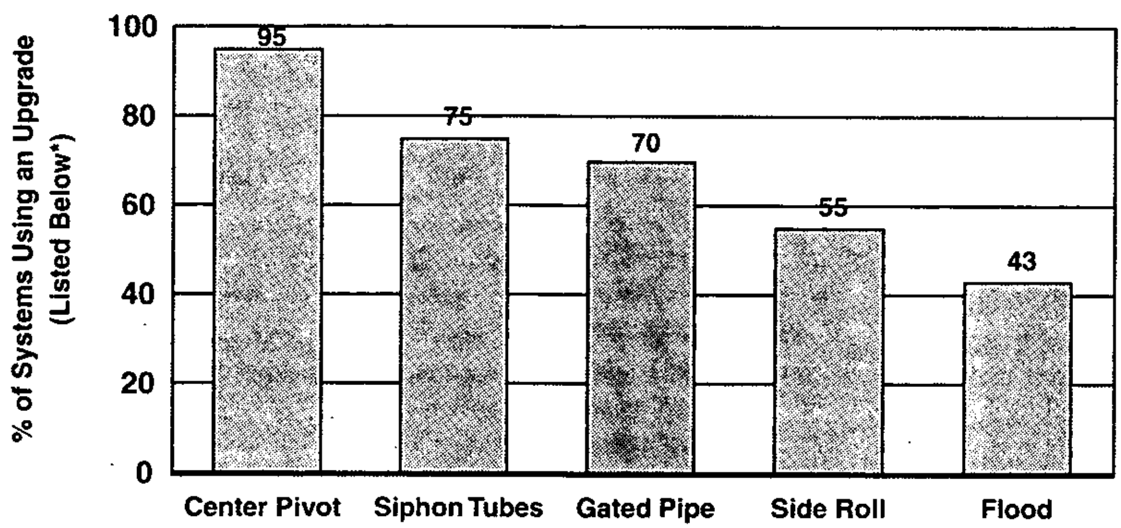
Table 3. Differences in amount of water applied as affected by water source.

	Amount of Water to Apply				
Water Source	**Crop Determines**	**Same Amount Each Time**	**Other**	**Replenish Soil Moisture**	**Replenish Accumulated ET**
	--------------% Respondents Citing Reasons for How Much to Apply----------------------				
Groundwater	49	23	10	27	9
Ditch Company	51	33	21	7	2
Direct Diversion	38	33	29	7	2

Another fundamental irrigation BMP involves applying the water necessary to replace crop consumption. Respondents indicated that the "crop determines amount" of irrigation water to apply as the most commonly used method (Figure 3). We can infer from this that producers consider crop growth stage and accumulated ET when making an application decision. It is also possible that they were equating "crop determines amount" with the idea that crop appearance indicates how much water is needed. Interestingly, this response was a misprint, and the question was originally intended to read "Crop consultant determines amount". As with the irrigation timing method, groundwater users also base their application decisions more on ET and soil moisture and were less likely to apply the same amount each time than surface water users (Table 3).

Much of the survey consisted of questions regarding irrigation systems used and technology upgrades to these systems. These upgrades generally are designed to improve the uniformity of application and/or increase irrigation efficiency. Figure 4 characterizes upgrades to irrigation systems on respondents' *Representative Field*. These results suggest that producers choose to use some irrigation upgrades more often than implement management changes. Nearly all the respondents using center pivot irrigation systems installed at least one of the upgrades provided in the question. The frequency of upgrades decreases as the system changes to surface systems and side roll systems. Options available for upgrading systems such as center pivots are numerous, but the only way to upgrade a flood system is to change to a different system.

The upgrades most frequently selected were field leveling for surface systems and low pressure for sprinkler systems. One tool that is not used often is flow meters. This finding is consistent with the low number of people reporting knowledge of how much water they applied (Table 4).



***Options given in survey for selecting irrigation system upgrades:**

LEPA	Corner catcher	Surge valves
Drop nozzles	Flow meters	None apply
Low pressure sprinklers	Lined ditches	Other
Computer controller	Field leveling	

Figure 4. Results of the following question:

Check all irrigation upgrades used on the system identified for this field.

Table 4. Respondents knowing and keeping records on the amount of water applied*.

	Region						
	South Platte	Eastern Plains	Arkansas Valley	San Luis Valley	Mountains	Western Slope	Statewide Average
	----% Respondents per Region----						
Know Amount Applied	36	38	25	30	17	17	28
Keep Records	16	19	15	25	12	12	16

*Questions read: Do you know how much water was applied to the representative field in 1996?
Did you keep written or computerized records of water applied throughout the season?

Another significant finding from the survey was producers' perception of their *Representative Fields'* irrigation application efficiency (Figure 5) and their knowledge of the quantity of water applied (Table 4). Slightly over one-quarter of respondents reported they knew the amount of water applied to their *Representative Field*, and less than one-sixth of respondents indicated keeping records of water application. Sixty-eight percent of those producers who kept records knew their water application amount compared to 20% of those that did not. The majority of respondents indicated they knew system efficiency, but their estimates of application efficiency tended to be much higher than commonly measured values obtained from research and field demonstration projects, especially among surface irrigators.

Without knowledge of water application amounts and records of these applications, improvement in water management such as advanced scheduling techniques may be difficult to implement. This may also help irrigators plan water needs during drought years and assist in conflicts over water rights. Helping producers to realize the efficiency limits of their irrigation systems may help them irrigate in dry years and make improvements to their systems and management where feasible.

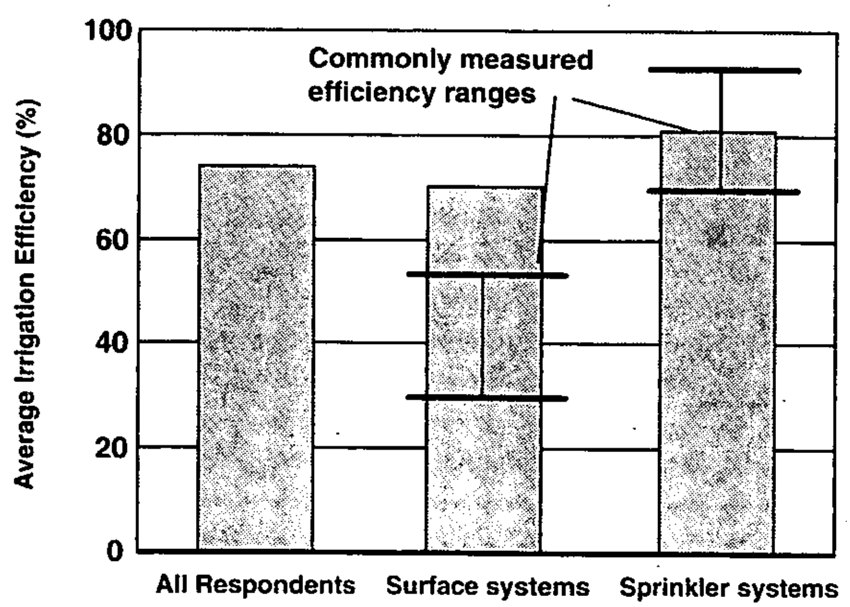


Figure 5. Result of the following question:
Check your best estimate of the system's average field application efficiency for 1996.
Application efficiency = crop use ÷ water applied

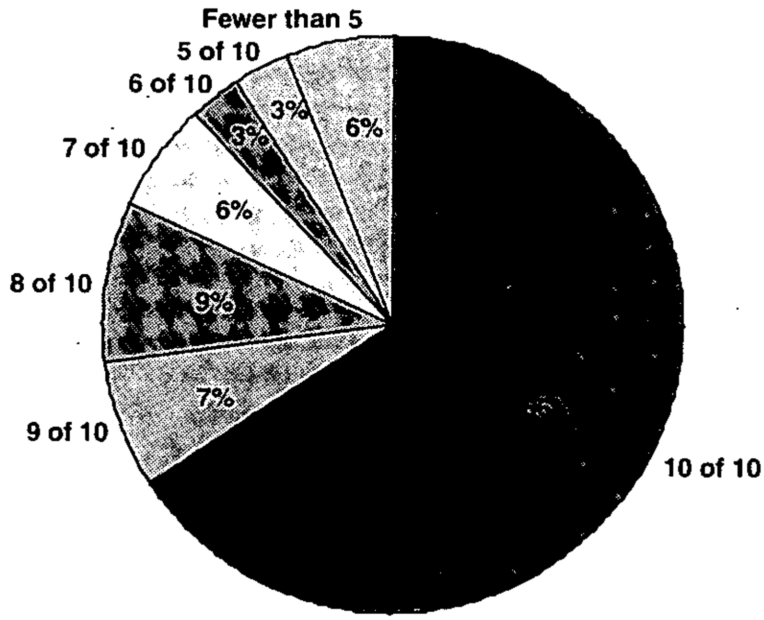


Figure 6. Results of the following question:

Check the number of years out of 10 that your water sources are able to provide a full water supply for the crops grown on the Representative Field.

Some Colorado producers have more opportunities and incentives to adopt new technologies and management techniques than others do. For example, Figure 6 shows that the majority (66%) of respondents statewide was not limited on their *Representative Field* by water sufficiency and had an adequate supply of water 10 years out of 10. However, some regions of the state (Arkansas Valley) are more limited in water supply and should have more incentive to adopt irrigation technologies and management strategies that conserve water (Table 5). These survey results suggest that stretching water supplies is not a significant incentive to change irrigation management for the majority of Colorado irrigating producers.

Table 5. Regional differences in water supply on respondents' *Representative Field*.

	Region						
Number of Years out of 10	South Platte	Eastern Plains	Arkansas Valley	San Luis Valley	Mountains	Western Slope	Statewide Average
	% of Respondents						
10	74	82	46	63	59	54	65
9	7	4	6	9	7	10	7
8	7	4	14	8	13	13	9
7	5	2	14	6	4	7	6
6	2	2	2	4	7	4	3
5	1	1	9	4	4	3	3
Fewer than 5	4	5	10	7	6	9	6

[a] Number of years out of 10 that the water source provides a full water supply for the crop grown on the representative field.

Table 6. Age of system installed on the *Representative Field* and irrigation experience of respondents.

	Irrigation System					
	Center Pivot	Side Roll	Gated Pipe	Siphon Tubes	Flood	All Systems
	---------------------------------- Average Years					--
Age of system	14	10	11	35	74	32
Irrigation experience	28	26	30	32	33	31

Irrigation management and technology adoption in Colorado is progressing, but many producers have not incorporated irrigation best management practices in their operations. The age of many irrigation systems and the average irrigation experience of Colorado irrigators may represent significant barriers to improving water management (Table 6). Colorado irrigators are highly experienced and may not perceive a need to make management changes. Additionally, most producers are apparently not motivated to keep an accurate accounting of crop water use and irrigation water applied. This may be partially explained by the fact that many irrigators feel their water supplies are adequate during most years. The management time and costs required to implement higher levels of water management may not be justified or economically feasible for these irrigators. However, the results of this irrigation survey show that Colorado irrigators will implement improved technology when it is practical, economical or when other significant motives exist. It may be inferred that higher levels of irrigation water management will be adopted in Colorado as farmers perceive an incentive to do so.

Technical Report TR99-5

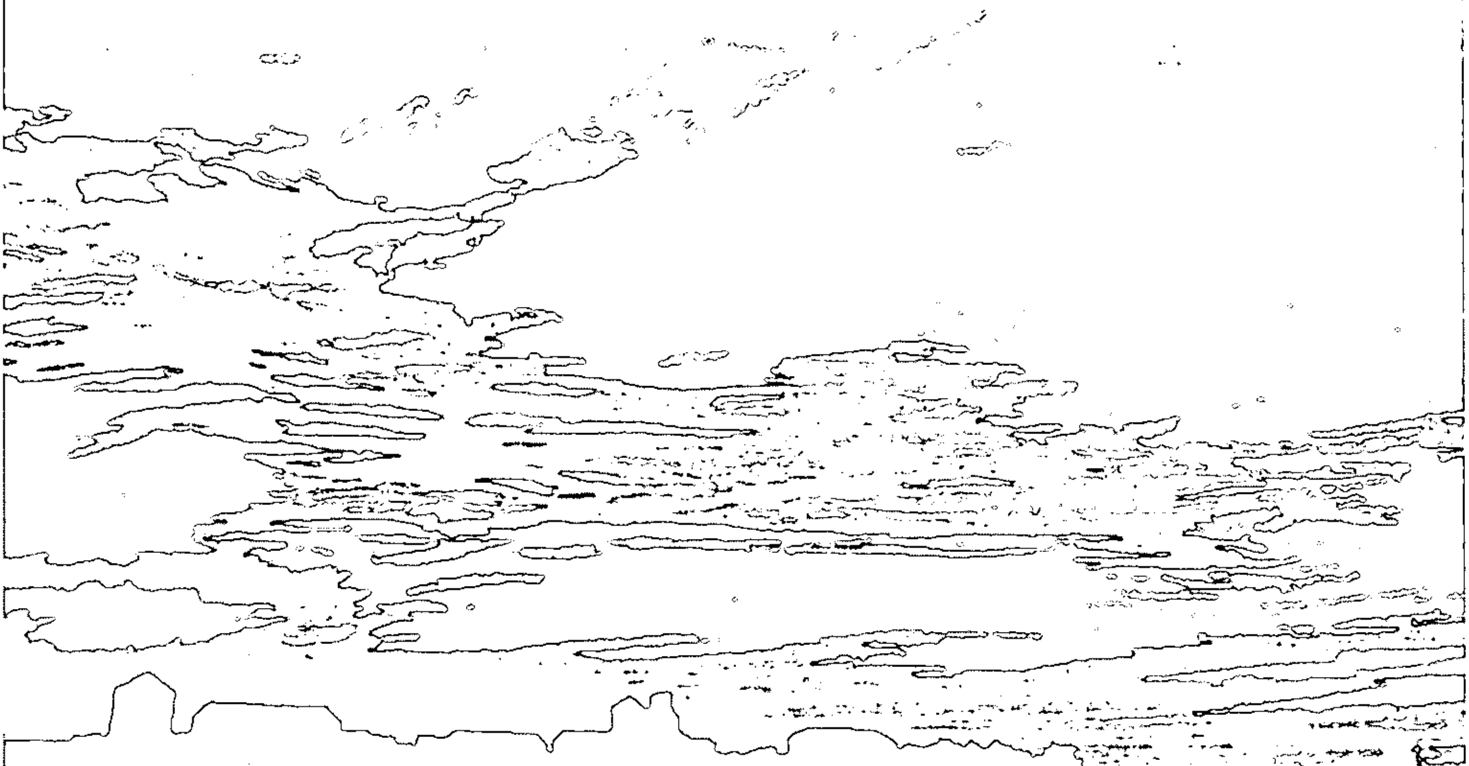
Agricultural Experiment Station | Cooperative Extension | Department of Agricultural & Resource Economics | Department of Soil and Crop Sciences | May 1999

Irrigation Management in Colorado: Survey Data and Findings

W. Marshall Frasier
Reagan M. Waskom
Dana L. Hoag
Troy A. Bauder

Colorado State University

Best Management Practices For Manure Utilization



Colorado State University Cooperative Extension

APPENDIX II

1999 Annual Report
Colorado State University Cooperative Extension

Summary of Accomplishments:

- Conducted educational programs throughout Colorado on SB 90-126 and issues related to agricultural chemicals and groundwater quality. Groups addressed include commercial applicators, chemical dealers, weed districts, crop consultants, crop and livestock producers, agency personnel, and urban chemical users.

- Conducted training related to the Colorado Best Management Practice Manual. Distributed booklets to Colorado citizens covering nutrient, pesticide, irrigation, manure, and water well management.

- Cooperated with the Colorado Corn Growers Association to develop and demonstrate BMPs appropriate for corn production (Attachment A).

- Conducted an irrigation runoff study to evaluate the potential for Balance herbicide to move to downstream fields (Attachment B).

- Collaborated with Colorado School of Mines to develop ground water vulnerability matricies for assessing nitrate and pesticide contamination potential.

- Developed and published a revised bulletin on BMPs for Manure Utilization (Appendix I).

- Published a factsheet on N management BMPs entitled "Reducing Fertilizer Costs By Crediting Irrigation Water Nitrogen" (Appendix I).

- Published two factsheets and one technical report on the status of BMP adoption in Colorado. These publications report the results of a statewide survey of irrigated crop producers to determine status of BMP adoption by farmers. The report was published by the Colorado Agricultural Experiment Station as Technical Report TR 99-05 "Irrigation Management in Colorado - Survey Data and Findings". The factsheets are entitled "Irrigation Best Management Practices: What are Colorado Producers Doing?" and "Water Quality Best Management Practices: What are Colorado Producers Doing?" (Appendix I).

- Revised the Pesticide Record Book for Private Applicators.

- Worked on the Certified Crop Advisors Program in Colorado; including rewriting the state performance objectives and the state exam and representing Colorado at the National Advisory Board.

- Maintained a CSU Extension Water Quality Website to disseminate BMP information via the Internet.

- Provided a focused program to work on education and demonstration projects with farmers in the South Platte River Basin, a high priority watershed for SB 90-126 efforts. This work included farmer demonstrations to show the benefits of crediting N received through irrigation water, working on nutrient management under manured conditions, and using atmometers to schedule irrigations.

- Continued a program to monitor nutrient runoff from high altitude golf courses.

- Cooperated on a field project to evaluate ammonia volatilization on fields receiving swine effluent applications.

- Distributed a series of four factsheets to educate Colorado homeowners on BMPs for urban pesticide and fertilizer use. These factsheets are entitled:
    Homeowner's Guide to Protecting Water Quality and the Environment
    Homeowner's Guide to Pesticide Use Around the Home and Garden.
    Homeowner's Guide: Alternative Pest Management for the Lawn and Garden.
    Homeowner's Guide to Fertilizing Your Lawn and Garden.

- Distributed a booklet of BMPs specifically for greenhouse growers in Colorado entitled:
    Pollution Prevention for Colorado Greenhouses

- Cooperated with county Extension agents on nutrient management demonstrations on farmer fields and conducted manure management field days in eastern Colorado to discuss proper nitrogen, manure, and water management practices.

- Produced newsletter articles, press releases, fact sheets, technical papers, radio and other mass media articles on groundwater protection in Colorado.

- Distributed a 20 minute instructional video entitled "Best Management Practices for Colorado Agriculture".

- Worked to coordinate efforts of the Agricultural Chemicals and Groundwater Protection program with other state and federal programs in Colorado.

- Assisted the Colorado Department of Agriculture in the implementation of the Bulk Storage Regulations and the development of the generic State Management Plan. Contracted with a private consultant to prepare a protocol for developing a Colorado groundwater sensitivity map.

Ongoing BMP Development and Education

Colorado State University Cooperative Extension is working with the Colorado Department of Agriculture to develop Best Management Practices for Colorado farmers, landowners, and commercial agricultural chemical applicators. The chemical user because of the site-specific nature of groundwater protection must ultimately determine the BMPs adopted for use at the local level. The local perspective is also needed to evaluate the feasibility and economic impact of these practices. The SB 90-126 Advisory Committee has recommended that a significant level of input be received at the local level prior to adoption of recommended BMPs.

Colorado State University Cooperative Extension has compiled a broad set of BMPs encompassing nutrient, pest, and water management that will be used as a template for local committees. These documents were published in a notebook form in 1995 that are updated as needed and expanded to include additional guidelines.

Cooperative Extension has piloted the local BMP development process in the San Luis Valley and in the Front Range area of the South Platte Basin. The local working committees consist of a small group of producers, consultants, and chemical applicators. The San Luis Valley group has produced a set of BMPs appropriate for their area that are being publicized and will be implemented by cooperating farmers in field scale demonstrations. The South Platte group is working towards consensus in a very complex farming region. Both of these groups have produced BMPs for nutrient and irrigation management - the most serious problem in their respective areas. They are now working on pest and pesticide management BMPs for specific crops. A local BMP group was formed in 1995 in the Montrose/Delta area. The Shavano SCD worked with local Extension agents and producers to develop a set of practices appropriate for the West Slope entitled "Best Management Practices for the Lower Gunnison Basin". During 1996, a fourth local BMP work group was initiated in the lower South Platte Basin. They published their findings in a bulletin entitled "Best Management Practices for the Lower South Platte River Basin."

Field Demonstrations

Colorado State University Cooperative Extension has worked with the USDA Agricultural Research Service and farmers on field research and educational plots to demonstrate improved nitrogen, manure, and irrigation management techniques. New production tools are being evaluated and demonstrated to farmers that may improve producer profitability and help protect groundwater.

Field trials are held on farm fields in Colorado to demonstrate BMPs. Educational field days are held at these sites to acquaint other producers and interested parties with the need for groundwater protection. Farmers are shown BMP's related to nutrient and irrigation management.

A technology known as in-season nitrate testing is demonstrated to farmers on strip trials on their farms. This tool may help farmers improve N recommendation accuracy and minimize the use of "insurance" N fertilizer. By complementing preplant soil testing with in-season testing, it may be possible to improve N fertilizer requirement prediction accuracy, resulting in reduced leaching of nitrate to groundwater. Quick soil test kits for nitrate have been developed that allow "field testing," thereby alleviating the problem of slow turn-around time in commercial soil testing laboratories. The development of these quick test kits has made the in-season nitrate test a viable soil testing procedure for assessing the N fertility status of crops at any growth stage. It is expected that this will result in the joint use of preplant deep soil nitrate testing and in-season testing which will increase the accuracy of N fertilizer recommendations. The total application of N fertilizer can be decreased without negatively affecting crop yields as farmers adopt this improved technology.

Other production tools being evaluated and demonstrated to farmers include the portable chlorophyll meter to access N status of growing plants and surge irrigation valves to help decrease irrigation water runoff and leaching.

1999 Colorado Corn Growers / CSU BMP Project

Yield Results for the Presidedress Nitrate Test (PSNT) Demonstration

Cooperators: Steve and Judy Kelly

- The PSNT (pre-sidedress nitrate soil test) is an in-season soil test for corn that has been tested extensively on non-manured fields in Colorado.
- The PSNT may be used on manured fields in Colorado, although the critical level has not been conclusively established.
- The PSNT allows producers to have more confidence in their decision to apply additional fertilizer to manured and non-manured corn fields.
- The critical level for the PSNT on non-manured corn fields is 13-15 ppm NO_3-N in the top 12".
- Call Troy Bauder with CSU (970) 491-4923 or Jerry Alldredge with Weld Co. Coop. Extension (970) 336-7230.

Background Information

The primary objective of the demonstration at this site is to evaluate manure nutrient crediting and the PSNT (pre-sidedress nitrate soil test) as part of a sound nutrient management program. The PSNT is an in-season soil test for corn that has been tested extensively on non-manured fields in Colorado. This site is one of several trials where the test is being used on manured fields.

The PSNT was originally developed for the humid Eastern U.S., but has been calibrated for Colorado's soils and climate in recent years. This soil test will allow you to make a confident, sound decision whether to sidedress your corn crop and avoid unnecessary fertilizer costs or yield loss to due insufficient N.

Previous research in northeastern Colorado on nonmanured fields has indicated that if the top foot of soil contains from **13 - 15 ppm NO_3-N** when the corn is approximately 12 inches tall (V6 growth stage) you can expect optimum corn grain yields under typical irrigated Colorado conditions. Lower NO_3-N values mean the crop requires additional N for optimal yields. The test will tell you whether or not enough soil N is available, but not how much is needed. Crop producers must assess yield potential as well as soil nitrate levels at the sidedress period to determine actual sidedress N rates.

Results:

Average* corn silage yield results for PSNT demonstration; harvest date: September 24,1999.

	Field tons/acre	Dry tons/acre	%Dry Matter	Adjusted tons/acre (30% DM)
No Sidedress N	30.8	10.8	34.5	34.9
60 lb Sidedress N	31.5	10.2	33.5	33.9
Average	31.2	10.5	34.0	34.4

*Results provided are an average of three replications of each treatment.

What Did We Learn?

The soil NO_3-N level was slightly below the PSNT critical level (13-15 ppm) for non-manured fields at the 6-leaf growth stage. However, we found no significant difference in the silage yield between the sidedressed and unfertilized strip-plots. This result suggests that manured fields may have a lower critical level than non-manured fields and may not respond to additional nitrogen when they are close to the critical level. With further field trials, we will be able to more accurately pinpoint the critical level for manured fields.

Field Background information:

Soil type:	Olney sandy loam
Hybrid and population:	Pioneer 3260; ~34,000 plants/acre
Manure rate and timing:	25 to 30 tons applied Fall 1998
Preplant soil NO_3-N:	0-1'= 21 ppm; 0-4' = 11 ppm
Presidedress soil NO_3-N:	0-1' = 12 ppm
Previous crop:	Carrots
Sidedress fertilizer:	55 to 60 lbs of Nitrogen applied as UAN 32%, June 23

1999 Colorado Corn Growers / CSU BMP Project

Yield Results for the Presidedress Nitrate Test (PSNT) Demonstration

Cooperator: Ron Ditson with Wes Moser and Sons

- The PSNT (pre-sidedress nitrate soil test) is an in-season soil test for corn that has been tested extensively on non-manured fields in Colorado.

- The PSNT may be used on manured fields in Colorado, although the critical level has not been conclusively established.

- The PSNT allows producers to have more confidence in their decision to apply additional fertilizer to manured and non-manured corn fields.

- The critical level for the PSNT on non-manured corn fields is 13-15 ppm NO_3-N in the top 12".

Background Information

One objective of the demonstration at this site was to evaluate manure nutrient crediting and the PSNT (pre-sidedress nitrate soil test) as part of a sound nutrient management program. The PSNT is an in-season soil test for corn that was originally developed for the humid Eastern U.S., but has been extensively tested for Colorado's soils and climate in recent years on non-manured fields. This soil test will allow you to make a confident, sound decision whether to sidedress your corn crop and avoid unnecessary fertilizer costs or yield loss to due insufficient N. This site is one of several trials where the test is being used on manured fields.

Previous research in northeastern Colorado has indicated that if the top foot of soil contains from **13 - 15 ppm NO_3-N** when the corn is approximately 12 inches tall (V6 growth stage) you can expect optimum corn grain yields under typical irrigated Colorado conditions. Lower NO_3-N values mean the crop requires additional N for optimal yields. The test will tell you whether or not enough soil N is available, but not how much is needed. Crop producers must assess yield potential as well as soil nitrate levels at the sidedress period to determine actual sidedress N rates.

Results:

Average* corn silage yield results for PSNT demonstration; harvest date: September 14, 1999.

	Field tons/acre	Dry tons/acre	%Dry Matter	Adjusted tons/acre (30% DM)
No Sidedress N	15.6	5.5	35.6	18.5
60 lb Sidedress N	15.1	6.0	39.5	19.9
Average	15.3	5.7	37.5	19.2

*Results provided are an average of two replications of each treatment.

What Did We Learn?

The soil NO_3-N level (9.5 ppm) was below the PSNT critical level (13-15 ppm) for non-manured fields at the 6-leaf growth stage. We found a small (but not statistically significant difference) in the adjusted and dry silage yield between the sidedressed and non-sidedressed strip-plots. However, the whole field did receive additional nitrogen through one fertigation and through nitrate in the well water. Without this additional nitrogen we would most likely expect more of a difference between the plots. These results suggest that the PSNT may be appropriate for manured fields, and with further field trials, we will be able to more accurately pinpoint the critical level for manured fields.

Field Background information:

Soil type:	Valent and Vona loamy sand
Hybrid and stand count:	Pioneer 3211; ~30,000 plants / acre
Manure rate and timing:	20 to 25 tons applied Winter 1998
Preplant soil NO_3-N:	0-1'= 13.1 ppm; 0-4' = 5.2 ppm
Presidedress soil NO_3-N:	0-1' = 9.5 ppm; 1-2' = 6.1 ppm;
Previous crop:	Potatoes
Sidedress fertilizer:	40 lbs of Nitrogen applied as UAN 32%
Fertigation:	25 lbs of Nitrogen applied as UAN 32%

1999 Colorado Corn Growers/ CSU BMP Project

Manure and Irrigation Water Nitrate Crediting Demonstration Results

Cooperator: Steve Eckhardt

Quick Facts:

- Beef feedlot manure supplies approximately 10 lbs N per acre for each ton applied during the first year following application.
- Beef feedlot manure supplies approximately 19 lbs of available P_2O_5 per acre for each ton applied during the first year following application.
- One inch of irrigation water supplies 0.23 lb N per acre for each ppm of NO_3-N in the water.
- Many irrigation wells in the S. Platte alluvial aquifer are enriched with NO_3-N.
- Call Troy Bauder (970) 491-4923 with CSU or Jerry Alldredge with Weld Co. Coop. Extension (970) 336-7230 for more information.

Background Information

The primary objective of this demonstration site was to evaluate irrigation water and manure crediting as parts of a sound nutrient management program. Livestock manure is rich in plant available nutrients, especially nitrogen, which can be credited toward the nitrogen fertilizer requirement of a crop. Irrigation water containing nitrate can also supply considerable amounts of nitrogen because it is applied during the growing season and is immediately available for crop uptake, thus potentially reducing the amount of fertilizer required. In most situations, fields applied with manure and irrigated with high nitrate water will not require additional nitrogen fertilizer. This site had these conditions for the 1999 cropping year.

Three nitrogen fertilizer rates (0, 65, and 130 lbs / acre) were applied to 8-row strips. The 130 lb rate represents the recommended rate when the manure and water credits are not considered. The 65 lb rate approximates the recommended nitrogen rate when the water nitrogen is considered, but the manure nitrogen is not. The control or 0 lb rate takes into consideration both manure and irrigation water credits. Fertilizer strips were replicated two times.

Results: Average* corn grain yield and economic comparisons.

Nutrient Management Practice	Fertilizer Nitrogen Rate	Grain Moisture	Test Weight	Grain Yield	$ Return on Practice**
	-- lb / acre --	-- % Water --	-- lbs / bu --	-- bu / acre --	-- $ / acre --
BMP rate (manure & water credit)	0	15.6	55.9	242	+62.95
Water credit, but no manure credit	65	15.7	56.4	203	-95.85
No water or manure credit	130	15.9	54.7	225	-65.20
Average		15.7	55.6	223	

*Results provided are an average of two replications of each treatment.
**Return was computed using a $2.00 / bu corn price and a $0.24 / lb N cost.
Return on Practice = (yield difference between practice and BMP N rate x $2.00)- N cost - cost to implement BMP

What Did We Learn?

There was no real (statistically significant) difference between the N fertilizer rates at this site. Therefore, the highest economic return resulted from crediting both manure and water N sources. These results support using all appropriate nitrogen credits for maximum economic yield.

Field Background information:

Soil type:	Julesburg sandy loam
Planting Date:	April18, 1999
Hybrid and population:	NC+ 3869; ~33,400 plants/acre
Manure rate and timing:	Approximately 15 tons applied late Fall 1998, incorporated Spring 1999
Preplant soil NO_3-N:	0 -1'= 33 ppm; 0-4' = 14 ppm
Presidedress soil NO_3-N:	0 -1' = 9.3 ppm
Previous crop:	Potatoes
Starter fertilizer:	None
Sidedress fertilizer:	UAN 32%, applied June 6
Harvest date:	November 3, 1999

1999 Colorado Corn Growers/ CSU BMP Project

Manure and Irrigation Water Nitrate Crediting Demonstration Results

Cooperator: James Ewing

Quick Facts:

- Beef feedlot manure supplies approximately 10 lbs N per acre for each ton applied during the first year following application.
- Beef feedlot manure supplies approximately 19 lbs of available P_2O_5 per acre for each ton applied during the first year following application.
- One inch of irrigation water supplies 0.23 lb N per acre for each ppm of NO_3-N in the water.
- Many irrigation wells in the S. Platte alluvial aquifer are enriched with NO_3-N.
- Call Troy Bauder (970) 491-4923 with CSU or Jerry Alldredge with Weld Co. Coop. Extension (970) 336-7230 for more information.

Background Information

The primary objective of this demonstration site was to evaluate irrigation water and manure crediting as parts of a sound nutrient management program. Livestock manure is rich in plant available nutrients, especially nitrogen, which can be credited toward the nitrogen fertilizer requirement of a crop. Irrigation water containing nitrate can also supply considerable amounts of nitrogen because it is applied during the growing season and is immediately available for crop uptake, thus potentially reducing the amount of fertilizer required. In most situations, fields applied with manure and irrigated with high nitrate water will not require additional nitrogen fertilizer. This site had these conditions for the 1999 cropping year.

Three nitrogen fertilizer rates (0, 70, and 140 lbs / acre) were applied to 6-row strips. The 140 lb rate represents the recommended rate when the manure and water credits are not considered. The 70 lb rate approximates the recommended nitrogen rate when the water nitrogen is considered, but the manure nitrogen is not. The control or 0 lb rate takes into consideration both manure and irrigation water credits. Fertilizer strips were replicated two times.

Results: Average* corn grain yield and economic comparisons.

Nutrient Management Practice	Fertilizer Nitrogen Rate	Grain Moisture	Test Weight	Grain Yield	$ Return on Practice**
	-- lb / acre --	-- % Water --	-- lbs / bu --	-- bu / acre --	-- $ / acre --
BMP rate (manure & water credit)	0	15.7	55.4	187	+9.35
Water credit, but no manure credit	70	17.3	56.8	182	-24.55
No water or manure credit	140	17.6	57.3	198	-11.60
Average		16.8	56.5	189	

*Results provided are an average of two replications of each treatment.
**Return was computed using a $2.00 / bu corn price and a $0.24 / lb N cost.
Return on Practice = (yield difference between practice and BMP N rate x $2.00)- N cost - Cost to implement BMP

What Did We Learn?

There was no real (statistically significant) difference between the N fertilizer rates at this site. Therefore, the highest economic return resulted from crediting both manure and water N sources. These results support using all appropriate nitrogen credits for maximum economic yield.

Field Background information:

- Soil type: Julesburg sandy loam
- Hybrid and population: Pioneer 3571; ~29,000 plants/acre
- Manure rate and timing: Approximately 20 tons applied Fall 1998, incorporated Spring 1999
- Preplant soil NO_3-N: 0 -1'= 41 ppm; 0-4' = 14 ppm
- Presidedress soil NO_3-N: 0 -1' = 11.4 ppm
- Previous crop: Corn
- Starter fertilizer: None
- Sidedress fertilizer: UAN 32%, applied June 2
- Harvest date: October 26, 1999

1999 Colorado Corn Growers / CSU Cooperative BMP Education Project

Presidedress Nitrate Test (PSNT) Demonstration - Cooperator Ritchie Pyeatt

- The PSNT (pre-sidedress nitrate soil test) is an in-season soil test for corn that has been tested extensively on non-manured fields in Colorado.
- The PSNT may be used on manured fields in Colorado, although the critical level has not been conclusively established.
- The critical level for the PSNT on non-manured corn fields is 13-15 ppm NO_3-N in the top 12".
- Call Troy Bauder (970) 491-4923 with CSU or Jerry Alldredge (970) 336-7230 at Weld Co. Coop. Ext. for more information regarding these results.

Background Information

The objective of this demonstration site was to evaluate manure nitrogen crediting and the PSNT (pre-sidedress nitrate soil test) as part of a sound nutrient management program. The PSNT is an in-season soil test for corn that has been tested extensively on non-manured fields in Colorado. This site is one of several trials where the test is being used on manured fields.

The PSNT was originally developed for the humid Eastern U.S., but has been calibrated for Colorado's soils and climate in recent years. This soil test will allow you to make a confident decision whether to sidedress your corn crop and avoid unnecessary fertilizer costs or yield loss to due insufficient N.

Previous research in northeastern Colorado on nonmanured fields has indicated that if the top foot of soil contains from **13 - 15 ppm NO_3-N** when the corn is approximately 12 inches tall (6-leaf growth stage) you can expect optimum corn grain yields under typical irrigated Colorado conditions. Lower NO_3-N values mean the crop requires additional N for optimal yields. The test will tell you whether or not enough soil N is available, but not how much is needed. Crop producers must assess yield potential as well as soil nitrate levels at the sidedress period to determine actual sidedress N rates.

Results: Average* corn grain yield and economic comparisons.

Nutrient Management Practice	Fertilizer Nitrogen Rate	N Cost	BMP Cost	Grain Yield	$ Return on Practice**
	-- lb / acre --	-- $ / acre --	-- $ / acre --	-- bu / acre --	-- $ / acre --
No PSNT (control)	0	0.00	0	169	+10.00
PSNT with Sidedress	50	7.50	1.50	174	-1.00
PSNT with Sidedress at 2x rate	100	15.00	1.50	178	-1.50
Average				174	

*Results provided are an average of two replications of each treatment.
**Return was computed using a $2.00 / bu corn price and a $0.15 / lb N cost.
Return on Practice = (yield difference between Control and PSNT rate x $2.00) - N cost - Cost to implement BMP
BMP cost is expense of taking PSNT sample = $15.00 analysis + $15.00 labor ÷ 20 acre field = $1.50 / acre

What Did We Learn?

The presidedress soil NO_3-N level of this field (8.0 ppm) was well below the PSNT critical level (13-15 ppm) for non-manured fields at the 6-leaf growth stage. We found a small, but not statistically significant, yield increase in the strip plots that received additional fertilizer. This yield increase resulted in a small net return after the cost of additional fertilizer and soil sampling was considered. These results suggest that a PSNT level of 8.0 ppm is below the critical level for manure fields. With additional field trials, we will be able to more accurately pinpoint the critical level for manured fields.

Field Background information:

Planting date:	May 15, 1999
Soil type:	Bresser sandy loam
Hybrid and population:	Pioneer 3730; ~29,000 plants/acre
Manure rate and timing:	20 tons applied Fall 1998
Preplant soil NO_3-N:	Unavailable
Presidedress soil NO_3-N:	0-1' = 8.0 ppm; 1-2' = 4.5 ppm;
Previous crop:	Dry beans
Sidedress fertilizer:	50 & 100 lbs of Nitrogen applied as anhydrous ammonia, June 14

1999 Colorado Corn Growers/ CSU BMP Project

Polyacrylamide (PAM) Demonstration Results; Cooperator: Ron Bakel

Quick Facts:

☞ PAM can greatly reduce irrigation induced erosion.

☞ PAM also increases infiltration and allows for higher flow rates.

☞ Call Troy Bauder (970) 491-4923 with CSU or Jerry Alldredge (970) 336-7230 Weld Co. Coop. Ext. for more information regarding these results.

Background Information:

The objective of this demonstration site was to evaluate the use of PAM as an irrigation BMP to prevent erosion and increase infiltration. Furrow irrigation induced soil erosion causes a multitude of problems for both farmers and the environment. Sediment carried in tail water removes valuable silt and clay sized soil particles, plant nutrients, pesticides, and organic matter. As sediment is moved off of the top of fields and deposited lower, it changes a field's intended slope requiring more frequent grading. Sediment in runoff also fills up drainage ditches and tail water pits, and causes problems for other users downstream. Polyacrylamide (PAM) is a relatively new product that can greatly reduce erosion due to irrigation when properly used. PAM is an environmentally safe, water-soluble polymer that works by binding clay and silt particles together enabling them to settle to the furrow bottom. PAM has been studied for several years and found to be both environmentally safe and effective.

Methods:

During the first three irrigations of 1999, PAM and No-PAM strip plots were conducted. A fish-feeder applicator metered dry PAM material (SuperFloc A-836) into the irrigation water at the head ditch at a 0.67 lb / acre application rate. We measured runoff volume with furrow flumes and samples collected for nutrient and sediment analysis during the first irrigation. Treatments were only replicated one time within an irrigation. Yields were obtained at harvest from weighing the grain harvested from six rows out of each strip using a weigh wagon.

Results: Runoff analysis results and corn grain yields from PAM and no PAM treatments.

	Runoff Results						
Sample ID	Soil loss	Total N	NO_3-N	Soluble - P	Total-P	Application Cost	Grain Yield*
	lb / acre					$ / acre	bu / acre
PAM	60	0.65	2.98	0.08	0.08	2.50	171
No PAM	358	1.14	3.21	0.15	0.70	0	166
% Reduction	83 %	43 %	7.0 %	46 %	88 %		
$ savings	$0.25	$0.12	$0.06	$0.06	$0.55	Sum savings = $1.04	

*Grain yield was based upon only one replication

**Nutrient savings was based upon a $0.25 / lb N cost and $0.39 / lb P_2O_5. Soil value was computed using a price of $16.75 / ton, a replacement cost if purchased from a landscaping supply company.

What Did We Learn?

Application of PAM reduced soil loss during the first irrigation by 83%. There was also a reduction in the loss of nitrate-nitrogen (7%), total nitrogen (43%), soluble phosphorus (6%) and total phosphorus (55%) in the irrigation runoff water. These lost nutrients and soil could have an approximate value to $1.04 / acre. However, we did not analyse the runoff for other plant nutrients (potassium, sulfur, micronutrients) or pesticides. Although these savings do not exceed the treatment cost, other researchers have found additional PAM benefits such as lower labor costs for cleaning return ditches, and the ability to increase flow rates without washing out furrows. The PAM treated strip plot had a higher yield than the No-PAM strip, however keep in mind this was based upon only one replication at this site.

Field Background information:

- Soil type: Fort Collins clay loam
- Planting Date: May16, 1999
- Hybrid and population: Pioneer 37H97 (High oil variety) ~28,000 plants/acre
- Preplant soil NO_3-N: 0 -1'= 19.5 ppm; 0-4' = 6.6 ppm
- Previous crop: Alfalfa (4 year stand)
- Starter fertilizer: None
- Preplant fertilizer: UAN 32%, applied March 31, broadcast incorporated
- Harvest date: November 6, 1999

1999 Colorado Corn Growers/ CSU BMP Project

Legume (Alfalfa) Crediting Demonstration Results; Cooperator: Ron Bakel

Quick Facts:

☞ Alfalfa and other legume crops supply valuable nitrogen to subsequent crops.

☞ The nitrogen credit fromalfalfa can range from 30 to 100 lbs. per acre.

☞ Call Jerry Alldredge (970) 336-7230 Weld Co. Coop. Ext. or Troy Bauder (970) 491-4923 with CSU for more information regarding these results.

Background Information:

The objective of this demonstration site was to evaluate legume crediting as part of a sound nutrient management program. This field had been in alfalfa for the four to five years prior to the 1999 corn crop. Alfalfa is a legume crop, which can be a significant source of plant available N due to bacterial N_2 fixation in root nodules. Plowing down a full stand of alfalfa will release as much as 100 pounds of N per acre in the first year after plowdown. The amount of N credit given to the following crop depends upon the stand and degree of nodulation. A minimum of 30 lb. N/acre should be credited in the first year after any legume crop.

Methods:

Three nitrogen fertilizer rates (100, 120, and 155 lbs / acre) were applied preplant to 30 foot wide strips the entire field length. Based upon projected yield expectation and soil sampling results the recommended N fertilizer rate was 155 lbs without a legume credit. Because of the alfalfa stand age and condition, the highest estimated legume credit applicable to this field was 55 lb N /acre (100 lb fertilizer rate). A more conservative N credit of 35 lb N/acre was also included (120 lb fertilizer rate). This was also the fertilizer rate the cooperator applied to the rest of the field. These fertilizer treatments were replicated twice within the test area. Yields were obtained at harvest by weighing the grain harvested from six rows out of each strip with a weigh wagon.

Results: Average* corn grain yield and economic comparisons.

-----Plot Description-----		Results			
Legume N Credit	Fertilizer N Rate	Grain Moisture	Test Weight	Grain Yield	$ Return on Practice**
--lb N / acre--	-- lb N / acre --	-- % Water --	-- lbs / bu --	-- bu / acre --	-- $ / acre --
55	100	11.3	54.4	161	-0.25
35	120	11.2	55.2	174	+20.75
None	155	11.3	54.3	168	-20.75
Site Average		11.3	54.6	168	

*Results provided are an average of two replications of each treatment.

**Return was computed using a $2.00 / bu corn price and a $0.25 / lb N cost.

Return on Practice = (yield difference between legume credit and no legume credit x $2.00)- N cost - Cost to implement BMP

What Did We Learn?

The 35 lb legume nitrogen credit (120 lb N fertilizer rate) had the highest yield and also the highest economic return. The strip plots with no legume credit had the next highest yield, but the lowest economic return due to higher fertilizer costs. Even though the 55 lb legume credit had the lowest grain yield, it compared more favorably than the no legume credit economically. Extremely cool, wet conditions in the spring and early summer may have slowed breakdown of alfalfa residue to plant available nitrogen resulting in less nitrogen from the legume crop than expected. Since the fertilizer was applied preplant, the wet conditions also may have resulted in nitrogen losses due to leaching. These conditions may partially explain the lower yield for the highest legume credit. These results show that using a legume credit after alfalfa is a sound economic and agronomic practice, even for an older stand.

Field Background information:

- Soil type: Fort Collins clay loam
- Planting Date: May16, 1999
- Hybrid and population: Pioneer 37H97 (High oil variety) ~28,000 plants/acre
- Preplant soil NO_3-N: 0 -1'= 19.5 ppm; 0-4' = 6.6 ppm
- Previous crop: Alfalfa (4 year-old stand)
- Starter fertilizer: None
- Preplant fertilizer: UAN 32%, applied March 31, broadcast incorporated
- Harvest date: November 6, 1999

1999 Colorado Corn Growers/ CSU BMP Project

Irrigation Water Nitrate Crediting Demonstration Results; Cooperator: Terry Wiedeman

Quick Facts:

- One inch of irrigation water supplies 0.23 lb N per acre for each ppm of NO_3-N in the water.
- Many irrigation wells in Weld County are enriched with enough NO_3-N to benefit crop production.
- Call Troy Bauder (970) 491-4923 with CSU or Jerry Alldredge (970) 336-7230 at Weld Co. Coop. Ext. for more information.

Background Information:

The objective of this demonstration site was to evaluate irrigation water nitrate crediting as part of a sound nutrient management program. Irrigation water containing nitrate can supply considerable amounts of nitrogen because it is applied during the growing season and is immediately available for crop uptake. In most situations, fields irrigated with nitrate enriched water will require less nitrogen fertilizer.

Methods:

Three nitrogen fertilizer rates (75, 125, and 175 lbs / acre) were applied to 3-row strips. The highest irrigation water credit applicable to this field was 100 lb /acre. This credit was calculated from the measured NO_3-N content of the irrigation water (30 ppm) multiplied by a conversion factor (0.23 lbs /acre inch) times 15 inches of water. Fifteen inches is typical corn water use during the maximum nitrogen uptake period. The 175 lb rate is the recommended rate (based upon soil test results and yield goal) without an irrigation water credit. The 125 lb rate is the recommended nitrogen rate with half water credit, and the 75 lb rate is the recommended nitrogen rate with the full water nitrate credit. This site also had two varieties, Pioneer 3571 and NC+6589. Both variety and fertilizer treatments were replicated twice.

Results: Average* corn grain yield and economic comparisons.

----Plot Information----			----Results----			
Water Credit	Fertilizer Nitrogen Rate	Hybrid	Grain Moisture	Test Weight	Grain Yield	$ Return on Practice**
-- lb N / acre --	-- lb N / acre --		-- % Water --	-- lbs / bu --	-- bu / acre --	-- $ / acre --
100	75	NC+6589	16.9	55.3	202	+35.75
50	125	NC+6589	16.7	55.5	206	+31.75
None	175	NC+6589	17.3	55.6	195	-35.75
Hybrid Average			16.9	55.4	201	
100	75	P-3571	16.1	55.9	188	+39.75
50	125	P-3571	16.3	56.6	182	+15.75
None	175	P-3571	16.4	55.7	179	-39.75
Hybrid Average			16.2	56.1	183	
Site Average			16.6	55.7	192	

*Results provided are an average of two replications of each treatment.
**Return was computed using a $2.00 / bu corn price and a $0.24 / lb N cost.
Return on Practice = (yield difference between water credit and no water credit x $2.00)- N cost - cost to implement BMP

What Did We Learn?

Corn variety had a greater impact upon grain yield than did applied N fertilizer rates. Grain yield was not affected by the N fertilizer rates at this site, and therefore the highest economic return resulted from the highest irrigation water credit. The grain yield results from this harvest and a similar trial at this site last season support irrigation water nitrate crediting as a reliable BMP for maximum economic yield.

Field Background information:

- Soil type: Julesburg sandy loam
- Planting Date: May 16, 1999
- Hybrid and population: NC+6589 and Pioneer 3571 ~33,600 plants/acre
- Preplant soil NO_3-N: 0 -1'= 20.1 ppm; 0-3' = 10 ppm
- Previous crop: Sugar beets
- Starter fertilizer: None
- Sidedress fertilizer: UAN 32%, applied June 4
- Harvest date: November 8, 1999

Attachment B

Report on 1999 Balance Herbicide Runoff Sampling Project

Lack of data on irrigation runoff transporting the corn herbicide, Balance (Isoxaflutol), to down-gradient fields prompted a runoff study during the summer of 1999. The relatively high solubility, low soil adsorption, long half-life, and high phytotoxicity of the first metabolite raised concern about the product's safety in areas of Colorado where corn is grown in direct proximity to sensitive, high value vegetable crops. Rate study plots at the CSU ARDEC research farm offered a controlled environment where runoff could be sampled without incurring the possibility of contamination from ambient fields.

Irrigation runoff from the first irrigation event was sampled at ARDEC on June 24, 1999 using the procedure described below. The source of irrigation water was from the North Poudre Ditch combined with ground water from a well at the farm. The irrigation water was gravity fed though underground pipe to the study site and applied at a rate of 20 gpm per furrow. Water was sampled from the pipe at the top end of the field to confirm that the source was not contaminated with any Isoxaflutol residue. Replicated plots established by Dr. Phil Westra on a Fort Collins Clay Loam soil were treated with Isoxaflutol at rates of 0, 1.25 and 2.0 oz/acre applied on May 21, 1999. Corn (DK493) was planted on May 14, 1999 on 30 inch rows at approximately 28,000 plants per acre. Rainfall reported at the ARDEC station between May 14 and June 24, 1999 was 2.75 inches. Irrigation runoff samples were collected only from the first irrigation event. The plots were oriented length-wise down a 400 foot irrigation gradient with a slope of 0.5 to 1.0%. Runoff samples were collected immediately after water began to flow over a notched weir placed across the furrow and then a second sample was collected approximately 1 hour later. Selected runoff samples from the non-treated plots were spiked with IFT metabolite #248 at 500 and 1000 ppt to assess lab recovery rates from the irrigation water matrix. Samples were frozen and sent to Rhone-Poulenc water laboratory for analysis.

Sampling Procedure for Irrigation Runoff

1. Upon arrival at the sampling site, assess field situation and stage of irrigation set. Note soil type and number of rows in set. To avoid contamination **do not** enter Balance treated field before sampling. Find out where water is leaving field. Find out if runoff water is only from the Balance treated field or if an adjacent field's runoff has entered the runoff stream. Also determine whether irrigation water is from ditch or well source.

2. Sample water where runoff leaves field. If possible, sample at a point 15 to 20 feet away from actual treated field to reduce the potential for contamination. If the runoff ditch contains water from another field, sample at point where Balance treated field enters runoff ditch.

3. Lay down clean plastic drop on ground at sample location. Keep cooler and all sample equipment on sheet to avoid contamination.

4. Place notched weir into irrigation stream so runoff flows over notch. Allow any sediment stirred up to settle before taking sample.

5. Using waterproof ink, complete the sample label on the brown Nalgene bottle with the sampler's initials and date the sample was collected.

6. Collect runoff water running over weir into clean 250 ml Nalgene wide mouth bottles about 1/4 full. Replace cap and shake for 3 to 5 seconds. Discard this rinse water being careful to dispose of the rinse water away from any other sample supplies (cooler, bottles, etc.). Repeat this 2 more times with the water to be sampled.

7. Fill rinsed 250 ml Nalgene bottles with runoff water. Filter this water to remove residue through clean mesh filter into sample (brown Nalgene) 125 ml bottles, rinsing bottles three times as described in step 5. Fill the rinsed sample bottle with filtered water about 1 inch from the top (just below the bottle shoulder), replace the cap, and tighten securely.

8. Dry the bottle with a clean paper towel and place into the bottom of the supplied cooler and place the pre-frozen cold packs on top of the bottles.

9. If the water source is ditch water, sample the inflow water as described above, taking care to avoid contamination from treated field.

10. Dispose of plastic drop and store used sampling materials (250 ml Nalgene bottle, mesh filter, weir) away from clean sampling materials for other locations.

11. Complete sample information form for each sample. Place in zip-lock bag. Take care to insure that paperwork does not contact potentially contaminated surfaces.

Spiking Procedure

1. Target spiked rate is 500 and 1000 ppt

2. Spiked samples will be actual samples from field. Spike set will consist of: "clean" sample and two spiked duplicates.

3. Select sampling location and use protocol as described in sampling procedure.

4. Using triple rinsed 250 ml Nalgene bottle, filter runoff into triple rinsed one liter graduated cylinder until full.

5. Cover with parafilm and invert five times.

6. Triple rinse and then fill brown Nalgene sample bottle with unspiked sample water.

7. Record volume in graduated cylinder.

8. Using Epindorf Pipette, Spike bottle with 1.0 ml or 0.5 ml of 1000 ppb (1.0 ppm) IFT 248 solution.

9. Cover with parafilm and invert bottle for one minute.

10. Triple rinse two brown Nalgene sample bottles with spiked solution and fill to below shoulder with same solution. Treat samples as described in sampling procedures.
11. Discard remaining solution in graduated cylinder away from clean sample materials. Triple rinse one liter glass bottle with Methanol to clean.

Runoff Results

Table 1 summarizes the results reported from the Rhone-Poulenc water laboratory for runoff samples selected for analysis. From the spiked samples we found that the lab recovered 62 to 82% of the IFT248 added to the irrigation water matrix. The runoff from the control plots that received no Isoxaflutol contained no detectable (ND) chemical and essentially no quantifiable level (<LOQ) of the primary metabolite, IFT248. One out of four of the sampled furrows that was treated at the 1.25 oz/acre rate contained runoff with quantifiable levels of IFT248. One hour later, the same furrow still produced measurable levels of the active metabolite, but at a fraction of the initial concentration. The secondary metabolite, IFT328 was also measured in the runoff from this one furrow. Two out of four of the sampled furrows that were treated at the 2.0 oz/acre rate contained runoff with quantifiable levels of IFT248 and IFT328. Again, these levels dropped significantly when re-sampled after 1 hour of continuous irrigation.

Table 1. Irrigation runoff samples collected at CSU Research Farm, Summer '99.

Plot ID	IFT Rate Applied (5/21/99)	Sample Time (6/24/99)	RP Lab Results IFT	248	328
	oz/acre		ppt		
0-Spike 0.5 - 1	0.00	T=0	ND	314	ND
0- Spike 1.0 - 1	0.00	T=0	ND	820	ND
0-Spike 0.5 - 2	0.00	T=0	ND	385	ND
0- Spike 1.0 - 2	0.00	T=0	ND	644	ND
0 - 1	0.00	T=0	ND	< LOQ	< LOQ
0 - 2	0.00	T=0	ND	< LOQ	ND
0 - 3	0.00	T=0	ND	< LOQ	ND
1.25-1	1.25	T=0	ND	< LOQ	ND
1.25-2	1.25	T=0	ND	< LOQ	ND
1.25-2-T2	1.25	T= + 1 hour	ND	< LOQ	ND
1.25-3	1.25	T=0	ND	< LOQ	ND
1.25-4	1.25	T=0	ND	71	31
1.25-4-T2	1.25	T= + 1 hour	ND	17	< LOQ
2.0-1	2.00	T=0	ND	< LOQ	ND
2.0-2	2.00	T=0	ND	16	< LOQ
2.0-2-T2	2.00	T= + 1 hour	ND	< LOQ	ND
2.0-3	2.00	T=0	ND	< LOQ	ND
2.0-4	2.00	T=0	ND	59	29
2.0-4-T2	2.00	T= + 1 hour	ND	14	< LOQ

Interpretation of Runoff Results

We found that the corn herbicide Balance will move with irrigation runoff, but at levels below thresholds of concern for crop injury. Greenhouse studies conducted by Dr. Scott Nissen and Dr. Phil Westra have shown that sensitive crops of concern in Colorado are not affected by residues of the active metabolite of Isoxaflutol at the levels we observed in these runoff studies. While these studies indicate that irrigation runoff from fields treated with Balance does not present a phytotoxicity concern, it should be noted that the field sampled does not represent a worse case scenario. The study site at ARDEC had received Balance over one month previously and 2.75 inches of rainfall had occurred prior to irrigation runoff sampling. Additionally, the site has an atypically short irrigation run length and a very moderate slope. A significant runoff event shortly after application on a more erosive site could potentially transport greater amounts of the active metabolite.

APPENDIX III

Colorado Department of Public Health and Environment
1999 Annual Report

Summary of Accomplishments:

- Published a technical report on ground water monitoring on the West Slope.
  This publication reports on the results of a region wide survey of ground water quality on the West Slope of Colorado. The report was published by the Colorado Department of Agriculture, as "Report to the Commissioner of Agriculture Colorado Department of Agriculture Ground Water Monitoring Activities West Slope of Colorado 1998".

- Published a technical report on ground water monitoring on the High Plains.
  This publication reports on the results of a region wide survey of ground water quality in the High Plains of Colorado that was a joint project between the Ag Chemicals program and the local Ground Water Management Districts. The report was published for the Colorado Department of Natural Resources, as "Report to the Office of the State Engineer Colorado Department of Natural Resources Ground Water Quality Monitoring High Plains Ground Water Management Districts 1997".

- Continued the long term monitoring project in the South Platte River Basin, a high priority watershed for SB 90-126 efforts. This year the sampling program sampled twenty (20) monitoring wells and sixty (60) irrigation wells.

- Adopted four monitoring wells that were to be abandoned by the USGS NAWQA program into the statewide monitoring network. These wells were sampled for the complete suite of analytical parameters to establish their baseline.

- Conducted a follow-up monitoring program on the West Slope of Colorado to resample those wells that showed a pesticide hit or nitrate above the drinking water standard in 1998.

- Initiated a project and provided contract oversight for the Colorado School of Mines to develop ground water vulnerability matrices for assessing the potential for pesticide contamination.

- Collaborated with Colorado State University researchers on the development of a statewide aquifer sensitivity map and vulnerability model for nitrate.

- Participated in the irrigation runoff study to evaluate the potential for Balance herbicide to move to downstream fields.

- Collaborated with the Department of Agriculture Standards Laboratory to revise and refine the laboratory analysis used on all ground water samples.

- Assisted the Colorado Department of Agriculture in the development of the generic Pesticide Management Plan and the implementation of the Bulk Storage Regulations.

- Appeared before the Colorado Water Quality Control Commission and the Colorado Ground Water Commission to address ground water quality issues.

- Worked on the Certified Crop Advisors Program in Colorado. Served on the Board of Directors. Assisted with certification testing.

- Revised the Standard Operating Procedures for field sampling protocol.

- Developed a new database structure and began the changeover to Access from dBase for all ground water data storage and retrieval.

- Addressed groups throughout Colorado on SB 90-126 and issues related to agricultural chemicals and groundwater quality. Groups addressed include chemical dealers, groundwater management districts, crop and livestock producers, and agency personnel.

- Cooperated with the Colorado Corn Growers Association in their BMP's for corn production project.

- Assisted with the formulation of a CDPHE Water Quality Website to disseminate water quality information via the Internet.

- Distributed fact sheets and reports on Colorado groundwater quality to interested parties and fielded question by phone and e-mail to Colorado citizens.

- Cooperated with county Extension agents on disseminating information about Colorado groundwater quality.

- Worked to coordinate efforts of the Agricultural Chemicals and Groundwater Protection program with other state and federal programs in Colorado.

- Cooperated and provided assistance to the South Platte BMP workgroup.

- Cooperated with the USGS NAWQA program in the upper Colorado River basin.

Weld County Long Term Monitoring

Nineteen ninety nine was the fifth year of a long term monitoring effort initiated in the South Platte alluvial aquifer from Brighton to Greeley. The long-term monitoring network was established in 1995 and is a combination of three types of wells previously sampled in the area (Figure 1). The long term monitoring network consists of three sets of distinct well types: a) Twenty (20) dedicated monitoring wells operated by the Central Colorado Water Conservancy District have been sampled each year since 1995; b) Sixty (60) irrigation wells that have been sampled in 1989, 1990, 1991, 1994, 1995, 1996, 1997, 1998, and 1999; c) Eighteen (18) domestic wells sampled in 1992, 1995, and 1998.

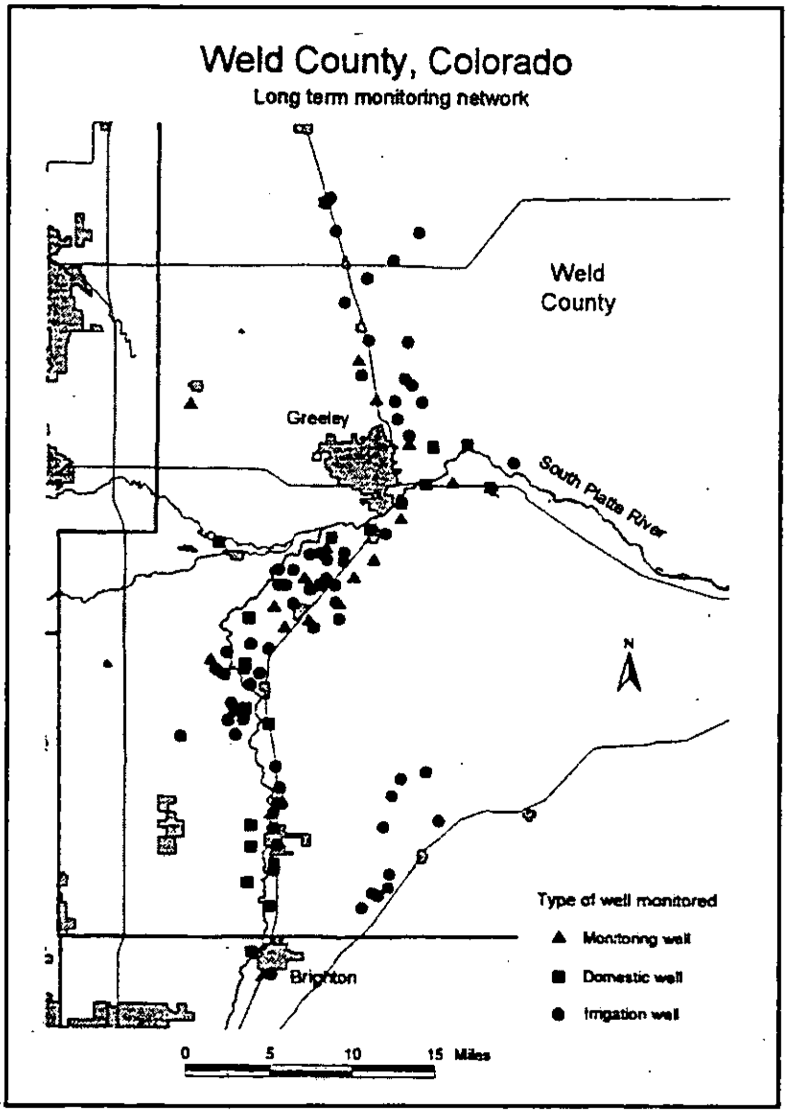


FIGURE 1 - Location and type of wells comprising the Weld County long term monitoring network

From June through August 1999, 73 wells in the long-term network were sampled. All wells were analyzed for nitrate-nitrite as nitrogen. The 20 monitoring wells were analyzed for the complete suite of 45 pesticides listed in Table 2. The pesticide analysis for the 53 irrigation wells was an immuno assay screen for the triazine herbicides.

Nitrogen analysis indicated that 75% of the monitoring wells and 68% of the irrigation wells exceeded the nitrate drinking water standard of 10 mg/L. In the monitoring wells, nitrate levels ranged from a low of 4.1 mg/L nitrate as nitrogen to a high of 83.6 mg/L. In the irrigation wells, nitrate levels ranged from below our detection level of 0.5 mg/L nitrate as nitrogen to a high of 36.1 mg/L (Table 1).

TABLE 1 - Summary statistics for the Weld County nitrate monitoring results, 1999.

Weld County Long Term Monitoring Network		
	Monitoring wells	Irrigation wells
Mean	24.5	16.1
Median	19.2	16.1
Standard Deviation	19.55	9.63
Minimum	4.1	< 0.5
Maximum	83.6	36.1
# wells sampled	20	53

Note: all values (except # wells) are nitrate-nitrite as nitrogen in mg/L (parts per million).

Pesticide data revealed six pesticides, Atrazine, Hexazinone, Metalaxyl, Metolachlor, Metribuzin, and Prometone present in the monitoring well samples. The breakdown products of Atrazine, Deethyl Atrazine and Deisopropyl Atrazine were also detected. Atrazine was present in 30% of the wells, Deethyl Atrazine in 45%, and Deisopropyl Atrazine in 15%. Allowing for multiple products in one well that accounts for Atrazine of some form present in 55% of the wells. Metolachlor was detected in 30% of the wells and Prometone in 30%. Hexazinone, Metalaxyl, and Metribuzin were each detected in one well. The level of Metolachlor reached 11.8 ug/L (ppb) in one well. Detection levels for the other pesticides averaged less than 0.5 ug/L (ppb). No pesticide was detected at a level exceeding an applicable standard.

The triazine herbicide screen used on the irrigation wells detects any pesticide in this family, which includes Atrazine, Simazine, Cyanazine, Deethyl Atrazine, Deisopropyl Atrazine, and Prometone. The results are calibrated in units of Atrazine equivalent but may be actually composed of one or more of the components. In 1999, triazine herbicides were detected in 92% of the irrigation wells. Levels ranged from 0.05 ug/L to 0.59 ug/L (ppb).

Randy Ray of Central and Brad Austin of CDPHE sampled the monitoring wells in Weld County in cooperation with the Central Colorado Water Conservancy District in June 1999. John Colbert, of CDPHE, sampled the irrigation wells in Weld County in July and August 1999. Brad Austin performed all West Slope resampling, in September 1999. Field sampling procedures followed the protocol developed by the ground water Quality Monitoring working group of the Colorado nonpoint task force.

Follow-up Monitoring West Slope Colorado

The 1998 monitoring program began a regional groundwater quality baseline study for the western slope of Colorado. The West Slope of Colorado includes all of Colorado west of the continental divide. However, this monitoring program excluded the central core of the Rocky Mountains where the land use is predominately National Forest. The majority of the ground water sampled on the west slope occurs along stream and river valleys in alluvial deposits with some local aquifers on the larger mesas. No single aquifer underlies this area; therefore this survey differs from past work that tended to focus on a single regional aquifer. The agriculture in this region is dominated by ranching with associated hay production. Dry land wheat in Moffat County, corn in the tri river area, dry beans in Montezuma County, and the fruit and vineyards of Mesa County are the exceptions.

In the 1998 results, only one well exceeded the nitrate drinking water standard of 10 mg/L, with a test result of 32.0 mg/L. This well was located in Moffat County, north of Craig. The 1998 pesticide data revealed one well testing positive for the pesticide Malathion at 0.23 ug/L (part per billion) with a detection limit of 0.1 ug/L. This well was located in Montrose County, west of Montrose.

A follow-up monitoring was conducted in 1999 to resample thes two wells. Well samples were analyzed for nitrate, and selected pesticides. The Colorado Department of Agriculture, Standards Laboratory performed the laboratory analysis. The complete analysis performed on all samples, along with laboratory methods and reporting limits for each analyte is presented in Table 2. Temperature, conductivity, and total dissolved solids were measured in the field.

The high nitrate well north of Craig had dropped to a level of 14.8 mg/L, nitrate as nitrogen. Results were still above the drinking water standard but approximately half of the 1998 reading. The Malathion detected in the well near Montrose was not present in 1999. Both wells were below detection levels for all pesticides.

Aquifer Vulnerability Study Summary

In addition to monitoring ground water for the presence of agricultural chemicals, the Ag Chemicals Program is required to determine the likelihood that an agricultural chemical will enter the ground water. This determination is based upon the chemical properties of the chemical in question, the behavior of a particular chemical in the soil types of the region under study, the depth to ground water, the farming practices in use, and other factors. This type of determination has been described as a vulnerability analysis.

In the process of writing the generic Pesticide Management Plan (PMP), the staff at CDPHE, CDA, and CSU has studied various types of vulnerability analysis. The goal has been to satisfy the requirements of the PMP and SB 90-126, while remaining within the confines of existing staffing, organization and budget. In early 1996, a project was contracted to conduct a limited test of an aquifer sensitivity method in the northeastern section of the state. The results of this pilot project were evaluated by CDPHE, CDA, CSU, and USEPA and approved for use throughout the state. The Program expanded this effort statewide in 1997 to produce an aquifer sensitivity map for Colorado. The project was completed in June 1998. This final map product will provide a standard method to determine aquifer sensitivity to pesticides statewide.

In 1999, the legislature approved additional funding to expand this effort to the next phase, the addition of the vulnerability factors. This project, which will last two years, aims to develop a method to determine aquifer vulnerability to both pesticides and nitrate statewide. A nitrate sensitivity map will be created in a similar fashion to the method developed for pesticides. Those unique factors that influence nitrate movement to ground water will be incorporated as new GIS layers for the map. The project will then develop a vulnerability matrix for both pesticides and nitrate. These vulnerability matrices must account for the local factors that influence pesticide and nitrate movement. Irrigation practice, soil properties, pesticide properties, nitrogen leaching chemistry, and pesticide and nitrogen application methods are some but not all of the factors to be investigated.

Upon completion of the project, the program will be able to determine groundwater vulnerability to agricultural chemicals statewide. Results will be evaluated and incorporated into a standard method to delineate those areas of the state were ground water is vulnerable to contamination from agricultural chemicals. The monitoring program can then target resources to those areas where attention is most needed. This effort will become a key element of the Pesticide Management Plan implemented under the Federal Insecticide, Fungicide, and Rodenticide Act

Revisions to the chemical analysis used on ground water samples

The program has taken advantage of a slow sampling year to evaluate the current analysis performed on ground water samples by the Standards Laboratory at the Colorado Department of Agriculture. We wanted to compare our analyte list to other regional ground water studies to determine if we were missing key pesticides from the analysis. In addition we wanted to determine if some current pesticide analysis could be modified or dropped if sufficient proof developed that the analysis was not providing needed data.

The procedure developed was to compare our analysis list to those used by the USGS and EPA. Other factors were if the pesticide has a ground water advisory on the label, detection rates in other surveys and most importantly the usage of that pesticide in Colorado. A decision matrix pulled up the top thirty (30) pesticides that fit these criteria. Currently the laboratory is conducting an analysis to determine how many of these thirty we can include in a new analysis. Laboratory factors in the decision process include wither the addition of the pesticide entails adoption of a new analytical method, or simply adding that pesticide to a current method.

Table 2 - Laboratory Methods and Detection Levels

Colorado Department of Agriculture Standards Laboratory

PESTICIDE ANALYSIS

Pesticide Trade Name	Pesticide Common Name	Pesticide Use	Chemical Type	EPA Method	MDL (ug/L)
Harness	Acetachlor	Herb	acetoalinide	525.1	0.1
Lasso	Alachlor	Herb	OrganoCL	525.1	0.1
AAtrex	Atrazine	Herb	Triazine	525.1	0.1
	Deethyl Atrazine		Triazine	525.1	0.2
	Deisopropyl Atrazine		Triazine	525.1	0.2
Balan	Benfluralin	Herb	OrganoFL	525.1	0.2
Hyvar	Bromacil	Herb	uracil	525.1	0.4
Captane	Captan	Fungi	carboximide	525.1	1.4
Lorsban	Chlorpyrifos	Insect	OrganoPH	525.1	0.1
Bladex	Cyanazine	Herb	Triazine	525.1	0.2
Dacthal	DCPA	Herb	phthalic acid	525.1	0.1
Dazzel	Diazinon	Insect	OrganoPH	525.1	0.2
Barrier	Dichlobenil	Herb	nitrile	525.1	0.1
Cygon	Dimethoate	Insect	OrganoPH	525.1	0.5
	p,p-DDT	Insect	OrganoCL	525.1	0.4
	Endrin	Insect	OrganoCL	525.1	0.3
	Heptachlor	Insect	OrganoCL	525.1	0.6
	Heptachlor epoxide	Insect	OrganoCL	525.1	0.8
Velpar	Hexazinone	Herb	Triazine	525.1	0.1
Gamma-mean	Lindane	Insect	OrganoCL	525.1	0.1
Malathion	Malathion	Insect	OrganoPH	525.1	0.1
Ridomil	Metalaxyl	Fungi	acylalanine	525.1	0.2
Marlate	Methoxychlor	Insect	OrganoCL	525.1	0.9
Dual	Metolachlor	Herb	acetamide	525.1	0.1
Sencor	Metribuzin	Herb	Triazine	525.1	0.5
Prowl	Pendimethalin	Herb	dinitroaniline	525.1	1.2
Primatol	Prometon	Herb	triazine	525.1	0.1
Princep	Simazine	Herb	triazine	525.1	0.2
Treflan	Trifluralin	Herb	OrganoFL	525.1	0.3
Weed B Gone	2,4-D	Herb	PhenoxyAcid	515.2	0.2
Banvel	Dicamba	Herb	BenzoicAcid	515.2	0.1
Kilprop	MCPP	Herb	PhenoxyAcid	515.2	2.0
Agritox	MCPA	Herb	PhenoxyAcid	515.2	2.0
Tordon	Picloram	Herb	PicolinicAcid	515.2	0.35

Table 2, continued - Laboratory Methods and Detection Levels

Colorado Department of Agriculture Standards Laboratory

PESTICIDE ANALYSIS

Pesticide Trade Name	Pesticide Common Name	Pesticide Use	Chemical Type	EPA Method	MDL (ug/L)
Temik	Aldicarb	Insect	Carbamate	531.1	1.0
	Aldicarb sulfone		Carbamate	531.1	2.0
	Aldicarb sulfoxide		Carbamate	531.1	2.0
Sevin	Carbaryl	Insect	Carbamate	531.1	2.0
Furadan	Carbofuran	Insect	Carbamate	531.1	1.5
	3-Hydroxycarbofuran		Carbamate	531.1	2.0
	Methiocarb	Insect	Carbamate	531.1	4.0
Lannate	Methomyl	Insect	Carbamate	531.1	1.0
	1-Naphthol		Carbamate	531.1	1.0
DPX	Oxamyl	Insect	Carbamate	531.1	2.0
Baygon	Propoxur	Insect	Carbamate	531.1	1.0

INORGANIC ANALYSIS

	EPA Method	MDL (mg/L)
Nitrate/Nitrite as N	300	0.5

APPENDIX IV

1999 Annual Report
Colorado Department of Agriculture

Rules and Regulations for Agricultural Chemical Bulk Storage Facilities and Mixing and Loading Areas

Section 25-8-205.5 (3)(b) of the Agricultural Chemicals and Groundwater Protection Act requires the Commissioner of Agriculture to develop regulations where pesticides and fertilizers are stored or handled in quantities that exceed the established thresholds. These regulations were adopted in July 1994 and became effective September 30, 1994. The law mandated at least a three-year phase-in period for the regulations. As a result of comments prior to and at the public hearings, a graduated phase-in schedule was adopted.

Regulation of pesticide secondary containment/storage facilities and mixing and loading pads, and for liquid fertilizer tanks greater than 100,000 gallons (one of the three prescribed methods of leak detection must be utilized unless secondary containment is in place) began on September 30, 1997. Regulation of fertilizer secondary containment/storage facilities (storing between 5,000 and 100,000 gallons) and mixing and loading pads began on September 30, 1999. Compliance is required by:

- **September 30, 2004** for secondary containment for fertilizer storage tanks with a capacity greater than 100,000 gallons.

During 1999, presentations were made to groups throughout the state on the requirements of the regulations and the time line for compliance. The presentations were given to organizations and associations, which have a substantial number of their members subject to the regulations. In addition, facilities were visited to provide information and answer specific questions. This educational process aids individuals in determining first, whether or not compliance with the regulations is required and second, what specifically must be accomplished to meet the requirements.

Pesticide facility inspections continued in 1999. A total of 23 secondary containment facilities and 35 mixing and loading pads were inspected. Fertilizer facility inspections began on September 30, 1999 and a total of 39 containment and mixing/loading facilities were inspected. In addition, four leak detection inspections were conducted for facilities storing fertilizer in tanks larger than 100,000 gallons. Six Cease and Desist Orders and one Violation Notice were issued during 1999; modifications were needed at some sites. A database of inspection sites continues to be developed to track inspections. Inspection of pesticide and fertilizer facilities will be ongoing during 2000.

One requirement of the regulations is that the facility design be signed and sealed by an engineer registered in the state of Colorado; or the design be from a source approved by the commissioner and available for public use. The Colorado Department of Agriculture (CDA) in conjunction with Dr. Lloyd Walker, extension agricultural engineer with Colorado State University Cooperative Extension, produced a set of plans that meet the second criteria. The document is entitled, Agricultural Chemical Bulk Storage and Mix/Load Facility Plans for Small to Medium-Sized Facilities. The plans are available from Colorado State University or CDA free of charge. The Colorado Department of Agriculture is currently working on developing a set of generic plans for steel containment facilities to compliment the existing publication mentioned previously which focuses on concrete.

Copies of the complete regulations and a summary sheet that contains a check list to allow individuals to determine if the regulations apply to their operation are also available from CSU or CDA or via the internet at www.ag.state.co.us/DPI/programs/groundwater.html.

Pesticide Registration and Groundwater Protection

A significant amount of time was spent in 1999 regarding the registration of the corn herbicide Balance, which has groundwater impact concerns. Balance was registered for use in Colorado under a 24c registration in 1999. Data on Balance is still being collected, reviewed, and evaluated. A decision regarding re-registration is expected to be made in early 2000.

State Management Plans for Pesticides

In October of 1991, the EPA released their Pesticides and Ground-Water Strategy. The document describes the policies, management programs, and regulatory approaches that the EPA will use to protect the nation's groundwater resources from risk of contamination by pesticides. It emphasizes prevention over remedial treatment. The centerpiece of the Strategy is the development and implementation of State Management Plans (SMPs) for pesticides that pose a significant risk to groundwater resources.

The EPA will require an SMP for a specific pesticide if: (1) the Agency concludes from the evidence of a chemical's contamination potential that the pesticide "may cause unreasonable adverse effects to human health or the environment in the absence of effective local management measures; and (2) the Agency determines that, although labeling and restricted use classification measures are insufficient to ensure adequate protection of groundwater resources, national cancellation would not be necessary if the State assumes the management of the pesticide in sensitive areas to effectively address the contamination risk. If the EPA invokes the SMP approach for a pesticide, its legal sale and use would be restricted to States with an EPA-approved pesticide SMP.

EPA published the proposed rule for state management plans for pesticides on June 26, 1996. As stated in previous year's reports, comments on the proposed rule were submitted under the signature of the Commissioner of Agriculture, Director of Colorado State University Cooperative Extension and the Executive Director of the Colorado Department of Public Health and the Environment. These comments were printed in the 1996 report. To date, EPA has not published the final rule. It is uncertain when the document will be completed and what will be included based on the comments submitted.

In 1996, a complete draft of the generic state management plan was finished and provided to EPA for their informal review. If Colorado can complete and receive concurrence from EPA on a generic plan, it should be much easier for a pesticide specific plan to be approved once the proposed rule is finalized. A redrafted, general state management plan based on EPA's comments on previous versions was submitted in January 1998. Comments on this version were received from EPA in April 1998, and Colorado then submitted a document final in August 1998 for formal review and concurrence. Two subsequent documents were submitted to EPA based on comments received, the last being in January of 2000. We are currently waiting for EPA's response to the Colorado plan.

As discussed in last year's report, one of the more significant issues involves EPA's demand for a sensitivity analysis/vulnerability assessment map of the state in a Geographic Information System (GIS) format by which to determine where to focus education and monitoring activities. In late 1995, a small EPA grant was obtained to perform a sensitivity analysis pilot project for the northeastern part of the state. This work was completed in 1996 and provided to EPA. EPA reacted favorably to the project and provided funding for a statewide sensitivity analysis, which was completed in 1998. This information has been published in an 8 page fact sheet titled Relative Sensitivity of Colorado Groundwater to Pesticide Impact. This publication assesses aquifer sensitivity based on 4 primary factors: conductivity of exposed aquifers; depth to water table; permeability of materials overlaying aquifers; and availability of recharge for the transport of contaminants. These factors were selected because they incorporate the best data currently available for the entire state and incorporate important aspects of Colorado's unique climate and geology.

In 1999, the SB 90-126 program was given spending authority to begin an aquifer vulnerability project to compliment and improve the existing aquifer sensitivity map. Work has begun on this project and completion will be June 30, 2001.

Pesticide use data at the county level is another requirement of the SMP. In addition, with the passage of the Food Quality Protection Act by Congress, accurate pesticide use information has become more critical. To try and provide this data, CDA along with CSU Cooperative Extension contracted with the Colorado Agricultural Statistics Service to perform a statewide pesticide use survey. All commercial pesticide applicators were surveyed during the winter of 1997/98. In addition, farmers who responded to a pre-survey that they apply some portion of their own pesticides were surveyed. Data is currently being sorted and transformed into a useable format and will then be analyzed and a report generated.

Waste Pesticide Disposal

In 1995, CSU Cooperative Extension operated a pilot waste pesticide collection program in Adams, Larimer, Boulder and Weld Counties. The purpose of this type of program is to provide pesticide users an opportunity to dispose of banned, canceled or unwanted pesticides in an economical and environmentally sound manner. Part of the funding for the program was provided by an EPA Nonpoint Source 319 grant. The program was a success. Approximately 17,000 pounds of waste pesticides from 67 participants were collected and safely disposed.

Based on the success of this pilot program, CDA was asked to continue a program that could collect and dispose of waste pesticides in other areas of the state. However, CDA currently has no statutory authority or funding to operate such a program. In light of this, two alternatives were discussed as a way for a waste pesticide collection program to continue. The first was for CDA to seek statutory authority and funding from the Legislature to operate a state-run program. The second was to determine if a private program, operated by a hazardous waste handling company, was possible.

The EPA and the Colorado Department of Public Health and Environment made the possibility of continuing a waste pesticide disposal program significantly easier by the passage of the Universal Waste Rule (UWR) in late 1995. The UWR was developed to encourage disposal of products identified as universal wastes by relaxing the regulations in the Resource Conservation and Recovery Act (RCRA) and therefore making it easier to properly dispose of these products. Waste pesticides were defined in the rule as a universal waste.

CDA spoke to hazardous waste contractors to determine if they would be interested in attempting to collect and dispose of waste pesticides as a private program. One company, MSE Environmental Inc., stated they would be interested. Discussions were initiated with the company and it appeared it would be possible for MSE to operate a private program at a reasonable cost to the participants. The collection and disposal costs for participants would be between $2.25 and $2.75 a pound.

Based on this information, it was determined that the private program option would be pursued since the possibility of getting legislation passed was slim. Furthermore, the time required for legislation to be passed would considerably delay the operation of a program.

After numerous issues were addressed, MSE targeted two areas of the state to initiate the program, the San Luis Valley and the six counties in northeastern Colorado. Registration for participants was set to begin in early 1997, with a scheduled collection of pesticides set for mid-March 1997. This program was very successful. Over 10,500 pounds of waste pesticides were collected from 33 participants. The cost to participants was $2.65 per pound.

Based on the success of this program, MSE conducted a statewide collection program in November 1997. Over 23,000 pounds of waste pesticides were collected from 75 participants. Again the cost was $2.65 per pound.

There was no pesticide collection in 1998, but a statewide collection program was conducted in 1999. A total of 19,792 lbs of pesticides from 47 participants was collected during this program. A sign-up for a 2000 statewide collection is currently underway with an anticipated pick-up of March, 2000. The possibility of another program in the fall of 2000 also exists.

APPENDIX V

AGRICULTURAL CHEMICALS AND GROUNDWATER PROTECTION ACT ADVISORY COMMITTEE 1999

Water Quality Control Commission

Mr. Rob Sakata
P.O. Box 508
Brighton, CO 80601
(303) 659-1559
Original Appointment: 1991

General Public

Mr. John Stout
P.O. Box 11213
Englewood, CO 80151
(303) 708-1841
Original Appointment: 1998

Ms. Barbara Fillmore
18150 North Elbert Road
Elbert, CO 80106
(H) (303) 648-9972
(W) (303) 648-9897
Original Appointment: 1997

Commercial Applicators

Mr. Mark McCuistion
McCuistion Aerial Applicators
P.O. Box 232
Rocky Ford, CO 81039
(719) 254-7999
Original Appointment: 1999

Mr. Steven D. Geist
Swingle Tree Co.
8585 East Warren Avenue
Denver, CO 80231
(303) 337-6200
Original Appointment: 1994

Green Industry

Mr. John Wolff
Grand Lake Golf Course
P.O. Box 590
Grand Lake, CO 80447
(970) 627-3429
Original Appointment: 1998

Mr. Eugene Pielin
GMK Horticulture
2768 Crestview Ct
Loveland, CO 80538
(970) 663-7333
Original Appointment: 1999

Ag Chemical Suppliers

Mr. Anthony Duran
American Pride Coop
P.O. Box 98
Henderson, CO 80640
(303) 659-3643
Original Appointment: 1998

Mr. Wayne Gustafson
Agland, Inc.
P.O. Box 338
Eaton, CO 80615
(970) 454-4038
Original Appointment: 1991

Producers

Mr. Mike Mitchell
1588 East Road 6 North
Monte Vista, CO 81144
(719) 852-3060
Original Appointment: 1991

Mr. Don Rutledge
10639 County Road 30
Yuma, CO 80759
(970) 848-2549
Original Appointment: 1995

Mr. Max Smith
48940 Road X
Walsh, CO 81090
(719) 324-5743
Original Appointment: 1994

Mr. Lanny Denham
2070 57.25 Road
Olathe, CO 81425
(970) 323-5461
Original Appointment: 1996

Mr. Leon Zimbelman, Jr.
0949 WCR G7
Keenesburg, CO 80643
(303) 732-4662
Original Appointment: 1993

Mr. Jim Lueck
32850 CR 58
Iliff, CO 80736
(970) 522-8115
Original Appointment: 1997

Mr. Steven Eckhardt
21454 WCR 33
La Salle, CO 80645
(970) 284-6495
Original Appointment: 1997

Mr. John Hardwick
24700 County Road 19
Vernon, CO 80755
(303) 332-4211
Original Appointment: 1991