Best Management Practices to Reduce Nitrate Impacts in Ground Water and to Assess Atrazine and Arsenic Concentrations in Private Water Wells

CWA, Section 319(h) Agricultural/Silvicultural Nonpoint Source Program

Submitted by:

Monty C. Dozier
Assistant Professor and Extension Specialist – Water Resources
Texas Cooperative Extension
2474 TAMU
Department of Soil and Crop Sciences
College Station, Texas 77843-2474
Telephone: (979) 845-2761
Fax: (979) 845-0604
Email: m-dozier@tamu.edu

And

Gaylon Morgan
Assistant Professor and Extension Specialist – Small Grains
Texas Cooperative Extension
Department of Soil and Crop Sciences
College Station, Texas 77843-2474
Telephone: (979) 845-1461
Fax: (979) 845-0604
Email: gmorgan@ag.tamu.edu

And

John Sij
Professor and Agronomist
Vernon Research and Extension Center
Vernon, TX 76384-2159
Telephone: (940) 552-9941
Email: j-sij@tamu.edu

6 June, 2007

1. Title of Project: Best Management Practices (BMPs) to Reduce Nitrate Impacts in Ground Water and to Assess Atrazine and Arsenic Occurrences in Private Water Wells

2. Project Goals/Objectives: The objectives of this project are to: 1.) demonstrate the effectiveness of winter cover crops in removing nitrate-nitrogen from the soil profile to minimize nitrate leaching, 2.) demonstrate the ability of zeolite to reduce atrazine and arsenic concentrations in water, 3.) and assess the extent of atrazine and arsenic detections in private groundwater in the Seymour and High Plains of Texas.

3. Project Tasks: Major tasks of this project include: 1.) establishing and monitoring a winter cover crop demonstration site in the Rolling Plains, 2.) determine the effectiveness of a zeolite as a BMP to reduce atrazine and arsenic concentrations in groundwater, and 3.) conduct private water well screening events in the Texas High Plains and Rolling Plains to determine extent of nitrate, atrazine and arsenic concentrations in the Ogallala and Seymour Aquifers.

4. Measures of Success: Reduce nitrate-nitrogen loading in the soil profile by greater than 15% with winter cover crops. Evaluate zeolite as a potential media to reduce atrazine and arsenic concentrations in groundwater. Finally, screen 50 private water wells in the Texas High Plains and Seymour Aquifer to determine atrazine and arsenic concentrations.

5. Project Type: Statewide ( ); Watershed (x); Demonstration (x)

6. Waterbody Type: River ( ); Groundwater (x); Other (x)

7. Project Location: The Texas High Plains (Ogallala Aquifer) and Texas Rolling Plains (Seymour Aquifer)

8. NPS Management Program Reference: *Texas Nonpoint Source Pollution Assessment Report and Management Program* approved Oct. 1999.

9. NPS Assessment Report Status: Impaired ( ); Impacted (x); Threatened ( )

10. Key Project Activities: Hire staff ( ); Monitoring (x); Regulatory Assistance ( ); Technical Assistance ( ); Education (x); Implementation (x); Demonstration (x); other

11. NPS Management Program Elements: Based on the Groundwater Management section of the *Texas Nonpoint Source Pollution Assessment Report and Management Program* approved Oct. 1999, this project will address the reduction of nitrate-nitrogen loading from agricultural nonpoint sources, provide public education on BMPs for agricultural use of nitrate-nitrogen and atrazine, and determine the extent of atrazine and arsenic concentrations in groundwater for the Seymour and Ogallala Aquifers of Texas.

12. Project Costs (3 years): $98,341 (Federal), $118,113 (Non-federal), $216,454 (Total)

13. Project Management: Winter Cover Crop portion managed by Morgan and zeolite and atrazine/arsenic monitoring managed by Dozier.

14. Project Period: September 1, 2003 to August 31, 2008

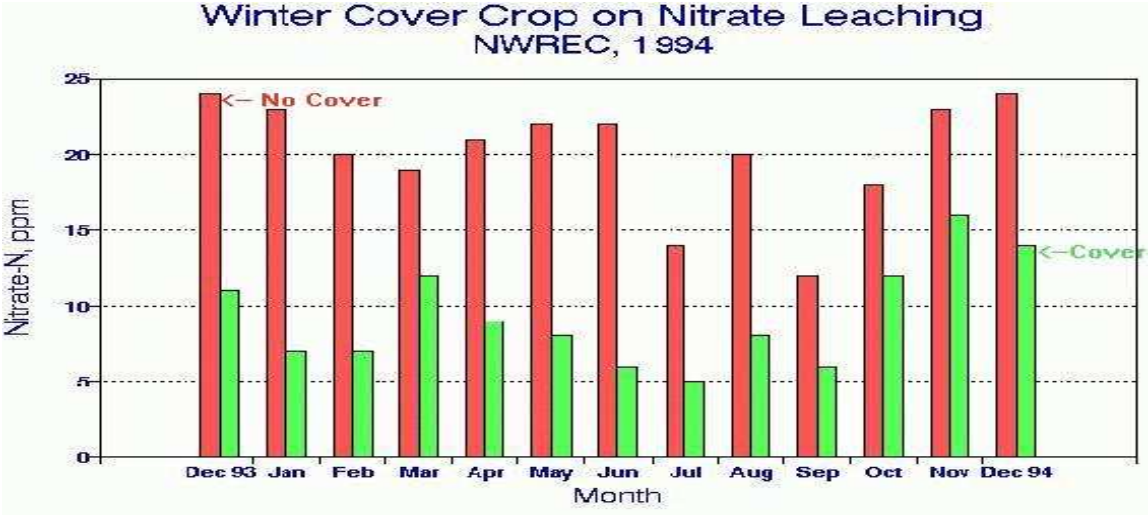
WORK PLAN:

TITLE OF PROJECT: Best Management Practices to Reduce Nitrate Impacts in Ground Water and to Assess Atrazine and Arsenic Concentrations in Private Water Wells

PROBLEM/NEED STATEMENT: Rural Texas relies almost entirely on groundwater for its domestic needs[1]. The contamination of groundwater from nonpoint sources related to the production of food and fiber has been noted by the Texas Commission on Environmental Quality (TCEQ[2]). Detections of atrazine and nitrates have been noted in water wells located in the Texas High Plains and Texas Rolling Plains[3]. Producers need to learn information related to best management practices (BMPs) associated with agriculture production designed to reduce the risk of nonpoint source contamination of groundwater.

One such BMP that can provide reductions in nitrate concentrations in soils is the use of a winter cover crop. In the past, cover crops were primarily planted to minimize soil loss from wind and water erosion. More recently the long-term benefits of cover crops for maintaining and improving soil characteristics, such as nutrient retention, aggregate stability, water holding capacity, organic matter, and nitrogen assimilation are being realized (Hussian et al., 1999[4]; Needleman et al., 1999[5]). The ability of cover crops to capture and recycle nitrogen and other nutrients reduces the potential for non-point source water pollution caused by nitrate leaching, soil erosion, and can reduce nitrogen fertilizer inputs (Meisinger et al.[6], 1991; Decker et al., 1994[7]; Duck and Tyler, 1996[8]).

Previous research has demonstrated a high potential for nitrate is loss in the winter, which are typically the highest precipitation months of the year in Texas. Winter cover crops minimize nitrate leaching by sequestering residual nitrate leftover from the summer crop. With a winter cover crop present, the nitrate can be mined from the soil by the cover crop roots prior to the nitrate leaching beyond the crop root zones. The nutrients, including nitrate, that are recycled by the winter cover crop are then available for to following summer crop. For example, rye cover crops have been reported to decrease in soil N of 143 lbs/acre during the wet months of December through April (Kavdir and Smucker, 1999[9]). Brandi-Dohrn et al., 1997[10] reported soil solution nitrate-N collected 4 feet beneath the soil surface to be approximately 50% less in cover crop plots compared to bare soil treatments (see Figure below). Additional organic matter is also added to the soil, which will increase water holding capacity and soil structure and conserves soil moisture.



The use of zeolite has been proposed as a method to reduce contaminates concentrations in water. However, very little work exists related to setting up a system to wellhead treatment of groundwater through a zeolite filter. If this filtering system proves effective, groundwater could be treated at the wellhead to reduce atrazine and arsenic concentrations before water enters the private water well distribution system.

Finally, there is a need to conduct water well screening events for private water well users related to nitrate, atrazine, and arsenic concentrations. Private water well users can make more informed decisions related to the use and management of their individual water resource when they have information related to potential contaminate concentrations.

GENERAL PROJECT DESCRIPTION: In this project, Dr. Gaylon Morgan and Dr. John Sij will design and implement a cover crop demonstration. In this demonstration, three different winter cover crop will be planted and maintained as well as one bare soil treatment. Porous cup samplers will be placed below each treatment to collect nitrate-nitrogen leaching through the soil profile. This leachate will be analyzed for nitrate-nitrogen concentrations. Soil samples will be taken from each treatment at the beginning and end of the growing season to determine soil nitrate levels. Cover crop biomass samples will be taken prior to cover crop desiccation to determine the amount of nitrate-nitrogen assimilated by the crop. All information generated from this demonstration will be shared with agricultural producers at field days, CEU meetings, news letters, and through a demonstration report.

The zeolite portion of this project will focus on determining the feasibility of using a zeolite filtering system to reduce atrazine and arsenic concentrations in groundwater. Groundwater samples of a known concentration will be filtered through a filtering device packed with zeolite and the concentration of the filtered water determined. From this information, the percent reductions in initial atrazine and arsenic reductions will be determined. All analysis will be done using a field-level Hach kit and immunoassay kit.

For the assessment portion of this project, 50 samples total will be collected during a total of three annual private water screening days conducted in the High Plains and Rolling Plains of Texas.

Screening days will be rotated annually to different counties in the two regions to increase the sampling area. All samples will be screened for the presence of fecal coliform bacteria, nitrate concentrations, conductivity, atrazine concentrations, and arsenic concentrations. Bacterial analysis will be done using Millipore techniques and equipment, atrazine will be conducted using immunoassay techniques, and the remaining parameters using Hach kit methods. The additional parameters of nitrate concentrations, conductivity, and presence of fecal coliform will be performed at no charge to this grant.

Task 1: Removal of Nitrate from Soil Profile with Winter Cover Crops**.**

Costs: $32,514 (Federal), $39,371 (Non-federal), $71,885 (Total), This task is 33% of Total

Objective: to determine the amount of leachable nitrate that can be removed from the soil profile by winter cover crops.

Subtasks 1.1: Porous cup water samplers will be inserted into the soil at a sufficient depth to catch the leached nitrogen-nitrate.

Subtasks 1.2: Winter cover crops, including wheat, cereal rye, and vetch, will be planted in the fall of 2007 with a grain drill. Planting will occur following the harvest of cotton or sorghum.

Subtasks 1.3: In order to obtain adequate information on soil nitrate leaching for the entire year, water samples will be collected from the porous cup samplers a minimum of three times while the cover crops are present. Soil samples will also be analyzed for soil nitrate levels at the beginning and end of the cover crop.

Subtasks 1.4: Nitrogen assimilation by each cover crop treatment will be estimated from using the cover crop biomass and nitrogen content. Approximately three weeks prior to planting cotton or sorghum, the winter cover crop will be desiccated with a burn down herbicide.

Schedule: The demonstration project will be initiated in the fall of 2007 and will consist of planting the winter cover crops. Following the desiccation of the winter cover crop, cotton or sorghum will be planted. The nitrogen management for the summer crop will based on soil test results, nitrogen will be applied uniformly over all treatments. In June 2007, a summary of nitrate concentration in the soil and water will be summarized along with the estimated levels of nitrate removal by the winter cover crops. Quarterly reports will be submitted at appropriate times, and the final report will be turned in at the conclusion of the project. This demonstration project will be completed by August 2008.

Deliverables: Information gained from the nitrate removal by cover crops will be presented at multiple educational events and meetings on a state and local level. Information gathered from effort will also be prepared in a newsletter distributed to all county extension offices in the Texas High and Rolling Plains. Copy of newsletter, educational agendas, and attendance sheets will be attached to reports.

Task 2: Demonstration of Zeolite as a BMP to Reduce Atrazine and Arsenic in Groundwater

Costs: $27,940 (Federal), $39,371 (Non-federal), $67,311 (Total), This task is 31% of Total

Objective: to demonstrate the percent reduction in atrazine and arsenic concentrations in water by use of zeolite filtering media

Subtask 2.1: Water will be spiked with known concentrations of atrazine and arsenic and passed through zeolite apparatus before being collected into a receiving tank. Samples from the tank will be taken at 1 minute after entering the tank, and then at 5 minutes, 60 minutes and 24 hours and atrazine and arsenic concentrations determined. The zeolite system will be placed in columns and water allowed to flow through the zeolite. This system should yield information on the ability of zeolite to reduce atrazine and arsenic concentration in water.

Schedule: The zeolite portion of this project will be conducted in the Spring and Summer of 2008 and will be completed by August 2008. QAPP will be prepared by month 3 of the project before sampling in initiated.

Deliverables: Information gained from the zeolite study will be presented to private water well owners/users at various water quality educational programs across Texas. Information gathered from effort will also be prepared in a newsletter distributed to all county extension offices in the Texas High and Rolling Plains. Copy of newsletter, educational agendas and attendance sheets will be attached to reports. An article will be written on findings of the demonstration.

Task 3: Assessment of Nitrate, Atrazine and Arsenic Concentrations in Private Water Well Samples of the Texas High and Rolling Plains.

Costs: $37,887 (Federal), $39,371 (Non-federal), $77,258 (Total), This task is 36% of Total

Objective: to assess 50 private water well samples per year for nitrate, atrazine and arsenic concentrations

Subtask 3.1: Annually two private water well screening event will be held in the Texas High Plains and the Rolling Plains of Texas.

Schedule: Sampling screening events will be conducted on-site in county locations in the Texas High Plains and Rolling Plains. Two total events per fiscal year will be conducted and all screening events will be completed by August 2008.

Deliverables: Information gained from the assessment study will be presented to private water well owners/users at various water quality educational programs across Texas. Information gathered from effort will also be prepared in a newsletter distributed to all county extension offices in the Texas High and Rolling Plains. Results of the private water screening effort will

also be presented to the TCEQ ag. chem. Subcommittee of the Groundwater Committee by the conclusion of the end of the project. QAPP will be prepared by month 3 of the project before sampling in initiated. Agendas and attendance sheets will be attached to reports.

Coordination, Roles, and Responsibilities: This demonstration project is a collaboration of extension specialist in water quality management and small grains specialist in the Texas Cooperative Extension. The responsibilities for these projects will be shared by both investigators; however, Gaylon Morgan will be primarily responsible for the winter cover crop demonstration project and Monty Dozier will be primarily responsible for assessing the atrazine and arsenic concentrations in private water wells. Dozier will be responsible for securing information, data, writing, and submitting quarterly reports and the final project report. Quarterly reports due end of each quarter and final report prepared and submitted at project's end.

Public Participation: Information gather from these projects will be disseminated to the public via TCE county agricultural agents, field days, educational programs for private well owners/users, newsletters, and CEU meetings.

Measures of Success and Performance:

- Conduct multiple educational programs for regional producers.
- Use the demonstration site as an educational site throughout the project
- Reduce nitrate leaching by a significant level
- Determination of the atrazine and arsenic concentrations in private water wells
- Educational programs for private well owners on proper wellhead protection to reduce groundwater contamination risks and treatment techniques for homeowners

Reference to Project in the NPS Management Program: As a ground water project, the program area will be based upon the aquifer formation area of the Texas High Plains (Ogallala Aquifer) and Texas Rolling Plains (Seymour Aquifer). *Texas Nonpoint Source Pollution Assessment Report and Management Program* approved Oct. 1999. pp. 1-16.

Monty C. Dozier
Assistant Professor and Extension Specialist – Water Resources
Texas Cooperative Extension
2474 TAMU
Department of Soil and Crop Sciences
College Station, Texas 77843-2474
Telephone: (979) 845-2761
Fax: (979) 845-0604
Email: m-dozier@tamu.edu

Citations:

1. Texas Water Development Board. 1997. Water for Texas: A consensus-based update to the state water plan. Vol. 2. Austin, TX. Document No. GP-6-2.

2. Texas Groundwater Protection Committee. 1999. Joint groundwater monitoring and contamination report – 1998. SFR-56/98.

3. Texas Natural Resource Conservation Commission and Texas State Soil and Water Conservation Board. 1999. Texas no point source pollution assessment report and management program.

4. Hussain, I., K.R. Olson, and S.A. Ebelhar. 1999. Long-term tillage effects on soil chemical properties and organic matter fractions. Soil Sci. Soc. Am. J. 63:1335-1341.

5. Needleman, B.A., M.M. Wander, G.A. Bellero, C.W. Boast, G.K. Sims, and D.G. Bullock. 1999. Interaction of tillage and soil texture: Biologically active soil organic matter in Illinois. Soil Sci. Soc. Am. J. 63:1326-1344.

6. Meisinger, J.J., W.L. Hargrove, R.L. Mikelsen, J.R. Williams, and V.W. Benson. 1991. Effects of cover crops on groundwater quality. *In* Cover crops for clean water, ed. W.L. Hargrove, Ankeny, IA: Soil and Water Conservation Society, pp. 57-68.

7. Decker, A.M. A.J. Clark, J.J. Meisinger, F.R. Mulford, and M.S. McIntosh. 1994. Legume cover crop contribution to no-tillage corn production. Agronomy J. 86:126-135.

8. Duck, B.N. and D.D. Tyler. 1996. No-till winter cover crops: Management and Production. Tennessee Agri-Science. 179:12-16.

9. Kavdir, Y. and A.J. M. Smucker. 1999. Cover crop absorption and deep leaching reductions of soil N in corn agroecosystems. Long-term Ecological Research in Row-crop Agriculture. Michigan State University. http://lter.kbs.msu.edu.

10. Brandi-Dohrn, F.M., R.P. Dick, M. Hess, S.M. Kauffman, D.D. Hemphill, J.S. Selker. 1997. Nitrate leaching under a cereal rye cover crop. J. Environmental quality 26:181-188.

03-08 "Best Management Practices to Reduce Nitrate Impacts in Groundwater and to Access Atrazine and Arsenic Concentrations" Budget Revision 10/16/2008			
Federal 319(h)	$98,341	% of total project	60%
Non-Federal Match	$118,113	% of total project (at least 40%)	40%
Total $ Cost	$216,454	Total project %	100%

Category	Federal	Non-Federal Match	Total
Personnel	$33,813	$48,600	$82,413
Fringe Benefits	$9,351	$13,608	$22,959
Subtotal Personnel & Fringe	$43,164	$62,208	$105,372
Travel	$15,599	$0	$15,599
Equipment	$0	$0	$0
Supplies	$21,756	$40,500	$62,256
Contractual	$4,995	$0	$4,995
Construction	$0	$0	$0
Other	$0	$0	$0
Subtotal	$42,350	$40,500	$82,850
Total Direct Costs	$85,514	$102,708	$188,222
Indirect Costs (15%)	$12,827	$15,405	$28,232
Total Project Costs	$98,341	$118,113	$216,454

Itemized Budget Justification

Personnel:

Extension technician will spend 20% of his/her time on the project. Their responsibilities will be to assist with set-up of the demonstrations, zeolite work, and securing and analyzing private water well samples.

A student worker will work 20 hrs/week for 44.5 weeks at $7.00/hr. and will assist with field demonstrations, copying and collating education information, printing agendas, and organization of reports.

Fringe benefits were calculated using 28%.

Travel:

In-state: Seven trips to the Vernon area to conduct the cover crop demonstration portion of the project and educational programs. A round trip to Vernon is approximately 666 miles at a state rate of $0.35/mile, ($1,632). Lodging at a state rate of $80/night for eight nights ($640). Anticipation of 10 days of meals at $30/day ($300).

Four trips will be to the Dumas area to conduct the water sampling for atrazine and arsenic and participate in demonstration events. Round trip to Dumas is approximately 1,104 miles at a state rate of $0.35/mile, ($1,546). Lodging at a state rate of $80/night for twelve nights ($960). Anticipation of 16 days of meals at $30/day ($480).

Out-of-state travel: One trip per year to an annual meeting such as the International Soil and Water Conservation Society or the National Agronomy Society of America to present information and experienced gained from project ($2,000).

Supplies: Fifteen porous cup samplers and setup materials to collect soil nitrates from each cover crop and bare soil treatment for $100 each ($1,500).

One soil auger ($300) and one TDR probe ($500) will be used to collect soil samples and monitor soil moisture levels, respectively.

Sample bottles (100) will be purchased to sample and store the soil leachate from the porous cup samplers ($250).

Sufficient quantities of zeolite to determine its effectiveness as an atrazine and arsenic filter ($500).

Structure to contain the zeolite as an atrazine and arsenic filter ($500).

One LCD projector will used to present educational information and demonstration results at county and regional water quality meetings ($3,500).

Office supplies, including paper for educational materials, publications, and printer cartridges.

Lab analysis for soil, water, and plant.

50 soil samples at $11/sample ($550)
50 water samples at $20/sample ($1,000)
25 plant biomass at $10/sample ($200)