Proposal to the Oregon Department of Agriculture for a 1998 groundwater research and development grant

1. Project name **Protecting groundwater while optimizing N applications for pasture forage production in Oregon**

Proposal is Category 1. Contacts: John Hart, Gene Pirelli, and Mylen Bohle Institution is Oregon State University

2. Project rationale

Forage production is vital to Oregon's one billion-dollar forage-livestock industry. Livestock enterprises are the leading agricultural commodity in Oregon and forage production is of primary importance to Oregon's agricultural economy. The combined sales of cattle, calves, dairy products, sheep, and horses are estimated at 610 million dollars in 1996 (Sears, 1997). Forage production is essential to a sustainable livestock industry. High quality, low cost forage is required for future production in a world market (Rogers, 1995). Forage production in Oregon is extensive. Improved pastures occupy approximately 850,000 acres and a potential of 2 million acres of hill land pastures. Much of the land used for grazing in Oregon is unsuited for more intense agricultural use. Areas used for grazing are a major component of watersheds, the first link in the continuum of rainwater, groundwater, and surface water. Livestock producers or grazers traditionally add nitrogen (N) fertilizer to these areas to increase forage quantity. Appropriate applications of N are key to protection of groundwater under almost one-fifth of Oregon.

Nitrogen, especially in the nitrate form, can enter surface and groundwater. Elevated nitrate concentrations in drinking water decrease the suitability to both humans and livestock (Cheek, 1998 and Fan and Steinberg, 1996). In addition, degradation of fish and other aquatic life habitat is associated with nutrients from fertilizers entering steams (Oregon State University, 1998). Water entering aquifers and surface waters, passes over or through hundreds of thousands of acres of land used for grazing in Oregon. Nitrogen fertilizer is routinely applied to this grazing land to increase forage production. Although the amounts of N applied to pastures are not high compared to use in vegetable crops, the application occurs in areas of groundwater recharge.

1997 Oregon Revised Statutes, section 568.909, states "(1) The State Department of Agriculture may describe the boundaries of agricultural and rural lands that are subject to a water quality management plan. For an area whose boundaries have been designated under this section, the department shall develop and carry out a plan for the prevention and control of water pollution from agricultural activities and soil erosion. The plan shall be based upon scientific information".

Section 568.912 states "The department may require any landowner whose land is located within an area subject to a water quality management plan, to perform those actions on the landowner's land necessary to carry out a water quality

management plan. Such actions may include agricultural and cropping practices necessary for the prevention or control of water pollution of the waters of the state".

Nutrients supplied to crops can be beneficial to crop growth if taken up by the plant or stored in the soil for future plant utilization. Unfortunately, some nutrients are moved into the atmosphere, surface water and groundwater. The goal of any producer is to manage nutrients so that the greatest economic return is received while having minimal or no adverse affect to environment. Nutrient management can be divided into four basic areas: 1) the amount of a nutrient to apply 2) timing of application 3) method of application, and 4) the source to use.

Adverse environmental consequences from nutrient application can occur if nutrients, such as N are: 1) applied incorrectly, for example, directly to water, 2) applied at a rate that exceeds plant needs, leaving the remainder of a soluble material to be leached into groundwater, or 3) the application is too late for plant needs, leaving soluble nutrients susceptible to leaching.

In continental Europe, the United Kingdom, British Columbia, and the Willamette Valley, increased pasture forage production has been documented by timing the first N application according to an accumulation of average daily air temperature. The initial N application is recommended when air temperatures above 0° C from January 1 reach a total of 200° C (Kowalenko et al 1989 and Pirelli, 1996). This is known as the T-Sum 200 method.

Application of N in synchrony with plant needs is one of the easiest methods of assuring that N will not reach surface and groundwater. The T-Sum 200 approach provides a physiological timing of application, rather than an estimate using calendar dates. The T-Sum 200 approach has been used successfully in areas of moderate winters. Use of T-Sum 200 in areas of frozen soil/cold climates has not been widely investigated, especially in North America. We desire to investigate whether the T-Sum 200 approach for scheduling N application is appropriate in forage producing areas with cold temperatures such as Crook, Jefferson, Lake, and Baker, Klamath and Harney counties. Also, the T-Sum approach will be investigated in two high rainfall coastal locations in Tillamook and Coos or Curry counties. In addition, a location drier and warmer than the Willamette Valley, Douglas County, will be the site of a research trial.

In areas such as the Willamette Valley where the T-Sum method for initial N application has proven useful, information is now needed on the timing of subsequent N, especially in management intensive-grazing systems. The traditional practice by livestock producers is a single application of N in late March or early April. This application, however, contributes to the already rapid forage growth rate. In many cases, the amount of forage exceeds what livestock can consume during this period. Additional forage is not needed during this time of peak growth, rather it is desirable earlier in the grazing season to reduce winter feeding costs. Field trials showed that the T-Sum 200 method for scheduling the first N application is effective in producing early forage growth. The 30-year range for T-Sum 200 to occur in the Willamette Valley is January 28 to February 14. A single application of 60 lb N/a is

not sufficient to maintain forage production throughout the season in intensively grazed systems. Research has shown that the aboveground portion of forage accumulates approximately 30 lb N/1000 lb forage. Approximately one thousand pounds of dry matter is removed in one grazing of an intensively managed grazing system. Grazing twice should remove about 60 lb N/a. We desire to determine when a second application is needed to maintain forage production in an intensively managed grazing system.

We estimate this project will supply information on the timing of N fertilization for more than one million acres of grazing lands in Oregon. It is designed to provide the scientific background required by Oregon Statues for judicious use of N in watersheds and maintain water quality. Any calculation of economic impact would be speculation. The potential to assist producers in prudent N use while maintaining water quality is quite large.

Results of the work will be used for extension workshops in counties around the state, as well as area and regional conferences. The field sites can be used for livestock producer field tours. The data collected will provide the basis for statewide Extension publications on Nitrogen timing and the use of T-Sum 200 in environmentally sound practices.

This is submitted as a category 1 proposal, since the thrust is to show that a reasonable amount of N applied at a time when the forage will use the N, is not detrimental to groundwater quality. We will use the information in outreach programs. Those programs receive limited description in this proposal. We may desire to have the project continue for one or two more years. Depending upon the outcome of the first year, application of a limited amount of labeled N fertilizer will likely be proposed. The use of labeled material will allow stronger statements to me made about the fate of applied fertilizer N. No other sources of funding are currently being solicited.

References:

Cheeke, P.R. 1998. Natural toxicants in feeds, forages and poisonous plants. 2nd Edition. Interstate Publishers, Inc., Danville, IL, p 231.

Fan, A.M. and V.E. Steinberg. 1996. Health implications of nitrate and nitrite in drinking water: an update on methemoglobinemia occurrence and reproductive and developmental toxicity. Regul. Toxicol. Pharmacol. 23(1, Part 1):35.

Kowalenko, C.G., S. Freyman, D.L. Bates, and N.E. Holbek. 1989. An evaluation of the T-sum method for efficient timing of spring nitrogen applications on forage production in south coastal British Columbia. Can. J. Plant Sci. 69:1179-1192.

Oregon State University. 1998. A snapshot of salmon in Oregon. EM 8722, OSU Extension Service, Corvallis, OR.

Pirelli, Gene. 1996. Timing of Nitrogen Fertilizer for Western Oregon Pastures. Oregon State University Area Fact Sheet. Polk County Extension Office, Dallas, OR.

Rogers, J. 1995. The effect of topdressed lime upon pasture production and quality. Master of Science Thesis, Oregon State University, Corvallis, OR.

Sears, S. 1997. 1996 Oregon county and state agricultural estimates. SR 790, OSU Extension Service, Corvallis, OR.

3. Objectives

Determine (investigate) if the T-Sum method can be used for scheduling initial fertilizer application in diverse forage production areas of Oregon.

In the Willamette Valley where data exists to support initial N fertilizer application at T-Sum 200, the appropriate time for a second N application needs to be investigated.

4. Procedures

Locations in Baker, Coos (or Curry), Crook, Tillamook, Douglas, Klamath, Lake, Harney, and Jefferson counties and the Willamette Valley will be selected. Each location will have 3 treatments and three or 4 replications. Treatments will be: 1) no addition of nitrogen, 2) no nitrogen at T sum 200 and 60 lb N/a at a later developmental stage, possibly the traditional calendar timing of N for the area, and 3) 60 lb N/a at T sum 200 and no N later. Soil samples for site characterization will be taken at the time of fertilizer application. Soil samples from each individual treatment, to be analyzed for available N, will be taken at the same time the last clipping/grazing is made.

Treatments for the Willamette Valley location will be: 1) no nitrogen, 2) 60 lb N/a applied at T Sum 200, and an additional 60 lb N/a applied after grazing or simulated grazing has removed 2000 pounds of dry matter, and 3) no N at T sum 200 but a single application of 120 lb N/a in late March or early April.

The plots will be grazed or clipped to simulate a rotational grazing system that keeps plants in phase two stage of growth. The plot will be monitored for plant growth and forage removed when the dry matter accumulation reaches 2200 pounds per acre. The plot will be grazed or clipped back to 1200 pounds of dry matter. The growth and harvest will occur as many times as plant growth allows during the grazing season.

Plot size will vary for each location and method of harvest. If mechanical simulation of grazing is used, the harvested area will be approximately 2.5 feet wide and 25 feet long. Smaller plots will be used if hand clipping is employed and larger plots used if sites are grazed.

Clippings will be weighed and a sub sample taken for drying or entirely dried and weighed. Each sample clipped will be analyzed for total N content. The amount of N accumulated in the clipped material will be calculated from the two measurements.

5. Implementation Plan

T sum measurements will begin January 1. Locating experimental sites will also begin at this time. Plots will be delineated and treatments made at approximately T-Sum 200. Clipping will occur when the most mature plot is deemed ready for grazing, approximately 2200 pounds of dry matter/a. Plots will be clipped to a height

equivalent of grazing. Forage will be weighed and subsampled. The subsample will be weighed, dried and weighed again to determine moisture content. The whole sample weight will then be adjusted for moisture and forage weight reported on a dry matter basis. The subsample will also be analyzed for N using a CNS analyzer.

6. Personnel

Baker County—Jay Carr
Crook County—Mylen Bohle
Harney County—Ray Angell
Klamath County—Randy Dovel
OSU campus—John Hart
Willamette Valley—Gene Pirelli
Coos and Curry County—Amy Peters
Douglas County—Shelby Filley
Jefferson County—Mylen Bohle
Lake County—Marni Porath
Tillamook County—Troy Downing

All personnel are full time faculty at Oregon State University and have Experiment Station and/or Extension Service appointments. The appointments include forage and/or livestock production responsibility. All personnel have been involved in previous field research projects. Educational experience is, at minimum, an MS degree. Practical experience in forage or livestock production varies from one to more than 20 years per individual.

7. Project Budget

Analyses of tissue samples for N content will cost $12 each. Four clipping dates x 4 replications x 3 treatments per location is 48 samples per location. The cost of N analyses is $576/location x 10 locations is $5760.

Analyses of soil samples for characterization includes appropriate tests for each geographical area from the following analyses: soil pH, lime requirement, electrical conductivity, extractable P, Ca, Mg, K, Na, B, and Zn, nitrate and ammonium-N, and carbon, total N, and S by CNS analyzer @ $75/ea x 10 locations = $750.

End of project available soil N analyses each experimental unit $10/ea or $120/location = $1200

Each location will require approximately $250 for travel, $25 for fertilizer, $600 for mower rental/service/repair and $225 in miscellaneous expenses for paper, copies related to publications, slide preparation and workshops. Each site will require $1100 to operate. The cost for 10 locations will be $11,000.

Project coordinator's (Hart) supplies ($100), travel ($300), and long distance phone costs ($100) for report prep, site visits and required presentation in 2000 is $500

The project cost is $19,210 + $2,134 (10% overhead) = $21,344

	Grant Funds	Match Funds	Other Funds	Total Funds
Salaries and Benefits	--	----	--	0
Equipment	--	--	--	--
Materials and Supplies	2,600	--	--	2,600
Services	13,810	--	--	13,810
Travel	2,800	--	--	2,800
Other	--	--	--	--
Indirect Costs	2,134	--	--	2,134
TOTAL	21,344		--	21,344

8. Anticipated Accomplishments. We expect to accomplish the following:

Develop strategies that lead to increased economic forage production for the leading agricultural commodities in the state. Provide data that shows the economic value of increased forage growth early in the spring from judicious use of nitrogen as opposed to the current, large, one-time application during the peak portion of the growing season.

Provide data supporting preservation of groundwater quality and the prudent use of N fertilizer on pastures according to crop and livestock needs.

Develop the basis for an environmentally friendly approach to N use, including timing and grazing strategies for prevention of groundwater quality problems due to nitrate leaching or N contamination of surface water.

Develop practical, written information that will be distributed in the form of Extension publications, newsletter articles and popular press articles that summarizes the research results and lists the strategies we develop.

Inclusion of information statewide grazing and forage conferences, such as were held in 1997 and 1998, attended by 150 participants.