5/6/2011

Publication List Related to Pasture And Grazing Research

Publications and abstracts are listed in reverse chronological order. A limited number of reprints are available, and can be requested by referring to the NAEW number. Use your browser's "find" feature to search for words of interest. For more information, please contact:

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Dinku, M.E, Fisher, D.S., Owens, L.B., Jenkins, M.B., Schomberg, H.H., Tebes-Stevens, C.L., Bonta, J.V. 2011.Runoff water quality during drought in a zero-order Georgia Piedmont pasture: nitrogen and total organic carbon. Journal of Environmental Quality. 40(3):969-979. **(NAEW #474)**

Abstract:

Approximately 11% of the Southern Piedmont (1.8 million ha) is used for pasture and hay production. These systems are mostly under low-input management. Cattle manure can lead to enrichment of surface soils with nutrients raising concerns about water quality. We present 11 years (1999-2009) of hydrologic and 10 years of water quality data from a 7.8-ha, zero-order catchment with bermuda grass over-seeded with winter annuals rotationally grazed as pasture near Watkinsville in the Georgia Piedmont. Between 20 and 225 head of cattle grazed the pasture a total of 69 times for a third of the overall period, spending from 1 to 71 days each grazing period. Cattle days (number of cattle x number of days) varied from 8 to 611 (mean 182.4) ha-1 grazing-period-1. Annual rainfall was 176 to 463 mm below the long-term average of 1240 mm in 7 of the 11 years. Only 20 runoff events were recorded during 86 months of below average rainfall (deficit period) compared to 54 runoff events during the 46 months of the non-deficit period. Nutrient analyses were carried out for 43 to 47 out of 67 runoff events from 2000-2009. A forward step-wise regression was used to screen 23 independent variables for best predictors of nutrient load, runoff volume and peak runoff rate. Mean flow weighted concentration (FWC) in mg L-1 was 0.96 for nitrate-nitrogen (NO3-N), 0.97 for ammonium-nitrogen (NH4-N), 3.70 for total nitrogen (TN), and 9.12 for total organic carbon (TOC). Nutrient loads in kg ha-1 averaged 0.038 for NO3-N, 0.031 for NH4-N, 0.188 for TN, and 0.542 for TOC. Peak nutrient concentrations and loads

occurred during calving season and/or when monthly rainfall was above average. Assuming these averages would hold for all 74 runoff events, total nutrients leaving the whole catchment in kg over 11 years would have been approximately 22 for NO3-N, 18 for NH4-N, 108 for TN, and 312 for TOC. These data suggest that nitrogen and organic carbon releases from Southern Piedmont pastures under low-input management may be of limited environmental concern. However, the data were obtained from a catchment that confined cattle away from creeks and during a period when the region was experiencing below average rainfall.

Stavi, I., Lal, R., Owens, L.B. 2011. Effects of cattle grazing during the dormant season on soil surface hydrology and physical quality in a moist-temperate region. Ecohydrology. 4(1):106-114. **(NAEW #470)**

Abstract:

Livestock grazing in paddocks of temperate regions during the dormant season adversely affects soil quality. The adverse effects stem from trampling action under wet soil conditions. Thus, the objective of this study was to evaluate the long-term effects of livestock grazing on soil quality, with special reference to some mechanical and hydrological characteristics of the soil. Soil properties were measured in a paddock under rotational grazing during the growing season only (GR) and compared with those under grazing during the dormant season and rotational grazing during the growing season (DO). Soil series in both paddocks is Coshocton (Aquultic Hapludalfs). Soil properties were studied for 3 depths (0-5, 5-10 and 10-15 cm). In comparison with GR, DO had a larger penetration resistance (0.93 vs. 1.42 MPa) and bulk density (1.24 vs. 1.44 g cm-3), and lower water stable aggregates (880 vs. 830 g kg-1, respectively), coarse root (> 1 mm) biomass (1.11 g / 86.7 cm3 vs. 0.62 g / 86.7 cm3), and field moisture capacity (364 vs. 326 g kg-1). Some indices of water infiltrability were higher in GR than in DO, including sorptivity (47.8 vs. 24.7 mm min-0.5), transmissivity (2.2 vs. -0.5 mm min-1), final equilibrium rate (4.8 vs. 1.4 mm min-1) and cumulative infiltration (865.6 vs. 260.0 mm). However, only small difference between the two grazing treatments was observed in vane shear strength (0.13 and 0.12 MPa for GR and DO, respectively), and no difference in aggregate's mean weight diameter. Soil depth affected most of the soil properties. In general, the effect of grazing treatment decreased with increase in soil depth.

Owens, L.B., Shipitalo, M.J. 2008. Runoff Quality Evaluations of Continuous and Rotational Over-wintering Systems for Beef Cows. Agriculture, Ecosystems and Environment. 129(4):482-490. **(NAEW # 461)**

Abstract:

Over-wintering cattle out of doors can be detrimental to the areas that the cattle occupy and cause increased runoff, sediment loss, and nutrient transport. As management practices vary, the impacts on the occupation areas vary. Two systems of over-wintering cattle were evaluated for their environmental impacts over a 12-yr period. In a

high fertility system, beef cows were rotated weekly during the summer. They were then rotated through fall regrowth on hayed areas and rotationally fed hay in those areas. In a medium fertility system, cattle were rotated weekly during the summer and then continuously fed hay in one winter area. Vegetative cover in the continuous wintering area frequently decreased to less than 50% by late winter/early spring. Monthly runoff averages were greater from the continuous wintering system than the rotational wintering system in 9 out of 12 months (annual runoff of 120.4 and 37.5 mm, respectively), with the greatest difference being in April. Similarly, sediment loss was greater from the continuous system (2.68 and 0.24 Mg ha-1, respectively), with the greatest losses occurring in April. Surface runoff losses of N were greater during the dormant season than the growing season for both systems. Average annual total N transported for the 12-yr period during the dormant seasons was 13.2 and 6.7 kg ha-1 for the continuous and rotational wintering systems, respectively; for the growing seasons, it was 4.6 and 1.3 kg ha-1, respectively. Runoff N losses were considerably less than leaching losses. Runoff, sediment, and N losses were less with a rotational wintering system than with a continuous occupancy wintering system. But for the two systems studied, the cattle occupancy rate was also much greater in the continuous wintering system compared with the rotational wintering system (1497 and 1860 cow days ha-1 compared with 528 and 576 cow days ha-1). This shows that a rotational wintering system is more sustainable than a continuous wintering system, but more land area per cow would be necessary.

Owens, L.B., Shipitalo, M.J., Bonta, J.V. Water Quality Response Times to Pasture Management Changes in Small and Large Watersheds. Journal of Soil and Water Conservation. 63(5):292-299. **(NAEW #454)**

Abstract:

To interpret the effects of best management practices on water quality at a regional or large watershed scale likely response times at various scales must be known. Therefore, 4 small (<1 ha, 2.5 ac) watersheds, in rotational grazing studies at the North Appalachian Experimental Watershed (NAEW) near Coshocton, OH, were used to study management impacts on water quality and response times. Surface runoff was sampled on an event basis; subsurface flow was sampled monthly. An underlying clay layer created a perched water table in these watersheds. Samples of shallow groundwater were taken from springs developed where the clay outcropped at the soil surface. Such return flow feeds base flow in watersheds large enough to have continuously flowing streams. In 4 large watersheds, ranging from 18 to 123 ha (44 to 303 ac), base flow was over 50% of total annual stream flow and approximately 20% of annual precipitation. Nitrate-N transport in base flow was 31 to 59% of total annual NO3-N transport in stream flow. When the N fertilization rate in a ¿medium fertility¿ area, that contained 2 small watersheds, was increased from 56 kg ha-1 to 168 kg ha-1 (50 lbs ac-1 to 150 lbs ac-1) per year there was very little change in NO3-N concentrations in shallow groundwater for 4 years. Then NO3-N levels in groundwater began to increase and were still increasing after 10 years at the higher rate. With discontinuation of N fertilization, NO3-N concentrations in groundwater returned to pre-

N increase levels after 6 years. In a ¿high fertility¿ grazing area with a similar perched water table, 224 kg N ha-1 (200 lbs ac-1) was applied annually. Concentrations of NO3-N increased to >10 mg L-1 (ppm) after 5 years. Legumes were then interseeded into the grass forage, and mineral N fertilization was discontinued. Nitrate-N concentrations in groundwater returned to their pre-fertilization levels after about 5 years. This multi-year response of subsurface water quality to management change in small watersheds, shown by this 25-yr data set, indicates that the response time for measurable change in multi-square-mile watersheds will be equally long, if not longer, and trends will be muted. The percentage of the large watershed that experiences a management change and spatial distribution of treated areas will affect the extent to which trends will be muted. Trends in the NAEW watershed with 23% treated area were less muted than in a watershed with 14% of the area treated.

Hensler, A.L., Barker, D.J., Sulc, R.M., Loerch, S.C., and Owens, L.B. Comparison of management intensive grazing and continuous grazing in beef cattle pasture. Proc. of the 2007 Conference of the American Forage and Grassland Council 16:48-51. **(NAEW #447)**

Abstract:

Management intensive grazing (MIG) offers the potential to increase the financial profitability and productivity of grazing beef and dairy farms in Appalachian Ohio, with minimum environmental impacts. The objective of the project was to compare MIG with conventional continuous grazing (CG) and relate seasonal forage growth in these systems to livestock production. The project was conducted on four replicated pastures totaling 42.5 ac and with 35 cow-calf pairs at the North Appalachian Experimental Watershed (NAEW) located in Coshocton, OH in 2006. Cattle in the MIG system were moved 3-5 times per week. Forage biomass was measured using a calibrated rising plate meter (RPM) weekly in 15 paddocks per pasture from June 21-Oct. 26,2006. Cattle weight and body condition score were recorded every 4 weeks. The calibrations slopes for each week of measurements ranged from 137-247 lb DM/ac per RPM-unit. Cows on the CG pasture had an average weight gain of 112.9 lb/cow while cows on the

MIG gained an average of 136.2 lb/cow. The calves on the MIG pasture also gained more (484.8 lb/calf) than the calves on the continuous pasture (472.9 lb/calf). The cattle on the MIG system were able to graze 17 d longer than those on the CG system. An additional 19,140 lb of hay was harvested from each MIG pasture (averaging 1.645 lb/ac). It was concluded that MIG is a viable grazing option for livestock production in Appalachian Ohio.

Stout, W.L., A.N. Sharpley, L.B. Owens, J.B. Cropper, and R.R. Schnabel. 2006. Environmental impacts of grazing. In: Forage Production for Pasture-Based Livestock Production, E.B. Rayburn, ed. Chapter 5, pp. 64-79 and 131-134. NRAES-172; Natural Resource, Agriculture, and Engineering Service, Ithaca, NY. **(NAEW #439)**

Abstract:

Grazing is first and foremost an animal production system whose main purpose is to make the producer money by efficiently cycling nutrients and energy through ruminant animals to produce animal products. As with confinement production systems, grazing will have impacts on the environment and care must be taken to ensure that these impacts are acceptable to society. In contrast to confinement systems, however, grazing systems do not necessarily allow the producer to have the same degree of control over nutrient and energy flows. Consequently, if environmental impacts of grazing systems are to be minimized, constant care must be taken to employ the controls available to the grazing manager. Some key management practices that can help control the potential negative environmental impacts of grazing are: Use of legumes as the pasture N source. This will reduce N leaching and help control stocking rate. Cattle eat more legume forage so fewer animals are needed to eat the forage there. Use of moderate energy supplementation to improve N utilization by the animal. This will reduce N excretion in urine and consequently reduce N leaching, provided that stocking rates are not increased excessively. Use of bank fencing and off-stream watering systems to reduce animal access to streams. This will reduce direct defecation and urination into streams and reduce stream bank degradation. Maintaining healthy pasture swards through proper stocking rate, grazing pressure and soil fertility management. This will help prevent soil erosion and pasture degradation through compaction.

Owens, L.B. and M.J. Shipitalo. **2006.** Surface and subsurface phosphorus losses from fertilized pasture systems in Ohio. J. Environ. Qual. 35:1101-1109. **(NAEW #430)**

Abstract:

Phosphorus is an essential plant nutrient and critical to agricultural production, but it is also a problem when excessive amounts enter surface waters. Summer rotational grazing and winter feeding beef pasture systems at two fertility levels (56 and 28 kg available P ha^{-1}) were studied to evaluate the P losses from these systems via surface runoff and subsurface flow using eight small (0.3-1.1 ha), instrumented watersheds and spring developments. Runoff events from a 14-yr period (1974-1988) were evaluated to determine the relationships between event size in mm, total dissolved reactive phosphorous (TDRP) concentration, and TDRP transport. Most of the TDRP transported was via surface runoff. There were strong correlations (r^2 = 0.45-0.66) between TDRP transport and event size for all watersheds, but no significant (P = 0.05) correlations between TDRP concentration and event size. Flow-weighted average TDRP concentrations from the pasture watersheds for the 14-yr period ranged from 0.64 to 1.85 mg L^{-1}. The highest concentrations were in events that occurred soon after P fertilizer application. Average seasonal flow-weighted TDRP concentrations for subsurface flow were <0.05 mg L^{-1}. Applying P fertilizer to pastures in response to soil tests should keep TDRP concentrations in subsurface flow at environmentally acceptable levels. Management to reduce runoff and avoidance of P fertilizer

application when runoff producing rainfall is anticipated in the next few days will help reduce the surface losses of P.

Owens, L.B., and J.V. Bonta. **2004**. Reduction of nitrate leaching with haying or grazing and omission of nitrogen fertilizer. J. Environ. Qual. 33:1230-1237. **(NAEW #401).**

Abstract:

In some high-fertility, high-stocking-density grazing systems, nitrate (NO_3) leaching can be great, and ground water NO_3-N concentrations can exceed maximum contaminant levels. To reduce high N leaching losses and concentrations, alternative management practices need to be used. At the North Appalachian Experimental Watershed near Coshocton, OH, two management practices were studied with regard to reducing NO_3-N concentrations in ground water. This was following a fertilized, rotational grazing management practice from which ground water NO_3-N concentrations exceeded maximum contaminant levels. Using four small watersheds (each approximately 1 ha), rotational grazing of a grass forage without N fertilizer being applied and unfertilized grass forage removed as hay were used as alternative management practices to the previous fertilized pastures. Ground water was sampled at spring developments, which drained the watershed areas, over a 7-yr period. Peak ground water NO_3-N concentrations before the 7-yr study period ranged from 13 to 25.5 mg L^{-1}. Ground water NO_3-N concentrations progressively decreased under each watershed and both management practices. Following five years of the alternative management practices, ground water NO_3-N concentrations ranged from 2.1 to 3.9 mg L^{-1}. Both grazing and haying, without N fertilizer being applied to the forage, were similarly effective in reducing the NO_3-N levels in ground water. This research shows two management practices that can be effective in reducing high NO_3-N concentrations resulting from high-fertility, high-stocking-density grazing systems, including an option to continue grazing.

Owens, L.B., R.W. Van Keuren, and W.M. Edwards. **2003.** Non-nitrogen nutrient inputs and outputs for fertilized pastures in silt loam soils in four small Ohio watersheds. Agric., Ecosyst. Environ. 97:117-130. **(NAEW #383).**

Abstract:

Evaluations of non-nitrogen nutrient budgets in pasture systems are limited, and there needs to be greater knowledge of these budgets. Although most nutrient budget studies from grasslands have focused solely or primarily on N, maintenance of a proper nutrient balance is important to healthy plant growth and reduction of potential water quality problems. Budgets of non-nitrogen nutrients were studied in a rotational pasture system during two treatment periods, which received different levels of nitrogen (N) fertility. Rotationally grazed grass pastures in Ohio (USA) received 56 kg N ha^{-1} as NH_4NO_3 for a 5-year period and then 168 kg N ha^{-1} for a 10-year period. A topsoil pH of 6.0 and available P and K levels of 28 and 168 kg/ha, respectively, were maintained.

Cattle grazed four paddocks during the summer and were fed hay in one of the paddocks during the winter. Inputs of phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg), sodium (Na), and chlorine (Cl) from precipitation, fertilizer, and hay were determined. Losses of these nutrients plus total organic carbon (TOC) were measured in surface runoff and in water from springs draining each area. The majority of the nutrients from the summer only grazed (SG) paddocks were transported in subsurface flow. Hay was the major source of P and K in the winter feeding/summer grazing (WF/SG) paddock, and surface runoff was the major transport pathway for them and TOC. Most of the transport of Ca, Mg, Na, and Cl from the WF/SG area occurred via subsurface flow. Concentrations of P in subsurface flow were low; Na concentrations changed little during the 15-year study; Mg, Ca, and Cl concentrations increased slowly from the SG area but much more rapidly from the WF/SG area. When large amounts of nutrients are brought into an area with hay, there can be a soil buildup of P and K. This increases the possibility for adverse water quality impacts. Nevertheless, the evaluation of non-nitrogen nutrients in pasture systems showed that when they are balanced and meet the plant requirements for the N fertility level, the possibility of detrimental environmental impact is low.

Owens, L.B., G.C. Starr, and D.L. Lightell. 2002. Total organic carbon losses in subsurface flow under two management practices. Journal of Soil and Water Conservation 57(2):74-81. **(NAEW #376)**

Abstract:

Greenhouse gases and global warming have become major topics. Much of the greenhouse gas discussion has dealt with carbon dioxide (CO_2) and methods to sequester or store atmospheric carbon in soils and forests. The entire carbon cycle needs to be studied to better understand the overall process. The major carbon transformations are loss of CO_2 to the atmosphere or the storage of carbon in sinks such as soil. Although it is a minor pathway, carbon leached through the soil and into groundwater needs to be quantified. Numerous carbon studies have been performed, but concentrations and losses of total organic carbon (TOC) moving through a soil profile have received little attention. Therefore, this study was to assess TOC levels in subsurface flow under two management practices. TOC was determined monthly in the percolate from large soil blocks, called lysimeters, (2.4 m [8 ft] deep) with undisturbed soils under row crops. Most of the TOC concentrations in the percolate ranged from 0.5 to 6.0 mg/L with the corn/soybean-rye rotation. Developed springs in two rotational grazing systems were sampled for 10 years. TOC concentrations in the groundwater from the springflow developments had less variability than in the lysimeter percolate. Most TOC values from these pasture systems were in a concentration range of 1 to 3 mg/L. Annual averages of TOC transport were similar for the lysimeter percolate and groundwater springs, ranging from 3.7 to 6.0 kg/ha (3.3 to 5.4 lb/ac).

Owens, L.B., W.M. Edwards, and R.W. Van Keuren. **1999.** Nitrate leaching from grassed lysimeters treated with ammonium nitrate or slow release nitrogen fertilizer. J. Environ. Qual. 28(6):1810-1816.**(NAEW #348).**

Abstract:

Nitrate leaching is a potential in humid regions when crops and forages are fertilized. This study was conducted to compare NO_3 leaching with two different N fertilizer formulations applied to forages. For 11 yr, ammonium nitrate (AN) was applied to a large (8.1 m^2 surface area), undisturbed, monolithic lysimeter Y101B at an annual rate of 168 kg N ha^{-1}, and methylene urea (MU), a slow-release fertilizer, was applied to a similar lysimeter (Y101D) at the same rate. Nitrate-N concentrations in the percolate from these 2.4 m-deep lysimeters were measured weekly. Even though NO_3-N levels increased steadily with the AN applications, the greatest increases occurred during the eighth year of treatment and reached levels above 20 mg L^{-1}. With the MU, NO_3-N concentrations remained relatively constant until after 8 yr of treatment, reaching concentrations of 6 mg L^{-1}. The highest rates of annual NO_3-N transport in percolate were 42.3 and 12.1 kg ha^{-1} from lysimeters treated with AN and MU, respectively. (Losses from NH_3 volatilization were measured at 12.0 and 44.8 kg N ha^{-1} for An and MU, respectively.) Nitrate-N transport in percolate varied seasonally with the greatest amounts being moved during the late winter-early spring. Following 11 yr, the NO_3-N concentrations in each lysimeter declined to approximately 1 mg L^{-1}. Based on this study with a 168 kg N ha^{-1} annual application rate, less NO_3-N leaching will occur when a slow-release N fertilizer, such as MU, is applied to forages than when AN is applied.

Owens, L.B., R.W. Van Keuren, and W.M. Edwards. **1998.** Budgets of non-nitrogen nutrients in a high fertility pasture system. Agric., Ecosyst. Environ. 70:7-18.**(NAEW #338).**

Abstract:

Concentrations and transport of non-nitrogen nutrients in surface runoff and subsurface flow were determined under a high fertility pasture system during a multi-year study. Most studies of nutrient loss from grasslands have focused solely or primarily on nitrogen. Nevertheless, maintaining a proper balance of other nutrients is important to healthy plant growth, avoidance of toxicity problems from improper nutrient balances, and reduction of potential water quality problems. Rotationally grazed grass pastures received 224 kg N/ha annually as NH_4NO_3 for a 5-year period and had a legume interseeded into the grasses to be the N source during the following 8-year period. Part of the pastures were grazed during the summer only. The other pastures were used in the winter months with cattle eating fall regrowth and the hay made on that area during the summer. Topsoil pH of 6.5 - 7.0 and available P and K levels of 56 and 336 kg/ha, respectively, were maintained by soil amendments. Concentrations of P, K, Na, Ca, Mg, Cl, and TOC were measured in surface runoff collected from small watersheds with automated samplers and in water from springs draining each area. Nutrient concentrations in both surface runoff and subsurface flow were strongly influenced by

the amounts of fertilizer and lime applied. The majority of P and K were transported via surface runoff. The concentrations and transport of P and K were greater during the 8-year period because of increased rates of application of these fertilizers. Nutrient concentrations in subsurface flow did not vary greatly on a monthly basis but there were some increases during the span of the study. Concentrations of K and Na changed very little; Mg increased slightly; and Ca and Cl had large increases during the 13 years. Increased rates of KCl application during the 8-year period was a primary cause for the increased Cl concentrations in the shallow groundwater. Concentrations and transport of non-nitrogen nutrients from a pasture system were little influenced by the summer vs. winter management of this study or the change in N source form fertilizer to legumes. The application of non-nitrogen fertilizers and lime was the major factor of influence. In a pasture system where balances are maintained, the possibility of detrimental environmental impacts from non-nitrogen nutrients is low.

Owens, L. B., W. M. Edwards, and R. W. Van Keuren. **1997.** Runoff and sediment losses resulting from winter feeding on pastures. J. Soil Water Conserv. 52:194-197. **(NAEW #332).**

Abstract:

Grazing is an important land use in the humid, eastern U.S. When the grass is dormant, late fall through early sprint, the land is most vulnerable to the pressures of livestock. Runoff and sediment losses from a small pastured watershed (WS) in eastern Ohio have been studied for 20 years. In Period 1, a beef cow herd grazed it rotationally during the growing season for 12 years and was fed hay in this WS during the dormant season (high animal density with feeding). During the next 3 years of this study (Period 2), there was summer rotational grazing only. There was no animal occupancy on this WS during the last 5 years (Period 3). Annual runoff was more than 10% of precipitation during Period 1 (120 mm) and less than 2% during Periods 2 and 3 (14 and 6 mm, respectively). The decrease in annual sediment loss was even greater with the change in management, yielding 2259, 146, and 9 kg/ha for the three respective periods. Over 60% of the soil loss during Period 1 occurred during the dormant season. In response to weather inputs, there was considerable seasonal and annual variation in runoff and soil loss within management periods. Low amounts of runoff and erosion from three adjacent watersheds with summer-only grazing supported the conclusion that the increased runoff and erosion during Period 1 resulted from the non-rotational, winter feeding on pastures. When the management was changed, the impacts of the previous treatment were not long lasting, changing within a year.

Owens, L.B., W.M. Edwards, and R.W. Van Keuren. **1996.** Sediment losses from a pastured watershed before and after stream fencing. J. Soil Water Conserv. 51:90-94. **(NAEW #322).**

Abstract:

Livestock induced sediment loss is one of the potential detrimental impacts from grazing grasslands. Near Coshocton, Ohio, a 26-ha unimproved pasture watershed was grazed

year-around, and no fertilizer was applied. A beef cow heard had access to the entire watershed study area including the small stream that originated within the watershed, i.e. there was no rotational grazing in the pasture. Sediment loss via the stream was measured at the base of the watershed. Following 7 years of this management practice, the stream and the wooded areas on the sides of the stream were fenced so that the cattle no longer had access to them. During the next 5 years, with the cattle fenced out of the stream, the annual sediment concentration decreased by more than 50% and the amount of soil lost decreased by 40%. Average annual soil losses were reduced from 2.5 to 1.4 Mg/ha while annual precipitation averages were similar during each management period.

Owens, L.B., W.M. Edwards, and R.W. Van Keuren. **1994.** Groundwater nitrate level under fertilized grass and grass-legumes pastures. J. Environ. Qual. 23:752-758. **(NAEW #307).**

Abstract:

High levels of N fertilizer applied to pastures can result in NO_3-N concentrations in groundwater exceeding the USEPA potable water standard of 10 mg N/L. This study was conducted to determine groundwater NO_3-N levels following a change in N source from fertilizer to a legume in a grass-pasture grazed by beef cattle. For 5 yr, 224 kg N/ha was applied annually to small watersheds with orchardgrass (*Dactylis glomerata* L.) pastures used for summer-grazing and tall fescue (*Festuca arundinacea* Schreb.) areas used for winter-grazing-feeding. At the beginning of the sixth year, alfalfa (*Medicago sativa* L.) was interseeded into the grass pastures and N fertilizer was no longer applied. Groundwater samples from developed springs and surface runoff samples were collected and analyzed for NH_4-N, NO_3-N, and total N for the 5-yr fertilization period and for the following 10-yr period without applied N fertilizer. Nitrogen in groundwater was present mainly in the NO_3 form, and concentrations increased throughout the 5-yr period of fertilizer application and reached levels that were usually in excess of 10 mg N/L. With the change from N fertilizer to legume N, the NO_3-N concentrations in groundwater dropped rapidly during a 2-yr period. In a tall fescue-alfalfa area, NO_3-N levels decreased from 17.7 to 9.3 mg N/L. In two orchardgrass-alfalfa areas, NO_3-N levels decreased from 11.2 to 2.7 and from 8.3 to 3.6 mg N/L. During the remainder of the 10-yr period, NO_3-N concentrations declined to levels similar to those before N fertilization. Although the amount of N lost via subsurface flow decreased with decreasing concentrations, subsurface flow remained the main pathway for N loss compared with surface runoff or sediment-attached N. Owens, L.B. and W.M. Edwards. **1992.** Long-term groundwater quality changes from a one-time surface bromide application. J. Environ. Qual. 21:406-410. **(NAEW #289).**

Abstract:

The purpose of this experiment was to use a conservative tracer to study the impacts on groundwater quality of a one-time application of a water soluble chemical. Potassium bromide was applied at a rate of 168 kg Br^-/ha to two 1.1-ha pasture watersheds in

east-central Ohio. The watersheds had well-drained residual silt loam soils and with slopes of 12 to 25%. A nearly impermeable clay layer under the watersheds created a perched aquifer from which groundwater samples could be taken at developed springs. There were seasonal variations in Br^- concentrations in the groundwater and the highest concentrations (9.2 mg/L maximum peak) occurred within 3 yr following the Br^- application. Ten years following the Br^- application, Br^- concentration in the groundwater was still slightly above initial baseline levels. Even with a one-time application of a soluble chemical constituent on the surface of a small aquifer system, a multiyear impact was produced on the quality of groundwater.

Owens, L.B., W.M. Edwards, and R.W. Van Keuren. **1992.** Nitrate levels in shallow groundwater under pastures receiving ammonium nitrate or slow-release nitrogen fertilizer. J. Environ. Qual. 21:607-613. **(NAEW #292).**

Abstract:

This study examined the impact on groundwater quality of conventional and slow-release N fertilizer to small, grazed watersheds in eastern Ohio. Three small watersheds (each less than 1 ha) received 56 kg N/ha annually as NH_4NO_3 for 5 yr. For the next 10 yr, one watershed received 168 kg N/ha annually as NH_4NO_3 and two others received the same amount of N as methyleneurea, a slow-release fertilizer. Shallow groundwater samples were collected from springs and analyzed. After the 5-yr prestudy period, NO_3-N levels in the groundwater from the three watersheds were in a 3 to 5 mg/L range. Groundwater NO_3-N concentrations increased slightly during the first 3 yr at the higher N fertilizer rate, though they remained in the 3 to 5 mg/L range. Nitrate-N levels increased more sharply during the rest of the study. Although these NO_3-N levels varied more between the growing and dormant seasons than when lower rates of fertilizer were applied, they eventually reached a slower rate of increase. During the 9^{th} and 10^{th} yr of the high application, seasonal NO_3-N levels in groundwater ranged from 10 to 16 and 7 to 14 mg/L from the watersheds receiving NH_4NO_3 and methylene urea, respectively. This study showed that 168 kg N/ha was too much for this system, regardless of whether conventional or slow-release N was used.

Owens, L.B., W.M. Edwards, and R.W. Van Keuren. **1989.** Sediment and nutrient losses from an unimproved, all-year grazed watershed. J. Environ. Qual.18:232-238.**(NAEW #268).**

Abstract:

A common practice for grazing land in the humid, eastern USA is continuous grazing with little or no fertilizer use. Concentrations and transport of nutrients from a 28-ha unimproved grassed watershed were assessed in east-central Ohio for 2 yr without the presence of livestock, for 3 yr with a 17-cow beef (*Bos Taurus)* herd grazing during the summer months only, and for an additional 6-yr period with all-year grazing with hay being brought in for winter feed. Nutrient concentrations remained low during all three grazing levels. An exception was K concentration, which increased with all-year

grazing. Concentrations of NO_3-N, mineral-N, P, Ca, Mg, Na, and Cl were similar to or less than the concentrations from a nearby 17.7-ha wooded watershed that contained no pastured areas and received no agricultural inputs. Nutrient concentrations showed no consistent seasonal variation. Concentrations of organic-N, total organic C and sediment increased with increased grazing pressure. Greatest sediment concentrations and transport rates generally occurred during July and August regardless of grazing system. Largest monthly average sediment concentrations were 0.8, 1.3, and 3.2 g/L for the three systems, respectively; annual sediment losses were 0.2, 1.2, and 2.1 Mg/ha, respectively. All-year cattle grazing/feeding on an unimproved pasture in this area would not be expected to produce degradation of stream water quality from nutrient concentrations or transport.

Owens, L.B., R.W. Van Keuren, and W.M. Edwards. **1985.** Groundwater quality changes resulting from a surface bromide application to a pasture. J. Environ. Qual. 14:543-548. **(NAEW #252).**

Abstract:

Potassium bromide was applied at a rate of 168 kg Br^-/ha to two 1.1-ha pasture watersheds in east-central Ohio to study the impacts on groundwater quality of a one-time application of a soluble constituent. The watersheds had well-drained residual silt loam soils and average slopes of about 20%. A nearly impermeable clay layer under the watersheds created a perched aquifer from which groundwater samples could be taken at developed springs. Three monolith, grassed lysimeters having soil profiles similar to the watersheds also received the Br^- treatment. The lysimeters, which were 8 m^2 in surface area and had a depth of 2.4 m, had shorter leaching pathways than the watersheds and showed peak Br^- concentrations in percolation (24.0 mg/L maximum peak) occurring 52 – 78 weeks following the Br^- application. The Br^- concentration in the groundwater from the watersheds had lower peaks (9.2 mg/L maximum peak) but occurred 84 to 104 weeks after the Br^- application. Because of variable leaching pathway lengths, including pathways much longer than those in the lysimeters, the watershed groundwater Br^- applications had shown no meaningful decrease by 2 yrs after the Br^- application. A one-time application of a soluble, nondegradable chemical constituent can have a multi-year influence on groundwater quality.

Owens, L.B., W.M. Edwards, and R W. Van Keuren. **1984.** Peak nitrate-nitrogen values in surface runoff from fertilized pastures. J. Environ. Qual. 13:310-312. **(NAEW #247).**

Abstract:

Pastured watershed on hill slopes in eastern Ohio were fertilized with ammonium nitrate (NH_4NO_3) at two different levels for 5 years. The pastures were rotationally grazed during either the growing season (May-October) or the dormant season (November-April). Nitrate-N concentrations were measured in surface runoff events >0.1 mm from nine watersheds. During the 5-year period, there were 890 runoff events. Sixty-four of

these events (7%) had NO_3^- -N concentrations >10 mg/L, and 48 of the 64 events occurred within a 30-d period following fertilizer application. Ten events, <2% of all of the runoff events, exceeded 30 mg/L NO_3^- -N, and all of these were within 17 d of fertilization. Although all surface runoff events which closely followed fertilizer applications did not have high NO_3^- -N concentrations, all surface runoff with high NO_3^- -N was shortly preceded with a fertilizer application. The closeness of the high NO_3^- -N concentration and fertilizations suggested that fertilizer was the major contributor to high NO_3^- -N in runoff as opposed to animal waste.

Owens, L.B., W.M. Edwards, and R.W. Van Keuren. **1983.** Surface runoff quality comparisons between unimproved pasture and woodland. J. Environ. Qual. 12:518-522.**(NAEW #242).**

Abstract:

The influence of pasturing on surface runoff water quality was studied on a 26-ha, unimproved pasture watershed in east-central Ohio. Data were collected for 2 y with no cattle in the pasture and for 3 y with summer grazing by a 17-cow beef cattle herd. Because of springs and seep areas in the pasture, a small stream (accessible to the cattle) in the watershed flowed permanently. Samples of storm runoff were collected with a rotating vane sampler. The concentrations of most of the measured chemical parameters (NO_3-N, mineral N, organic N, total P, K, Ca, Mg, Na, S, Cl, HCO_3, total organic C, salts) in the storm discharge water were low and changed very little as a result of grazing. The weighted annual NO_3-N concentrations for the ungrazed period and grazed period were 0.5 and 0.7 mg/L, respectively, and the highest event concentrations were 1.2 and 3/8 mg/L, respectively.

A 17.7-ha, wooded watershed that contained no pastured areas and received no agricultural chemical inputs, had concentrations of chemical parameters in surface discharge that were greater than or equal to those from the unimproved pasture during the grazing period.

Nutrient transport during storm runoff from the unimproved pasture was greater during the 3-y period with summer grazing than during the 2-y, ungrazed period. This largely resulted from increased precipitation and subsequent increased surface runoff during the 3-y period. The transport levels from the pasture during the 3-y period were similar to or less than the transport levels from the wooded watershed during the same period. The increase in sediment transport from the pastured area was more than could be attributed solely to the increased surface runoff.

Owens, L.B., R.W. Van Keuren, and W.M. Edwards. **1983.** Hydrology and soil loss from a high-fertility, rotational pasture program. J. Environ. Qual. 12:341-346. **(NAEW #239).**

Abstract:

Five small watershed (0.25-3.1 ha) on sloping uplands in eastern Ohio were used to evaluate environmental effects of a beef management program of rotational summer grazing on one area, and rotational winter grazing/feeding with stored hay on another area. During the 5-y study, annual precipitation was 1080 mm, which was 8-15% greater than the long-term average. The surface runoff was measured by precalibrated H-flumes, and automatically sampled using Coshocton wheels. Surface runoff from watersheds with beef cattle management increased, compared with the long-term averages when hay was grown on the watersheds. Greater precipitation was the primary factor causing more runoff during the growing season (May – October), and the cattle management was a major contributing influence on the runoff increase during the dormant season (November – April). Maintenance of good vegetative cover on the study areas was a major factor in limiting annual average surface runoff to < 110 mm, which was a relatively small amount. The large runoff events, although a small percentage of the total number of events, produced most of the runoff volume. Soil loss from these pastures was minimal.

Owens, L.B., R.W. Van Keuren, and W.M. Edwards. **1983.** Nitrogen loss from a high-fertility, rotational pasture program. J. Environ. Qual. 12:346-350. **(NAEW #240).**

Abstract:

A beef cattle-pasturing system involving four rotationally grazed summer pastures (SG) and four pastures used rotationally for winter grazing/feeding (WGF) was studied on sloping upland watersheds in Ohio to determine effects of livestock management on N levels in water. Both summer and winter areas annually received 224 kg N/ha as NH_4NO_3 fertilizer. Surface runoff was collected automatically during runoff events, and subsurface flow was sampled from spring developments on a weekly basis. Although seasonal N concentration and transport in surface runoff tended to be greater in the area occupied by the cattle, N concentration and transport in runoff from the two areas were quite similar and did not significantly impair water quality, based on U.S. Public Health Standards. The NO_3-N concentration in the subsurface flow from the WGF area was higher than in the subsurface flow from the SG area. The NO_3-N concentration in the subsurface flow from both areas increased progressively throughout the study period, and reached levels as high as 18 mg/L. The subsurface flow provided the main pathway for N transport, with the surface transport being approximately 20 and 14% of the total N transport from the SG and WGF areas, respectively. The amount of sediment-N transported was very small because of low soil loss.

Owens, L.B., R.W. Van Keuren, and W.M. Edwards. **1982.** Environmental effects of a medium-fertility 12-month pasture program: I. Hydrology and soil loss. J. Environ. Qual.11:236-240.**(NAEW#231).**

Abstract:

Four small, sloping upland watersheds in Ohio (0.5 – 1.1 ha) were studied for 5 years to investigate hydrologic and soil erosion changes resulting from a beef cattle pasturing

program. The cattle grazed all four pastures rotationally during the summer (May – October) and were wintered on hay (November – April) on the same pasture each year. The long-term record for these pastures, which had been in meadow and light pasturing during the previous years, showed average annual surface runoff to be approximately 15 mm. During the 5 years of the grazing project, the three summer-grazing-only pastures showed a slight increase in surface runoff and a trace of soil loss. However, the winter-feeding/summer-grazing area showed a large increase in surface runoff (131 mm/year) and soil loss (1,355 kg/ha per year). Eighty-one percent of the soil loss occurred during the dormant season. Large runoff events, although a small percentage of the total number of events, produced most of the runoff volume and most of the soil loss. Water balance studies indicated that subsurface flow was relatively unchanged by the grazing program. The increase in surface runoff was offset by a decrease in the evapotranspiration.

Owens, L.B., R.W. Van Keuren, and W.M. Edwards. **1982.** Environmental effects of a medium-fertility 12-month pasture program: II. Nitrogen. J. Environ. Qual. 11:241-246. **(NAEW #232).**

Abstract:

Four small, medium fertility (56 kg/ha per year N) watersheds were used in a rotational summer-grazing and winter-feeding program to determine its effects on N levels in water. During a 5-year study on sloping uplands in Ohio, the concentrations on NO_3-N and NH_4-N were determined in precipitation, surface runoff, subsurface flow, and sediment. Although the NO_3-N concentration was generally higher in the surface runoff from the summer-grazing/winter-feeding area than from the summer-grazing-only areas, it usually resulted in no significant impairment of water quality, except on a few occasions when the NO_3-N concentration exceeded 10 mg/liter. The N transported in the subsurface flow from the summer-grazing only areas was approximately equal to that transported from the winter-feeding area and to the amount of N received in the precipitation. Both surface runoff transport and sediment transport of N were much greater in the winter-feeding area than in the summer-grazing-only areas because these latter areas yielded very little surface runoff and only a trace of soil loss. Reduction of vegetative cover and increased soil disturbance on the winter-feeding area resulted in increased surface runoff and soil erosion and thus more N was transported. Surface and subsurface losses of N from the winter-feeding area were nearly equal. A large percentage of N was transported by the large storms, which represented a small percentage of the total number of storms.

Van Keuren, R.W., J.L. McGuinness, and F.W. Chichester. **1979.** Hydrology and chemical quality of flow from small pastured watersheds: I. Hydrology. J. Environ. Qual.8:162-166.**(NAEW#217).**

Abstract:

Surface runoff, soil loss, and subsurface flow were measured from four rotationally grazed summer pastures. One of these pastures was also used as a winter-feeding area. Surface runoff volumes and peak rates from the three pastures used only for summer grazing were generally less as compared with values for earlier years when the fields were in meadow and light pasturing; however, runoff from the winter-feeding area was markedly increased. Both before and after the initiation of grazing, the areas used only for summer grazing had but a trace of soil loss. More soil was lost from the winter-feeding area, particularly during the dormant season. Water-balance studies indicated that during the growing season surface runoff and subsurface outflow were higher and evapotranspiration (ET) was less from the winter-feeding area than from areas summer-grazed only. During the dormant season, surface runoff was higher and subsurface outflow was lower from the winter-feeding area than from the summer-grazed areas, whereas ET was similar.

Chichester, F.W., R.W. Van Keuren, and J.L. McGuinness. **1979.** Hydrology and chemical quality of flow from small pastured watersheds: II. Chemical quality. J. Environ. Qual. 8:167-171. **(NAEW #218).**

Abstract:

A beef cattle-pasturing system involving four rotationally grazed summer pastures with winter-feeding on one pasture was studied on sloping upland watersheds in Ohio to determine its effect on chemical quality of water. The concentrations of chemicals in runoff from the pastures, which were summer-grazed only, increased relative to that of incoming precipitation but not enough to significantly impair water quality. No measurable sediment was lost from the pastures used only for summer grazing, allowing no chemical movement via that pathway. Much soil and plant-cover disturbance on the pasture used for winter-feeding, however, resulted in increased runoff, some surface erosion, and more chemical movement as compared with the pastures grazed only in summer. Considerably more chemicals moved in subsurface than in surface flow from the summer pastures while amounts of chemicals transported from the winter-feeding pasture were equally as great in surface runoff and subsurface flow. Watershed surface management was a key factor in determining the flow route of water in excess of that used for evapotranspiration and, hence, the pathways and amounts of chemical transport from the pastures.