INTEGRATED DAIRY WASTE MANAGEMENT, WATER QUALITY AND CROP UTILIZATION SYSTEM

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ABSTRACT

Livestock-crop farmers have very limited opportunities to efficiently utilize manure in an environmentally safe manner during the crop-growing season. In this study, dairy manure slurry was surface-applied over a two year period on reed canarygrass (*Phalaris arundinacea* L.), a perennial grass cover (living filter) at one location each in Iowa, Minnesota, and Wisconsin. Public and private (University and Cenex/Land O'Lakes) research and development capabilities were coupled to request and receive funding from a nationally-mandated program on water quality (United States Department of Agriculture). The primary objective was to study factors which impinge upon acceptable ground water quality using a living filter. Contrasting soil types were included to evaluate slurry application methods, timing, and rates; RC response to manure or fertilizer N; and herbage, soil, and soil solution N levels. We suggest our effort as an example of cooperation between private and public agriculturalists in seeking funding for research addressing important issues.

KEYWORDS

Manure, slurry, reed canarygrass, N cycling, biomass

INTRODUCTION

For livestock-crop agriculture, re-cycling of nutrients in an environment-friendly manner is a major undertaking for the producer, is of great concern to the public, and requires further study by scientists. In the upper Midwest, many dairy producers have limited capacity for slurry storage and find it necessary to empty slurry storage structures during the growing season.

We chose reed canarygrass (RC) (*Phalaris arundinacea* L.) because it is widely adapted and particularly tolerant to extreme conditions, for example, both wet and upland soils. RC spreads by underground stems (rhizomes) and forms a dense sod. Also, new, low-alkaloid cultivars offer increased promise for animal forage use. Marten et al. (1979) studied seven grass species and stated for RC "it stands alone as the species best suited for removing N from sewage effluent as well as the species most likely to yield maximum protein for use in ruminant rations". Also, it has been extensively tested for use as a biomass crop in Sweden, where it is known as their "energy grass" (Burvall, 1992).

Our objective was to determine if RC could effectively re-cycle large applications of dairy slurry N without abuse to the soil environment while maintaining a productive stand. Sub-objectives of the study included comparing rates, methods, and times of slurry application; stand persistence; and herbage utilization options.

METHODS

Planning meetings involving all participants were held to develop the research proposal, and annual review sessions were conducted during the duration of the trial.Pure stands of RC were established on Nicollet clay loam soils at Southern Research Station, Waseca, MN (1992) and Land O'Lakes Research Farm, Webster City, IA (1993); and on a Sparta loamy sand soil at the University of Wisconsin Lab Farm I, River Falls, WI (1993). All sites had four replications of the 11 slurry and 4 fertilizer N treatments in a randomized complete block design (Table 1). Treatments began in the year after establishment following second cutting and continued through two cycles over two years except fertilizer N treatments which began in the spring and ended after the first cut two years later.

An abbreviated summary of the types of data obtained in the study are presented in Table 2. Across all sites and years, three cuttings were made annually; soil cores to 1.5-m depth were taken each spring and autumn; and soil solution samples were taken in spring, after each cutting, and in autumn from specified treatments using ceramic suction cup samplers at 1.5-m depth. Stand evaluations were made at all locations in 1994. Separate RC stands treated with various N rates were evaluated for yield, nitrate, and alkaloid levels in adjacent trials. The bedding utilization study was done at the Iowa site.

DISCUSSION

A synopsis of the results from the field experiments are presented in the paper by Russelle et al., 1997. Other data are being summarized and will be reported later. In this paper, we limit discussion to the types of data generated and the value of the data in technology transfer to the producer and the public.

Blending of the research at the three distinct locations has allowed some important generalizations of the results to a broader group of dairy enterprises in the three states. In the past, with a more applied approach to problems, industry has relied heavily on demonstrations at farmers' sites, whereas university and experiment station research has often been site specific with a desire for very definitive data. Efficient and environmentally safe use of animal slurry is of increasing concern to producers, agribusiness interests, and the general public. There has been much concern and research activity in Europe for decades regarding manure slurry use. van der Meer et al. (1986,1987) pointed out that there are serious implications of excessive or improper slurry application and also great concern when slurry is not handled to the public's satisfaction. Without adequate data to illustrate that slurry use practices are environment-friendly, restrictions on how the producer can operate in the future could become very detrimental to agricultural activities.

With sharply rising costs of research limiting possibilities for academic researchers to work on many of the questions and problems related to agricultural practices, more unique means must be found to research critical issues and effectively disseminate results. We believe that this project illustrates an option for doing research so that the results are positioned for immediate application via the agribusiness community given their interest and involvement in planning and conducting the experiment.

The objectives of the USDA program on water quality (Schmidt et al., 1993) have been well served via this "living filter" research. We have shown that on the finer-textured soils the application of slurry N up to the maximum used in this trial optimizes DM yields without posing a threat to ground water supplies via leaching. On the coarse-textured soils where there is potential for leaching losses we have begun to identify the limits of slurry N application which both crop and soil can accommodate before endangering the ground water supply.

This study adds to several previous studies indicating the great potential of RC to produce well under diverse soil and microclimate conditions. Coupled with other research, our data also will be helpful in developing the possible use of this grass as an alternative energy biomass source. Using nutrients which need to be re-cycled to protect the soil and ground water for driving the productivity of high biomass-yielding grasses such as RC offers great opportunity for the future, an opportunity yet to be fully taken advantage of in the United States.

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Table 1

Field treatments showing application methods, rates and times of dairy manure slurry and fertilizer N treatments used at three sites (Iowa, Minnesota, and Wisconsin).

	Total annual rate		Application	
Trt.	$m^3\ ha^{-1}$	gal ac^{-1}	Method	Time
1*	0	0		
2*	93.7	10,000	Broadcast	After 2nd and 3rd cuttings
3*	187.4	20,000	Broadcast	After 2nd and 3rd cuttings
4*	281.1	30,000	Broadcast	After 2nd and 3rd cuttings
5*	374.8	40,000	Broadcast	After 2nd and 3rd cuttings
6	187.4	20,000	Broadcast	After 2nd cutting
7	187.4	20,000	Banded	After 2nd cutting
8	187.4	20,000	Banded	After 2nd and 3rd cuttings
9	187.4	20,000	Banded	Early spring and after 2nd cutting
10	187.4	20,000	Broadcast	Early spring and after 2nd cutting
11*	374.8	40,000	Broadcast	Early spring and after 2nd cuttings

Ammonium nitrate N treatments

	kg N ha^{-1}	lbs N ac^{-1}	Method	Time
12	112	100	Broadcast	Early spring
13	224	200	Broadcast	Early spring
14*	336	300	Broadcast	224 (200) early spr., 112 (100) after 1st cut
15*	448	400	Broadcast	224 (200) early spr., 224 (200) after 1st cut

* Porus suction cup lysimeters installed at a depth of 1.5 m in these treatments for water samples.

Table 2

Data generated from the dairy slurry study at three sites (Iowa, Minnesota, Wisconsin).

Water quality:

NO_3-N in water percolating through the profile at 1.5 m (5 feet).

Soil N:

Total N applied, NO_3-N at increments of 0.3 m (1 foot), from 0-1.5 m (0-5 feet).

Forage/ biomass:

DM yield, herbage NO_3-N, alkaloid concentration, bedding suitability, energy assessment.

Agronomic performance:

Percent ground cover, reflecting persistence following slurry applications and cutting treatments.