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RESTORING PRODUCTIVITY OF ERODED SOILS WITH MANURE APPLICATIONS

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INTRODUCTION

Erosion removes not only soil material but also organic matter and nutrients contained in the soil resulting in reduced productivity. This lost productivity is difficult to restore with just fertilization because changes in soil texture, structure, bulk density and water holding capacity cannot be replaced by fertilizer. Efforts to restore lost productivity require that some of these factors be restored through amending the soil with plant material or animal manures or through major changes in residue management. Greenhouse work by Er-Raji (1990) showed that adding animal manures gave greater improvement in productivity of an eroded soil than additions of combinations of fertilizer and crop residues.

Animal manures are readily available in western North Dakota but may be limited in quantity in a given year for application to eroded soils to improve soil productivity. This study was established to evaluate applications of long-term low rates of animal manure to eroded soils and to study the effects of these applications on soil productivity and changes in selected physical and chemical soil properties. This report presents data which has become analyzed and available since the 1997 report.

MATERIAL AND METHODS

The study was initiated in October of 1990 at the NDSU Dickinson Research and Extension Center Ranch Headquarters near Manning, North Dakota. The study included 4 treatments and 3 replications in a randomized complete block design. Treatments included: (1) no manure; (2) 10 T/A applied in the first year of the study only; (3)

10 T/A applied in the first and second years of the study; and (4) 10 T/A applied in all three years of the study which ended with the growing season of 1993. In October of 1993, a second treatment cycle was initiated with the same treatments but with the manure rate being increased to 20 T/A per application (Table 1). This resulted in annualized average rates of 0, 5, 10 or 15 T/A rates of manure. A third application cycle was initiated in October 1996, again using a 20 T/A manure application rate.

The soils at this site are classified as a complex of Cabba (loamy, mixed (calcareous), frigid, shallow Typic Ustorthents) and Chama (fine-silty, mixed Entic Haploborolls) soils formed from siltstone. These soils occupy a concave hilltop position with slopes of 1-6% with an easterly and southerly aspect. These soils have been severely eroded with long-term cultivation and an approximate 10 acre area directly to the west of this site was previously reseeded to grass due to the low productivity. Depth to siltstone is approximately 15 inches for the Cabba soils and 30 inches for the Chama soils.

Soils are being sampled to a depth of 4 feet, when possible, for available water and NO_3^--N content each spring and fall. Fertility is also being measured on the surface 6 inched each spring and fall. Bulk soil samples are being collected with a flat bottomed shovel to a depth of 2 inches for water stable aggregate and aggregate distribution analysis.

Cultural practices include the standard production practices used in the surrounding field. Tillage included moldboard plowing during the first treatment cycle and no-till during the second treatment cycle. However, due to a buildup of manure on the soil surface under no-till culture, a light tillage with a field cultivator was used prior to seeding in 1996.

The second cycle of manure applications was concluded in 1996 and a third cycle of manure applications using a 20 T/A manure rate was initiated in the fall of 1996 to be continued through the fall of 1999. A fertilizer treatment based on an average of the soil test values of 3 plots was added in the spring of 1997.

Data on soil profile sampling depth, and long-term changes in soil organic matter and soil nitrate-N was reported in the 1996 Annual Report (Cihacek, 1997). Data on changes in soil aggregation and aggregate stability and in soil test nutrient status was reported in the 1997 Annual Report (Cihacek, 1998). This report covers yield data for oat hay and silage corn grown during the 1997 and 1998 growing season. Due to the manure stimulating weed growth (mainly Russian thistle) yield data for weed biomass and total biomass were also collected.

RESULTS AND DISCUSSION

1997 yields

Dry matter yields for oat hay, weed biomass and total biomass are reported in Table 2. Manure numerically increased oat hay production for low and intermediate rates of manure (Treatments 2 and 3) but these values were not significantly different from the untreated control or fertilizer treatments.

Weed biomass showed a significant increase due to manure application with a slight linear but non-significant increase due to manure rate. This increased biomass translated to significant increases in total biomass for the manure treatments.

1998 Yields

Dry matter yields for silage corn, weed biomass and total biomass shown in Table 3. Corn dry matter yield was significantly increased by manure application and the fertilizer treatment also showed a slight increase over the untreated check treatment weed biomass showed no statistical differences between treatments. Total biomass yield also showed significantly higher values for the manure treatments. In this case, corn yield showed about 1000 lb/A increase for each manure treatment over the next lower rate.

Significant differences in weed biomass between the oat and corn crop are probably related to the shading effect of each crop's canopy. Oat is relatively short in stature and does not shade the ground and weeds like the taller corn does.

SUMMARY

The soils at this site were selected for their low productivity part of which is due to a shallow rooting depth for crops. In the past, crop yields have shown variable results due to manure application because of stimulation of weed growth and weed competition with the crop. As time has progressed, it appears that enough restoration of soil productivity has occurred that under favorable conditions, the crops are better able to compete with the weed population. Although no particular extra effort was expended on weed control in this plot area, the main problem weeds present (Russian thistle, pidgeon grass) are readily controlled by a variety of commercial herbicides available to growers. Also, in the corn crop, weeds can be controlled by mechanical cultivation. The situation that is presented here is a "worst production case scenario".

This work has shown that even on soils of limited productivity, soil productivity can be significantly improved by repeated applications of relatively low rates of manure over a period of years. This illustrates opportunities for growers to improve production in poorly producing areas of fields under certain conditions while utilizing a resource readily available on farms with a livestock operation.

Table 1. Application Times and Rates of manure Applications through 1998.

Treatment	Manure Rate	Times of Application	Total Application
	T/A	Month/year	T/A
1	0	No manure applied	0
2	10	10/90	50
	20	10/93, 10/96	
3	10	10/90, 10/91	100
	20	10/93, 10/94, 10/96, 10/97	
	10	10/90, 10/91, 10/92	

4	20	10/93, 10/94, 10/95, 10/96, 10/97	150
5	Fertilizer rate based on average of 3 plots sampled the previous fall, 4/97, 4/98		
[1]1998 manure applications were applied after the 1998 growing season and data beyond the 1998 growing season is not presented in this report.			

Table 2. 1997 dry matter yield of oat hay, weeds and total biomass.

Treatment	Dry matter yields [1/]		
	Oat	**Weeds**	**Total**
	lb/A		
1	2649 a	43 a	2691 a
2	3457 a	1485 b	4943 b
3	3386 a	1571 b	4958 b
4	2486 a	1650 b	4136 b
5	2486 a	53 a	2539 a

[1/] Values followed by the same letter are not significantly different at the $P \leq 0.05$ level.

Table 3. 1998 dry matter yield on corn silage, weeds and total biomass.			
Treatment	Dry matter yield		
	Corn	Weeds	Total
	lb/A		
1	1548 a	1405 a	2953 a
2	4119 bc	2743 a	6862 bc
3	5046 c	3540 a	8947 c
4	6039 c	2257 a	8297 c
5	1889 ab	2651 a	4540 ab
Values followed by the same letter are not significantly different at the $P \leq 0.05$ level.			

LITERATURE CITED

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