DEVELOPING A SYSTEM TO TRACK NITROGEN CYCLING ON PASTURE-BASED DAIRIES

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Introduction

Dairy farmers in the coastal areas of Oregon rely heavily on pastures for both grazing and silage production. As managers, they ideally should be matching the nutrients supplied in the form of manure to their forage crops for maximum productivity, without over applying any one particular nutrient.

Several studies have shown the timing of manure application is important in the uptake of nutrients from the soil. The more frequent applications increase nutrient removal and total crop yield. Perennial plants have also been shown more effective in removing nutrients when compared to annuals crops with similar requirements (Knezack and Miller, 1976; Hensler, 1970). Some of the more modern forage grasses have limited to no data on nutrient utilization. Moore and Gamroth (1995) showed some grass varieties in the Willamette Valley, Oregon, treated with 300lbs/N per acre in season removed over 400 lbs/N per acre in plant growth. In their study they also had a treatment of manure at 450-lbs/N per acre, with plant removal rates of nitrogen near 500 lbs/ N per acre. It was thought for years, forage grasses utilized only around 200 lbs up to 300 lbs /N acre for the highest producing grasses like orchard grasses.

Most animal waste management plans written for pastured based dairies use estimates for manure produced and yields removed to design the waste plan. Landowners theoretically have been required to apply nitrogen (N) in quantities equal to what they remove annually in a crop. As concerns for water quality have increased, so has the need to demonstrate that the nutrients applied are equal to what is removed. Over the past year, a trial was conducted to develop a realistic plan for dairymen to document nutrient application and removal on pasture based dairies. This project was designed to be a model for documenting manure applications and forage removal in pasture-based dairies.

Materials and Methods

An animal waste management plan and record keeping system was developed that allowed the land owner to make daily recordings and have running totals on nitrogen balance for each field. The customized nitrogen tracking spreadsheet was designed in Microsoft Excel. During the grazing season, the quantity of forage-removed was measured daily to track dry matter removed and estimate N removal rates. Standing forage height was recorded using a Farm Tracker electronic rising plate meter (Farm Works, Feilding, New Zealand) before and after grazing each pasture. The rising plate meter was calibrated by clipping, drying and weighing known areas in the field to determine standing dry matter (DM). Forage samples were analyzed for nitrogen content and these values were multiplied by DM harvest data to determined nitrogen per acre removed. All cuttings and grazing cycles were totaled for DM yields and nitrogen removed through grazing.

Soil samples (12”deep) were taken from all major fields from the cooperating dairy at the end of each growing season. These data where used to evaluate the effectiveness of nitrogen removal. Manure application equipment was calibrated and nutrient application rates were recorded by field. Manure applied by grazing animals was estimated using Natural Resource Conservation Service excretion values and adjusted for the number of hours a day the cows were in a particular paddock.

Results and Discussion

Dairymen have historically done an excellent job keeping track of essential information to manage the dairy cow. Everything from production information, genetic merit information, reproductive statistics, feed analysis, and various other information sources to make good management decisions about their cattle have been used. However, most do not have the same desire or see the need to have a detailed record keeping system to make management decisions about their cropland. This project was as much about the behavior and attitudes of dairymen as much as it was about waste management or managing cropland for optimal fertility.

The cooperating farm took this project very seriously. The dairyman took daily records and recorded them on the spreadsheet, giving them the daily totals of nitrogen balance for each field. Running totals by field were used early in the spring to confidently add some additional commercial fertilizer. Table 1 illustrates the total N applied, estimated N balance, yield and fall nitrate soil results for each field on the farm. In year one, dry matter yield ranged from 3.9 to 8.8 tons per acre/year. Fall soil nitrates showed ranging from 39 to 146 lbs/acre essentially leftover after the growing season. Soil nitrates in year one are considered high. It was theorized the commercial fertilizer applications were too late in the growing season to be properly utilized. Figure 1 illustrates the percentage of N applied throughout the year from liquid, solid or grazing cow manure, in addition to commercial N fertilization.

Table 2 illustrates the total N applied, estimated N balance, yield and fall nitrate soil results for each field on the farm in year two. This year yields ranged from 7.4 to 9.4 tons of dry matter per acre/year. This represents a 20.1% increase (1.45 tons/acre) in total dry matter production from the first year. This second year commercial N was applied earlier in the season to maximize the growing potential. Soil nitrate levels were appreciably lower in year two ranging from 18 to 84 lbs. of N per acre. Figure 2 illustrates the percentage of N applied throughout the year from liquid, solid or grazing cow manure, in addition to commercial N fertilization.

Conclusion

At the start of year one, the animal waste management plan written described spreading all manure evenly (approximately 276 lbs/N/acre). Yields were estimated to be 5.5 tons dry matter acre, with no commercial fertilizer added. By making informed decisions, the dairy altered their manure applications and added some commercial fertilizer. The change in management resulted in an increase of 20% more feed grown. After two years experience, the farm was milking 25 more cows than it had historically and saved on purchased hay costs during the second summer. Having this information to make decisions is just as important to them now as the information they have on their cows to make management decisions.

Documenting agronomic utilization of nitrogen application in grazing dairies is a challenge. Dairymen that conduct high intensity, short duration grazing are apt to be more successful because grass growth during the spring flush can be so significant it can complicate measurements. In addition, is appears essential to have daily running balances available to the

dairymen to make management decisions and document grazing or other pasture management successes.

Dairymen typically have a significant percentage of their total enterprise investment in cropland. It is impossible for them to make good decisions without good information. Changes in management on dairies like the ones illustrated in this project should go a long way to solving of our waste management problems in addition to making dairies more profitable.

References

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Knezak, B.D. and Robert Miller. (1976). Application of sludges and wastewaters on agriculture land. A planning and educational guide. Ohio Agriculture Research and Development Center. Research Bulletin 1090.

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Table 1. Nitrogen applied, estimated N balance, dry matter yield and fall $N0_3$ recorded by field for year 1

Field	N Applied[1]	Balance lbs/acre[2]	DM Yield[3]	Fall soil nitrates[4]
1	201	-132	7.1	83
2	316	-98	7.1	51
3	353	-70	7.4	73
4	383	-58	7.4	98
5	375	-93	7.8	146
6	436	-91	8.8	109
7	356	-85	7.4	111
8	379	-17	6.6	88
9	404	-55	7.7	145
10	357	-84	7.4	100
11	344	-115	7.7	98
12	407	-70	8	105
13	358	-137	8.3	81
14	355	-68	7.1	66
15	361	-134	8.3	75
16	347	-193	9	80
17	236	2	3.9	54
18	206	-70	4.6	39
19	277	-74	5.9	56

[1]Nitrogen applied is presented as lbs of N per acre by field

[2]Balance is the difference between Nitrogen applied and estimated removal per field

[3] Dry Matter yield estimated by measure grass height before and after grazing

[4]Soil nitrates taken at 12” at the end of the growing season (lbs/acre)

Table 2. Nitrogen applied, estimated N balance, dry matter yield and fall $N0_3$ recorded by field for year 2

Field	N Applied[1]	Balance Lbs/acre[2]	DM Yield[3]	Fall Soil nitrates[4]
1	421	-101	8.1	27
2	428	-58	9.4	52
3	593	-39	9.4	66
4	569	-91	8.3	84
5	568	-106	8.5	65
6	279	-62	7.4	68
7	530	-162	8.9	65
8	526	17	9.2	50
9	548	-5	9.2	40
10	419	-1	9	45
11	383	-130	9	48
12	514	-157	8.6	61
13	539	-26	8.8	59
14	445	-203	9	66
15	462	-195	8.8	26
16	476	-151	8.5	33
17	335	-160	8.3	27
18	449	-64	8.6	34
19	357	-87	7.4	18

[1]Nitrogen applied is presented as lbs of N per acre by field
[2]Balance is the difference between Nitrogen applied and estimated removal per field
[3] Dry Matter yield estimated by measure grass height before and after grazing
[4]Soil nitrates taken at 12” at the end of the growing season (lbs/acre)

Figure 1 - Total field inputs in year one

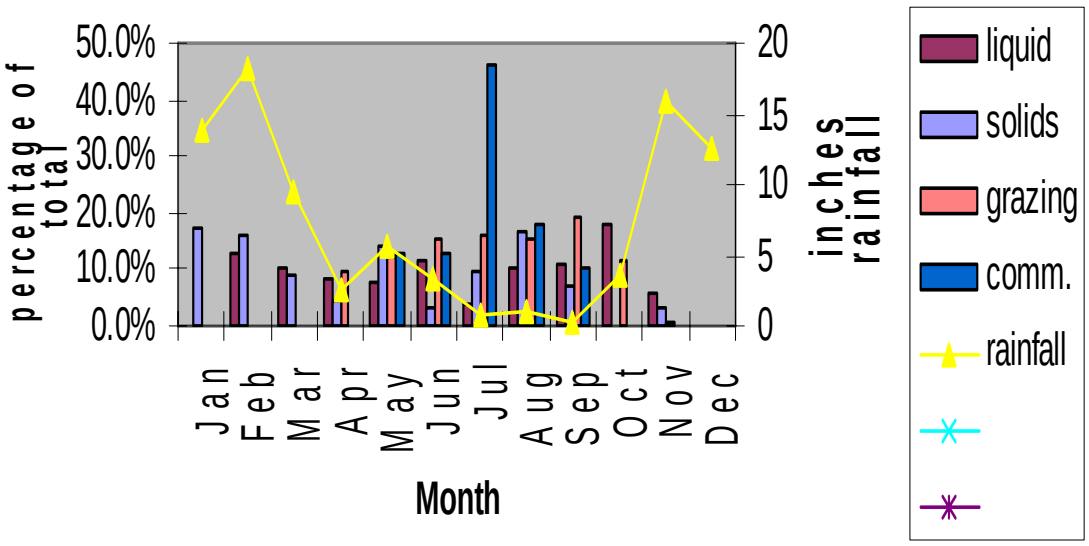

Figure 2 - Total field inputs in year two