



Effects of nutrient management and cropping strategies in a dual-crop forage production system of silage corn and perennial grass on nutritional quality and predicted milk production of dairy cattle

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Introduction

- A challenge of intensive dairy production is to match the nutrients of generated manure with crop requirements to minimize nutrient loss and optimize production and nutritional quality of farm feeds for milk production.
- The objectives of this study were to determine the effects of incrementally applied enhanced nutrient management, cropping practices, and advanced production technologies on nutrient composition and in vitro degradability of whole plant corn and perennial grass and the predicted milk production of dairy cattle.

Materials and Methods

Table 1. Farm management strategies

Item	F1 Conventional System	F2 Nutrient management	F3 Cropping strategies	F4 Advanced technologies
Corn				
Nutrients	Whole slurry broadcast + starter P fertilizer	Separated sludge, injected for P	Separated sludge, injected + spring slurry on relay crop	F3 + nitrification inhibitor (DCD)
Cropping	Late harvest corn	Late harvest corn	Early harvest corn + relay crop	F3 + irrigation
Grass				
Nutrients	Whole slurry broadcast	Separated liquid, band spreading	Separated liquid, band spreading	F3 + nitrification inhibitor (DCD)
Cropping	5 cuts	5 cuts	3 cuts	F3 + irrigation

Results

Table 2. Nutrient composition and in vitro degradation of whole plant corn, Italian ryegrass, and perennial grass (tall fescue) harvested in spring, summer, and fall under incrementally enhanced nutrient management, cropping practices, and advanced production technologies

Item	F1 Conventional system	F2 Nutrient management	F3 Cropping strategies	F4 Advanced technologies	P-value
Whole plant corn					
CP, % of DM	5.59 ^c	5.98 ^b	6.81 ^a	7.09 ^a	< 0.001
Starch, % of DM	32.7	32.7	32.2	30.7	0.72
NDF, % of DM	44.7	44.3	44.0	43.7	0.91
30-h IVNDFD, % of NDF	45.5	47.9	47.4	47.9	0.44
Italian ryegrass					
CP, % of DM	-	-	15.6 ^a	14.7 ^b	0.033
NDF, % of DM	-	-	46.0	45.7	0.52
30-h IVNDFD, % of NDF	-	-	83.2 ^a	81.4 ^b	0.021
Grass - spring harvest					
CP, % of DM	15.3 ^a	16.4 ^a	12.6 ^b	12.3 ^b	< 0.001
NDF, % of DM	58.7 ^b	57.0 ^c	61.1 ^a	61.6 ^a	< 0.001
30-h IVNDFD, % of NDF	63.6 ^a	64.5 ^a	49.1 ^b	47.6 ^b	< 0.001
Grass - summer harvest¹					
CP, % of DM	15.0 ^b	16.4 ^a	14.5 ^b	14.7 ^b	< 0.001
NDF, % of DM	49.0 ^b	49.6 ^b	54.2 ^a	54.6 ^a	< 0.001
30-h IVNDF, % of NDF	67.8 ^a	66.1 ^a	60.5 ^c	63.0 ^b	< 0.001
Grass - fall harvest¹					
CP, % of DM	17.9 ^b	19.0 ^a	18.0 ^b	17.9 ^b	0.037
NDF, % of DM	50.1	50.1	51.3	50.6	0.12
30-h IVNDF, % of NDF	72.1 ^a	72.4 ^a	68.0 ^b	68.7 ^b	< 0.001
Crop production ² , kg/h	15.4 ^b	15.7 ^b	16.1 ^b	17.6 ^a	< 0.001
Milk Production, kg/d	33.9	34.9	34.1	34.4	-

¹For F1 and F2, data for cuts 2 and 3 were combined for the summer harvest and data for cuts 4 and 5 were combined for the fall harvest for statistical comparison with F3 and F4 where grass was cut 3 times annually.

²Based on 50:50 corn to grass land allocation.

^{a-c}Means within a row with a different superscript differ ($P < 0.05$).

- Enhanced nutrient, cropping, and advanced management increased ($P < 0.05$) the CP concentration in corn compared to the conventional system while maintaining the starch concentration and in vitro fiber degradability.
- The advanced technologies which included a nitrification inhibitor (dicyandiamide, DCD) and irrigation reduced ($P < 0.05$) the CP concentration and fiber degradability of the relay crop, however, the fiber degradability remained high (> 81% of NDF).
- Decreasing the number of cuts of grass reduced ($P < 0.05$) the CP concentration in the spring harvest, increased ($P < 0.05$) the fiber concentration in spring and summer harvests, and reduced ($P < 0.05$) fiber degradability in all harvests.
- Crop production based on 50:50 corn to grass land allocation was either maintained or improved with enhanced management.
- Milk production predicted from the nutritional quality and representative proportions of forages in a total mixed ration using the Cornell Net Carbohydrate and Protein System was increased with enhanced management.

Conclusions

- The lower forage quality of grass cut 3 times compared to 5 times annually was offset by the improved quality of the corn and relay crop and higher crop production yield under enhanced field management of the dairy farm.