Proceedings of the 52nd National Conference of the Italian Society for Agronomy

La ricerca agronomica per la transizione verde

Galoppatoio reale – Reggia di Portici
University of Naples “Federico II”

25 - 27 September 2023

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Società Italiana di Agronomia (SIA)
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ISBN: 978-88-908499-7-8

Planning and Managing a Forage System to Constrain Nitrogen Surplus in Dairy Farms

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Introduction

The intensification of dairy farming systems has been accompanied by the development of an intensively fertilized corn-based system to the detriment of forage legume crops and other annual grasses, which are considered to be low producing crops and difficult to conserve as silage (Tabacco et al., 2018). Such a system relies on a high external input, with an increasing demand for nitrogen fertilizers to maintain the high dry matter (DM) yield of mono-cropped corn, and concerns have thus arisen about the environmental impact of such intensive forage systems on dairy farms. Tanaka et al. (2002) and Tabacco et al. (2018) developed the concept of dynamic forage/cropping systems that means growing more crops (both annual and perennial) in the forage system and re-designing crop rotations and intercropping to develop a more self-sufficient, integrated and closed-loop livestock and vegetal production system, using an agro-ecological and ethological approach. The aim of this study was to verify how planning and managing a forage system characterized by high N uptake capacity can maintain high dry matter (DM), crude protein (CP) and metabolizable energy (ME) yields, while reducing potential environmental impacts. We focused on evaluating how such an alternative cropping system, coupled with highly efficient forage conservation practices, can affect the nitrogen balance of a dairy farm operating in the Po plain in Italy.

Materials and Methods

The study was conducted over a 6-year period on a commercial dairy farms located in the Torino Province (Piedmont, Italy). The effects of the transition of the forage system management from a PRE (2017-2019) to a POST (2020-2022) situation were evaluated. Data covering herd composition, livestock production systems, livestock feed management, crop cultivation and management were collected through on-farm questionnaires and registered data available on the farms. All the data concerning farm inputs and farm outputs were obtained through the analysis of all the farm invoices. The nitrogen balance approach involved calculating the difference between the total imported nitrogen and that exported at the farm gate-scale. Results were analysed by means of a paired *t*-test.

Results

The proportion of crops and their utilization is reported in Figure 1a. From PRE to POST period the farm decreased the proportion of UAA for whole crop corn silage and increased that for high moisture ear. Winter cereals for grain were partially substituted by winter cereal for silage. In POST period the farm introduced in the cropping system alfalfa (about 16% of the UAA) and sorghum crops. The farm characteristics, nitrogen output, input and efficiency from PRE to POST situations are reported in Table 1. The farm increased the surface cultivated and milk production, resulting in higher kg milk/ha of UAA from PRE to POST situation. The change in the management of forage system resulted in higher N output and lower N input from PRE to POST situation. N output from milk and meat increased, whereas decreased from sold cereals. N input from mineral fertilizer decreased from PRE to POST situation, whereas increased the N input from biological fixation. The optimized planning and management of the forage system allowed to reduce N surplus per farm (- 36%) and per hectare (-44%), resulting in higher N efficiency from PRE to POST period (+31%). The N input per tonne of milk is reported in Figure 1b. From PRE to POST period the kg of N input per tonne of milk was reduced (31 vs. 21 kg N/t milk). This reduction was mainly due to a reduction of N input from fertilizer, and from purchased feeds.

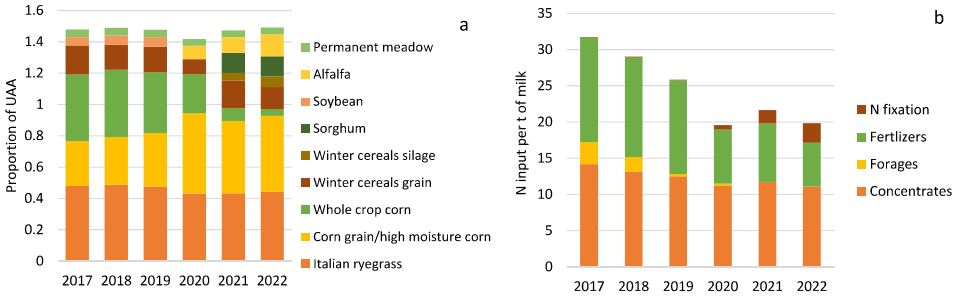

Figure 1. Proportion of crops and their utilization (a); and N input per t of milk (b) in a 6-year period on a commercial dairy farms located in the Torino Province (Piedmont, Italy).

Table 1. Farm characteristics, N output, input and efficiency from PRE to POST situations of forage system management

	PRE	POST	SE	*P*-value
Farm characteristic				
UAA (ha)	78	89	2.1	0.051
kg milk/ha UAA	15	17	0.4	0.013
N Output (kg)				
Total	16277	18165	393	0.046
Milk	6402	8075	345	0.002
Meat	667	1068	81	0.015
Crops	3208	1118	327	0.253
Slurry	6000	7904	416	0.135
N Input (kg)				
Total	35926	30671	1318	0.049
Concentrates	16172	16843	271	0.268
Forages	2952	0	600	0.107
Fertilizers	16649	10469	1396	0.004
Biological N fixation	153	3359	664	0.053
N Efficiency				
Surplus kg/ha	252	140	23	0.016
Efficiency (kg N out/kg N in)	0.45	0.59	0.03	0.005
kg N surplus per t milk	17	8	1.7	0.008

Conclusions

Acting on forage system management and introducing forage legumes in the crop rotation could enhance production efficiency and environmental quality in the more intensive forage systems adopted on dairy farms in the Po plain in Italy.

Literature

Tabacco E. et al. 2018. Tabacco, E., Comino, L., & Borreani, G. (2018). Production efficiency, costs and environmental impacts of conventional and dynamic forage systems for dairy farms in Italy. Eur. J. Agron., 99: 1-12.

Tanaka D.L et al. 2002. Dynamic cropping systems: An adaptable approach to crop production in the Great Plains. Agron. J., 94: 957–961.

Acknowledgment

This study was carried out within the Agritech National Research Center and received funding from the European Union Next-GenerationEU (PIANO NAZIONALE DI RIPRESA E RESILIENZA (PNRR) – MISSIONE 4 COMPONENTE 2, INVESTIMENTO 1.4 – D.D. 1032 17/06/2022, CN00000022).