NUTRIENT CYCLING FOR PASTURE FERTILIZATION MANAGEMENT OF DAIRY FARMS IN THE BASQUE COUNTRY (NORTHERN SPAIN)

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ABSTRACT

The implementation of the European Agricultural Policy implies a new orientation for the management of dairy farms and, as a result, of pasture fertilization. It is important to develop a new methodology for the calculation of fertilizer recommendations. In order to do this, a model based on P and K nutrient cycles has been used and a computer program has been developed to calculate these cycles and estimate the following parameters: potential pasture yield, yield at the different cuttings, efficiency of excreta recycling in the pasture and efficiency of grass utilization, all these parameters being necessary for the calculation of P and K cycles for pastures. The program developed has been proven to be solid enough and it is being used for giving pasture fertilizer recommendations.

KEYWORDS

Nutrient cycles, fertilization, phosphorous, potassium, management system

INTRODUCTION

In the European Union daily production systems are constrained by three factors: milk quotas, cost reduction and the maintenance of nutrient reserves in the soil avoiding any possible problems of agrarian contamination, that is, sustainable production systems have to be developed.

One of the most important factors in forage production is fertilization. Fertilizer application must be oriented toward obtaining the economic optimum which normally is far from the agronomic optimum. To obtain this economic optimum it is necessary to adjust the fertilization to the maintenance requirements of the different pasture management systems.

A methodology to calculate the P and K requirements of the pastures of the Basque Country was developed (Sinclair, 1992). This methodology requires the determination of a number of parameters of difficult quantification and the calculation of these parameters and the validation of the complete methodology are the objectives of the present study.

MATERIALS AND METHODS

To calculate the P and K nutrient cycles it is necessary to estimate the potential yield of the pasture, the yield removed by the cuttings, efficiency in excreta recycling and efficiency in herbage utilization (Fig. 1). Once these parameters have been estimated, the calculation of P and K requirements consists only in simple mathematical calculations. To validate the goodness of the system 30 pastures have been selected and fertilizer recommendations provided by the scheme. The recommended fertilization is applied to the pastures and soil P and K contents as well as nutrient ratios (N/P, N/K, and K/P) in white clover are determined to study if these parameters are approaching the adequate ones.

RESULTS AND DISCUSSION

To estimate pasture potential yield (t DM/ha) several parameters are taken into consideration. *Geographic situation*. In the Basque Country the climatic zone is the main factor that affects potential yield and so three zones with different productivity potentials were established: coastal zone, inner valleys and north of Alava (Rodriguez and Ascazibar, 1988). *Terrain quality.* It refers to soil texture and structure. To simplify the assessment of terrain quality so the farmers could provide this parameter the following division was proposed: good terrain, medium terrain, and bad terrain. To each one of the terrains was assigned a different level of production within the geographic area. *Pasture type.* Again a new subdivision of potential yield was performed according to the type of pasture: a) Permanent pastures, potential yield was estimated as a function of the productivity of the species present at the pasture, considering that some species like perennial ryegrass (*Lolium perenne*), Italian ryegrass (*Lolium multiflorum*), tall fescue (*Festuca pratensis*) and cocksfoot (*Dactylis glomerata*) are productive species while others like *Poa annua, Paspalum dilatatum, Holcus lanatus* and *Plantago lanceolata* are less productive (Amella, 1990). Thus, a pasture with a botanical composition with less than 25% of low productivity species is classified as “good”, with 25-50% “medium” and with more than 50% “bad”, b) Temporary pastures, Seeded species, in particular grasses, are the parameters affecting potential productivity.

Yield removed by cutting (t DM/ha). To determine the yield removed by cutting three different management systems have been taken into account: grazing, cut or mixed. This estimation has been done specifically for each geographic zone, the number and the time of the year of the cuts.

Efficiency of excreta recycling. While grazing, excreta distribution by animals is heterogeneous. For a pasture at the most convenient conditions (flat terrain, no drinking-througs and no trees/shrubs in the pasture) efficiency is taken as 90% and at the most unfavourable (steep slope, stream and many trees) as 70%.

Efficiency in grass utilization. In case of poor management at the cutting or a low intensity grazing, grass utilization efficiency decreases. This parameter is estimated only by means of grass height after utilization considering three ranges: a) <4 cm with 90% efficiency, b) 4-8 cm with 85% efficiency, and c) >8 cm with 80% efficiency.

Adjustment of fertilization levels taking into account soil analysis. The objective of maintenance fertilization is to replace nutrient losses and to maintain the adequate level of soil nutrients to obtain an optimum growth of the grass. If the level of soil nutrients is higher than the one considered as adequate (24 mg P/kg and 150 mg K/kg) it requires less fertilizer than the calculated maintenance fertilization. To the contrary, if soil P and K levels are less than adequate, a higher amount of fertilizer will be needed to increase soil levels and replace losses. In the fertilization scheme, once we have obtained the maintenance fertilization, the soil P and K levels are used to adjust the amount of fertilizer.

Validation. From former studies at the Basque Country P and K soil contents of 24 and 150 mg/kg, respectively, are considered as adequate. Besides, optimum nutrient ratios in white clover have been calculated (Rodriguez et al., 1993) giving these values: N/P=11.5, N/K=1.9 and K/P=5.9. In Table 1 are shown the values of these parameters for the 30 pastures under study corresponding to years 1992, 1993 and 1994. Soil P values have remained very constant showing no clear effect of the fertilization. However, soil K values decreased indicating a positive effect of the fertilizer recommendation. With regard to the nutrient ratios in white clover, the N/P and N/K ratios approach the optimum value in 1993 and 1994, and in 1993 the same occurs for the K/P ratio, but in 1994 this ratio gets away from the optimum value. The evolution of soil P and K contents, and the N, P and K ratios in white clover suggest that the fertilization scheme described based in the nutrient cycles works well for obtaining fertilizer recommendations in pastures of the Basque Country.

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Table 1
Soil P and K (mg/kg) and ratios for N, P and K concentrations in white clover for the three years of study

	Soil		White clover		
	P	K	N/P	N/K	K/P
1992	37.4(17.7)	213(84)	13.01(1.5)	2.20(0.5)	6.21(1.5)
1993	34.5(19.9)	191(70)	12.16(1.6)	2.20(0.4)	5.65(1.1)
1994	35.3(18.2)	195(84)	11.91(1.4)	1.89(0.4)	6.49(1.1)

Values in parentheses are the standard deviation of the mean

Figure 1
Nutrient cycle for a pasture