Nutrient management on Galician dairy farms

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Abstract

Soil fertility was studied in 687 plots of 103 intensive dairy farms from Galicia (Northwest Spain). The average characteristics of these farms are 78.8 LSU (Live Stock Units), 8,198 L of milk by cow and year and an stocking rate of 2.8 LSU ha^{-1}. Average soil test values of P and K were very high with of 50.9 mg kg^{-1} and 184.6 mg kg^{-1} for phosphorus and potassium, respectively. The average pH (water) was low (5.6), and the percent of soil acidity (Al^{3+} + H^{+}) was high (20.3 % of the CEC). In 41% of the plots, the application of P was unnecessary, and in 29% of the plots it was unnecessary the application of K. The percent of soil acidity was higher than 10 in the 63% of plots. Picked out the 427 plots that had P and K soil test higher that maintenance level, in the 55 % of these plots, the percent of soil acidity was higher than 10, showing that regardless of intensive use of mineral fertilisers, the use of lime is poor. A good technical advising on nutrient management would be necessary.

Keywords: soil analysis, phosphorus, potassium, lime, slurry, fertilizer recommendations.

Introduction

Dairy farming is the first source of jobs and incomes in many rural areas in Galicia (INE, 2005). There were 16308 dairy farms in October of 2005, that represent 53% of the total Spanish dairy farms and that have 40,5 % of the total Spain milk quota (FEGA, 2005).
The change from grazing systems to zero grazing, with high stoking rates and high levels of milk production was necessary to increase their farm income due to the scarcity and the high price of the land and the market competitiveness. In these types of farms many nutrients come into the farm as purchase feeds, an only part of them are exported as milk, with about 75 % of nitrogen and phosphorus remaining in the dairy slurry (Novoa *et al.*, 2005). Fertilizer recommendations generally don't take into account organic fertilization, and thus mineral fertilizer is normally applied in excess increasing the levels of soil phosphorus and potassium.

Materials and methods

Technical advisers of PROGANDO S.L (Galician animal nutrition company), selected 103 farms and supplied soil samples to CIAM, as well as farm and plot information. Records of mineral and organic fertiliser applied were registered for every plot. Some characteristics of this selected 03 dairy farms, like total LSU (Livestock Units) and SAU (total agricultural area), annual milk yield per cow, and kg of concentrates by litre of milk were registered. (Table 1). Soil pH (water), percent of soil acidity expressed as ((Al^{3+}+ H^{+}) *CEC^{-1} * 100) (Mombiela and Mateo, 1984), phosphorus (Olsen) and potassium (ammonium nitrate) levels, were determined in 687 plots of the 103 intensive dairy farms. Records of mineral and organic fertilizer applied the last year were registered for every plot.

Table 1. Some characteristics of the dairy farms

	Minimum	Maximum	Mean
Agricultural area (ha)	5	140	27.7
Livestock units (LSU)	15	350	78.8
Milk yield (L cow^{-1} yr^{-1})	5950	10000	8197
Stocking rate (LSU ha^{-1})	1.5	5	2.8
Concentrate (kg L^{-1})	0.3	0.5	0.4

Results and discussion

Phosphorus and potassium: Soil tests show that soil P and K, levels are very high (Table 2), with average values of 50.9 and 184.6 mg kg^{-1}, respectively. Considering that recommended maintenance values in soils are 25 and 100 mg kg^{-1} for P and K, respectively, 74 and 80 % of plots had soil test values higher than the maintenance levels for P and K respectively, and 69 % of plots had higher values than the maintenance simultaneously for P as for K.

Table 2. Soil analysis and fertilisation of dairy plots.

	N	Minimum	Maximum	Mean	Std. Deviation
Soil pH	687	4.3	7.2	5.6	0.4
Soil acidity (%)	667	0	88	20,3	17
Soil P (ppm)	687	2	274	51	36
Soil K (ppm)	687	31	1044	185	104
P_2O_5 (kg ha^{-1} yr^{-1})	539	0	144	70,4	32
K_2O (kg ha^{-1} yr^{-1})	539	0	150	49	38
Slurry (m^3 ha^{-1})	253	20	100	41	12

We suggest, as good management practise, that plots with soil fertility levels higher than the recommended, the slurry produced by 2.5 LSU ha^{-1} is enough to maintain soil test levels and obtain the optimum forage yields and in those cases, do not need any mineral fertilizer applied. In the plots that we had complete information about soil analysis, farm stocking rate and mineral fertilizer applied (458 plots of 687), it was found that in the 41% (Figure 1) of those mineral P was applied unnecessarily. In 29% of those plots, mineral K, was also applied unnecessarily, because the soil test values were higher than maintenance levels.

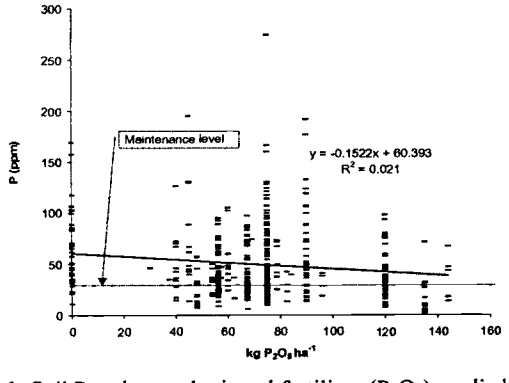

Figure 1. Soil P and annual mineral fertilizer (P_2O_5) applied in 458 plots.

In these cases the purchase of mineral fertiliser was unnecessary, showing a deficient nutrient management that leads to accumulation of P and K in soil with risks of leaching (Heckrath *et al.*, 1995).
Soil acidity: Soil tests (Table 1) show that average pH is low (5.6), and that average percent of soil acidity is high (20.3). Soil acidity may be a limiting factor for forage production because Al^{+++} is toxic for plants (Kamprath, 1970). In Galician soils, a maximum of 10 % soil acidity is recommended to obtain optimum yields (Mombiela and Mateo, 1984).
Percentage of soil acidity was over 10 in 435 of 687 plots (63%) and in 427 of those plots, soil P and K levels were higher that those recommended for maintenance. In 55 % of those plots, the percentage of soil acidity was over 10, showing that regardless the intensive use of mineral fertiliser in these farms, the use of lime is poor. High level of aluminium in soil causes poor root growth (Adams and Moore, 1983) and therefore, even if soil fertility is high, the assimilation of nutrients can be deficient.

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Conclusions

Intensive dairy farms in Galicia show accumulation of P and K in the soil. Nevertheless, P and K fertilization were applied unnecessarily in 41% and 29 % of plots, respectively. Farmers need to improve their management and be confident of the slurry fertilizing value, because the high stoking rate (2.8 LSU ha-1) and the high use of concentrates (0.4 kg L^{-1} of milk), allow enough P and K to be recycled on farm forage crops and obtain good yields. Soil acidity was high in 63% of plots probably due to a deficient liming, therefore farmers should increase the use of lime and reduce the applications of mineral P and K. A good nutrient management would allow saving money while reducing the risk of pollution.

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