ESTIMATION OF NUTRIENT VALUE OF SLURRY IN DAIRY FARMS IN GALICIA FROM THE DENSITY AND ELECTRICAL CONDUCTIVITY

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In Galicia, the primary milk production region of Spain, feeding dairy cows is based on concentrates and own-grown crops (maize and grass silage). The own slurry produced in the farms is used in the fertilization of the crops and generally the farmer doesn´t know the nutrient value of this slurry. Quick methods for estimating the composition of slurry from physical-chemical parameters such as electrical conductivity and density allow in situ estimation of nutrients by the technicians who advise these farms and therefore immediate adjustment of slurry doses, with subsequent environmental and economic benefits. Good correlations between electrical conductivity and total and ammoniacal nitrogen were found in cattle slurries (Provolo and Martínez Suller, 2006; Martínez Suller et al., 2010) although some authors only found good correlations with ammoniacal nitrogen (Mangado et al., 2006; Parera i Pous et al., 2010), reasonable correlations with potassium (Provolo and Martínez Suller, 2006; Parera i Pous et al., 2010) and low correlations with phosphorus (Provolo and Martínez Suller, 2006; Parera i Pous et al., 2010). Good correlations between dry matter and nitrogen total and phosphorus and low correlations with potassium were found (Martínez Suller et al., 2010). Dry matter is highly correlated with density that is a direct and quick measurement. So Mangado et al. (2006) found a good correlation between phosphorus and density. The aim of this study was to obtain equations linking direct readings of physicochemical parameters such as density and electrical conductivity with the fertilizer value of slurries to estimate reliably the nutrient value of slurry generated in Galician intensive dairy farms.

Materials and Methods

Thirty-eight samples of cattle slurry generated in different dairy farms were analyzed. Slurry dry matter (DM) was determined after 24 h of oven-drying samples at 105ºC. Analysis of N, P and K was determinated in fresh samples. Fresh samples were previously digested with sulphuric acid and hydrogen peroxide. Total N was analyzed by a colorimetric method using a continuous flow analyzer. Slurry K content was determined by atomic absorption spectroscopy. Total P was determined by a UV-vis spectrophotometer. Density was measured directly in the slurry, applying it to a measuring cylinder, stirring, introducins a hydrometer and taking measurement at 5 minutes when stabilized. Electrical conductivity was measured with a conductivity meter (Crison) equipped with a titanium electrode that was inserted directly into the slurry or into diluted slurry with distilled water in the ratio of 1:9 to prevent electrical and ionic interactions between the ions. Correlations between nutrient value of slurry: Kg of N, Kg of P2O5 and Kg of K2O per cubic meter with density (D) and electrical conductivity (EC) were calculated. After these correlations, simple and multiple regressions were done with these variables. The data were analyzed using the SPSS statistical package.

Results and Discussion

Analyzed slurries had an average chemical compositon of 7.67% of dry matter, 35.97 g•kg-1 of N, 6.52 g•kg-1 of P y 32.46 g•kg-1 of K. Correlations between nutrient value of slurry and electrical conductivity (Table 1) are reasonable for potassium and low for phosphorus, in agreement with other authors (Provolo and Martínez Suller, 2006; Parera i Pous et al., 2010). Correlations are somewhat low for nitrogen but higher that those found by Parera i Pous et al. (2010). Correlations were better for electrical conductivity measured in diluted slurry with distilled water in the ratio of 1:9 (ECdil) than for electrical conductivity measured directly (EC), so that the first was taken to obtain the regression equations. Correlations between nutrient value of slurry and density (Table 1) are good for phosphorus, in agreement with other authors (Mangado et al., 2006) and somewhat low for nitrogen and potassium. The best regression equations obtained are displayed in Table 2. Phosphorus value of slurry showed a good simple regression (R2 0.82, P< 0.001) in relation to the density. Simple regression equations obtained for nitrogen and potassium value with electrical conductivity were not so good. Multiple regression equations that considered as variables D and ECdil significantly improved prediction of nitrogen and potassium and lightly prediction of phosphorus.

Table 1. Pearson correlations between parameters.

	EC $mS{\cdot}cm^{-1}$	EC_{dil}(1:9) $mS{\cdot}cm^{-1}$	D ($kg{\bullet}m^{-3}$)	N ($kg{\bullet}m^{-3}$)	P_2O_5 ($kg{\bullet}m^{-3}$)
EC(1:9)	0.93***				
D	0.26	0.35*			
N	0.65***	0.75***	0.70***		
P_2O_5	0.42**	0.56**	0.90***	0.89***	
K_2O	0.69***	0.79***	0.53**	0.81***	0.63***

*** P<0.001; ** P<0.01; *** P<0.05

Table 2. Simple and multiple regression equations.

$Kg{\cdot}m^{-3}$	Equation	Coefficient of determination
	Simple regression equations	
N	$1.31EC_{dil}+0.63$	0.57***
P_2O_5	$1.97D-1.03$	0.82***
K_2O	$1.73EC_{dil}-0.11$	0.63***
	Multiple regresión equations	
N	$1.03EC_{dil}+4.12D-3.38$	0.81***
P_2O_5	$1.75D+0.25EC_{dil}-1.23$	0.88***
K_2O	$1.51EC_{dil}+6.00D-6.13$	0.73***

*** P<0.001

Conclusions

In this work was proved that in Galician Dairy farms is appropriated to use physicochemical parameters such as density and electrical conductivity to estimate the fertilizer value of slurries. Good regression equations between nitrogen, phosphorus and potassium value with the combined measure of both parameters were obtained. The implementation of these quick measurements in situ and the application of obtained equations will allow farmers immediate adjustment of the dose of slurry applied to silage crops.

Mangado J, Sanz A, Soret B 2006. Navarra Agraria 159: 35-42.

Martínez Suller L, et al. Irish J. Agric. Food Res. 49:93-97.

Parera i Pous, J Canut Torrijos, N; Domingo Olivé, F; Mallol Nabot, C 2010. Tierras de Castilla y León 174: 74-81.

Provolo G, Martínez Suller L 2006. Biores. Technol. 98: 3235-3242.

FIRST 20 YEARS OF DNDC: MODEL EVOLUTION AND GRAMP

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The DNDC (DeNitrification and DeComposition) model was first developed by Li et al. (1992) as a rain event-driven process-orientated simulation model for nitrous oxide, carbon dioxide and nitrogen gas emissions from the agricultural soils in the U.S. Over the last 20 years, the model has been modified and adapted by various research groups around the world to suit specific purposes and circumstances.

The Global Research Alliance Modelling Platform (GRAMP) is a UK-led initiative for the establishment of a purposeful and credible web-based platform initially aimed at users of the DNDC model. With the aim of improving the predictions of soil C and N cycling in the context of climate change the objectives of GRAMP are to: 1) to document the existing versions of the DNDC model; 2) to create a family tree of the individual DNDC versions; 3) to provide information on model use and development; and 4) to identify strengths, weaknesses and potential improvements for the model.

Materials and Methods

At present limited documentation exists on the differences between successive updates for each of the DNDC model versions. Consequently, users are often unaware of more appropriate versions of the model for their purposes. To rectify this GRAMP has created a database of DNDC model versions and constructed a "family tree". Versions of DNDC were found through a combination of literature searches, web searches and input from the DNDC user-community.

The published literature was reviewed to identify how different modellers applied the DNDC model and the techniques used for model calibration. A range of statistical indicators were also used to compare the performance of different versions of DNDC. Further information on important changes to the model was also obtained as part of a survey distributed to *c.* 1500 model users around the globe. Information gathered included data on validation practices and datasets and records of changes made to individual versions of the model

Results and discussion

Through GRAMP, 17 different versions of the DNDC model have been identified and their history documented. Figure 1 is a schematic diagram of the model versions and how they relate to each other and the early versions of DNDC.

As part of GRAMP over 250 publications involving modelling with the 17 DNDC model versions were identified (Figure 2). In addition to the GRAMP team, the 98 survey respondents identified many strengths and weaknesses of the DNDC model versions which in addition to obstacles to process model uptake and recommendations for addressing the issues arising form the basis of a discussion document.

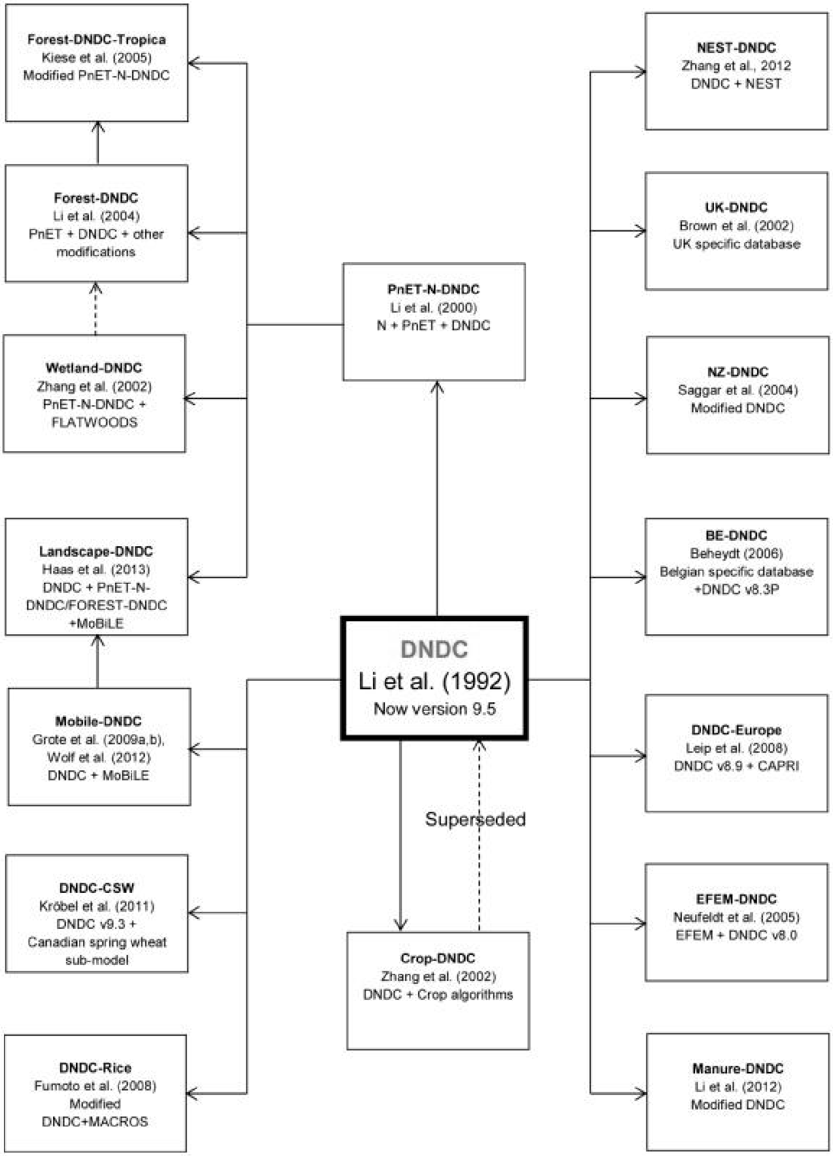
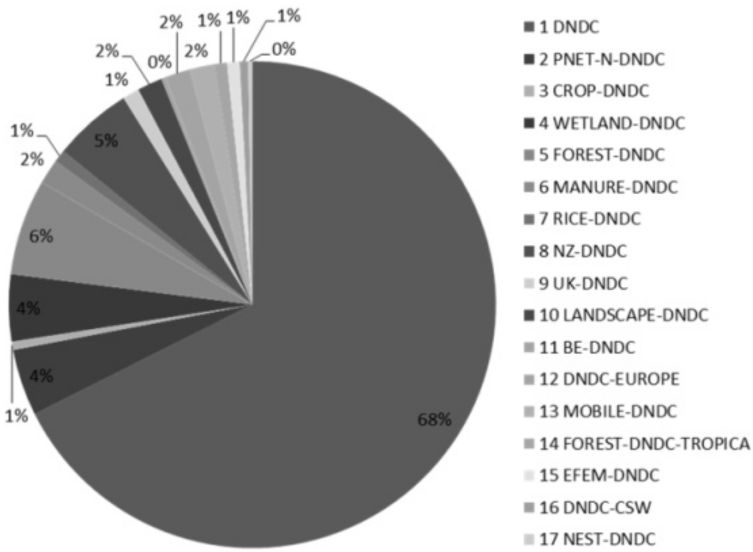


Figure 1. Schematic diagram of the DNDC extended family.



Conclusions

Throughout its 20 year history, the DNDC model has undergone many changes and its on-going value to the scientific community is reflected in the range of versions in current use, the number of current users, and an extensive published literature. However, in common with all biogeochemical process models, the DNDC model has both strengths and weaknesses. The GRAMP project has much to offer to the DNDC user community in terms of promoting the use of DNDC and addressing the deficiencies in the present arrangements for the model's stewardship.

Acknowledgement

The authors would like to thank DEFRA for funding this study.

Li, C. Frolking, S. & Frolking, T.A. 1992. J. of Geophysic. Res., 97, 9759-9776.