PoS2-35

Development of a Multi-Variate Model for matching Plant Nitrogen Requirements with Supply for reducing Losses in Farm Systems

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Abstract: Dairy farms are under pressure to increase productivity while reducing environmental impacts. Effective fertiliser management practices are critical to achieve this. Determination of optimum nitrogen (N) fertilisation rates which maximise pasture growth and minimise N losses is challenging due to variability in plant requirements and likely near-future supply of N by the soil. Remote sensing can be used for mapping N nutrition status of plants and to rapidly assess the spatial variability within a field. An algorithm is, however, lacking which relates the N status of the plants to the expected yield response to additions of N.

A simulation study was carried out using the APSIM model to develop an algorithm for determining N fertilisation rate for a target percentage of the maximum achievable yield based on the pasture N concentration. The algorithm, a three dimensional surface response function, was based on the Mitscherlich yield response function:
$Y=Y_{max}- (Y_{max}-Y_0) \exp (-\beta N_r)$ [1]

where Y is the targeted dry matter yield (kg/ha), Y_{max} is the maximum or potential yield, N_r is the rate of N applied (kg/ha), Y_0 is the yield when no N is applied, and β is an 'activity' coefficient which is a measure of the availability of the applied nutrient to the crop. The maximum yield was assumed to be independent on the initial pasture N content (N_{cont}), while both Y_0 and β were found to be dependent on it.

The amount of fertiliser required at any pasture N content (N_r,N_{cont}) can then be calculated as:
$N_r,N_{cont}=\ln ((Y_{max}-Y))/(Y_{max}-Y0,N_{cont})) /\beta N_{cont}$ [2]

The algorithm was then used for guiding fertilisation rates for a hypothetical dairy farm, where its performance for increasing pasture yield with more efficient N use was tested, including N losses from fertiliser and urinary N deposited during grazing.

APSIM simulations were done for an irrigated pasture under rotational grazing, in the Canterbury region of New Zealand. To simulate N leaching from fertilisers and urine patches, simulations were run in parallel with and without urinary N depositions and the outputs were aggregated based on the observations that urinary N return covers 2-5% of the paddock area during a grazing event. The developed algorithm was used to determine monthly required N fertilisation rates targeting 90% of the potential yield. Assessment of pasture yield and leaching from fertiliser indicated a large reduction in N losses when N fertilisation rates were controlled by the algorithm. However, the reduction in leaching losses was much smaller when urine patches were taken into account.

Before the approach can be used to help adjust fertiliser management practices further analysis, under different environmental conditions and validation is required.

Keywords: APSIM Modelling, Optimum N Fertilization Rate, Pasture N Content, Ryegrass Pasture, Three Dimensional Surface Response Function

PoS2-36

Assessing Sustainability in Maize-Based Farms Undergoing Rapid Transition: a Case-Study in Northern Laos

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Abstract: In Northern Laos, many farmers have switched within 15 years from a manual slash and burn system of long fallow and upland rice to a hybrid maize mono-cropping system with moto-mechanized plowing and chemical input use. This transition brought higher incomes to a majority of farmers, but sustainability of this system is henceforth challenged. This study identifies sustainability criteria that have to be considered to assess current cropping systems and alternatives. Our method considers 2 scales of analysis: 1. FARM level analysis identifies the diversity of farming systems and sustainability criteria from the farmer's perspective. It is based on 120 surveys in 6 villages (factorial analysis for mixed data and hierarchical clustering), focus groups discussions and card games (20 farmers in 4 villages). 2. FIELD level analysis identifies the factors explaining the variability of maize performances and impacts. It is based on surveys, 2-year monitoring of 38 plots, and a participatory game on tactical choices at cropping system scale (3 villages, groups of 20 farmers).

At the farm level, we identified four farm types: the first type is composed of poor farmers, the second type is also poor farmers but with more land; farmers from the third type focus on rice production, whereas farmers from the fourth type focus on upland crops (maize, livestock, with higher total income). Sustainability criteria identified by farmers include: self-sufficiency in rice, farm transmissibility, farm income, diversity of activities to reduce risks, workload, and cash requirement for activities. Field level monitoring showed that poor performances of maize are explained by the difficulties to manage the first stages of the cropping cycle: poor soil tillage quality due to inadequate machinery leading to a heterogeneous stand with low density, erosion risks due to bare soil, strong weed pressure and consequently increasing use of herbicide. This diagnosis stage proved to be very useful as the main findings are different from the common view about the cause of maize declining yield i.e. soil nutrient depletion under continuous mono-cropping. At the cropping system level, sustainability criteria (both determined by farmers and field monitoring) are: land and labor productivity, gross margin, resources use efficiency (nitrogen, water, light), erosion and herbicide risks, technical complexity, storage duration of harvest, and soil fertility. This field level analysis led to add two criteria at farm level: fertility transfer and farmers' health risk in relation with exposure to herbicide.

We derived indicators from this set of criteria to identify potential responses to sustainability issues that arose from the rapid evolution of cropping systems. Our study also prompted us to assume that maize is not a crop to be absolutely eliminated and could probably remain a sustainable option under more effective management.

Keywords: Sustainability, Multicriteria Assessment, Indicators, Maize

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