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Optimising sugarcane fertiliser rates for modelling water quality in the Wet Tropics

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Abstract: Accurately simulating dissolved inorganic nitrogen (DIN) flows from sugarcane farming into the Great Barrier Reef (GBR) requires models that capture both current management practices and potential changes to those practices. This study outlines an approach to calibrate nitrogen inputs using a Nitrogen Loss Risk Index (NiLRI) to assess water quality risks from fertiliser use.

Sugarcane farming in the GBR catchment is a major source of DIN, posing a significant threat to reef health. The Reef 2050 Water Quality Improvement Plan aims to reduce DIN loads by 60% by 2025, with 90% of agricultural land adopting best management practices by 2050. These practices include optimising nitrogen fertiliser use, retaining trash blankets, and managing soil amendments like mill mud, a sugar milling by-product rich in organic nitrogen.

The Paddock to Reef (P2R) program integrates monitoring and modelling to evaluate water quality improvements. It uses the Agricultural Production Systems Simulator (APSIM) to model sugarcane systems and assess the long-term impacts of sugarcane management practices on DIN loads. APSIM incorporates factors like soil, climate, and agronomic practices, enabling detailed simulations of nitrogen dynamics.

A Nitrogen Loss Risk Index (NiLRI) has been proposed[1] to better quantify water quality risks associated with farming practices. This metric, developed within the P2R framework, is the ratio of N-fertiliser applied to crops and the cane yield achieved, and it evaluates practices based on their potential to reduce DIN losses, whilst balancing agricultural productivity.

To incorporate this metric into the APSIM sugarcane modelling, fertiliser inputs needed to be aligned with the output cane yield along eight bands corresponding to NiLRIs ranging from 0.6 to 2.0. The industry led six-easy-steps (6ES) nutrient management guidelines and farm management surveys were used to guide yield and fertiliser ranges used in the field. Since various inputs contribute to the yield of a particular simulation, an empirical approach was developed to determine accurate fertiliser inputs. Model simulations applying various fertiliser amounts spanning a range of NiLRIs across a set of relevant soil types, climate, soil managements, mill mud applications, sowing dates and start years were run and polynomial regression was used to fit calibration curves to enable accurate estimation of fertiliser inputs.

When the calibrations were applied to unique simulations covering 95% of the Wet Tropics sub-catchments spanning a range of soil types, climate zones, soil and mill mud management combinations, good agreement was found between intended and simulated NiLRIs. Both yields and fertiliser rates aligned with ranges in the 6ES guidelines and management practice farm survey data. This enabled simulation and determination of DIN loads along defined NiLRIs providing insight into the impact of fertiliser application scenarios on water quality in the GBR catchment.

REFERENCES

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