Prioritising investment in diverse horticulture cropping systems for water quality outcomes using APSIM Next Gen

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Abstract: Horticulture accounts for only 0.2% (101,000 ha) of the Great Barrier Reef (GBR) catchment, yet evidence suggests that disproportionate quantities of nitrogen and soil move off paddock into waterways and the GBR lagoon. However, the overall impact of horticultural cropping on water quality remains undetermined due to the diversity of crops, complexity of management practices and a lack of measured data. Nevertheless, existing data and best available knowledge can be leveraged to simulate these systems to prioritise future investments aimed at improving water quality.

In this study, typical farming system scenarios consisting of representative weather, dominant soil types and typical management were set up *in silico* for each crop and losses of dissolved inorganic nitrogen (DIN) in runoff (Vilas et al. 2022) and drainage, as well as soil loss were simulated in APSIM Next Generation (Holzworth et al. 2018). Spatial data was used to determine crop distribution and dominant soils, while management inputs were informed by a literature review and expert opinion. Three distinct cropping systems, requiring tailored modelling approaches were simulated. Individual crops, within a system, were parameterised using data from existing literature and expert knowledge. Firstly, field row crops (i.e. sweetcorn, pumpkin, green bean, sweetpotato, pineapple) were simulated as single-zone systems using the Simple Crop Resource Uptake Model (SCRUM) within APSIM NextGen to model plant processes. Secondly, crops grown using film mulch (i.e. melons, capsicum, tomato) were simulated as two-zone systems, with one zone representing the bare interrow and the other representing the film mulch-covered bed. SCRUM was used to model plant processes in the film mulch zone with modifications implemented in manager scripts to: adjust evaporation constants (ConA and U) to reflect reduced soil evaporation on the bed during film mulch application; proportionally increase rainfall inputs to the interrow, based on bed and interrow widths, to reflect increased runoff from the film mulch bed; and exclude rainfall from the bed to account for reduced infiltration caused by the film mulch. Thirdly, orchard systems (i.e. avocado, macadamia, mandarin, mango) were simulated as two-zone systems, with trees modelled using the Simple Tree Resource Uptake Model (STRUM) in the tree row zone and grass modelled using the Simple Pasture Resource Uptake Model (SPRUM) in the alley zone. Modifications to STRUM were required to better represent evergreen trees, including continuous canopy cover and daily leaf fall. Losses from two-zone systems were weighted based on the width of each zone. Simulations were conducted over 30 years for each crop and soil-weather combination.

Median paddock-scale losses of DIN and soil from horticultural crops were ranked from lowest to highest to identify priority areas for future investment to improve water quality. Preliminary results indicated losses generally varied by system type with tree orchards having the smallest median DIN in runoff and soil loss per hectare, while film mulch systems had the largest. Critical data and knowledge gaps were identified that must be addressed to ensure the models more accurately reflect the true losses occurring from horticulture. These gaps include a lack of current management practice data and insufficient calibration and validation data. Further work is underway to address these knowledge gaps through one-on-one grower engagement and targeted research.

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