Use of APSIM Next Generation to identify in-field practices to reduce N leaching under intensive vegetable production systems

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Abstract: Research has shown that vegetable crop systems contribute substantially to the deterioration of water quality. While quantification of nitrate-nitrogen (NN) losses from intensive vegetable production systems is important, they are relatively difficult to measure in the field, particularly for free draining soils. Fortunately, simulation models can be used to identify the quantity and timing of nutrient leaching. In this study, APSIM Next Generation model (Holzworth et al., 2018) was parameterised and validated using detailed results from two experimental sites ("Potatoes site" and "Green vegetables site") established in vegetable crop fields in the Horowhenua region of New Zealand. Soil water and nutrient dynamics were monitored for two years (2020 - 2022). The modelling efficiency (*NSE*) (Nash & Sutcliffe, 1970) was used to assess the goodness-of-fit between measured and predicted values. Values of *NSE* for soil moisture content ranged from -1.19 to 0.8, with values often >0.35 even at a daily time-step, which indicated an overall 'satisfactory' performance of the model. Similarly, APSIM had a 'satisfactory' performance in predicting cumulative drainage depths, with *NSE* values ranging from 0.31 to 0.7. Measurements of NN concentration in soil and water were highly variable and very challenging to predict in APSIM. *NSE* values for NN concentration in soil and water ranged between -6.85 and 0.84, and between -7.33 and -0.10, respectively. However, APSIM estimations were reasonable in most cases, following a realistic trend in time, and responding appropriately to N inputs and the weather or management actions. Cumulative NN leaching estimations from APSIM had *NSE* values between 0.15 and 0.85, indicating a very 'satisfactory' performance. The calibrated and validated APSIM was then used to assess long-term leaching rates (30 years of climate data), the role of soil type in leaching, and the potential effects of a suite of in-field mitigation measures on NN leaching losses in the study area. Compared to the farmer's normal practice, NN leaching reductions at the Potatoes site were 47% and 7-17% under 'potato harvest at maturity and ryegrass cultivation', and 'potato harvest at maturity and winter crop cultivation' scenarios, respectively. At the Green vegetables site, NN leaching rates were reduced by 45-52%, up to 6%, 31-38%, and up to 48% when simulating a potential drainage management technique, alternative cover/catch crops to ryegrass, "in-season" vs "out of season" production and alternative crop rotation scenarios.

Keywords: *Nitrate losses, vegetable farming, mitigation, APSIM, crop rotations*