An environmentally-based systems approach to sustainability analyses of organic fruit production systems in New Zealand

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ABSTRACT

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This research introduces an approach for the assessment of the sustainability of farming systems. It is based on the premises that sustainability has an environmental bottom line and that there is very limited substitutability between natural capital and other forms of capital. Sustainability assessment is undertaken through analyses of energy and material flows of the system and their impacts on the environment. The proposed sustainability assessment approach is based on two high level criteria for sustainability: efficient use of energy and non-degradation of the environment from energy and material use.

Sustainability assessment of organic orchard systems in New Zealand was undertaken to demonstrate this approach. Five indicators which address the two criteria for the sustainability of the orchard systems are the energy ratio, the CO_2 ratio, changes in the soil carbon level, nutrient balances, and the leaching of nitrogen. Organic kiwifruit and organic apple systems are modelled based on their key energy and material flows and their interactions with the natural environment. The energy and material flows are converted into appropriate energy and matter equivalents based on coefficients taken from the published literature. Sustainability indicators are estimated over one growing season using two computer modelling tools, Overseer® and Stella®, in a life cycle approach.

Sustainability assessment of the organic orchard systems suggests that the approach is useful for evaluating energy use and key environmental impacts that occur in soil, water and atmosphere. The results indicate that the model organic orchard systems are sustainable in terms of energy use and are a net sink of CO_2-equivalent emissions. The implication of this result is that organic orchard systems potentially could trade carbon credits under the Kyoto Protocol. The findings also suggest that the sustainability assessment approach is capable of identifying the trade-offs within the sustainability indicators associated with particular management practices. Further research to improve and validate the proposed approach is essential, before it can be practically used for decision making at the orchard level and for policy making at the national level.

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