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Let's put this in perspective: using dynamic simulation modelling to assess the impacts of farm-scale land management change on catchment-scale water quality

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Natural Resource Management and Agri-industry development groups in Australia have invested considerable resources into the investigation of the economic, social and, particularly, environmental impacts of varying farming activities in a "catchment context". This research has resulted in the development of a much-improved understanding of the likely impacts of changed management practices at the farm-scale as well as the development of a number of conceptual models which place farming within this broader catchment context. The project discussed in this paper transformed a conceptual model of dairy farm phosphorus (P) management and transport processes into a more temporally and spatially dynamic model. This was then loaded with catchment-specific data and used as a "policy support tool" to allow the Australian dairy industry to examine the potential farm and catchment-scale impacts of varying dairy farm management practices within some key dairy farming regions.

Models were developed, validated and calibrated using "STELLA©" dynamic modelling software for three catchments in which dairy is perceived as a significant land use. The models describe P movement and cycling within and through dairy farms in great detail and also estimate P transport through major source, sink and flow sectors of the catchments.

A series of scenarios were executed for all three catchments which examined three main "groups" of tests: changes to farm P input rates; implementation of perceived environmental "Best Management Practices" (BMPs), and; changes to land use mosaics.

Modifications to actual P input rates into dairy farms (not surprisingly) had a major effect on nutrient transport within and from the farms with a significant rise in nutrient loss rates at all scales with increasing fertiliser use. More surprisingly, however, even extensive environmental BMP implementation did not have marked effects on off-farm nutrient loss rates. On and off-farm riparian management implemented over entire catchments, for example, only reduced P losses by approximately 20%. Most importantly, changes to land use mosaics within the catchments provided great insight into the relative roles within the catchment P system of the various land uses. While dairying uses large amounts of P, the effects that dairy farm management can have at the catchment scale when these farms represent only a small proportion of the landscape are limited.

The most important conclusions from the research are that:

• While State and regional environmental management and regulatory agencies continue to set optimistic goals for water quality protection, this research shows that these targets are not achievable within current landscape paradigms even after broadscale BMP implementation, and that either these targets must be re-considered or that significant land use change (rather than simply improved management within current systems) must occur to meet the targets.

• Catchment-scale effects of P losses at the farm scale are a complex function of P-use efficiency, landscape position and landscape footprint. Simply targetting those landuses perceived to have high nutrient loss rates does not adequately address the problem.

• Catchment P management must be considered in a more inclusive and holistic way, and these assessments should be used to inform future planning policies and development plans if environmental goals as well as community expectations about the productive use of agricultural land are to be met.