Green Trees for Clean Cheese

Our collective increase in affluence is resulting in a voluminous production of effluent. In other words, as the world's population grows and becomes increasingly wealthy, so too does the demand for high-value foods such as dairy products. In 2003, the global dairy industry was an estimated to be worth € 120 billion, and this was expected to grow by 9% in 2004. Compared to other forms of food production, dairy farming is an inefficient process that requires large amounts of land, energy and fertiliser for a relatively small amount of end product. Consequently, large-scale dairy production can result in a considerable amount of waste matter that can potentially cause environmental degradation.

In New Zealand, the dairy industry is already having a significant environmental impact, with groundwater, streams and lakes becoming contaminated with nitrates and phosphates. Subsequent eutrophication of these water bodies can result in toxic algal blooms, bad smells and the obliteration of other life forms such as trout. Needless to say, such effects please neither tourist operators nor local residents. A recent report by the Parliamentary Commission for the Environment lamented: "… at a time when New Zealand's natural capital is coming under increasing pressure from farming, funding for scientific research appears to be much more heavily geared toward improving productivity than to sustaining natural resources …".

In October of this year, Dr Marta Marmiroli from the University of Parma in Italy arrived in New Zealand on an OECD fellowship to work on an environmentally sound method for the disposal of dairy effluent. Dairy production is important for the economies of both Italy and New Zealand, resulting in exports of € 1.06 billion and € 3.2 billion respectively. However, compliance with environmental regulations can add significant costs to production, rendering our products less competitive in the global marketplace. In Italy, Marta led a team that developed low-cost constructed wetland systems to mitigate many of the negative environmental effects of dairy effluent disposal. In New Zealand, Marta will work with HortResearch's Environment Group and Prof. Nanthi Bolan and Massey University to elucidate the mechanisms of plant-soil-effluent interactions in order to produce a similar plant-based system that can be used in both countries.

Previous work at under a Sustainable Farming Fund project has shown that some fast growing willow varieties developed at HortResearch can be used as a sponge to mop up dairy shed effluent, while producing a nutritious food source for stock in late summer when pasture production is low. An additional benefit of using these trees for stock fodder is their high concentration of essential trace elements such as zinc and cobalt. Although the concept of this technology is proven, some key processes need to be unravelled before it can be applied as an effective low-cost technology on a large scale.

Dissolved Organic Carbon (DOC) is a major ingredient in dairy effluent. However, there is a lacuna of information on the role of DOC in the transport of nitrogen, metals and pesticides in the plant-soil-atmosphere continuum. It has been shown that DOC can render soluble certain metals such as copper, yet complex them in such a way that they become unavailable for plant uptake. Most New Zealand pastures contain elevated cadmium concentrations due to the application of cadmium-rich superphosphate. If cadmium behaves similarly to copper, then dairy effluent application may result in the potentially beneficial redistribution of this toxic element below the root-zone, or perhaps, result in groundwater contamination.

While dairy effluent is a potentially rich source of nitrogen for plant growth, the high potassium: nitrogen ratio of over 2:1 may cause nutrient imbalances that affect both plant-growth and the health of stock that are fed tree material. Moreover, in Italy, some dairy effluents contain elevated concentrations of lead that may enter the food chain if the effluent is disposed of on land.

To address these issues, Marta is working on a lysimeter experiment to determine the transport process of dairy effluent components in plant-soil systems (see Figure). In particular, this study will focus on the effect of effluent application on nitrogen and metal leaching.

These experiments will hopefully result in a Decision Support Tool (DST) that can be used to calculate effect of phreatophytic trees on mitigating the negative environmental effects of dairy effluent. The DST will integrate mechanistic models that describe the environmental fate of dairy effluent components. This way, efficient plant-based systems can be designed to protect receiving waters whilst providing secondary benefits such as stock fodder, soil stabilisation and potentially fuel-wood production.

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Figure 1: The effluent lysimeter experiment at HortResearch. Here, the trees are just six weeks old.