Nutrient Cycling in *Eucalyptus* Short Rotation Forests

Sustainable production linked with meatworks effluent land treatment

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ABSTRACT

Short rotation forests have the potential to provide a renewable energy source and thus reduce the demand for fossil fuels. They absorb CO_2 quickly during their rapid growth, which then is recycled during the energy conversion process. However, short rotation forests are highly nutrient-demanding, and cause great depletion of soil nutrients from the site after frequent harvests. Effluents, such as from meatworks, contain high levels of nutrients which could be irrigated on to land to aid crop productions in land treatment. In many instances, this is more acceptable than disposal to waterways. Application to short rotation forests is an ideal option as it may lead to a sustainable production system. The successful link between short rotation forests and effluent land treatment depends on good management based on knowledge of nutrient cycling in the system.

The objective of this study was to investigate the nutrient cycling in *Eucalyptus* short rotation forests linked with land treatment of meatworks effluent, through monitoring soil change, tree nutrient uptake, nutrient return via litter fall, and nutrient release via litter decomposition. A series of field experiments and one growth cabinet experiment were conducted from 1993 to 1997 at the Richmond Meat Processors & Packers Ltd. processing plant at Oringi, Dannevirke, and at Massey University, Palmerston North, New Zealand.

Application of meatworks effluent increased soil nutrient levels and enhanced tree biomass production. Compared with non-irrigated crops, biomass was increased by 17%, 25% and 80%, and nitrogen uptake by 15%, 64% and 77% among the three studied species (*E. botryoides*, *E. globulus* and *E. ovata*). *E. globulus* showed the best performance of the three species, whether without irrigation or irrigated with effluent. When *E. globulus* stands were irrigated with effluent, 90 oven dry t/ha of above ground total biomass was produced after 3 year growth with a total of 859 kg nitrogen uptake.

The amount of litter fall and nutrient return depended on the degree of biomass production and nutrient uptake in the stands. Up to 13.4 oven dry t/ha/y litter fall with up to 160 kg/ha/y of nitrogen was recorded. During the 3 year period, up to 20% of total above ground biomass

produced fell as litter and up to 24% of total nitrogen uptake was returned to soil surface via litter. Litter decomposition and subsequent nutrient release from the litter were significantly influenced by internal factors (species, litter source, and the initial contents of cellulose, lignin and magnesium) and external factors (planting density, plantation age, effluent irrigation, water irrigation, temperature and light condition).

The concept of growing short rotation forest linked with effluent land treatment has good potential to provide both a sustainable renewable energy source and a sustainable effluent treatment system. If they are designed and managed rationally according to the nutrient cycling within the system, the environment will be protected. The system design and management include: species selection (on the basis of biomass production, nutrient uptake, litter characteristics), tree planting density, effluent irrigation, rotation length, time of harvest, and litter management.

Key words: nutrient cycling, short rotation forests, *Eucalyptus*, biomass production; effluent land treatment.

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