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Effectiveness of Established Tree and Pasture Buffer Strips in Reducing Lateral Groundwater Movement and Nutrients from an Effluent Disposal Area Associated with a Beef Cattle Feedlot

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Declaration

I declare that the substance of this thesis has not already been submitted for any degree and is not currently being submitted for any other degree or qualification.

I declare that any help received in preparing this thesis, and all sources used, have been acknowledged in this thesis.

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ABSTRACT

Vegetated buffer strips (VBSs) have been promoted as a method to control non-point sources pollution. Trees and pastures are the most common components in VBSs. The aim of this project was to determine the effectiveness of trees and improved pasture in reducing lateral groundwater movement and nutrients from an effluent irrigated disposal area associated with a beef cattle feedlot. This question is significant in the experimental site because lateral groundwater movement occurs along the A-B interface as the soil is strongly duplex with a sand loam A horizon and a heavy clay B horizon. Consequently, the soil has a significant difference in hydraulic conductivity between the A and B horizons leading to lateral movement of water above the B horizon. A field experiment was established to determine the effectiveness of tree and pasture buffer strips in reducing lateral groundwater flow and associated nutrients. The field experiment was a randomized block design with two tree species (*Eucalyptus camaldulensis* and *Casuarina cunninghamiana*), two planting densities and three replications. Improved pasture was established as controls. A glasshouse simulation experiment was also conducted to compliment to the field experiment in measuring the ability of the trees and pasture in reducing lateral nutrient movement.

The field experiment showed that both the tree species and improved pasture established successfully as VBS vegetation at the early stage (<3 years) on the Northern Tablelands area, in terms of their survival and growth rates. Water deficit and water use of the tree treatments with the two species and two densities were not significantly different, principally because the trees were not large enough to occupy the site and to dominate water relation. The longer growing period and generally larger water deficit of the improved pasture indicate that the pasture has a greater potential and advantage to be used in VBSs at least at the early stage. The trees and pasture did not exhibit significant reductions in lateral groundwater flow and nutrients through comparing the change of water table, soil water storage and groundwater chemistry. N and P accumulated and removed by pasture harvest were189.9 and 17.0 kg ha^{-1} respectively over the experimental period, while N and P storage in the above-

ground biomass of the trees were estimated to be 49.1 and 9.4 kg ha^{-1} respectively. This suggests that improved pastures may take up and remove N and P more efficiently than trees at this stage provided that proper management, such as harvesting on time, is adopted.

The 11-month glasshouse experiment showed that *C. cunninghamiana* had higher growth rate in diameter and total biomass in comparison with *E. camaldulensis*. The growth of *E. camaldulensis* was more greatly affected by the density treatments than that of *C. cunninghamiana*. The evidence that *E. camaldulensis* had more roots penetrated into the soil B horizon in comparison with *C. cunninghamiana* showed that *E. camaldulensis* can more efficiently use subsurface soil water and tolerate drying environment conditions. *C. cunninghamiana* could use the surface soil moisture more efficiently than *E. camaldulensis* in terms that *C. cunninghamiana* had more fine roots in the surface soil.

The tree treatments demonstrated significantly higher capacity in retaining NO_3-N in the vegetation-soil system in comparison with bare ground. During the 'nutrient depletion period' and the 'low NO_3 addition period", tree treatments on average retained more NO_3-N than bare ground by 39.9 and 33.2%. Both tree and pasture plots significantly retained NO_3-N as NO_3-N enriched water flowed through the soil during the 'high NO3 addition period, the trees, however, did not show a significantly greater ability in retaining lateral moving NO_3-N in comparison with pasture. The experiment also showed that the efficiency of NO_3-N removal by trees was greater when NO_3-N concentration was relatively higher in the soil.

Finally, two integrated VBS models are presented that include both tree (combination trees with deep root systems and trees with surface dominant root systems) and pasture components to integrate the advantages of both trees and pastures in removing nutrients and reducing water flow from adjacent fields.

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