# Implications for N Transformations in Acidic Soils of Replacing Annual-Based Legume Pastures with Lucerne-Based Pasture in Dryland Farming Systems of Southern Australia

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# Implications for N transformations in acidic soils of replacing annual-based legume pastures with lucerne-based pasture in dryland farming systems of southern Australia

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**Introduction** The supply and demand for nitrogen (N) in annual-based pasture-crop rotations in southern Australia is often poorly synchronised, leading to large losses of inorganic N (Fillery, 2001). Perennial pasture species, particularly lucerne, are being recommended to minimise dryland salinity. The implications for N cycling of using lucerne in place of annual legumes on acidic sandy soils that are widespread have not been widely studied. Lucerne is less tolerant of acidity and could fix less N than annual legumes. Lucerne root residues mineralise at slower rates than annual pasture residues with lower N release to subsequent wheat crops (Bolger *et al*., 2003). The aims of the work were to compare N cycling under lucerne and the traditional annual legume-based pasture system.

**Materials and methods** Lucerne (*Medicago sativa*), and subterranean clover (*Trifolium subterraneum*) were sown into separate 60 m long by 20 m wide fenced plots that enabled grazing by sheep. Treatments were replicated four times. Dry matter production between grazing events, N content in pasture components (legume and non-legumes), $^{15}N$ natural abundance in legumes and non-legume reference plants and biomass were determined. Soil was sampled in layers to a depth of 1.6 m periodically during the growing seasons studied, and samples analysed for ammonium and nitrate ($NO_3^{-1}$). Net N mineralisation during the growing season of pasture phases and a subsequent wheat crop was determined using an *in situ* incubation technique. Rainfall and other climatic variables were also measured.

**Results** The amounts of N fixed by legume shoots over an 18-month period that covered two growing seasons (April 1999 to October 2000) included 215 kg N/ha N in subterranean clover-based pasture and 157 kg N/ha for lucerne-based pastures, a statistically significant difference. Uptake of soil-derived N in subterranean pastures (197 kg N/ha) was largely undertaken by non-leguminous species (125 kg N/ha) whereas lucerne used 69 kg N/ha and non-leguminous species in lucerne-based pastures used 95 kg N/ha soil N. Lucerne was an important sink for soil-derived N in the summer-autumn of 2000 when it accumulated 31-35 kg /ha of soil derived N in shoot. The effect of this uptake on soil $NO_3^{-1}$ levels ahead of winter rainfall is shown in Figure 1. Soil profiles under senesced subterranean clover contained 94 kg N/ha of $NO_3^{-1}$ to 1.6 m compared with 45 kg N/ha under lucerne. Root uptake of soil-derived N was not determined, thus legume and non-legume uptake of mineral N are underestimated. Soil $NO_3^{-1}$ under subterranean clover decreased through the winter growing season with the growth of non-leguminous species but plant recovery of $NO_3^{-1}$ would have been lower had leaching of $NO_3^{-1}$ occurred. Net N mineralisation in soil for the period April 1999 to October 2000 amounted to 178 kg N/ha under lucerne and 163 kg N/ha under subterranean clover (not significantly different). Rates of net N mineralisation during a subsequent wheat phase (June to December 2001) were 70 kg/ha after lucerne, and 76 kg/ha after the annual legume-based pasture, indicating that lucerne residues, in sandy soils at least, do not mineralise at lower rates compared with subterranean clover residues.

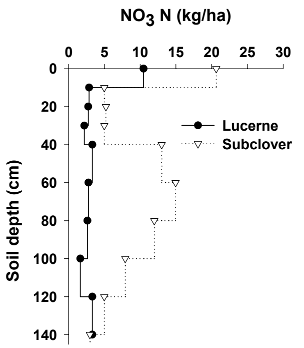


**Figure 3** Amounts of $NO_3$ in soil layers under pastures in May 2000, preceding winter rainfall

**Conclusions** The use of lucerne-based pastures did decrease N input through symbiotic N fixation compared with the widely used subterranean clover based pasture. However, the rate of mineralisation of organic N, either during or subsequent to pasture phases, was similar to the traditional annual-based pasture. The perennial growth habit of lucerne ensured quick plant capture of $NO_3^{-1}$ after rain in autumn when land is traditionally bare under annual-based production systems. This capture of $NO_3^{-1}$ by lucerne should reduce the potential for $NO_3^{-1}$ leaching when drainage occurs below the rooting depth attributed to annuals.

**References**

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