# LEGUMES IMPROVED DRYLAND GRAZING SYSTEMS IN NEW ZEALAND

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## Introduction

In this paper we summarize the use of lucerne (*Medicago sativa* L.) and subterranean clover (*Trifolium subterraneum* L.) in dryland grazing systems in New Zealand over two decades. These systems are located in the rain shadow of the Southern Alps. Low annual rainfall (350–800 mm) and high potential evapotranspiration (1400–1600 mm) are coupled with strong Northwest winds that produce daily evapotranspiration rates up to 8 mm. Together the climate and high soil variability (60–300 mm of water holding capacity) leave a 3–4 month window of reliable pasture growth. Each year the spring-born lambs are sold for export or finishing by specialist producers to enable the farm to destock and avoid the dry summer period. We aimed to develop sustainable grazing systems in this environment. This required plants to maximize spring water use efficiency, and provide a bulk of nutritious animal feed for grazing *in situ* during and shortly after lactation. This paper summarizes 15 years of on-station research and on-farm demonstration that has transformed some of these dryland farms. The research was based on first principles associated with the need to convert limited water to high quality feed to meet animal demand.

## Materials and Methods

A series of field experiments at Lincoln University assessed the relative merits of a number of plant species to fit into dryland farm systems. The first compared chicory (*Cichorium intybus*), red clover (*T. pratense*) and lucerne grown under irrigated (Brown *et al*., 2005) and dryland (Brown *et al*., 2003) conditions. The second assessed pasture production from cocksfoot (*Dactylis glomerata*) grown with or without nitrogen and irrigation (Mills *et al*., 2006). In the third, the above and below ground response of an irrigated lucerne monoculture to short (every 28 days) or long (every 42 days) grazing durations separated partitioning responses from moisture (Teixeira *et al*., 2007). A comparison of dry matter production, spring water use efficiency, pasture persistence, and animal performance was then made in a dryland grazed experiment of six pasture combinations in six replicates over nine years (Moot *et al*., 2008; Mills *et al*., 2015). These results informed farmers of appropriate pasture options and led to increased demand for technology transfer (Moot, 2014).

## Results and Discussion

Of the three deep-rooted forages tested, lucerne was the most productive and persistent (Brown *et al*., 2003). A strong seasonal response of nitrogen and carbon remobilization from lucerne storage organs to shoots was shown in spring (Teixiera *et al*., 2007). In contrast, there was a consistent switch to recharge these storage organs in autumn to return the reserves to about 4 t DM ha$^{-1}$. This seasonality of a fall dormancy 5 cultivar was then matched to grazing systems to provide a bulk of feed supply during the period of highest animal demand. Farmers took this information and were assisted to implement lucerne grazing strategies to maximize animal production and minimize the risk of animal health issues (e.g. Avery *et al*., 2010).

Cocksfoot data showed that nitrogen was actually limiting production more than water in these dryland systems. The use of legumes to provide the nitrogen supply was then explored in a pasture species trial. This confirmed higher animal and pasture production from legume-dominant pastures which resulted from greater spring water use efficiency (Moot *et al*., 2008). Lucerne was shown to be the most productive species but subterranean clover-based pastures provided earlier spring growth and are now also being utilized for early spring lamb production (Brown *et al*., 2006).

## Conclusions

Dryland pastures are always nitrogen deficient so they are inefficient users of soil water unless they are legume-dominant.

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