FARM

beef+lamb new zealand

FACT SHEET

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EXPLAINING PASTURE WATER USE

Rainfall is free. The challenge in summer dry pasture systems is to use stored soil moisture efficiently before it runs out. Water **evaporates** from the soil surface. Plants use water through **transpiration**. Together, the water loss is called **evapotranspiration**.

Like economics, pasture production is about supply (of water from the soil) and demand (for water by the pasture). How efficiently plants use water is calculated from the dry matter produced per millimetre of water used and is called water use efficiency (WUE).

Lincoln University's Dryland Pastures Research Team collected yield and botanical composition of six dryland pastures over nine years. Their findings have been reported in fact sheets 106, *Production and persistence of dryland pastures* and 109 *Live weight production of sheep grazing dryland pastures*.

KEY MESSAGES

- Most soil water extracted by pasture is transpired as water vapour from the leaves. Less than 1% is used in producing dry matter (DM).
- Spring is the most reliable period for DM production in summer dry farming systems because, in most years, rainfall over winter recharges water in the soil storage "bucket".
- Use pasture plants that grow rapidly in spring to maximise water use efficiency (e.g. subterranean clover).
- In summer dry systems, water use efficiency changes throughout the year depending on the extent, duration and severity of water stress.

Figure 1. Landscape farming with lucerne at 'Bog Roy' Station near Omarama

- Adopt a landscape farming approach (see figure 1). Sow deep rooting species, like lucerne, on the deepest soils so they can access stored water unavailable to shallower rooted grasses.
- Include legumes, such as lucerne, in your pastures. Pastures with adequate nitrogen can produce double the yield of N-deficient pastures from the same amount of water.

WATER USE EFFICIENCY OF DRYLAND PASTURES

- This study of dryland pastures over nine years showed the maximum showed the maximum annual water use efficiency was 27 kg DM/ha per mm of water used by lucerne in Year 8. The lowest was 7 kg DM/ha per mm of water used by the nitrogen deficient cocksfoot/white clover (CF/Wc) pasture in Year 7.
- Water use efficiency from lucerne monocultures was always higher than from grass-based pastures.
- Figure 2 shows a strong relationship between annual legume yield, rainfall and WUE.
- The right hand side of Figure 2 shows as legume yield increased from 0.6 t DM/ha (CF/Wc) to 12.9 t DM/ha (Lucerne) WUE increased from 7.4 to 21.6 kg DM/ha for every mm used. This was an increase of 1.2 kg DM/ha per mm of water use for every extra tonne of legume DM produced.

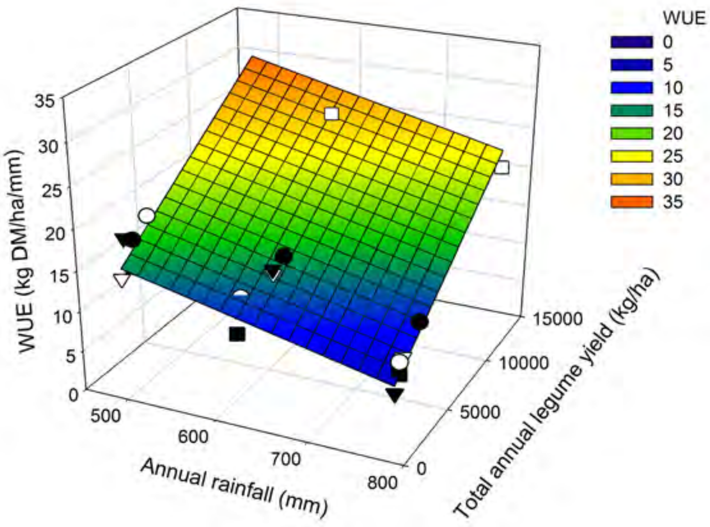

Figure 2 Relationship between total annual legume yield, annual rainfall and water use efficiency of CF/Sub (●); CF/Bal (O); CF/Wc (▼); CF/Cc (▽) RG/Wc (■) and lucerne (□) in Years 2, 3, 7 and 8

- WUE also increased when annual rainfall decreased. Here, annual rainfall was between 493 and 783mm/yr.
- The front of Figure 2 shows mean WUE decreased from 14.3kg DM/ha/mm to 7.4kg DM/ha/mm as rainfall increased from 493mm/yr to 783mm/yr. This means WUE decreased by 2.5kg DM/ha for every extra 100 mm/yr of rainfall.
- Increased WUE in dry years was due to reduced DM production (decreased water demand under stress) and a decrease in the transpired water losses (stomata on leaves close preventing water loss into the air). These processes give an increase in WUE under water stress.
- Figure 3 shows how WUE changed throughout the year for a ryegrass/white clover (RG/Wc) dryland pasture at Ashley Dene.
- In spring (a), before water stress limited growth, the pasture grew 22kg DM for every mm of water used.
- When water available to the plant ran out in summer (b), the rate dropped to 3kg DM produced per mm of water used. Rainfall (grey bars) in autumn alleviated stress conditions. The pasture recovered and grew 18kg DM per mm in autumn (c).
- The rate decreased to 9kg DM/mm in winter (d) when temperature slowed growth.

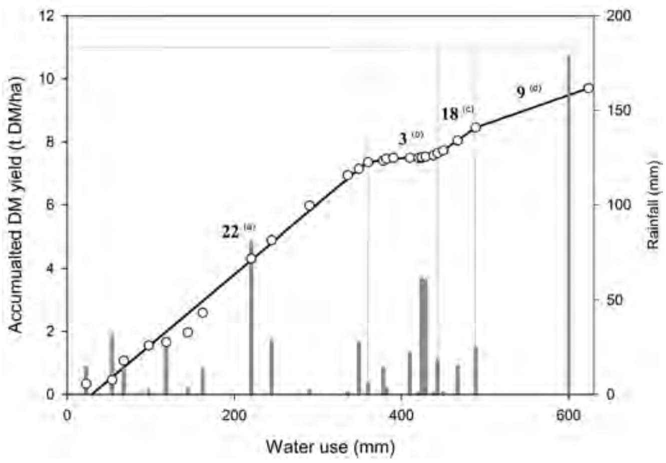

Figure 3 Change in water use efficiency of a dryland ryegrass/white clover pasture at Ashley Dene, Canterbury (Moot et al., 2008). Numbers in bold indicate how many kg of DM is produced per mm of water used in the four different seasonal phases

REFERENCES

Moot, D. J., Brown, H. E., Pollock, K. and Mills, A. 2008. *Yield and water use of temperate pastures in summer dry environments.* Proceedings of the New Zealand Grassland Association, 70, 51-57.

FURTHER INFORMATION

Information about management of dryland pastures can be found on the Beef + Lamb New Zealand website, www.beeflambnz.com:

- Factsheet 106: Production and persistence of dryland pastures
- Factsheet 109: Live weight production of sheep grazing dryland pastures
- Lucerne: Summary Papers for Establishing and Managing Lucerne booklet
- R&D Brief 125: Annual legumes enhance animal production from summer dry pastures
- R&D Brief 127: Using subterranean clover
- R&D Brief 143: Lucerne update on management
- FITT project: 04FT154 Supreme sub clover

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