GRAZING LEGUME FORAGES TO CHANGE FARM PROFITABILITY

Sub theme – Technology

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Abstract:

Two case study farms illustrate the complexity and power of introducing grazing legumes into farm systems. Lucerne (Medicago sativa) is documented in a very dry environment while red clover (Trifolium pratense) is used in a wet environment. Grassland pasture production was approximately 1950 and 10400 kg DM/ha/annum in the two environments respectively. The lucerne and red clover produced 6900 and 14400 kg DM/ha/annum by comparison. Introducing lucerne as a grazing legume into 8% of the grazing area increased net annual cash flow from $62,000 to $147,000 per annum, and increased the return on capital invested in livestock from 7 to 13% p.a.. Introducing red clover into 5% of the grazing area increased net annual cash flow from $211,000 to $352,000, though saw a slight reduction in return on capital invested in livestock from 23 to 21% p.a.. The lucerne was used to improve the lactation performance of the ewe flock. The red clover was used to increase the live weight and reproductive success of young stock to drive whole flock performance. In both cases extra spring growth from the legumes was able to spare feed elsewhere on the farm, alleviating feed shortages, or increasing productivity of other stock classes.

Keywords: *Grazing, investment returns, Lucerne, profitability, red clover, sheep.*

INTRODUCTION

Sheep farming in New Zealand has provided a model for capturing production and efficiency gains over the past 30 years (Fennessey *et al.,* 2016) since the removal of farming subsidies (Wallace, 2015). However, gains in genetics have often only been matched by improving the utilisation of pastures by better matching feed supply and

demand. Evidence is emerging that pasture production in New Zealand hill country has actually declined in the past 10 to 15 years (Mackay and Costall, 2016), especially on some slopes and aspects of our hill country. So while we have been able to maintain our advances in productivity and profitability by utilising more of our feed, this option is rapidly running out. We need new technologies for our hill country farmers to remain productive and profitable into the future.

Recent developments of our understanding of the growth pattern of lucerne, responses to defoliation, and interactions with root reserves have created new rules and grazing opportunities (Moot *et al.* 2003). An increase in the understanding of the water use efficiency (Brown *et al.* 2005a, b) and interactions with nitrogen (Moot *et al.* 2008) has enabled more accurate prediction of the responses of various forages to available soil water. This has increased the ability to predict responses and develop high performing lucerne grazing systems (Avery *et al.* 2008; Kearney *et al.* 2010).

This paper provides two case studies to demonstrate the power of new knowledge developed for grazing strategies for tap-rooted legume forages in two contrasting environments. Implementing the management rules developed for lucerne and red clover enables increased productivity and profitability for farming enterprises.

METHODOLOGY

Two case study farms are presented. Case study one (Farm 1) was part of a technology transfer programme, Lucerne for Lambs (Casey *et al.,* 2015; Stevens *et al.,* 2012), funded by the Ministry for Primary Industries (New Zealand). The farm developed approximately 100 ha of the 950 ha farm into grazing lucerne (*Medicago sativa*). Case study two (Farm 2) was part of the Beef + Lamb New Zealand Demonstration Farm programme (Fraser *et al.,* 2016), engaging professionals to guide the implementation of new technologies. In this case a cropping and red clover (*Trifolium pratense*) forage development was implemented over 4 years. Performance of the farms was recorded throughout.

Farm 1 is situated in Central Otago, with an average of 380 mm rainfall per annum and an average of 183 frost days in winter and 94 days of soil moisture deficit (Radcliffe and Cossens, 1974). Farm 2 is situated in the King Country, a region where rainfall averages 1400 mm per annum and soil moisture is more variable, generally only restricting

pasture growth in summer (Roberts and Thomson 1984). Average pasture growth profiles are represented in Figure 1. These were derived from Roberts and Thomson (1984) (King Country pasture), on-farm measurements (King Country red clover), and Stevens *et al*., (2012) (Central Otago pasture and lucerne). Annual pasture production estimates were 1950, 6900, 10400, and 14500 kg DM/ha for Central Otago pasture, Central Otago lucerne, King Country pasture and King Country red clover, respectively.

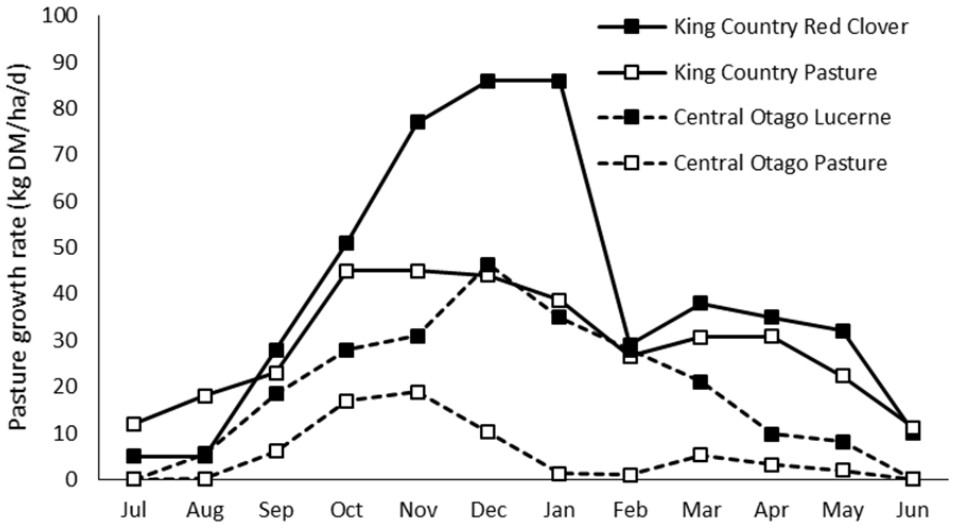

Figure 1. Growth rates of perennial pasture (open symbols) and legume options (closed symbols) in the King Country (solid lines) and Central Otago (dotted lines) regions of New Zealand.

Farm 1 is 950 ha approximately 7 km south of Oturehua in the Ida valley, rising from 470 m to 1000 m a.s.l. The property has approximately 100 ha of flat to rolling land of naturally high pH (6-6.5) with the remainder being low fertility, shallow loess-based soils on steep slopes, dissected by deep gullies. The livestock enterprise has traditionally been based on mid-micron wool and lambs sold at weaning to finishers from a Polwarth ewe flock. Typically stocking rates are 2-3 ewes per hectare, with stock being moved between different parts of the farm depending on season and feed supply. If lambs are finished they are often taken through the winter and sold as rising one year old.

Farm 2 is 1,100 ha approximately 5 km west south west of Aria, rising from 30 m to 200 m a.s.l. The farm has 700 ha of hills that are predominately clay based, with flat to rolling country being ash, clay flats and sedimentary river flats. Floods can occur every 2-3 years and can cover up to 30 ha. Approximately 400 ha is intensively sub-divided into bull finishing blocks. The livestock enterprises include both sheep and beef, and

both breeding and finishing. This case study considered only the sheep enterprises of the property, which are based on high fertility Coopworth ewes with approximately 35% of the flock bred to a terminal Texel-cross sire, producing coarse wool. There are also 220 breeding cows including 70 calving heifers and 560 rising two-year-old Friesian bulls. Bulls are finished at 15 months, averaging 280 kg carcase weight. Bull purchases are based on feed budget, to provide flexibility, from October through to September.

Production data collected from both farms was used to generate an estimate of farm profitability. The product values and farm costs in the final year of each study was used. Costs and values were sourced from the Beef + Lamb NZ Economic Farm Survey data (Beef and Lamb Economic Service, 2016) for the relevant farm types. Costs influenced by stock numbers and changing production intensity were varied according to total stock numbers. These included cropping, shearing, animal health, freight, feed, and contracting. Other costs were considered to remain constant and pooled before being added. Finally, an investment analysis compared the livestock enterprises before and after the development of grazing legume forage systems. Current livestock values were used, and development costs of investing in the forage systems were added. The life expectancy of lucerne was set at 10 years with an establishment cost of $540/ha, while the life expectancy of red clover was set at 4 years with an establishment cost of $1000/ha. Each new establishment was considered a new capital investment. The return on investment was then calculated over a 20 year period.

RESULTS

Case study one

Farm 1, in Central Otago, was able to improve 100 ha of the 950 ha property. The topography of the remainder of the property restricted further development. The inclusion of lucerne as a grazing forage saw ewe numbers increase by 24% and ewe death rate decrease by 66%. While increases in lambing percentage were moderate (5%), the number of lambs for sale increased markedly, and meat sales from the farm increased. Increases in stock numbers also increased the amount of wool harvested. Total income increased from approximately $255,000 to $370,000 per annum.

Costs were increased with the development programme, by approximately $44,000. The value invested in the livestock also increased, going from approximately $365,000 to $461,000.

Cash flow, including an interest payment for capital stock, increased from $65,000 to $147,000 per annum. The rate of return on investment for the livestock enterprise nearly doubled from 7% to 13%.

Table 1. A case study of whole farm performance when shifting from the conservation of lucerne to the implementation of a lucerne grazing programme in Central Otago, New Zealand.

Year		2008	2013
PRODUCTION			
Farm size (ha)		950	950
Lucerne area (ha)		23	100
Ewes	Number	2500	3100
	Death rate	9%	3%
	Ewes sold	475	857
Lambs	Total numbers	2625	3410
	Retained for replacements	700	950
	Number sold prime	960	2460
	Number sold store	965	0
	Carcass weight (kg)	15.5	17.2
Wool	5.07 kg/SSU[1] @ $6.15/kg	12675 kg	15717 kg
INCOME			
Gross income from wool sales at 2013 prices		$77,951	$96,660
Gross income from sheep sales at 2013 prices		$176,731	$274,067
Total income		$254,681	$370,727
COSTS (influenced by adding lucerne)			
Establishment and maintenance of lucerne		$3,107	$13,510
Shearing ($8.43/SSU)		$25,205	$31,739
Animal health ($4.71/SU)		$14,082	$17,733
Freight ($1.22/SU)		$3,648	$4,593
Feed ($4.09/SU)		$12,230	$15,399
Contracting ($2.30/SU)		$6,877	$8,660
OTHER EXPENSES NOT VARYING WITH LUCERNE INPUT		$109,135	$109,135
Livestock capital value		$365,650	$461,110
Interest costs (@5%)		$18,282	$23,055
Total costs (including interest)		$192,567	$223,524
Relative net position		$62,116	$147,203
Return on Investment (per annum)		6.7%	12.6%

[1] SSU – sheep stock units.

Case study two

Farm 2, in the King Country, improved 60 ha of the 1,100 ha property. Conflicts with the beef enterprises restricted further development, as the risk of stock deaths due to bloat are high in finishing cattle grazing red clover. The inclusion of red clover as a grazing forage enabled an increase in ewe numbers of 15% but ewe death rate increased from 4%

to 5% as lambing percentage and the number of triplet-bearing ewes increased. Increases in lambing percentage were significant (15%). The reliable outcome from mating ewe lambs (hoggets) also produced an increase in lamb numbers for sale. These two factors saw a major increase in sheep meat sales from the farm. Increases in stock numbers also increased the amount of wool harvested, though the value of coarse wool is relatively low. Total income increased from approximately $514,000 to $737,000 per annum.

Costs were increased with the development programme, with variable costs increasing by approximately $80,000. The value invested in the livestock of the sheep enterprises also increased, going from approximately $504,000 to $592,000.

Cash flow, including an interest payment for capital stock, increased from $211,000 to $352,000 per annum. The rate of return on investment for the livestock enterprise decreased slightly from 23% to 21%.

Table 2. A case study of whole farm performance when shifting from all grass-based pasture to the implementation of a red clover grazing programme in the King Country, New Zealand.

Year		2012	2016
PRODUCTION			
Farm size (ha)		1100	1100
Red clover area (ha)		0	60
Ewes	Number	3450	3980
	Death rate	4%	5%
	Lambs produced	4924	6245
	Ewes sold	834 (at 57.5kg)	984 (at 66kg)
	Ewe sales	$93,872	$127,128
Hoggets	Number	1003	1300
	Death rate	9%	9%
	Lambs produced	370	1250
Lambs	Total numbers	5294	7495
	Retained for replacements	1060	1350
	Number sold prime	4234	6195
	Carcass weight (kg)	17.3	16.8
	Mean sales date	5 Mar (value $4.58/kg	27 Jan (value $4.90/kg)
	Lamb sales	$335,377	$509,997

Wool	5.13 kg/SSU @ $4.00/kg	21,300 kg	25,086 kg
INCOME			
Gross income from wool sales at 2016 prices		$85,200	$100,343
Gross income from sheep sales at 2016 prices		$429,249	$637,100
Total sheep income		$514,449	$737,443
COSTS (influenced by adding red clover)			
Cropping and red clover		$48,000	$105,000
Shearing ($5.11/SSU)		$21,217	$24,988
Animal health ($4.83/SU)		$20,054	$23,619
Freight ($1.12/SU)		$4,650	$5,477
Feed ($3.48/SU)		$14,449	$17,017
Fertiliser ($12.96/SU)		$53,810	$63,375
OTHER EXPENSES NOT VARYING WITH RED CLOVER INPUT		$115,760	$115,760
Livestock capital values		$503,920	$591,840
Interest costs (@5%)		$25,196	$29,592
Total costs (including interest)		$303,136	$384,828
Relative net position		$211,313	$352,615
Return on Investment (per annum)		23%	21%

DISCUSSION

Production changes occurred because of the nature of legumes. Both lucerne and red clover are more water use efficient because they fix their own nitrogen (Moot *et al.,* 2008). This ensures that production is often higher than pasture that is not intensively fertilised with nitrogen. More high quality feed is produced as a result (Figure 1).

In case study one, key changes were the result of increasing water use efficiency and production during spring when water supply in the soil is relatively assured after winter recharge. This enabled an increase in stocking rate on the areas sown in lucerne, from approximately 5 to 10 ewes/ha. The increased feed quality then ensured that high lamb growth rates were achieved from birth to weaning, enabling a high proportion of lambs to be sold at this time. This also means that large areas of hill country can be spelled during spring, accumulating feed for use in summer. High feed quality and supply during spring also means that ewe liveweight and condition at mating match targets for tupping. Therefore, summer feed requirements are reduced compared to the previous system when summer live weight gain was needed to bring ewes up to tupping condition. The sale of large numbers of lambs at weaning and the reduced requirement for ewes means that any summer surplus lucerne is used for lamb finishing, meaning all lambs are now sold prime, rather than on to lamb finishers. Autumn rains are captured by lucerne much

faster, and at a higher rate of efficiency. Lucerne growth rates after autumn rain were measured on-farm at 30 kg DM/mm rainfall, while naturalised pasture responded at 4 kg DM/mm rainfall. This increases autumn feed supply from the areas now sown in lucerne. The late autumn and early winter grazing of lucerne, preparing for weed control, and removing weeds and pest residuals fills the early winter feed deficit. This, coupled with the extra growth, reduces the requirement for winter supplements. Thus the end result is a higher overall farm stocking rate, improved reproductive performance from the ewes, and a shift from store to prime stock sales.

In case study two, the red clover, as a deep rooted perennial legume for use in moist soil conditions, fixes its own nitrogen and so increases feed supply in spring, summer and autumn. The advantage of more, higher quality feed, in spring was used to feed growing hoggets with their lambs, on a rotationally grazed system. The result is that a high stocking rate of lambing hoggets (15-20/ha) relieves grazing pressure from the rest of the farm, while producing hoggets of approximately 64 kg and lambs of 31.5 kg at approximately 100 days of age. These hoggets improved the performance of the ewe flock by increasing the liveweight of ewes by 5 kg and pregnancy scanning from 175% to 195% and the lambing percentage from 140% to 155%.

Extra forage produced during spring is controlled by introducing young bull beef at approximately 1/ha from 1st October onwards, on a rotation behind the hoggets to utilise the residual, including the stalks, to allow for new growth.

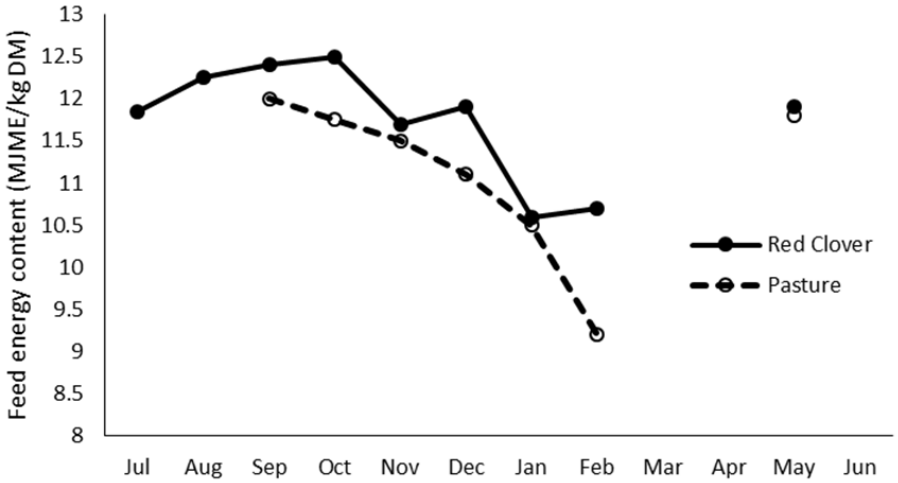

Figure 2. Pasture and red clover feed energy content throughout the main clover growing season (averaged over 2014 and 2015) as measured on-farm in case study two in the King Country region of New Zealand.

During summer, the improved feed quality of the red clover (Figure 2) is used to grow ewe lambs to meet mating liveweight targets. An average post weaning live weight gain of 150 g/d is targeted, and if lambs are too light to achieve mating weight targets they are grazed on red clover with an expectation of achieving a growth rate >240 g/d. This ensures that all ewe lambs reach mating weights in early May of greater than 42 kg, and an average of 48 kg live weight. The number of lambs from hoggets has increased from 370 to 1250 (37% to 96% lambing). Any surplus summer feed is first utilised by finishing lambs, and then by young cattle.

High stock concentration on red clover spares feed for the ewe flock on the rest of the farm. This has then ensured that higher lamb (33.5 kg), and higher ewe (66 kg) weights are achieved at weaning. The higher lamb weaning weight reduces the average slaughter date for the farm, gaining increased value for the carcase. It also reduces the farm feed requirement by approximately 2.5 t DM/d over the summer which is the most variable time of year for feed production. Pasture growth at this time can range from 5 to 35 kg DM/ha/d during January and February.

The increase in ewe live weight and condition means that ewes are at mating targets at weaning reducing summer feed requirement and enabling future production targets to be met even when pasture growth may be low. When pasture growth is average or above, the extra feed is captured in buying finishing lambs or cattle.

CONCLUSIONS

The two case studies provide an insight into the implementation of new techniques to manage tap-rooted perennial legumes in grazing systems. The power of the legume to fix atmospheric nitrogen when fertiliser nitrogen inputs are minimal provided significant increases in both total forage production, and in production at the key time of lactation.

These case studies illustrate the subtle and complex nature of the changes that need to be made to capture the value from grazing legumes. Both case study farms captured those benefits, even though the climates were different, using the appropriate legume for the environment. Each farm used the forage in different ways. Case study one used the lucerne to increase productivity of the main ewe flock. Case study two increased the live

weight and reproductive success of young stock to drive whole flock performance. In both cases the extra feed produced in spring was also able to spare feed on other parts of the farm, helping to alleviate feed shortages, or increase productivity of other stock classes. The small areas of improvement of the whole farm (8% and 5% in case studies one and two respectively) provided significant leverage in whole farm performance.

Lessons from the use of grazing legumes, over diverse environments, provides opportunities for the development and implementation of new insights into the many other legumes that are available around the world.

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