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UTILISING LUCERNES POTENTIAL FOR DAIRY FARMING*Richard Campion**Department of Agriculture Management and Property Studies
Faculty of Commerce, Lincoln University***Abstract**

New Zealand farming systems are based on ryegrass and white clover pastures. Production from these pastures under irrigation does not get much better than 17,000 kg of dry matter per hectare per year. This response relies on irrigation and nitrogen applications. Future potential lies in exploring species changes, or cropping to grow more dry matter. This paper discusses using lucerne to alter the farming system in irrigated dairy farming. Lucerne has been shown to grow up to 24,000 kg dry matter per year in irrigated trial situations.

Lucerne does not require nitrogen applications and has shown to be beneficial in assisting with nitrate removal. Projected budgets show a lucerne system can generate high returns.

However a change of this magnitude will require changes to farming systems. It is very important to manage lucerne correctly. Farmer experience has shown that it is not difficult to change and the potential benefits are high.

Keywords: lucerne, *Medicago sativa*, dairy farming, farm system

Introduction

Although lucerne has a long history in New Zealand the grazing of lucerne lost support from farmers in the 1980's, largely due to inappropriate management and various disease problems. Since then new varieties, management changes, and disease resistant cultivars have given farmers more confidence. The management system at Bonaveree, a dry land, hill country farm in Marlborough, has made full use of lucerne since its introduction in 2005. Sowing half of the farm in lucerne (alfalfa, *Medicago sativa*), has shown outstanding gains in production, profit and sustainability. The farm shows superior financial returns, compared to pre 2005, when the farm was performing poorly. The farm financial surplus has improved six fold over that time, completely rejuvenating the farm's performance (Avery, 2008).

There are some dairy farmers in New Zealand who are using lucerne as a direct feed, but the practice is not widespread (Moot, 2009). The current role of lucerne is mostly as a supplement dry feed on dairy farms.

Lucerne could be of interest to the dairy industry due to its ability to produce more dry matter than conventional pasture, the ability to grow without nitrogen inputs, its resistance to grass grub, and the fact that it has high feed value.

Production from lucerne is higher than pasture. Lucerne can produce around 25% more dry matter than pasture under irrigation in Canterbury. Some measurement suggests it could be higher than this but there is variability in soils and location. Lucerne is a high quality forage that can produce superior animal performance. Energy levels and protein in lucerne are generally higher than pasture particularly when pasture is not freshly growing. Correct management of lucerne will provide top quality herbage.

Examples from the sheep industry such as Bonaverree Farm, have shown consistently high animal growth rates with lamb growth rates in the top 5% of New Zealand's national flock (Avery, 2008). In addition, there is no taint to milk from cows eating lucerne.

Lucerne has produced yields of up to 20 t DM/ha/yr on Wakanui soils in a dry land situation (Hayman, 1985). The impact of irrigation depends on soil type and season, however Hayman, (1985) reported yield increases of 30-370% from irrigation. Yields of irrigated lucerne have been shown to be up to 24,000 kg DM/ha/yr (Brown, et al. 2000). Irrigated dairy pastures based on ryegrass and white clover at Lincoln University's Dairy Farm average around 17,000kg DM/ha/yr (SIDDC, 2010).

Cultural Characteristics of Lucerne

Climatic zones and differing soil types have an effect on the performance of lucerne, and different regions show differing use patterns. Lucerne does grow all over New Zealand but is most popular in the drier areas.

Lucerne requires a pH of 6 - 6.4 for best performance which means most soils require lime applications. Because it is deep rooting, soil tests for nutrient levels should be deeper than the standard 7.5 cm test, and herbage testing in spring is required to establish the correct nutrient status. Being highly productive, lucerne requires feeding. Farmers report using up to 500-1000 kg/ha (Moot, 2009), of 5% potassic super annually, applied after grazing in 3 applications. Intensive dairy farmers can use a similar amount in highly productive situations.

Management of lucerne is critical to obtain high yields. Each season has certain requirements (Moot, 2009). Management differs from ryegrass based pastures because emerging shoots from the crown require protection, and the lucerne stand must fully flower once a year to restore root reserves. Therefore, careful grazing management has proven most successful. Short grazing periods with high stock volumes is required. The stands need to be grazed hard prior to winter and be destocked through the winter period. The life of the stand will shorten if this is not followed.

Animal health problems arise from grazing hungry animals directly on quickly growing lucerne (Moot, 2009). Both red gut, a condition associated with sudden dietary change and bloat, a digestive disorder characterized by an accumulation of gas in the ruminant's stomach, can cause major problems.

It is important to control weeds in lucerne. Lucerne requires an annual weed spray with appropriate contact and residual herbicides (Moot, 2009). Spraying with a mix of bipyridyl (parable) and atrazine, seven days after the final hard grazing is completed, achieves control. Modern cultivars tolerate aphids, weevils, fungi, and viruses. Correct grazing management also helps control these pests. The

white fringed weevil, which feeds on roots, can be a problem, and cultivation is required to renew the stand if this pest is significant.

Case Study of Bonavaree Farm

Bonavaree Farm grazes the stands for 7 days, then gives them a 35 day spell before stock return (Avery, 2008). Stand life at Bonavaree Farm is 10 years or more. The requirement that no stock graze lucerne in winter means that a winter crop must be grown to provide feed for that period. This fits in well with a rotation where 10 % of the farm is cropped annually, as part of a rotation to resow lucerne stands. Lucerne paddocks are sprayed off in October and direct drilled with winter barley, and then the following October, are direct drilled again with lucerne. This rotation has maintained healthy lucerne stands.

At Bonavaree Farm red gut occurs, particularly when hungry animals are allowed to gorge. Bloat can occur, mainly in spring, and the few animals that are prone to bloat are culled. Culling losses in the first transition to lucerne were high in sheep, but once the animals are permanently raised on lucerne there is little problem. Around 5% of the ewe flock was culled in the first two years. Accepted practices of providing mineral blocks, straw or rough pasture, reduce this need. Bloat capsules and oils are helpful for cattle. Losses from animal health problems are minimal, but management should cater for the potential problems.

Ovulation performance can be affected in sheep grazing lucerne. Bonavaree Farm achieves high reproductive performance mating on lucerne, but if the lucerne is affected by fungus and aphids, it may be unsuitable for sheep during mating.

Lucerne for Irrigated Dairy Farming

Lucerne's growth pattern suits seasonal dairy farming. It starts growing in August after being hard grazed prior to winter. It takes a month for the herbage to reach its optimum grazing height, which maximises dry matter yield. Under current practice, dairy farmers could graze lucerne earlier than is optimum, and lose some potential feed in the first grazing. To alleviate this they could calve later and milk longer in the autumn. This is feasible as lucerne still grows in April/May and late autumn is when the required hard grazing prior to winter occurs. The other options are to grow winter forage, such as annual ryegrass or winter barley, for calving at the beginning of August. This could be supplemented with hay and silage. There are also varieties of lucerne that are winter active, and a portion of the farm area could be planted in these varieties. Another option would be to have a small area of permanent pasture to provide feed in August. Further study is required to establish the best feed plan for this period.

Growing winter feed fits well with the need to replant unhealthy or aged lucerne stands. Around 10% of the farm area is planted in winter crop. The crop area could be resown in lucerne in October which would be available for grazing in mid December.

Due to lucerne not being able to be grazed from late May to early August cows could be grazed off farm. Another option would be to sow brassica crops, such as kale, for wintering the cows and have

an area of annual ryegrass or winter barley for calving. This would require some form of runoff pad, and it may be easier grazing the cows off farm.

Spring management requires letting the lucerne maximise height and grazing it just before the new shoots emerge from the base. The less damage to the new shoots the better so large numbers of cows on a small area is optimum. This fits in very well with the standard grazing rotation dairy farmers use on pasture. With irrigation, the same principles apply right through the summer and autumn.

Experience has shown it is necessary to let the lucerne fully flower once in the growing season to let the plant build root reserves. This can be accommodated in the normal grazing round by adjusting the rotation length. The flowered lucerne could be baled as hay or grazed by the cows, however this would be of lower forage quality. The last rotation in the autumn would be used to clean the herbage right down for winter.

There is an option to mow the lucerne some 24 hours before grazing, to allow the herbage to wilt. Observations suggest the cows prefer wilted lucerne. Whilst no trials have been completed, it stands to reason that mowing 24 hours prior to grazing and wilting lucerne, would reduce the potential for bloat. Mowing lucerne daily during times when bloat is likely would be practical. There is room for further investigation as to how successful wilting would be in preventing bloat. Even without mowing, the tools for successful animal health management are available and work well.

When lucerne is fresh and growing quickly, the use of mineral blocks, making hay or straw available as roughage, or simply having a headland of pasture in the paddock, allows the animals some choice of food and this helps eliminate red gut and bloat problems. Oils in drinking water and slow release capsules are tools that help bloat management. Animals that are prone to health problems on lucerne should be culled. Mineral blocks can provide sodium, which is lacking in lucerne herbage (Douglas, 1986).

Most pests and diseases in lucerne are controlled by grazing off all herbage prior to winter. It is best not to leave a grazing residual for pests to harbour in. Correct grazing achieves this in the normal rotation. Grass grub *Costelytra zealandica*, is a common pasture pest that causes economic damage. The lucerne plant resists grass grub (Sutherland, et al., 1975), this is a significant advantage. However, care must be taken when grazing lucerne affected by aphids or fungus. The main effect on cattle, is lower performance from a drop in herbage quality when these circumstances arise. Cow ovulation is unlikely to be affected because aphids and fungus tend to occur later in the season after cattle have been mated.

Lucerne is a legume and fixes nitrogen, so does not require nitrogen applications. This has significance in reducing nitrate leaching problems. Lucerne can capture nitrate through its deep tap root, and as such, is seen as a tool for cleaning up excessive nitrate. Therefore, the plant is seen as being more sustainable than pasture where nitrogen must be applied. Lucerne also has the ability to ameliorate nitrate problems when cow shed effluent is applied to the land (Moot, 2009).

The ability of lucerne to provide approximately 25% more high quality feed than pasture, results in higher production potential. This is significant in economic terms. Lucerne costs more to establish than pasture, and has some additional animal health costs, but its savings in nitrogen application should more than make up for this. Annual costs of maintaining lucerne are higher due to the weed control and additional potash fertiliser and lime required.

The costs of culling cows that don't perform on lucerne would only be significant in the first season of lucerne production. Replacement stock could be raised on lucerne, so culling from year to year could be done before they reach the herd.

Replacement of around 10% of the lucerne annually is similar to the amount of normal regrassing. This area can be used for winter feed production. However, that area is removed from grazing from February when the winter feed is sown. A large crop is then available in August, which after grazing, is sown back to lucerne in October. The earliest this could be grazed would be mid December so there is a loss of grazing. There would be a loss in autumn grazing of 10% of the lucerne area, but a pastoral dairy farm planting 10% of its area in new grass effectively loses grazing as well. The lost grazing, caused by the need to replace 10% of the area would be balance by the additional production so it is safe to assume the same stocking rate.

There is potential to lose grazing when the lucerne has to be allowed to fully flower. This can be done at any time from December to May and only once in the season. From the optimum grazing height to full flower, is around a two week period of no grazing. The cows can still graze this after flowering, at a lower quality, or it can be made into hay. A pastoral dairy farm normally takes silage and hay so both systems lose areas for that purpose.

The need to winter graze cows off the farm is more important using a lucerne system. However, most high producing dairy farms, graze the cows off farm in winter, to ensure feed availability at calving.

Economic Factors

Table one shows the budget for the irrigated Lincoln University Dairy Farm for both the current operation, and a comparison of how lucerne systems would operate on the same farm.

This farm has high outputs and moderate inputs. Feed and grazing are high cost items and contribute to the high production.

The lucerne dairy system would be 90% lucerne and 10% winter crop. Winter active varieties of lucerne may be useful. Each lucerne paddock would have a small pasture headland so cows could have feed choice. Hay would be available at all times. All other management practices required for using lucerne are known, and are already available to pasture based dairy farmers.

Assumptions for the budget comparison are as follows

1. The example budget shows a 25% increase in feed production. This estimate comes from the extra dry matter potential.
2. The farm continues with wintering off cows from late May to calving in early August.
3. The system of buying in outside feed continues with the lucerne system.
4. There is no nitrogen fertiliser used on the lucerne system.
5. Fertiliser and lime expenses allow for a one third increase in potassic super and some lime for the lucerne system.

6. Animal health increases to allow two bloat control capsules (or equivalent) each year for each cow in the lucerne system.
7. Regrassing/crop allows for the cost of winter feed and resowing to lucerne.
8. Allowance has been made to winter spray the lucerne for weed control.

Results of Budget Comparison

Scenario 1	Existing,	4.15 cows/ha, 436 kg ms/cow	Cash Surplus	\$1,089,480
Scenario 2	Lucerne,	5.18 cows/ha, 436 kg ms/cow	Cash Surplus	\$1,504,868
Scenario 3	Lucerne,	4.15 cows/ha, 545 kg ms/cow	Cash Surplus	\$1,637,810
Scenario 4	Lucerne,	4.77 cows/ha, 473 kg ms/cow	Cash Surplus	\$1,557,300
Scenario 5	Lucerne,	4.77 cows/ha, 435 kg ms/cow	Cash Surplus	\$1,358,065

Scenario 1 is the existing grazed pasture situation. Scenario 2 and 3 alter the number of cows and the production per cow. There will be a trade off between increasing cow numbers per ha, or having much higher per head production, given the additional feed available.

Scenario 4 is increases the number of cows and the production per head. Scenario 5 is the same as scenario 4 but simply drops the production increase to 15%.

While it is difficult to exactly predict the increase in production, it is clear that the total costs do not change significantly. Any production increase achieved will serve to increase profit.

Table 4: Budget Comparison Lincoln University Dairy Farm Compared With Lucerne System (SIDDC, 2010).

Budget for the year ending 30 May 2011

Scenario	1		2		3		4		5	
	Existing Pasture		Potential Lucerne		Potential Lucerne		Potential Lucerne		Potential Lucerne	
	Per Cow		Per Cow		Per Cow		Per Cow		Per Cow	
Peak Cows	660		825		660		760		760	
Area Ha	159		159		159		159		159	
Stocking Rate	4.15 cows/ha		5.18 cows/ha		4.15 cows/ha		4.77 cows/ha		4.77 cows/ha	
Increase Feed			125%		125%		125%		115%	
Production Kg Milk/solid	287,971	436.32	359,964	436.32	359,964	545.40	359,964	473.64	331,167	435.75
Milk/price	\$6.60		\$6.60		\$6.60		\$6.60		\$6.60	
Income										
Milk/solids	1,900,609	2,879.71	2,375,761	2,879.71	2,375,761	3,599.64	2,375,761	3,126.00	2,185,700	2,875.92
Dividend	91,740	139.00	114,675	139.00	114,675	173.75	114,675	150.89	105,501	138.82
Stock sales	84,813	128.50	106,016	128.50	84,813	128.50	97,663	128.50	97,663	128.50
Stock Purchases	21,600	32.73	27,000	32.73	21,600	32.73	24,873	32.73	24,873	32.73
Gross Farm Revenue	\$2,055,562	\$3,114.49	\$2,569,452	3,114.49	\$2,553,649	3,869.16	\$2,563,226	3,372.67	\$2,363,992	3,110.52
Expenses										
Administration	23,650	35.83	23,650	28.67	23,650	35.83	23,650	31.12	23,650	31.12
Animal Health	45,636	69.15	57,045	69.15	45,636	69.15	52,551	69.15	52,551	69.15
Breeding	37,434	56.72	46,793	56.72	37,434	56.72	43,106	56.72	43,106	56.72
Electricity	18,500	28.03	23,125	28.03	18,500	28.03	21,303	28.03	21,303	28.03
Employment	198,276	300.42	247,845	300.42	198,276	300.42	228,318	300.42	228,318	300.42
Grass silage purchased	65,340	99.00	65,340	79.20	65,340	99.00	65,340	85.97	65,340	85.97
Silage making	17,183	26.03	17,183	20.83	17,183	26.03	17,183	22.61	17,183	22.61
Replacement Grazing	120,878	183.15	151,098	183.15	120,878	183.15	139,193	183.15	139,193	183.15
Winter grazing	125,355	189.93	156,694	189.93	125,355	189.93	144,348	189.93	144,348	189.93
Nitrogen	78,140	118.39	0	0.00	0	0.00	0	0.00	0	0.00
Fertiliser and Lime	36,355	55.08	48,352	58.61	48,352	73.26	48,352	63.62	48,352	63.62
Freight	400	0.61	500	0.61	400	0.61	400	0.53	400	0.53
Irrigation	66,333	100.50	66,333	80.40	66,333	100.50	66,333	87.28	66,333	87.28
Rates and Insurance	16,262	24.64	16,262	19.71	16,262	24.64	16,262	21.40	16,262	21.40
Regrassing/crop	15,040	22.79	15,040	18.23	15,040	22.79	15,040	19.79	15,040	19.79
Repairs	52,500	79.55	52,500	63.64	52,500	79.55	52,500	69.08	52,500	69.08
Shed expenses	8,200	12.42	10,250	12.42	8,200	12.42	9,442	12.42	9,442	12.42
Vehicle expenses	20,300	30.76	25,375	30.76	20,300	30.76	23,376	30.76	23,376	30.76
Weed and pest	300	0.45	16,200	19.64	16,200	24.55	16,200	21.32	16,200	21.32
Accommodation	20,000	30.30	25,000	30.30	20,000	30.30	23,030	30.30	23,030	30.30
Cash Working Expenses	\$966,082	\$1,463.76	\$1,064,584	\$1,290.40	\$915,839	\$1,387.63	\$1,005,927	\$1,323.59	\$1,005,927	\$1,323.59
Depreciation	117,500	178.03	117,500	142.42	117,500	178.03	117,500	154.61	117,500	154.61
Total Operating Exp	\$1,083,582	\$1,641.79	\$1,182,084	\$1,432.83	\$1,033,339	\$1,565.67	\$1,123,427	\$1,478.19	\$1,123,427	\$1,478.19
Dairy Operating Profit	\$971,980	\$1,472.70	\$1,387,368	\$1,681.66	\$1,520,310	\$2,303.50	\$1,439,800	\$1,894.47	\$1,240,565	\$1,632.32
Cash Operating Surplus	\$1,089,480	\$1,650.73	\$1,504,868	\$1,824.08	\$1,637,810	\$2,481.53	\$1,557,300	\$2,049.08	\$1,358,065	\$1,786.93

Conclusion

There is potential for an irrigated Canterbury dairy farm to use lucerne as its primary feed source. The expected increase production from a lucerne system may be significantly higher than what a pasture system offers.

The economic benefits of a lucerne system are potentially very high. Using Lincoln University Dairy Farm data shows increases of 38% and higher, in cash operating surplus, with little increase in total expenditure.

The ability of lucerne to assist with nitrate leaching problems is important from an environmental sustainability view. The plant's lack of susceptibility to grass grub is also a benefit.

The transition from pasture management to lucerne management will require planning. There is potential to further investigate lucerne management, and improve its production, through research and experience in the dairy situation.

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