Adapting farm systems in the Starborough-Flaxbourne district to a drier future

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Adaptation for survival; an overview

Small changes are continuously and progressively made to farm systems in response to market opportunities, increasing costs and the availability of better technologies for adapting to the environment. Adapting to survive in the face of a severe environmental constraint is less common, with fewer farmers able to make the necessary transition.

This project was fortunate to be able to study a farm system that has adapted to maintain business profitability and start the process of repairing hill slope erosion.

Adaptation is an evolutionary concept where an individual with unique characteristics for survival eventually dominates an ecological niche. This chapter is about the Avery family of Bonavaree farm and the adaptation of their farming system to a drier environment.

While there are few economic sheep and beef units in the region to benefit from this documented example of adaptation, it does provide a generic model of the process. The first step is to acknowledge the need to adapt. For a pastoral enterprise adaptation, the next step is identifying plants that survive in the environment.

The point of adaptation in this study was the introduction of a grazing system that fully utilised lucerne to improve ewe breeding efficiency and maximise lamb growth rates, resulting in a premium being paid for early season lambs. In hindsight, the adaptation can be seen as improving the efficiency of water use.

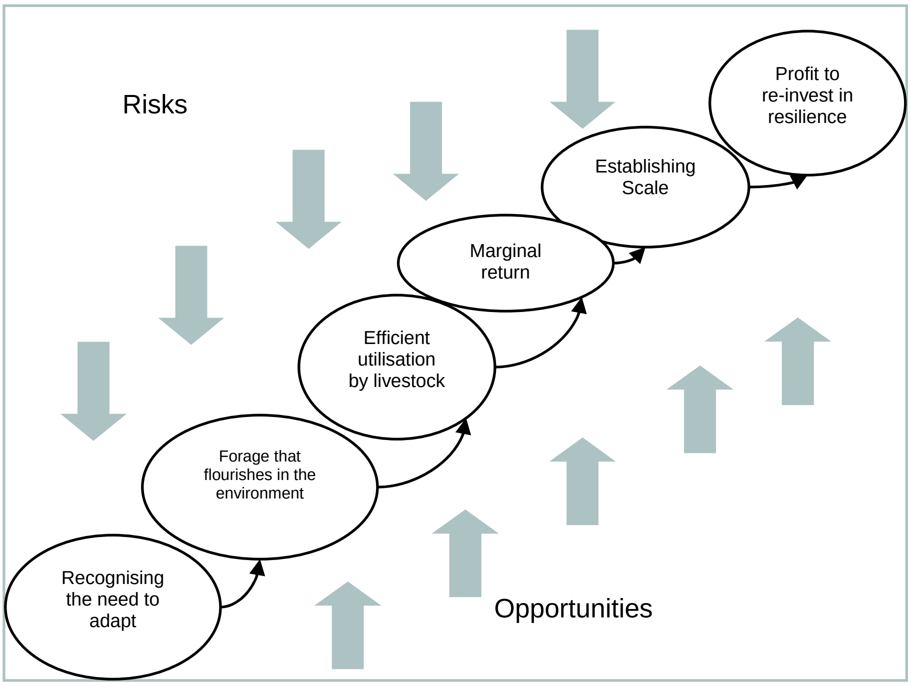

Figure 1; Improving resilience can be viewed as a series of important mile-stones that are in balance with risks/adversity and opportunities/ investment.

Feeding livestock well carries environmental benefits as animals are not left to graze fragile hill slopes for prolonged periods. Low pasture utilisation helps re-establish groundcover, thus reducing the risk of erosion when it rains.

The simple model of adaptation in farm systems (above) provides a framework for discussing the functional milestones of change. Each change needs to be achieved in sequence, with risks balanced against pressures to adopt the opportunities.

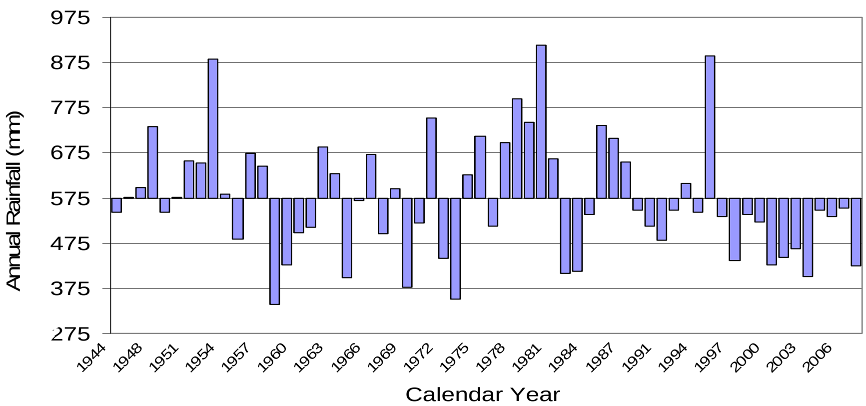

Figure 2; Deviation from 573mm mean annual rainfall at Grassmere.

Recognising the need to adapt

Prior to 1996, rainfall patterns were more generally benevolent in the Starborough Flaxbourne area and farm systems were designed around grass/clover based systems which provided early and late pasture growth. Lucerne was grown for conserving into supplements, providing reliable winter feed.

Lambing could occur early, with a portion of lambs sold before Christmas. From January on, liveweight gains decreased as pastures lost palatability with increasing temperature and dry weather. Brassicas such as rape and turnips were grown, boosting growth rates in late summer and autumn so remaining lambs could be finished before winter.

In 1997, these systems became less reliable due to prolonged dry through summer and autumn. Drought conditions prevailed in the following years, with rainfall consistently below the 561mm average recorded since the Lake Grassmere Saltworks started keeping records in 1943. See Chapter 1 (Porteous).

Pastures did not regain density and were invaded by weeds from surrounding hills, which are more adapted to dry conditions. Failing brassica crops delayed lamb finishing. Attempts to finish lambs over winter meant competition with ewes at tupping and lambing, with compounding poor results.

The model we propose concludes that farmers will attempt to continue with this system if they do not recognise the need to adapt. This 'do nothing' approach may arise from a belief that the situation is a cyclic phenomenon with an inevitable return to the spectacular rainfall years of the 1970's.

It is a waiting game with considerable risk. Some individuals will see the 'do nothing' approach as a wise balance between over-reacting and calm expectation of life returning to normal.

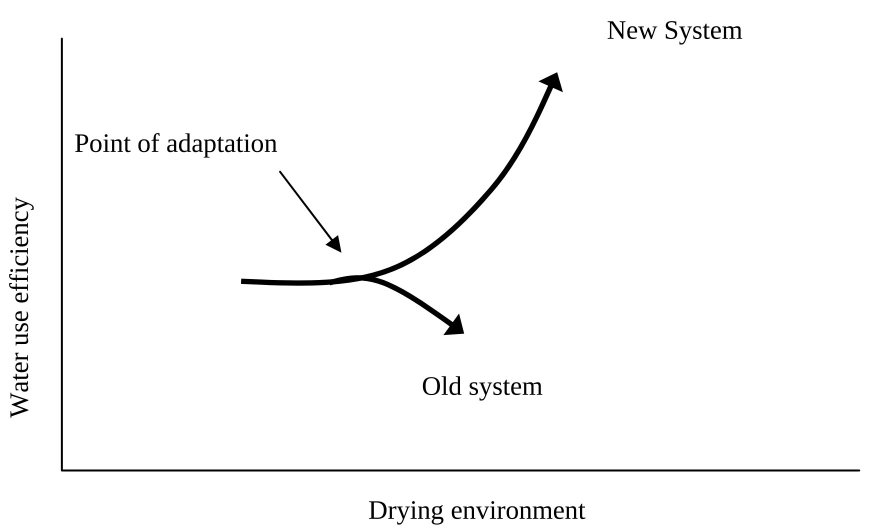

Figure 3; Adaptation to a drying environment.

The alternative is to recognise the need to change and acknowledge that some practices no longer work. In the context of a drying environment, adaptation could be seen as improving the efficiency with which water is used.

Adaptation occurs at the point where a farmer embarks on a new system and it is more successful. It is not about a middle road between these systems, and there is no reversion to previous practices.

Plants that flourish in the environment

Over 12 years of drier climate (Figure 2), ryegrass-based pastures have not survived drought. Grasses take time to regenerate back from small basal meristems or seed and considerable moisture is required. The efficiency of water use during this phase is poor and requires a prolonged period of soil hydration.

Factors that have considerable influence on the cost of forage production are:

- The number of establishment failures. An advantage of ryegrass-based pastures is that they can be established in autumn when moisture is most reliable. However, this has to be balanced against longevity;
- The longevity of the plants that are established. Ryegrass-based pastures are poor in this respect, with a longevity in the past 12 years of less than three years;
- The timeliness of re-establishment. After drought is a time when farmers can least afford ryegrass renewal. Inevitably, farmers elect to continue with very open pastures that are quickly invaded by unimproved pasture species from surrounding hills.

Individuals cannot successfully adapt to dry by choosing to re-establish species that have proven neither to survive nor be cost effective.

On Bonavaree, lucerne is a survivor that recovers rapidly even after the longest dry period. After rainfall it re-emerges, providing considerable quantities of forage for livestock when most needed. With its ability to send roots down over 20 metres, it can tap water out of reach for ryegrass roots making it highly efficient at utilising rainfall in the newly dry environment. Factors that make lucerne so successful on Bonavaree include:

- High soil pH that increases with depth. See Chapter 2 (Hunter and Collins).
- Lack of impediments to root penetration in the soil horizon;
- The Averys' long association with lucerne and high level of skill as growers.

Efficient utilisation by livestock

The niche for lucerne has traditionally been to reliably grow high quality winter supplements. Directly feeding livestock on lucerne is difficult, as they need to adjust to a high level of protein relative to carbohydrate. Small scattered areas may require stock to constantly switch from grass to lucerne, which carries the risk of high stock losses from bloat and red gut.

The decision to base Bonavaree's production on lucerne, with the emphasis on direct feeding rather than making supplements, was the point at which adaptation took place (Figure 3). Planting a mixture of species would not have reflected understanding of what would flourish in the newly dry environment.

Opportunity is maximised by having a large area of lucerne that can support mobs for a long period. Best utilisation is offered by multiple lambing ewes that require high levels of nutrition. They present an efficient livestock option, defined by the weight of lamb produced from the weight of ewe wintered. This efficiency ratio recognises the highest cost to supporting a breeding flock is forage eaten during winter.

Lamb growth rates achieved on lucerne are high, reaching 390g/day pre-weaning and 250-300g/day post-weaning in the 2005 and 2006 years (figure 4). Liveweight gain was in the top 5% of the Farmax[1] database.

Multiple ewes run on lucerne produced 34.8kg lambs at 85 days versus single ewes that produced 34.8kg lambs in the same period.

For a description of lucerne-based grazing systems at Bonavaree, see Chapter 3 (Moot and Avery).

Early finishing

High lamb growth rates are the pre-requisite to early finishing dates. In 2006/07 and 2007/08, on average 80% of all lambs at Bonavaree had been finished before the end of December. Lambing date is July 23 and weaning starts in late October and finishes in early November. See Chapter 3 (Moot and Avery). High lamb growth rates are the pre-requisite to early finishing dates.

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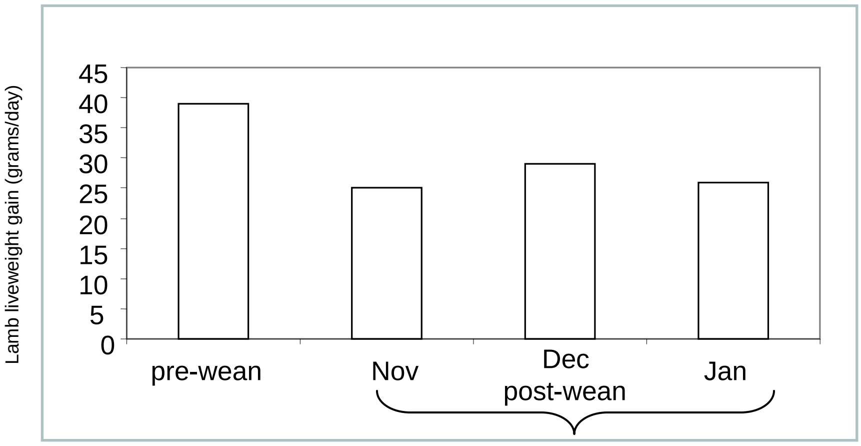

Figure 4; Growth rate of all lambs pre-weaning, and sale lambs in November, December and January, Bonavaree.

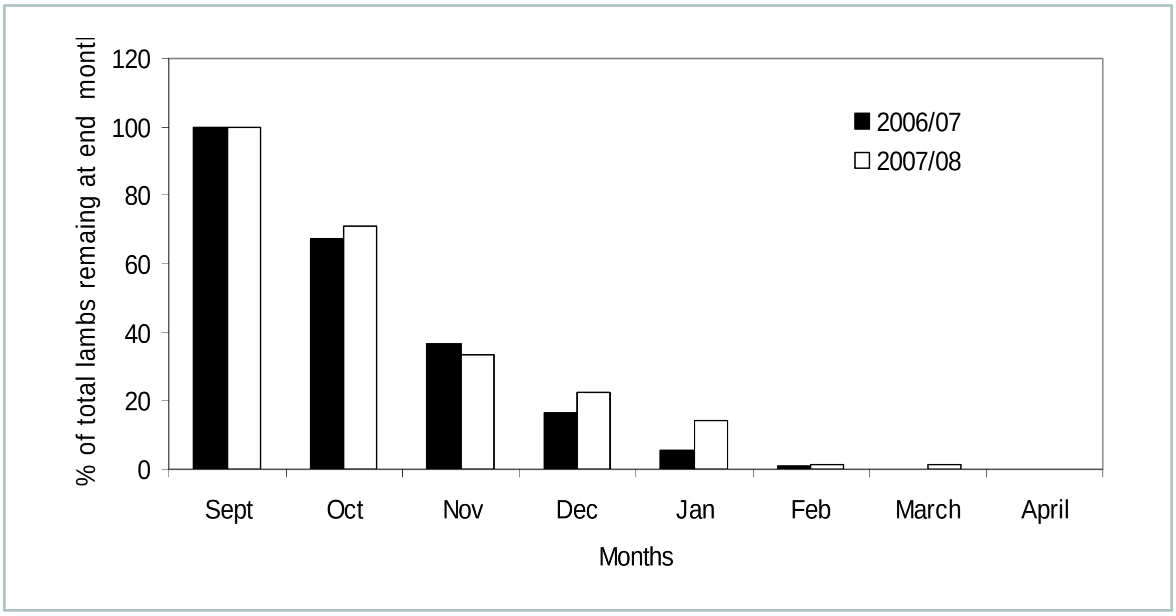

Figure 5; Percentage of total sale lambs on hand at the end of the month, 2006/07 and 2007/08 seasons, Bonavaree.

[1]A farm planning system for increasing profitability

Risk, revenue and recovery periods

Pasture growth rates are highly variable in this climate, especially from November to March, where the arrow is located. Farmers should not depend on generating more than 20% of their income in this high risk period, especially in January and February. The most reliable revenue period is from August until the end of November, when pasture and thus lamb growth is at its peak. To maximise this revenue period requires farmers to focus on the recovery period between March and June to ensure stock and pastures are in optimum condition. No recovery from previous seasons should be occurring in the revenue period.

In Figure 6 (below), mean pasture growth rate has been estimated by Farmax modelling and expected variation (risk) has been identified based on farmer knowledge and AgResearch's Pasture Forecaster.

Figure 7 demonstrates the premium to supply in November rather than January. From 2003 to 2007, this premium has averaged $1.14/kg of carcase weight. For the Averys' 17kg average carcase, this equates to $19.38 extra per head.

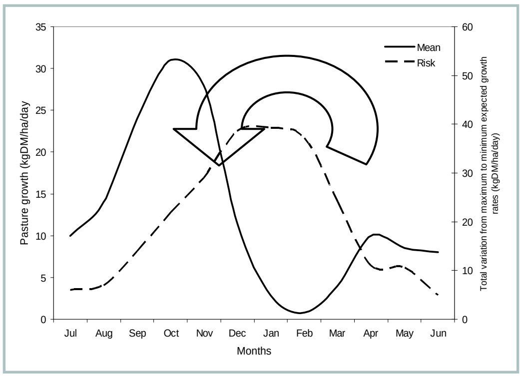

Figure 6; Mean pasture growth and expected variation (risk), Bonavaree.

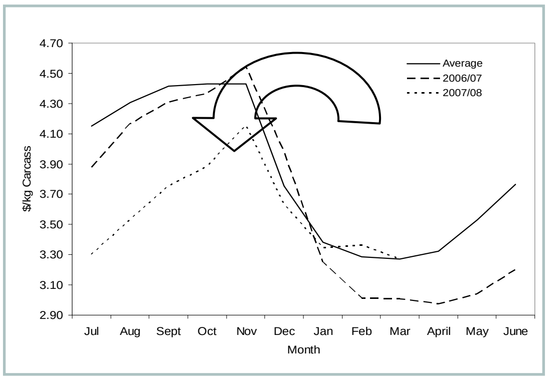

Figure 7; Average market premium for early supply of 15kg YM grade lamb in the South Island, 2003/04 to 2006/07. The arrow represents a premium of $1.14/kg of carcase weight for shifting lamb finishing from January to November.

Sheep		05/06 Bonavaree	06/07 Bonavaree	Group average	Top 20%
Tupping body weight (kg)[2]		67.1	61.5	61.1	61.5
Average birth date[2]		21 Aug	20 Aug	09 Sep	28 Aug
Scanning %[2]		160	153	165	168
Scanning index[2]		2.4	2.5	2.7	2.7
Losses - scanning to tailing (%)[2]		13	11	22	26
Tailing %[2]		139	136	130	124
Losses, tailing to weaning (%)[2]		1.7	1.5	2.0	2.4
Weaning %	Ewes tailing[3]	137	135	121	122
	Hogget tailing[4]	93	87	80	59
Survival - scanning to weaning (%)[2]		85	88	78	72
90 Day weaning weight[2]		39.3	40.3	29.7	39.2
Average growth rate to weaning (g/d)		379	396	276	382
Ewe efficiency[5]		80	88	61	72

Table 1. Sheep breeding performance compared with the Farmax average and top 20%.

Efficiency drives profits

The profitability of sheep breeding enterprises is driven by breeding efficiency (Ogle, 2008), determined by lamb weight produced compared with ewe weight at tupping (as a percentage). This expresses an efficient production goal of wintering a small amount of ewe liveweight and producing a large weight of weaned lamb.

Bonavaree has a breeding efficiency of around 80 to 82% compared with the Farmax top 20%, at 72%. This high result is driven by high lamb growth rate and survival rather than ewe fertility (Table 1).

[2]A weighted average of ewes mobs only (hoggets not included)
[3]Lambs from ewe mobs only divided by ewes only
[4]Lambs weaned from hogget mobs only divided by all ewe hoggets
[5]kg lamb weaned per kg ewe mated for ewe mobs only

	Gross margin per kgDM, Bonavaree	Farmax average	Top 20%	Gross margin per kg product, Bonavaree	Farmax average	Top 20%	kgDM/kg product, Bonavaree	Farmax average	Top 20%	% of feed eaten[6]
Sheep	11.2	6.0	9.9	2.50	1.77	2.47	22.4	29.2	25.0	71.7
Beef	7.6	6.4	10.9	2.72	2.33	3.05	35.6	36.6	27.9	23.3

Table 2. Gross marginal return, return per kilogram of product and kilograms of dry matter needed to produce a kilogram of product.

Adding value to this lamb production efficiency is the premium for early slaughter. Bonavaree earns well above the top 20% in gross margin per kilogram of dry matter (kgDM) consumed. Rapid growth rates ensure that the enterprise expends a lower than average amount on liveweight maintenance, and more on growth. The result is that only 22.4kgDM is needed to produce one kilogram of product compared to the average of 29.2kgDM.

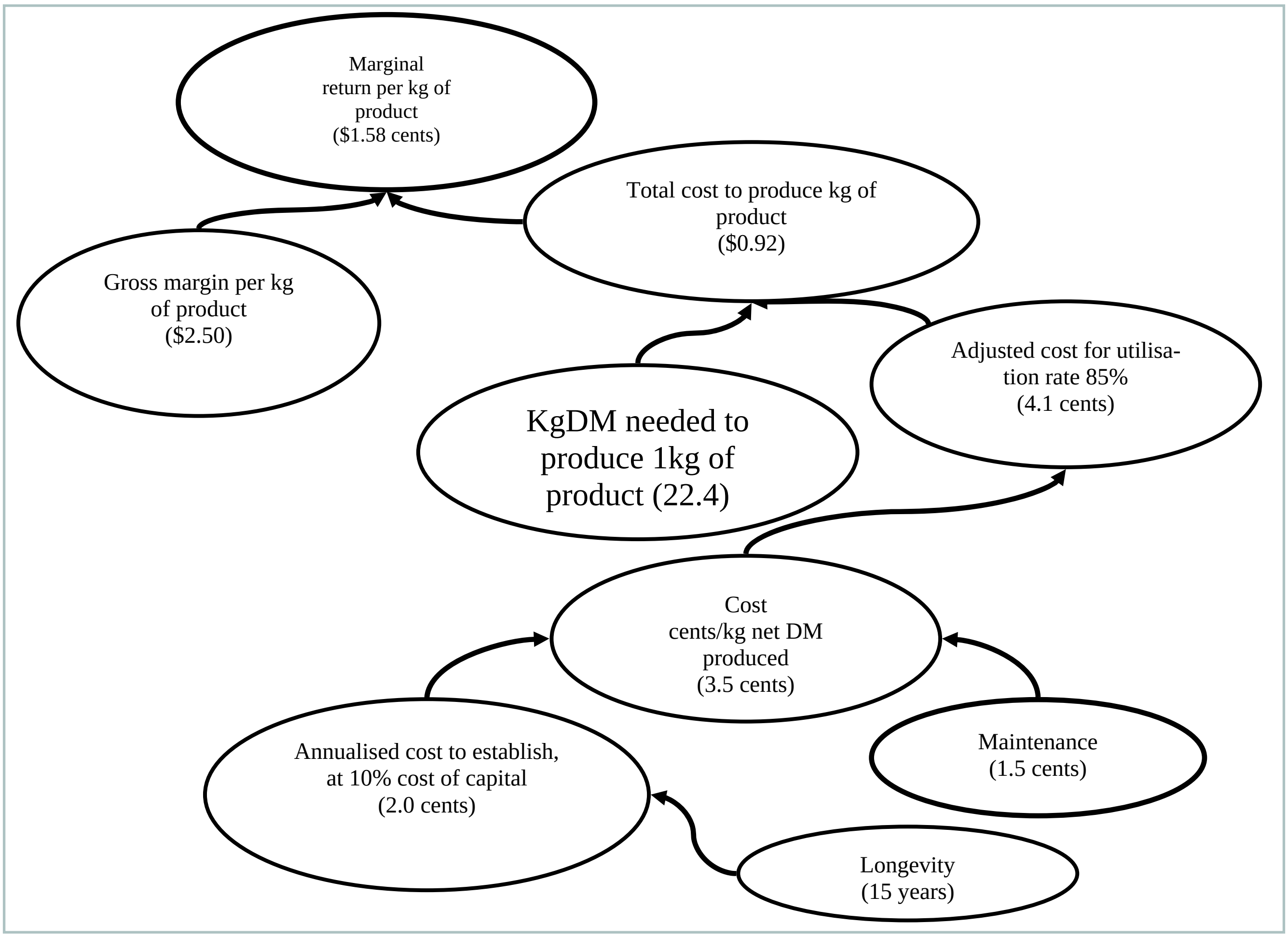

Figure 8; The marginal return from utilising lucerne. See Appendix, Table 7 for detailed establishment costs.

Marginal return

An adaptation will not work if a profit cannot be made. In livestock farming, cost of pasture comprises capital development costs plus annual maintenance costs.
Annual costs of lucerne must include weed and pest control. Clearly, lucerne's longevity will be a significant factor in calculating marginal return.

[6]Percentage of feed eaten refers to the percentage that enterprise consumes of the total livestock intake

Establishing scale

Business survival is not assured because lucerne has been successful in one or two paddocks. Success demands a sustainable net profit, satisfying both the short term need to provide for the owners and the longer term need to continue the adaptation process. Lucerne planting should therefore increase until some natural limiting factor means further scale will achieve no marginal return.

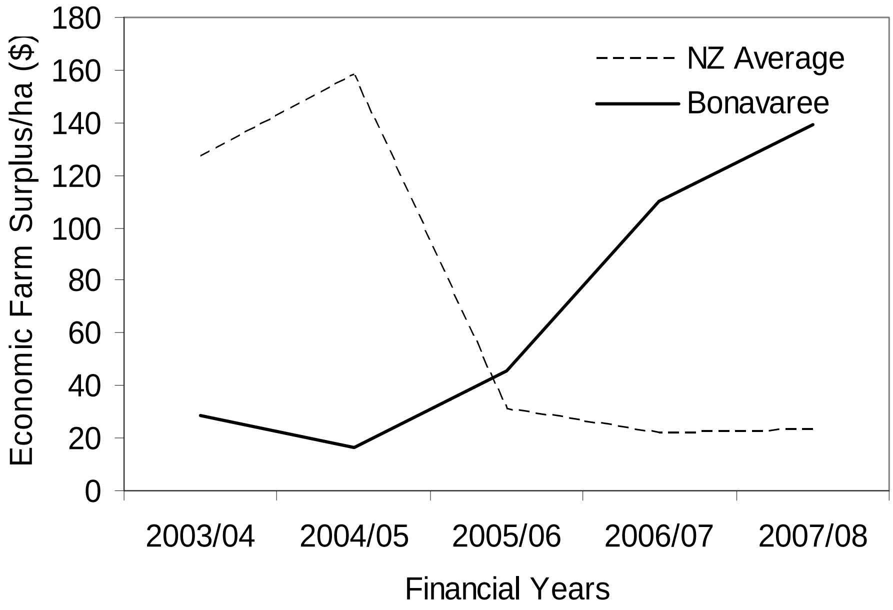

Figure 9; Economic farm surplus at Bonavaree compared with the average New Zealand sheep and beef farm.

Potential limits to scale are:

- Slope - over 15% slope, bare earth between lucerne plants can be exposed to wind erosion making soils susceptible to further damage
- Ability to utilise - when dry conditions occur considerable areas of lucerne need to be harvested within a short period or forage will be lost through leaves falling off the stem. Lack of sheep during the summer period (when it is too risky to be attempting lamb finishing) can limit ability to harvest.

It would be inefficient for a business to stop planting before lucerne reaches an ideal scale, and to start taking risks in experimenting with new adaptive strategies.

As the lucerne area has increased at Bonavaree, business profit (economic farm surplus) has improved, compared with the average New Zealand sheep and beef farm (MAF 2007 Pastoral Monitoring Report, http://www.maf.govt.nz/mafnet/rural-nz/statistics-and-forecasts/farm-monitoring/2007/pastoral/6-sheep-and-beef.pdf)

A functional landscape

A motivation for adaptation on Bonavaree was the condition of hill slopes. A direct approach, of investment into healing degraded slopes, was possible. However, to do so would have risked business failure as no species has yet been identified which would flourish in the dry conditions and could be economically established. See Chapter 5 (Wills). Without a profit margin, soil erosion problems could not have been tackled on any scale.

Is the only option for adaptation a landscape with good lucerne stands and a backdrop of highly eroded hill slopes? A more successful approach is to maximise returns from better soils so that revenue is available to invest in remediating hill slope erosion.

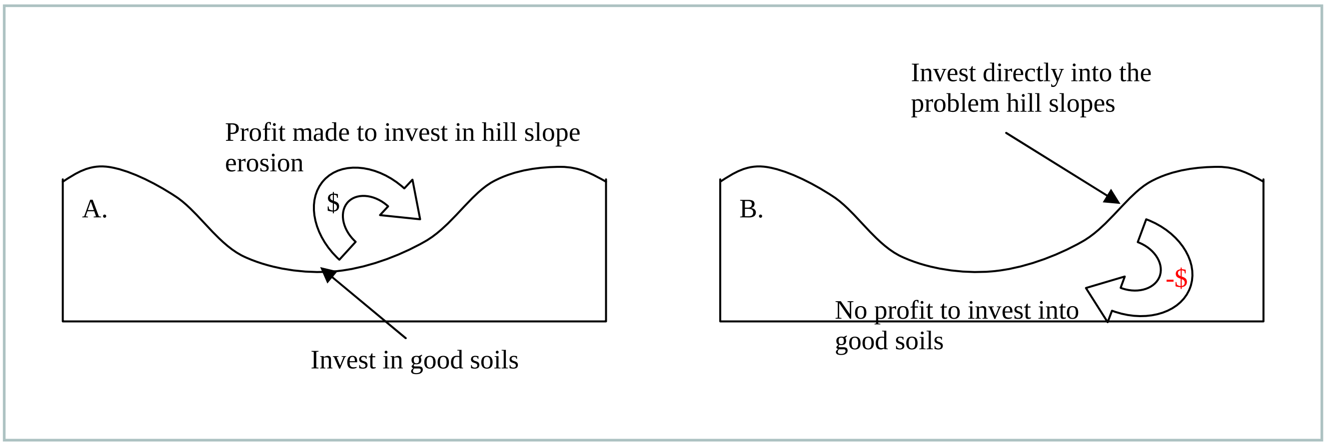

Figure 10; Routes to solving hill slope erosion: A. Invest in good soils and develop profit to tackle hill slopes when a successful strategy emerges. B. Invest directly in hill slopes with the risk this may not be profitable.

Quality feed on flats redistributes grazing pressure

The first step towards solving hill slope erosion is to remove prolonged grazing pressure and allow more plants to survive. At higher densities, plants will provide better ground cover and with lower grazing pressure more will progress to a reproductive state where they reseed and build a seed bank.

Pasture failure on flats followed by the ingression of low quality plants, is a major factor in pushing grazing pressure upslope. Introducing higher quality forage to flats has pulled this pressure off the slopes, with fencing not necessarily required to separate areas of different terrain.

Grazing pressure reduced

Farmax modelling of Bonavaree has calculated that 40% of potential pasture production was lost either through decay or did not grow because pasture height was sub-optimum (43% in 2005/06 and 37% in 2006/07). Feed utilisation thus averages 60%; the lowest utilisation rate in the Farmax database for those years.

Assuming that lucerne at Bonavaree is achieving 80-85% utilisation, then the hills are achieving 48% compared with a Farmax average of 80%. In the years the pasture utilisation measurements were made, no fertiliser was applied on the hills as a better return on investment was achieved by spending on lucerne expansion. It is therefore likely that hill slopes will remain in lower fertility grasses, with grazing pressure transferred to lucerne areas.

While the return per kilogram of dry matter eaten by animals was very high (Appendix 1, Table 3) the figure is slightly below average on a potential pasture growth rate basis.

However, a relatively low rate of utilisation is important in meeting the objective of reduced grazing pressure to enable hill slope regeneration.

Figure 11; Improving forage quality on the flats reduces grazing pressure on hill slopes.

Appendix 1. Farm performance against the average South Island farm measured through Farmax

	Bonavaree 05/06	Bonavaree 06/07	Group average	Top 20%
Effective area (ha)[7]	1066	1061	1053	535
Potential pasture production (tDM/ha)	4.79	3.52	7.59	7.82
Nitrogen boost (tDM/ha)[8]	0.00	0.00	0.38	0.78
Pasture losses (tDM/ha)[9]	2.14	1.58	1.58	1.55
Pasture loss percent of total production[10]	43.4	37.4	20.4	19.6
Net pasture production (tDM/ha)[11]	2.66	1.94	6.39	7.04
Feed conserved (tDM/ha)	0.04	0.00	0.12	0.19

Table 3. Forage supply summary

	Bonavaree, 05/06	Bonavaree, 06/07	Group average	Top 20%
Total feed eaten (tDM/ha)[12]	2.97	2.80	6.46	7.12
Demand from supplements (%)	9.3	17.9	6.7	6.8
Standardised stocking rate (SU/ha)[13]	5.4	5.1	11.7	12.9
Live weight wintered (kg/ha)[14]	337	330	704	844
Net product produced (kg/ha)	129	111	243	307
Feed conversion efficiency[15]	22.9	25.2	28.2	24.1
Sheep: cattle: deer ratio[16]	67:33:0	72:28:0	57:39:5	38:62:0

Table 4. Forage demand summary

Gross Farm Income[17]	Bonavaree, 05/06	Bonavaree, 06/07	Group average	Top 20%
Per kg of potential pasture production (c/kg)[18]	8.4	8.7	10.4	17.3
Per kg of dry matter eaten (c/kg DM eaten)	13.4	12.3	11.2	17.8
Per hectare ($/ha)	397	343	751	1260

Table 5. Gross farm income summary

Gross Margin[19]	Bonavaree, 05/06	Bonavaree, 06/07	Group average	Top 20%
Per kg of potential pasture production (c/kg)	6.2	5.8	6.9	13.5
Per kg of dry matter eaten (c/kg DM eaten)	9.9	8.2	7.5	14.0
Per hectare ($/ha)	294	229	512	985

Table 6. Gross margin summary

[7]Total grazable area less area in cash cropping
[8]Amount of extra pasture grown because of nitrogen applications
[9]Pasture lost from decay and the loss of potential growth due to sub-optimal pasture height
[10]Percentage of potential pasture growth lost to sub-optimal pasture height and decay
[11]Potential plus N boost less losses
[12]Total Feed Eaten (tDM/ha) is calculated on the effective area
[13]Total stock demand divided by 550 kgDM/SU
[14]Liveweight at July 1, based on effective area
[15]DM intake divided by total production of wool, carcase, velvet
[16]Calculated from the total annual intake of each species
[17]Sales revenue less purchase costs and plus or minus any change in the capital value of stock or conserved feeds (hay, silage). It excludes crop or other income, and is calculated on the average effective area.
[18]Potential Pasture Production is the pasture growth that would have occurred if the optimum pasture height had been achieved through the year, plus or minus any change in pasture cover from the start to the end of the year.
[19]Gross Farm Income less an allowance for annual health, shearing, velveting, supplementary feed and interest on stock capital value, calculated on average effective area

Appendix 2. Lucerne establishment and maintenance costs

	Type	Rate	Cost per unit	Total cost
Fertiliser	Crop 20 with drill	250kg/ha	$756/t	$189.00
Lime	Ag lime	1 tonne/ ha	$49 spread	$49.00
Spraying	Tractor $100/hour @ 3 applications	0.25 hours	$ 25 per ha	$75.00
Drill	Duncan enviro direct drill (Contractor)	120/ha	1 ha/hour	$120.00
Sprays				
-Weedicide	Glyphosate/Pulse/Granstar 2nd spray Glysophate and Pulse and Lorsban as below	4ltrs per ha/ 200mls/ 40gms 4ltrs per ha/ 200mls/ 40gms	$7.50 per ltr	$64.63 $36.63
-Weedicide	24DB after emergence	4ltrs/ha	$360 per 20 l	$72.00
-Pesticide	Lorsban cut worm/ springtail	500 mls/ha	$396/20 ltr	$9.90
Seed	Torlesse/ Super sonic/ Wairau	10 kgs	$21 /$18/ $12	$180.00
Inoculant	Inoculant	Packet to 25kgs of seed	$25 per packet	$8.60
Other	Organisation and attendance by ourselves	$60 per hrs	0.5 per ha	$30.00
Total				$798.13
Price used in Figure 8. The marginal return from utilising lucerne.				$900.00

Table 7. Establishment costs per hectare

An establishment cost of $900/ha repaid over 15 years at 10% gives a total repayment cost per year (principal and interest at 10%) of $118. Based on 6000kg/ha, this equates to 2 cents/kg of dry matter per year.

	Type (if applicable)	Rate	Frequency	Cost per unit	Total cost
Fertiliser	Superphosphate	250kgs/ha	Average every second year	$310 per tonne	$38.75
Lime	Ag lime	1 tonne/ha	Every 5 years	$49 spread	$9.80
Spraying	Tractor $100/hour	0.25	Average every two years	$25	$12.5
-Weedicide	Gramoxone	2 ltrs/ha	Every two years	$287 per 20 ltr	$14.35
-Weedicide	Atrazine	900 gms/ha	Every two years	$121 per 10 kg	$5.45
-Pesticide	Some times aphid spray				
Other	Sometimes spinnaker if mallow is a problem				
Total					$80.85
Price used in Figure 8. The marginal return from utilising lucerne.					$90.00

Table 8. Maintenance costs per hectare per year

Based on 6000 kgDM/ha/year, maintenance costs equate to 1.5 cents/kg of dry matter per year.

References

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