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An Economic Comparison of Sheep Grazing Systems on the Northern Tablelands of NSW

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Abstract

Three 54ha 'farmlets' were established in 2000 near Uralla, NSW to trial high input, moderate input and intensive rotational grazing systems. A representative farm approach was used to interpret the profitability results of the trial from July 2000 to June 2005 at a commercial scale level to make research results more relevant to farmers.

At the gross margin level, the high input farmlet had the highest annual gross margins, but this farmlet had the worst whole farm performance. These contrasting results support the claim that annual activity gross margins cannot alone indicate the profitability of an investment. This demonstrates that whole farm analysis is the most suitable method to assess different grazing systems.

Keywords: sheep, grazing systems, pastures, whole farm analysis

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Introduction

The Cicerone Project began in 1998 with the main objective of addressing land and pasture management issues that are of key importance to Northern Tablelands producers, in particular, the profitability and sustainability of grazing enterprises. The project has been undertaken at the CSIRO research station at Chiswick, Uralla NSW. The aim was to compare three different systems of pasture input and grazing management relevant to the Northern Tablelands of NSW (Gaden *et al.* 2004). Three 'farmlets' of approximately 54 hectares each commenced in 2000 to compare three different grazing and fertiliser systems, which were determined by producer members. The NSW Northern Tablelands livestock industries (mainly sheep and wool and beef cattle production) are the dominant industries (Alford *et al.* 2003) with over 89 percent of the value of agricultural production in the region from those industries in 2000-01. The climate of the region is generally described as a cool temperate highlands environment (Ayres *et al.* 2000). Rainfall is quite variable with seasonal, moderate and severe droughts recorded. High evaporation rates in the summer limit potential pasture growth in the region, and cold winter conditions limit pasture growth from April to October (Alford *et al.* 2003). The implications of the climate characteristics are that graziers in the Tablelands have to face the challenge of obtaining benefit from summer rainfall, which can be erratic, whilst also maintaining pasture quality and nutritive value in the cold winter months. Grazing enterprises have also been challenged in recent years by relatively frequent dry spring and autumn periods, the years 2000-2004 were all at or below median conditions for plant available water for the period 1957-2005 (Carberry et al. 2005).

Some recent sheep industry analyses have all been gross margin-based, which are not capable of indicating the whole farm and overall business performance impacts (Hassall and Associates 2004). Ronan and Cleary (2000) argued that enterprise-level analysis alone cannot result in whole business benchmark outcomes. Rather, that farm enterprise analysis and whole farm business analysis are both needed for a complete farm business plan. A farmlet based experiment in Syria found that the whole-farm approach to enable measurement of the results of integrating crop, sheep and pasture components was an extremely informative and useful methodology (Thomson *et al.* 1995).

Financial (cashflow) feasibility as well as whole farm rates of return must also be considered. For example, Barlow *et al* (2003) used net cash flow analysis over a ten year period to assess the economic impacts of a number of grazing management and sown pasture treatments under the Sustainable Grazing Systems (SGS) National Experiment.

In order to translate the results from the Cicerone project farmlets to information that is useful for growers at the whole farm scale, a whole farm business analysis that includes key measures such as return on assets, liquidity (ie net cash flow) and growth (ie equity change) is required.

Different budgeting techniques were used to analyse the profitability results for a five-year period (2000-01 to 2004-05 financial years) and the main influences on the outcomes. The analysis starts with gross margins at the farmlet and commercial scale, and then applies the commercial scale for whole farm analysis to show the key business measures such as return on assets, net cash flow (ie liquidity) and equity change (ie growth).

At both the farmlet and commercial scales, Farmlet A had the highest gross margin returns, followed by Farmlet B and then Farmlet C. However, at the commercial scale Farm A had the lowest whole farm returns over the analysis period due to very high capital costs of pasture improvement and high supplementary feed costs.

Methods

The Cicerone Project- Following a 1997 survey (Kaine and Doyle 1998) to identify the key problems of concern to producers in the Northern Tablelands, The Cicerone Project Inc. was set-up as a producer-led "research and adoption" group in 1998 with funding support from the Woolmark Company, later Australian Wool Innovation (AWI). The project aimed to fill the perceived gap between small-scale component research (seen as valid trials by government and university based researchers) and research on a scale that is relevant and credible to farmers in that it captures the interactions between pastures and livestock under different management strategies. The approach of

the Cicerone Project was to assess issues such as sustainability, sheep enterprise types and management for ongoing profitability at whole farm level, but also to produce conclusions on a scale relevant to farmers to facilitate adoption of improved technologies (Scott 2002).

After considerable planning (Scott 2002), the Cicerone Project farmlets were established in 2000 to investigate issues relating to dry seasons, fertiliser use, pasture composition and pasture persistence and to examine management techniques that were likely to improve the resilience, stability and longevity of pastures in the region. Three 'farmlets' of approximately 54 hectares each were set up to compare the profitability and sustainability of three different farm management systems differing in grazing management and input levels, with the specifications and goals for each farmlet determined by producer members. Farmlet A had relatively high inputs of sown pastures and fertilisers and used flexible rotational grazing in an eight paddock system. Farmlet B had moderate fertiliser inputs with a similar grazing pattern and number of paddocks to Farmlet A. Farmlet C had received medium level inputs but was been managed with an intensive rotational grazing system (Gaden *et al.* 2004), starting with 16 paddocks, but later increased to 33. Paddocks were allocated to each of the three farmlets to provide equivalent soil resources, slope and fertilizer history (The Cicerone Project Inc 2002). The farmlets are not replicated, however researchers associated with the project believe that the comparisons are valid because the land used for the farmlets was surveyed and classified into equivalent areas according to soil type, topography and fertilizer history (Scott 2002).

Data sources

An internet-based queriable database was set up as part of the project to be a central reference point for Cicerone data outputs (Scott 2002). Data used from the database included production results such as livestock weights and wool quality per head as well as livestock inputs such as drenches, vaccines and purchased supplementary feed. Cicerone project records of livestock purchases and sales, as well as variable costs such as shearing, marking, livestock selling and wool selling costs were also used.

Inputs relevant for economic analysis of each farmlet were collected such as labour hours (manager and casual), pasture seed and fertiliser applications in kilograms per hectare, fencing, animal health products used per head and supplementary fodder provided per head. This enabled reporting of farmlet-scale costs but also calculation of input costs at the commercial scale. The month when each input occurred was recorded which enabled calculation of cash flow statements on a monthly basis.

Table 1: Summary of Cicerone farmlet inputs recorded 2000-2005

Input category	Details recorded
Pasture development inputs	Seed variety and kg per hectare sowing rate per paddock, month of sowing Fertiliser type and rate per hectare per paddock, month of application Herbicides – date, name and rate per hectare
Animal health	Doses (ml per head) of each type of drench, vaccine, lice control and bloat capsules for both sheep and cattle and bloat capsules for cattle Number of lambs marked and mulesed
Shearing	Number of sheep in each category shorn (adults and weaners)
Selling (livestock and wool)	Total wool and livestock selling costs per year
Supplementary feed	Type of feed, number of head fed per week and kilograms per head
Labour (hours)	Manager hours and casual hours per farmlet per year

Farmlet and commercial scale

The 54 hectare scale of the Cicerone farmlets was used in order to be credible to farmers, in terms of reflecting the whole-farm complexity of pasture improvement and grazing rotations (Scott 2002). However, given the aim of the project is to enhance adoption of more profitable and sustainable grazing enterprises, some estimation of the commercial scale factors enables producers to compare the Cicerone research results at a scale relevant to the farms they operate. A recent report (Alford *et al.* 2003) on typical livestock farming systems on the Northern Tablelands of NSW used a representative

farm of 920 hectares. The farm area selected was the size of the average agricultural establishment on the Northern Tablelands according to the 1996-97 ABS Agricultural Census. The representative farm size and overhead costs were used in this analysis since the data were from a relevant time period, just prior to commencement of the Cicerone farmlet operations in 2000.

Economic and financial analysis methods

Livestock trading schedules and activity gross margins were constructed for the three Cicerone farmlets using financial year data for the five years from 2000-01 to 2004-05. Pasture and fencing costs were not included at the activity level since the returns from pasture improvement and grazing management changes due to investment in fencing occur over a number of years, so they should not be attributed to one activity in one year. These costs were therefore treated as "indirect" (or overhead costs) at the whole-farm level.

Livestock trading schedules and activity gross margins were also constructed at the commercial scale. Annual whole farm budgets were prepared at the commercial scale to determine key annual profitability measures such as operating and business return and operating return on assets and business return on equity (Malcolm *et al.* 2005). In order to do this, Assets and Liabilities Balance Statements and Profit and Loss Statements for each year were constructed for each farm. Cash flow statements were prepared for each of the three commercial scale farms to incorporate the cashflow effects of casual labour and capital expenditure on fencing and pastures, and to observe peak debt levels.

There are limits to the availability of operator labour (a constraint) so excess labour requirements would have to be met from hired labour. Owner/operator labour supply was assumed to be 250 hours per month (Alford *et al.* 2004). Hired labour was assumed to be a high level so that it was not limiting in the model, up to 420 hours per month (up to 3 people working a total of 140 hours per week) was allowed for. The Cicerone peak labour requirements matched quite well with the representative Northern Tablelands figures from Alford *et al* (2004) so labour requirements for a self-replacing Merino flock and trading cattle enterprise from Alford *et al.* (2004) were used in a simple linear programming (LP) model at the commercial scale for each financial year in order to ascertain the monthly casual labour requirements.

Additional labour requirements were experienced in Farmlet A since there were large areas that were either sown to pasture or topdressed with fertiliser every year. Cicerone records indicated which paddocks received which treatments and in which month, tractor figures were used to estimate the time per hectare it would take for each operation per paddock per month.

Cash flow statements also enabled monthly interest figures on loans and/or overdrafts to be calculated.

Results

Total farm gross margins at the commercial scale are shown in Table 2. As outlined in the previous chapter and following standard practice, hired labour were not included in the commercial scale gross margins but they were accounted for at the whole farm level.

Average gross margin for Farm A was $251.96 per hectare, which was $46.77 per hectare higher than that of Farm B ($205.19 per hectare). Farmlet B average gross margin per hectare was $27.94/ha above that for Farm C ($177.25 per hectare).

Gross margin differences were driven in part by the higher stocking rate on Farm A, resulting in higher total wool yield and trading livestock income. Farm A variable costs were also higher than for Farm B, but Farm A extra income more than made up for this. Farmlet A had a higher average farm gross margin and cumulative total gross margin than Farmlet B, due to both higher wool and cattle trading gross margins. Farmlet C had a lower farm gross margin than Farmlet B, principally due to lower wool enterprise returns. Even though Farmlet C had slightly better cattle trading returns than Farmlet B, this was not enough to make up for the difference in wool enterprise returns.

Table 2: Total farm gross margin budgets at the commercial scale

Farm A	2000-01 $	2001-02 $	2002-03 $	2003-04 $	2004-05 $	Average $
Gross Margin	197,716	119,124	284,394	339,813	217,962	231,802
GM/HA	214.91	129.48	309.12	369.36	236.92	251.96

Farm B	2000-01 $	2001-02 $	2002-03 $	2003-04 $	2004-05 $	Average $
Gross Margin	211,651	95,116	194,908	240,105	202,095	188,775
GM/HA	230.06	103.39	211.86	260.98	219.67	205.19

Farm C	2000-01 $	2001-02 $	2002-03 $	2003-04 $	2004-05 $	Average $
Gross Margin	166,461	71,055	183,842	199,637	194,339	163,067
GM/HA	180.94	77.23	199.83	217.00	211.24	177.25

Cumulative whole farm gross margins are shown in Figure 1. The results are similar to those at the farmlet scale. Farms A and B returns are very similar until 2002-03, when the higher productivity of Farm A results in higher returns. Farm C returns remain lower than Farm B returns.

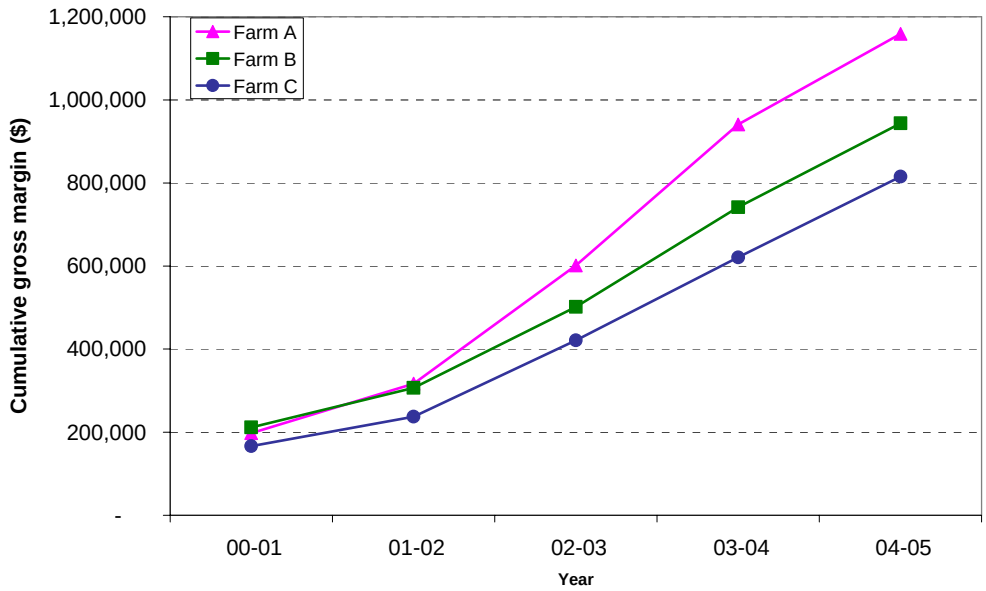

Figure 1: Cumulative gross margins at the commercial scale

A summary of the commercial scale annual whole farm results is shown in Table 3. Farm B maintained positive whole farms returns in each of the five years analysed and 100% closing equity. Farm A had negative business returns in 2000-01 and 2001-02, but returned to positive business return in the last three years. Farm A had higher business return than Farm B in 2002-03 and 2003-04 but lower in 2004-05. The heavy borrowings required by Farm A resulted in the early negative returns and a resultant decline in equity. However, with business return for Farm A returning to positive levels in 2002-03 to 2004-05, equity also began to recover. Farm C also has negative business returns in 2000-01 and 2001-02, due to lower productivity and expenses on fencing.

Table 3: Commercial scale whole farm results

Year	Farm A			Farm B			Farm C		
	Business return	Return on assets	Closing equity	Business return	Return on assets	Closing equity	Business return	Return on assets	Closing equity
2000-01	- 84,504	-4.8%	92%	78,985	4.6%	100%	- 75,085	-4.7%	100%
2001-02	-165,217	-10.2%	82%	8,331	0.5%	100%	- 21,225	-1.2%	100%
2002-03	64,632	5.8%	88%	69,982	3.9%	100%	67,530	4.3%	100%
2003-04	126,323	9.4%	90%	129,402	6.9%	100%	65,906	3.9%	100%
2004-05	43,592	3.9%	93%	116,840	5.9%	100%	96,630	5.4%	100%
Mean	- 3,035			80,708			27,098		
Std Devn	118,771			47,522			71,688		

Farm A return on assets and business return suffered a downturn in 2004-05 due largely to high supplementary feeding costs in that year. Farm C had lower returns in 2000-01 due to expenditure on fencing. Farm C only had better returns than Farm B in one year, 2002-03, and they had similar returns in 2004-05. Both had lower returns in 2004-05 than in 2003-04 due to a number of factors including lower income and higher supplementary feeding costs.

The standard deviation figures in Table 3 also show that Farm B had lower business return variability than either Farm A or Farm C. The mean and standard deviation figures are illustrated in Figure 2. This comparison is based on the mean- standard deviation efficiency (or mean – variance efficiency) rule described by Hardaker *et al.*(2004). In this context, if the expected business return of alternative X is greater than or equal to the expected business return of alternative Y, and the variance of X is less than or equal to the variance of Y, then X would be preferred to Y. Various extra conditions apply to the efficiency rule; that the decision maker prefers more rather than less of the measure concerned (in this case business return), that the outcome distribution is normal and that the decision maker has a quadratic utility function. If these factors are unknown or unable to be confirmed then the mean-standard deviation efficiency is only approximate. When the utility function of the decision maker (ie farmer) is unknown (as in this case), then using the type of figure as shown in Figure 2, the rule applied is that "an alternative is in the efficient set if there is no other alternative that lies in the 'north-western' quadrant" (Hardaker *et al.* 2004). Applying this rule to Figure 2, Farm B dominates the other two alternatives and is the efficient option.

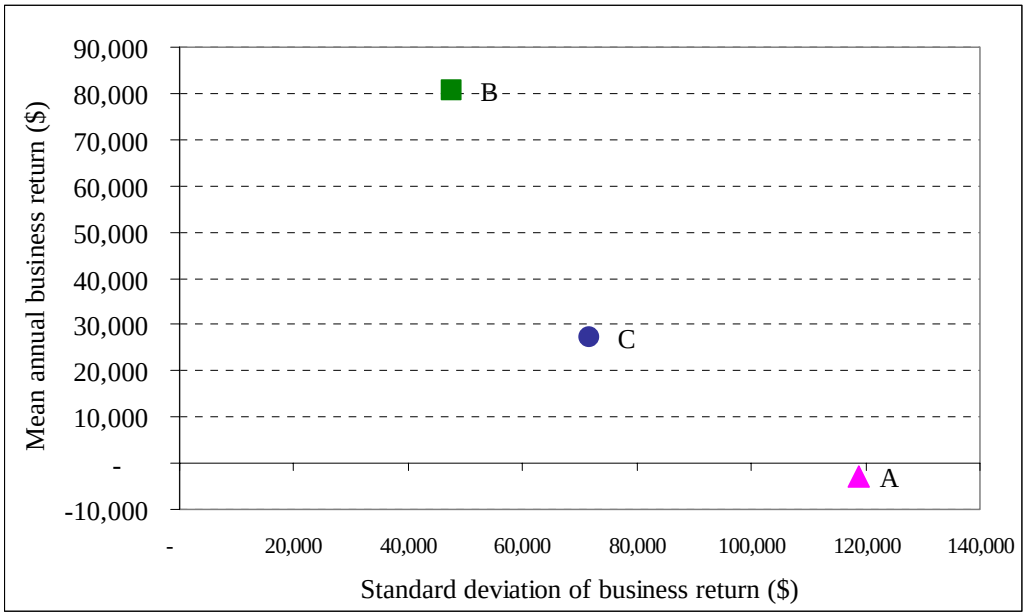

Figure 2: Mean-standard deviation efficiency of business return

Monthly cash flow statements were prepared for each commercial scale Farm. All farms were assumed to be starting from a zero balance position. The 'end of financial year' cash position for each farmlet is shown in Table 4. Farm A reached its peak overdraft in December 2004. This was in part due to the cumulative effect of the previous four and a half years but also due to a $126,000 purchase of cattle in that month. Farm B reached its peak overdraft in July 2000, due to no income but some expenses occurring in this month. Farm C reached its peak overdraft in July 2000 for the same reason as for Farm B. The Farm C overdraft was larger due to both pasture and fencing expenses being covered in the overdraft account.

Table 4: Cash position at end of financial year

Year	Farm A	Farm B	Farm C
2000-01	- 76,393	118,908	2,486
2001-02	-264,388	175,446	5,949
2002-03	-163,433	315,495	138,148
2003-04	-171,850	403,318	199,913
2004-05	-132,782	518,932	283,276
Peak overdraft	-415,305	- 19,637	- 87,371
End of month cash position			
Mean	-139,077	262,689	94,410
Stn Devn	117,696	129,271	92,857

Farm A and Farm B monthly cash flows are compared in Figure 3. The same pattern of peaks and troughs occurs due to wool income every August and livestock (both sheep and cattle) buying and selling. Farm A has a declining trend due to continuous large pasture improvement costs, which totalled approximately $507,000 over the five year period. Whereas Farm A had higher gross margins than Farm B, the level of pasture expenditure for Farm A far outweighed any gains in terms of animal productivity compared to Farm B. A great deal of variation between years on all Farms was due to livestock trading with large expenditures on purchased stock and large income from sale stock, especially in 2002-03. A large part of this variability was due to cattle trading.

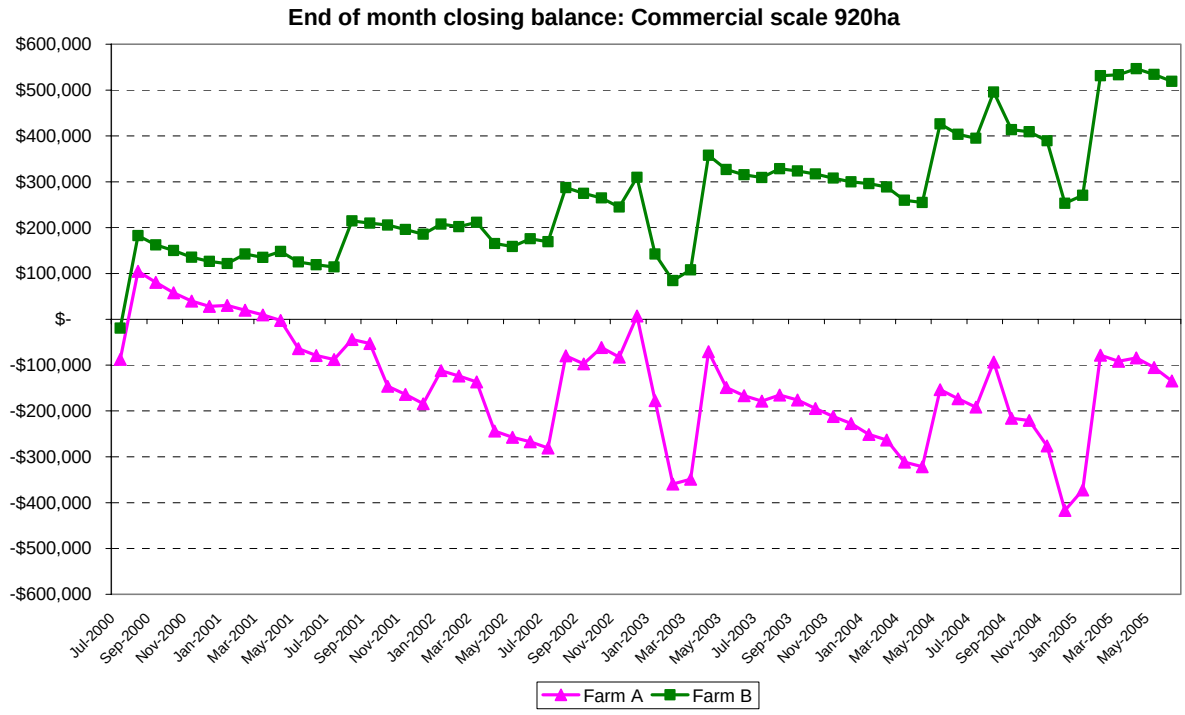

Figure 3: Comparison of Farm A and Farm B cash flow statements

Farm C and Farm B monthly cash flows are compared in Figure 4. Farm C started with a higher level of debt than Farm B, had slightly higher total farm costs and lower overall whole farm gross margin. Thus returns from Farm C were not enough to make up for its higher starting debt and higher costs, so its cash flow remained behind that of Farm B.

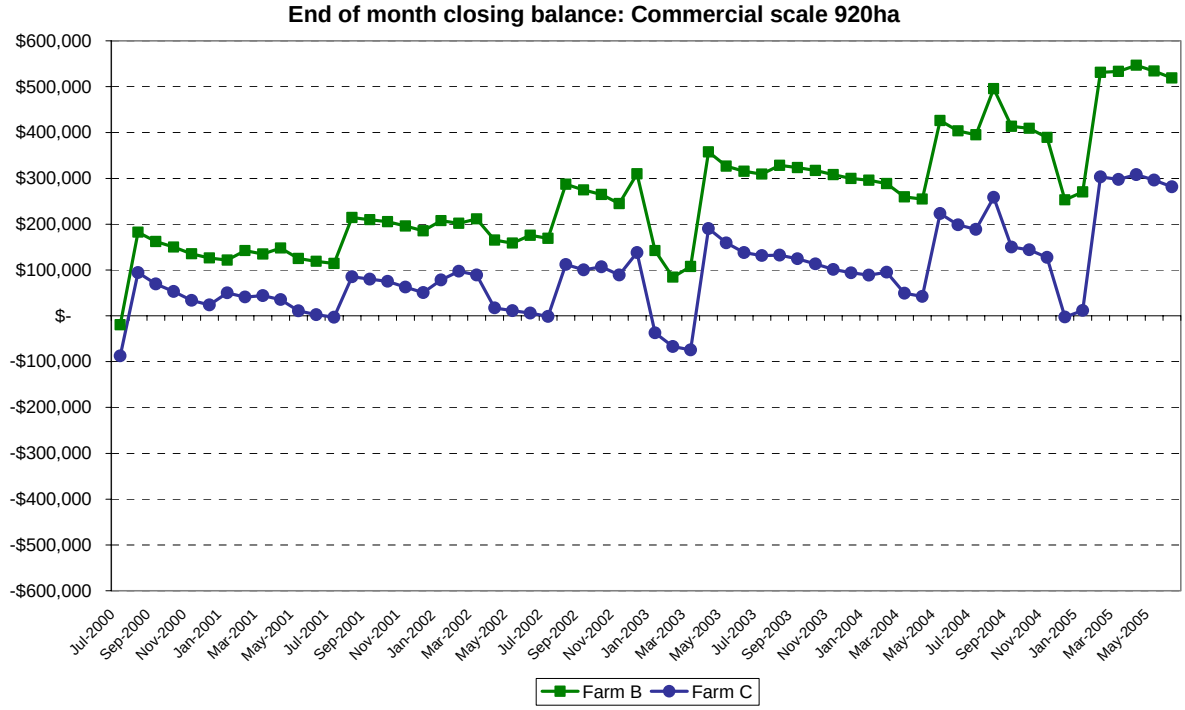

Figure 4: Comparison of Farm B and Farm C cash flow statements

The mean and standard deviation figures for cashflow are illustrated in Figure 5. In contrast to that for business return, Farm C has the lowest variability as measured by standard deviation. In this case Farm B and Farm C dominate Farm A and both are risk efficient options.

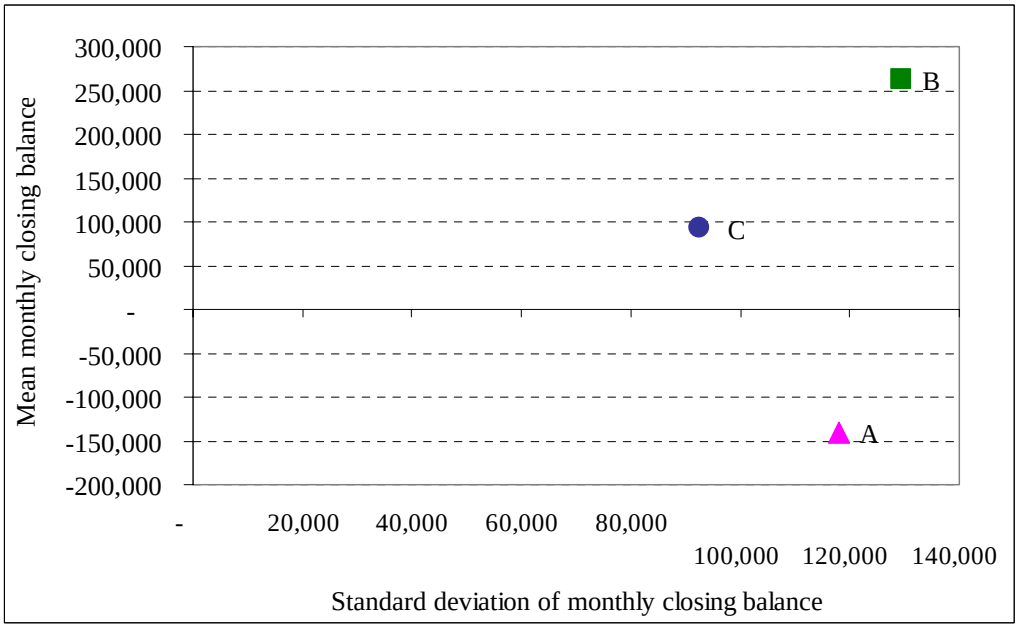

Figure 5: Mean-standard deviation efficiency of cashflow

Discussion

Farm A had poor returns in the first two years in terms of key business performance measures such as return on assets, net cash flow (i.e. liquidity) and equity change (i.e. growth). However, even though cash flow remained in the negative, business return for a commercial scale Farm A would have returned to positive levels in 2002-03 and 2004-05, with equity levels gradually building back up from a low of 82% in 2001-02. At the end of the five year period, the representative Farm A had returned to 92% equity but still had an overdraft. Although Farm A cash flows remained well behind those of Farms B and C, Farm A did not become insolvent (a business becomes insolvent when liabilities are greater than the value of assets (Malcolm *et al.* 2005)). Therefore the possibility remains that in future seasons Farm A could continue to generate positive business returns and recover to 100% equity; especially if some of those years received higher rainfall than the below-average years experienced thus far. Longer term profitability for Farm A would be dependent on grazing management permitting the more digestible and productive sown pastures to persist and pasture improvement costs to be reduced compared to the first five years.

The commercial scale Farm C had lower gross margin returns than Farm B, and combined with higher costs for labour and capital cost of fencing, its business return and cash flow position at the end of June 2005 were behind those of Farm B. Farm C was able to maintain a higher level of desirable pasture species composition than Farm B; however Farm C had a consistently low pasture legume percentage (Scott and Alford 2006). According to Hoad (2006) the lower returns for Farm C were partly due to the pasture rest period being too long, allowing pasture digestibility to fall, thus leading to lower stock bodyweights for both sheep and cattle and lower wool cut per head in the case of sheep (Hoad 2006).

The high capital costs of pasture improvement for Farm A were not covered by the increase in productivity between 2000 and 2005. This was due to the median or below-median conditions for plant available water for the whole period (Carberry *et al*. 2005), constraining the growth potential of Farm A pastures. However, since Farm A did not reach insolvency level, a commercial scale enterprise could have kept trading in spite of a large peak overdraft.

It is worth noting that the Cicerone Management Board was aware that the Farmlet A treatment was somewhat unrealistic compared to commercial practice at least over the first five years. This was largely due to the deliberate decision by the Board to adopt a higher than normal rate of pasture improvement on Farmlet A in order to differentiate the treatments quickly by increasing the percentage of sown pastures as fast as was feasible especially over the first five years (J. Scott, pers. comm.). Together with the high target stocking rate for Farmlet A, this resulted in excessive grazing pressure on pastures that were still establishing. In addition, an early decision to trial two paddocks of short-term biennial ryegrass on farmlet A which needed re-sowing within two years, meant that these two paddocks were in fact sown twice during the five-year period (Shakane *et al.* 2006b).

The goal of 100% sown species on Farmlet A has not been reached to date because the grazing pressure the paddocks were subjected to, coupled with below average rainfall, allowed less desirable (lower digestibility) pasture species to remain in the pasture sward (Shakane *et al.* 2006a).

In addition, there have been a low proportion of pasture legumes across all three farmlets, with the average legume percentage never getting above 10 percent. As Farmlet A livestock numbers and average liveweights were higher, Farmlet A had more periods of feed shortages than Farmlets B or C (Shakane *et al.* 2006b).

The level of pasture improvement and fertiliser applied to Farmlet A meant that, given sufficient rainfall, it had the potential to provide pasture growth above animal needs. This meant that there was the potential for fodder conservation (such as hay or silage) which could offset the costs of supplementary feed when pasture growth was inadequate to meet nutritional needs. Again, due to lack of rainfall, silage was unable to be made on Farmlet A until December 2005, which was outside the period of analysis. In December 2005, 160 round bales of silage were made from Paddock A1 pastures (3.8 hectares) of mature phalaris, lucerne and chicory (Edwards 2006). This illustrates the potential for Farmlet A to reduce future purchased feed costs.

The cash flow analysis showed a great deal of variability between months and between years. Much of the variability was due to livestock trading, especially cattle. The issue arises of how realistic an example this is – would growers in the real world incur these kinds of costs? Whilst an industry survey of the kind required to answer the question of how widespread a practice this would be was beyond the scope of this study, an example of livestock trading of this magnitude has recently been documented. In the "Land, Water & Wool: Northern Tablelands" project (2005-2008) (Land & Water Australia 2004), a case study enterprise made up of three properties (totalling 1297 hectares) near Glen Innes annually purchased approximately 600 head of weaner cattle (between May and June each year) to be grown out over a nine to 12 month period (Land & Water Australia 2005). The case study figures can be used as an example to estimate the appropriateness of the financial scale of the Cicerone full-scale farms as follows: 600 weaner cattle weighing approximately 240 kilograms per head and costing $2.00 per kilogram liveweight would cost $288,000. The same number of cattle sold at 450 kilograms per head at $1.90 per kilogram liveweight would return $513,000. These are similar levels of cattle trading costs and income to those for the commercial scale versions of the Cicerone farms.

If the farms were ranked according to gross margin returns over the five year period analysed, Farm A would rank first, followed by Farm B and then Farm C. But if the Farms were ranked in terms of business return results, Farm B would rank first, followed by Farm C and then Farm A. These contrasting results support the claim by Malcolm *et al* (2005) that annual activity gross margins cannot alone indicate the profitability of an investment. Activity gross margins are necessary to begin the assessment process, where capital investment are involved, however measures of business return on capital, gearing and liquidity are also needed (Malcolm 2001). These results also show that using production outcomes as proxies for profitability is incorrect (Malcolm and Ferris 1999; Ronan and Cleary 2000). For instance, Farm A produced more wool and beef per hectare than either Farm B or C, however it resulted in the lowest average business return over the analysis period.

Nevertheless as explained earlier, the rate of pasture improvement (20% of farm area per year) on Farmlet A was high; well above the range from the 2000-01 Agricultural Census of 4.6 to 13 percent per farm (ABS 2002). The Cicerone Board decided to sow Farmlet A with improved pastures at a very high rate in order to differentiate the farms quickly. However, the increase in productivity and income was not enough to cover the costs over the time period analysed.

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