The economics of transformation toward sustainable hill country land use: Whatawhata case study

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Abstract

The Whatawhata integrated catchment management project generated a substantial amount of data on the biophysical impacts of land use and management change – livestock enterprise performance, terrestrial biodiversity, water quality etc. The question has been posed: What was the impact of the changes on the financial viability of the catchment farm system? Farm operating budgets before and after land use changes, enterprise gross margins, costs associated with tree planting, and farm system modelling with FarmaxPro® have been integrated to give a whole-system view of farm business viability over the long term (1995–2030). This information compared the existing system (1990s) with the new system implemented in 2000. Annual operating profit for the 296 ha breeding ewe and breeding cow system in the late 1990s was between $25 000–$30 000 reflecting the size and land use capability distribution of the block. Changes to the livestock enterprises improved farm surplus from ca. $100/ha to ca. $330/ha in the first 3 years, but on a reduced pastoral land area (150 ha). This gave an annual operating profit (EFS) of ca. $50 000. Much of this difference reflected product price movements. The cost of land use change was approximately $969 000 over the first 10 years. Selective intensification of hill lands can improve per ha profitability in the short-medium term. Two key financial issues, the transformation cost and medium term viability, need to be addressed in implementing land use change to move toward hill land sustainability.

Keywords: integrated catchment management, land use change, sustainable hill country

Introduction

The Whatawhata Integrated Catchment Management project was a cross-disciplinary research project designed to explore the outcomes, at a whole farm/catchment scale, of land use and management change directed towards achieving the multi-stakeholder vision of a "well-managed rural hill country catchment" (Quinn *et al.* 2007). The stakeholders that defined such a vision, and its associated goals, were drawn from land managers (farming and forestry), regional policy agencies (local government and conservation) and scientists (agricultural and environmental). The goals included: viable businesses; healthy ecosystems; protected landscape values; active partnerships; demonstrable environmental performance; and adequate rural services and infrastructure (Dodd *et al.* 2008a). More than 25 key performance indicators (KPIs) at the whole-system level were identified as measuring progress towards those goals, including: economic farm surplus (EFS); suspended solids and nutrients in water; soil fertility; plant growth; landscape diversity; erosion levels; diversity and numbers of sensitive water creatures; and healthy stock.

The three major phases of the project included the assessment of the then current performance of the Mangaotama catchment farm system (296 ha); planning and initiation of substantial land use and management changes in 2001; and ongoing monitoring of the performance of the system against the KPIs (Dodd *et al.* 2008c). In addressing the goal of viable businesses, the most relevant KPIs included EFS, stock performance, return on business capital and property valuation.

In October 2013, a field day was held at Whatawhata to convey to the wider stakeholder community the outcomes of the project, in terms of research findings and progress towards the aforementioned goals as a result of the changes initiated in 2001. Approximately 150 people attended the day and there was considerable interest in the economic performance of the re-designed catchment farm system. Preliminary data has been presented elsewhere (Dodd *et al.* 2008b) but we undertook to provide a more detailed and updated assessment of the farm system financial performance, based as much as possible on actual data collected over the course of the project (1995–present). The objective of this paper is to outline that assessment, in order to highlight the economic issues facing stakeholders as they forge a pathway of sustainable use of North Island hill country.

Methods

System Description

At the commencement of the project in 1995, the Mangaotama catchment farm, defined by the stakeholder group, comprised 296 ha (270 effective ha in pasture) of low-altitude, steep-rolling country in the western Waikato. Major soil types are Dunmore Hill (Ash, 24%), Kaawa Hill (Sedimentary, 63%) and Waingaro Steepland (Sedimentary, 11%); which can also be categorised as Land Use Capability (LUC) Class IV-V (25%), VI (33%) and VII (42%) with the main limitation on all classes being erosion. The catchment includes 21 km of stream networks, of which 59% are 1st order, 19% 2nd order, 7% 3rd order and 15% 4th order. Vegetation cover was assessed as being 57% in moderately productive pastures based on perennial ryegrass, white clover and sub clover, with 38% in low productivity pastures based on browntop and sweet vernal with a small contribution from annual legumes. The livestock enterprises from 1995–2000, as part of the Whatawhata Research Centre systems, comprised a Romney sheep breeding flock (1500 head wintered) selling lambs to both store and finishing markets; and an Angus cattle breeding herd (120 head wintered) selling rising 1yr steers to store.

In the 2000-01 financial year, 130 ha of the catchment farm was planted in *Pinus radiata*, including 60% of the LUC class VII land, 18% of the LUC class VI land and 20% of the LUC class V land. The forestry was funded through a joint venture between AgResearch and Tainui Group Holdings. The planted tree stocking rate was 1200 stems per hectare (sph) with three pruning lifts in 2006, 2007 and 2008. The first thinning was in 2008/9 to 700 sph and a second in 2009–2011 to 360 sph. This afforestation also excluded livestock from 15 km of the streams. A further 12 ha around native forest remnants was fenced to exclude livestock from 1.5 km of streams and planted in mixed native tree and shrub species. The remainder of the stream network was fenced with 2-strand electric fence to exclude livestock from all waterways. One thousand poplar poles were planted in small steep gullies remaining in pasture, typically at 100 sph. The sheep breeding flock was reduced to 810 head wintered, mated to a terminal sire, and 80 ½ Finn + ½ Romney cross 2-tooth replacements were purchased each year to increase lambing percentage and provide facial eczema resistance. The breeding cow herd was sold and 110 rising 1yr Friesian bulls were purchased and farmed under an 18-month policy to sell them prior to their second winter. In 2005 the sheep breed was changed to a ¼ Finn + ¼ Perendale + ½ Romney cross and the farm started grazing dairy heifers.

Data Analysis

Farm livestock and financial data for the whole Whatawhata Research Centre and the Mangaotama catchment farm system were collected from 1995 to 2011 and used to construct FarmaxPro® (v6.5.3.05) models of the catchment farm. Actual data is subject to extraordinary features of the operation of a research farm and the models enabled us to produce consistent annual financial performance summaries relevant to the operation of a commercial farm. Specifically we have not included depreciation, management fees, cost of capital or rent and refer to the net result as operating profit. Forestry financial data from 2000–2010 were sourced from reports to Tainui and AgResearch by NZ Forestry Ltd, the consultants engaged to manage the forestry operations. Future projections of forestry returns and carbon accumulation were produced using the Atlas Forecaster software.

System performance of the original farm system was broken down into relevant LUC classes by assuming the whole farm area was comprised of that class and using the adjust numbers function in Farmax to derive a feasible livestock system. In addition, we assumed increased weed control and R&M costs for higher LUC classes (1.5× for class VII, 1.25× times for class VI, 0.75× for class V), to reflect the known variation in fixed costs associated with managing these landscapes.

Annual productivity and profitability of the grazed system was documented in annual Farmax models: a) for the 1995–2000 period prior to implementation of land use changes (270 eff. ha); b) for 2000/01 as a transition year (170 eff. ha); and c) for the 2001–2004 period under the new system (150 eff. ha). Forestry implementation costs for the 2000–2011 period were combined with grazing system data to derive net annual cash flows for this period.

The grazing system profitability was compared with the Beef + Lamb New Zealand (B+LNZ) Class 3 farm (NI hard hill country) from 1995–2000 and with the Class 4 farm (NI hill country) from 2000–2011 based on our assessment of the similarities in the underlying resource base. The breakdown of land contour for the Class 3 farm is 3% flat, 18% rolling and 79% steep; and for the Class 4 farm is 11% flat, 44% rolling and 45% steep (NZMWB 1997). To be consistent with the Whatawhata financial data, the B+LNZ data were adjusted to exclude depreciation, management fees, cost of capital and rent.

There was very limited livestock grazing in the pine forest blocks, due to high initial tree stocking rates, a strategy intended to suppress weeds in the steep blocks that were highly prone to gorse reversion. Thus, no financial benefit of agroforestry grazing has been included.

Results and Discussion

Annual farm operating profit for the 296 ha breeding ewe and breeding cow system in the late 1990s was

between $25 000 and $30 000. Operating profit for 1995/96 was $25 200 and for 1998/99 was $29 400 (Table 1) where improved market prices were partially offset by increased costs of purchased feed to manage a severe drought. Considering the B+LNZ NI Class 3 hard hill model, 1995/96 represented a low point for the sector in terms of product prices (wool at $3.30/kg, lambs at $35/hd and steers at $200/hd) leading to an operating profit of $65 300 (NZMWB 1997). On a per effective hectare basis the catchment farm operating profit was similar to the Class 3 Farm in both 1995/96 ($94/ha vs. $99/ha) and 1998/99 ($109/ha vs $117/ha) (Table 1). Given that the catchment farm costs do not include the cost of management or "drawings", the size of this system makes it financially non-viable for an owner-operator. Even if it were comparable in size to the B+LNZ model farm, the scope for funding system improvements from operating profit would have been very limited.

The profitability of the original Whatawhata system across LUC classes is shown in Table 2 and indicates low returns on the majority of the land resource (75% in LUC VI and VII) in 1998/99. This LUC balance has clearly influenced overall profitability. However, given the observation about this period being marked by poor product prices, a comparison with that system under more favourable product price conditions is warranted. Table 2 shows the profitability of the main LUC classes at a long-term product price high point (2001/02), illustrating the volatility of returns over that period. Thus, the data presented probably show the extreme scenarios. Obvious options for improving profitability at the farm scale would have been to double the farm area or incorporate more Class IV–V land into the Whatawhata system. However, this would have had little value from a research perspective. It was also observed by the stakeholder group at the time that another option would have been to reduce inputs (i.e. fertiliser and weed control) to maintain short-term profitability and accept a gradual decline in resource quality to a point where livestock farming was no longer physically viable.

Changes to the livestock enterprises improved the productivity of the grazing system via increases in per ha and per SU production of meat and wool in 2001/02 and 2002/03 (Table 1). This performance was underpinned by increased lambing percentage and a focus on growing young cattle. It should be recognised that the apparent increase in farm surplus, from $29 200 (1998/99) to approx. $50 000 between 2001 and 2004, was also a function of improved product prices. Again it seems prudent to compare the old and new systems given similar prices. Thus, Table 2 also shows a projection of the financial performance of the old system for the 2001/02 year, indicating that much of

Table 2 Estimated stocking rate and operating profit per hectare on major Land Use Capability (LUC) classes in the Mangaotama catchment farm based on the farm system in place during 1998–99.

LUC class	Land (%)	Stocking rate (SU/ha)	Operating profit ($/ha, 1998–99)	Operating profit ($/ha, 2001–02*)
IV-V	25	14.7	200	566
VI	33	10.1	61	298
VII	42	9.0	14	215

*assuming 2001–02 prices and costs if the 1998–99 system had been retained.

Table 1 Comparative performance of the grazing enterprise before and after land use changes on the Mangaotama catchment farm. SU = stock units; CW = carcass weight..

Indicator	1998/99 (old)	2001/02* (old)	2001/02 (new)	2002/03 (new)
Grazed area (ha)	270	270	150	150
Stock units (SU/ha)	10.7	10.7	8.8	8.8
Lamb weaning (%)	108	108	123	128
Sheep meat produced (kg CW/ha)	75	75	100	112
Wool produced (kg/ha)	28	28	30	32
Sheep margin ($/SU)	22.70	36.90	27.90	39.10
Calf weaning (%)	89	89	–	–
Beef produced (kg CW/ha)	89	89	188	193
Cattle margin ($/SU)	21.60	61.10	103.20	73.30
Farm gross margin ($/ha)	229	483	519	490
Operating profit ($)	29 200	89 200	50 200	49 700
Operating profit ($/ha)	108	330	335	331

*assuming 2001–02 prices and costs if the 1998–99 system had been retained.

Table 3 Financial effect of land use change implementation on the Mangaotama catchment farm 2000–2011, compared with B+LNZ benchmark models. Whole farm figures are rounded to the nearest $100.

Item	1995 -96	1998 -99	2000 -01	2001 -02	2002 -03	2003 -04	2004 -05	2005 -06	2006 -07	2007 -08	2008 -09	2009 -10	2010 -11	*2001 -10*[1]
Grazed area (eff. ha)	**270**	**270**	**170**	**150**	**150**	**150**	**150**	**150**	**150**	**150**	**150**	**150**	**150**	*150*
Sheep margin	57800	68600	[2]84900	38600	47700	48100	35400	62100	61500	25100	44200	61400	38000	*46200*
Cattle margin	32500	44200	[2]54300	55300	40000	32900	43500	59300	27400	38200	20500	34200	27400	*37900*
Farm expenses	-65100	-83600	-25200	-43700	-38000	-33500	-40800	-54400	-48000	-51800	-45800	-51800	-51800	*-45900*
Poplar planting			-3600											
Pine planting			-154900	-23300										
Native planting			-142400											
Native releasing			-17700	-17700	-17700									
New fencing			-18000											
Sheep sales														
Pine silviculture									-108000	-93000	-80000	-100000	-83000	
Pine maintenance[3]			-10000	-10000	-10000	-10000	-10000	-10000	-10000	-10000	-10000	-10000	-10000	
Operating profit ($)	25200	29200	114000	50200	49700	47500	38100	67000	40900	11500	18900	43800	13600	*38200*
Operating profit ($/ha)	94	108	760	335	331	317	254	447	273	77	126	292	91	*254*
System net result ($)	25200	29200	-232600	-800	22000	37500	28100	57000	-77100	-91500	-71100	-66200	-79400	
B+LNZ data[4]														
Operating profit ($/farm)	65300	73600	140500	172000	138700	118100	138100	111200	94000	70500	114600	48300	91300	*109700*
Operating profit ($/ha)	99	117	334	405	312	276	320	254	235	177	277	115	209	*258*

[1]Data is the 10-year average of 2001-2010 years.

[2]Includes breeding ewe and breeding cattle livestock disposal as part of system changes.

[3]Average of $77/ha, inclusive of insurance, rates, pest & weed control, fence maintenance and management fees.

[4]For 1995-6 and 1998-9 Class 3 North Island hard hill data (640 ha), for 2000 onwards Class 4 North Island hill data (430 ha).

the gain in later years was attributable to product price movements.

The immediate cost of land use change was approx. $425 000 in the first three years. This included the cost of pine tree planting, native tree planting, fencing, weed control and tree releasing. These costs were partly offset by the net livestock revenue from enterprise change (sales of sheep and cattle breeding stock cohorts). The additional cost to complete establishment of the new enterprise mix over the first 10 years was $544 000, reflecting the management costs of the pine forestry. The estimated stumpage value from the pine forestry harvested in 2030 was $2.87 M and the estimated value of net carbon credits (from 2008 to 2012 @ $5.00 per tonne CO_2-e) was $131 000.

The financial analysis presented here highlights two key economic issues that need to be addressed in contemplating this type of transformation of land use and management toward sustainability for North Island hill country. The first is the initial capital investment required to implement broad scale tree planting (as well as associated roading, fencing and water reticulation), which cannot be resourced from retained earnings of the pastoral enterprises. In this case the mechanism was an injection of capital, effectively from an external investor (AgR/Tainui). Other examples of external investment include those coming from the public purse, such as the the Afforestation Grant Scheme ($23.5M), the Hill Country Erosion Project ($14M) and the East Coast Forestry Project ($6M from 2007–9) (MAF 2011). This demonstrates a willingness by the wider public to invest in land use change where the driver has been explicitly environmental gain, but in terms of the total area of North Island hill country affected it is still relatively minor (ca. 50 000 ha).

The second issue is the business viability of the remaining pastoral enterprise, required to support the landowner in the medium term. If we assume that the B+LNZ models on average represent viable pastoral enterprises, over the last 10 years annual operating profit has averaged $258/ha or approx. $110 000 per farm. Given that the remaining Whatawhata pastoral enterprise, at 150 ha is returning a similar $254/ha but only $38 000 p.a. this suggests that more grazed area would need to be resourced to maintain business viability. To a certain extent this is occurring, as farms are being reconfigured via various contractual arrangements, which represents an important structural issue for the sector.

Conclusions

Land use change in the Mangaotama catchment farm improved per ha operating profit via a move from traditional sheep and cattle breeding enterprises to focussing on increased saleable liveweight production utilising the better land classes. However, the scale of the farm system was not sufficient to represent a viable pastoral business in the medium term. The study highlighted two key financial issues, the transformation cost and medium term viability, as needing to be addressed in implementing land use change to move toward hill land sustainability.

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