Linking Profits and Conservation on Hill Country Farmland

MAF Sustainable Farming Fund
Final Project Report – June 2005
Project Number 01-102

Sustainable Farming Fund
Final Project Report – June 2005
"Linking Profits and Conservation on Hill Country Farmland"
Project Number 01-102

Background

The McRae Trust Sustainable Land Management Project, has been an active group of farmers and supporters, who have met regularly, at the property since 1994. The focus has been both production/profit and environmental, throughout that period. Although the project had recorded many successes, it was decided in 2000 to increase the momentum toward firstly, development of a steeper hill country block and secondly to assist group members (and others) to better understand the soils on the McRae Trust as well as their own farms.
The project leaders successfully applied to MAF for financial assistance through the Sustainable Farming Fund. This mainly, enabled the group to employ the skills of land resource professionals, for the benefit of farmers in the district. Without the this assistance, it would not have been possible to firstly, be as effective in monitoring, reporting and publicising the hill country development results. It would not have been possible to run such a successful and effective on-farm course for local farmers (*'Growing Business from the Ground Up').* This programme had some of the most positive feedback of any local organised rural extension activity in recent years.
A project coordinator (Fenton Wilson) was employed for the duration of the three-year project, to assist with the extension aspects, particularly bringing farmers together to discuss various issues that arose, or that required group input prior to any action on the ground. Fentons report is attached as appendix 1.

Hill Country Development

Throughout the Land Management Project, there had been a strong focus on production, particularly return on investment. The main principle being that the better classes of land would give higher financial returns, sooner. However, many participants and other farmers had been concerned about the lack of emphasis on improving steeper hill country production during those years. The reasoning being that steeper hill country is the typical landscape of most Wairoa and east coast farms.
The type of improvement referred to included scrub clearance, oversowing with pasture species, capital fertilizer dressing and subdivision fencing.
During winter 2001, two adjacent paddocks known as Winiatas 1 and Winiatas 2, were chosen for the development project. The paddocks were south facing, steep and covered particularly on the upper slopes, with blackberry, tauhinu and manuka. Pasture composition was poor and paddock size (20ha and 17ha respectively) was too large to manage pasture well on this type of contour. Advice was sought from Alan McRae of Localsh Agriculture, as to the simplest method of gathering meaningful, comparable production data. It was decided to measure livestock grazing days and use this simple information to determine pastoral production during the three year period.

During the same winter, subdivision fencelines were identified, which would split each paddock into three sections. A new stock water supply system had recently been installed and with relative ease, water could be supplied to each of the subdivisions.
In mid December 2001. The development area was aerial sprayed with ‘Answer’ herbicide to kill woody weeds, then sprayed again in mid March 2002 with glyphosate as a dessicant prior to burning at the end of that month. Pasture seed was aerial sown in early April and then capital fertilizer applied in early May at the same time as thistle spraying was carried out. Subdivision fencing and water supply extension work was done in November 2002.
The whole area was lightly grazed with hoggets in June 2002 to promote tillering of the pasture grasses, which appeared at that time to have established very well.
In July 2002, a programme of water quality monitoring was begun. Although the catchment size of either paddock was rather small for good water quality data, the developed area comprised the whole catchment enabling monthly monitoring that would give some indication of land use effects on water quality.
In parallel, water samples were taken each month from a small (10ha) retired area on the property, which was covered in a combination of scrub and larger native bush. This was done on a comparative basis only, due to small catchment size in both cases.
A longer term monitoring project was also being carried out at the same time in the Waitahora Stream, which drained a larger catchment from both production forest and hill country pasture cover. Regional council staff reviewed water analysis methods during May 2003 and some refinements were made to give more meaningful results.
Pasture covers were estimated each month on the main land types of the property, including the Winiatas paddocks where an accurate diary was kept of livestock grazing days.
By late summer/early autumn of 2003, grazing of the Winiatas paddocks was well underway.
On 29th April 2003, a field day was held on the McRae Trust. This proved to be one of the most successful field days held over the previous 9 years of the project with over 80 local farmers in attendance. Success factors included the range of speakers delivering practical information relating to hill country farming, with the highlight being a field walk of the Winiatas block. With representatives from the regional council present, there was vigorous debate over the sustainability issues versus long-term pastoral production of steeper hill country. Specific sustainability issues included cattle treading on wetter steep soils and the inherent soil slip erosion risk of siltstone hill country. Other well debated issues included, economic return of the development exercise and whether the best development methods had been used (e.g. spray and burn versus cut and burn)
While not all opposing views were resolved, the discussion was an excellent forum for farmers, company reps and conservation organizations to put forward their perspectives. A well known seed company rep was able to point out the possible further gains which could have been made by sowing a more suitable strain of ryegrass. This was valuable information for field day participants.

Figure 1. Field Day Presentations

<u>Figure 2.</u> Visual Soils Assessment

The December 2003 discussion group visit included a close inspection of the block and it was noted that there was considerably more clover growth in areas, which had been sprayed and burned, rather than sprayed alone. There have been numerous anecdotes about this effect on other properties as well. It is thought that there may be a neutralizing effect of the fire on chemical residues in the soil.

In March 2004, a group of farmers who were not members of the community discussion group, inspected the development area. This was a very useful day, since most had been involved in scrub clearance/land development recently. The conclusion was that the McRae Trust had been very successful in achieving quality pasture cover, with very little

sign of regenerating woody weeds. Good grazing management was deemed to be the most critical factor in maintaining this status.
Erosion control planting using poplar and willow poles had been carried out each season. The numbers planted had been relatively high (250 – 300 each winter) for a smaller area compared to a normal hill country programme. However it was clear from discussions that most people considered more pole planting was required.

Figure 3 Winiatas – New Grass – First Winter

<u>Figure 4.</u> Winiatas Inspection of New Grass

<u>Figure 5.</u> Serious Discussions over Winiatas Development

Attached is a series of three graphs, showing a summary of economic analysis of the development costs and returns at $8, $19.50 (breakeven) and $30 per stock unit. At the field day, it was calculated that return on investment was only 5% to that point. However, since then good growing seasons along with good livestock returns, have doubled that to 10%. It should be noted that neither set of calculations included the cost of erosion control planting, which would have had a significant effect on both the above figures. Development costs and performance data used in this analysis are found in appendix 2.

Figure 6. **Financial result of development returns at $8/stock unit.**

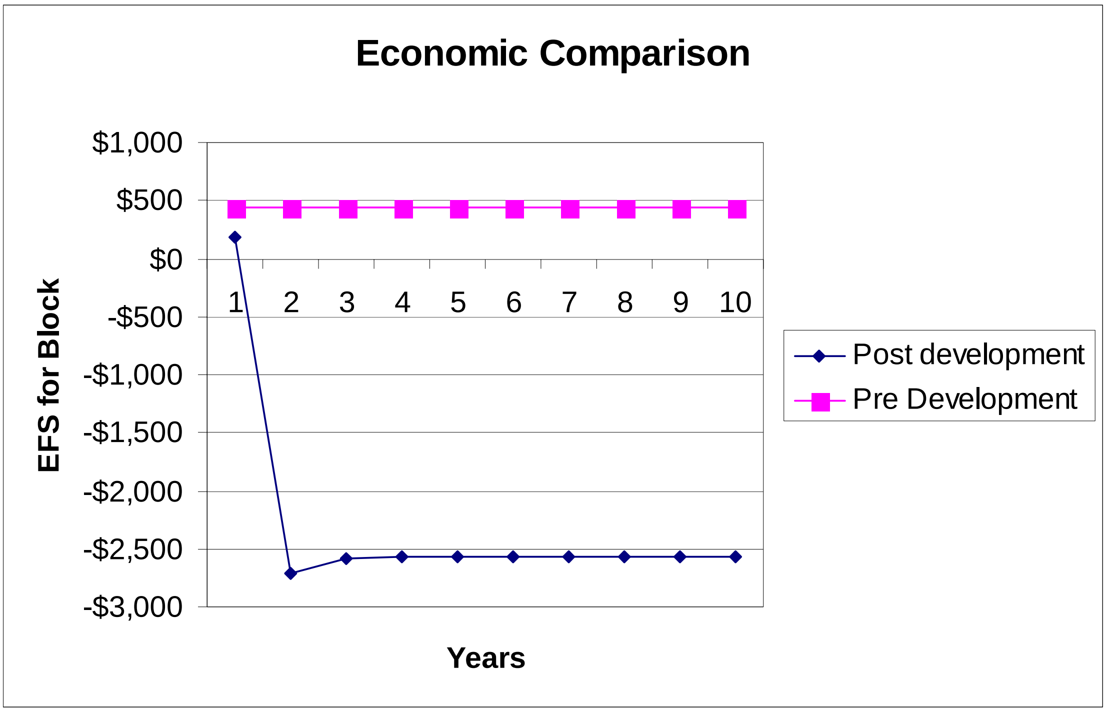
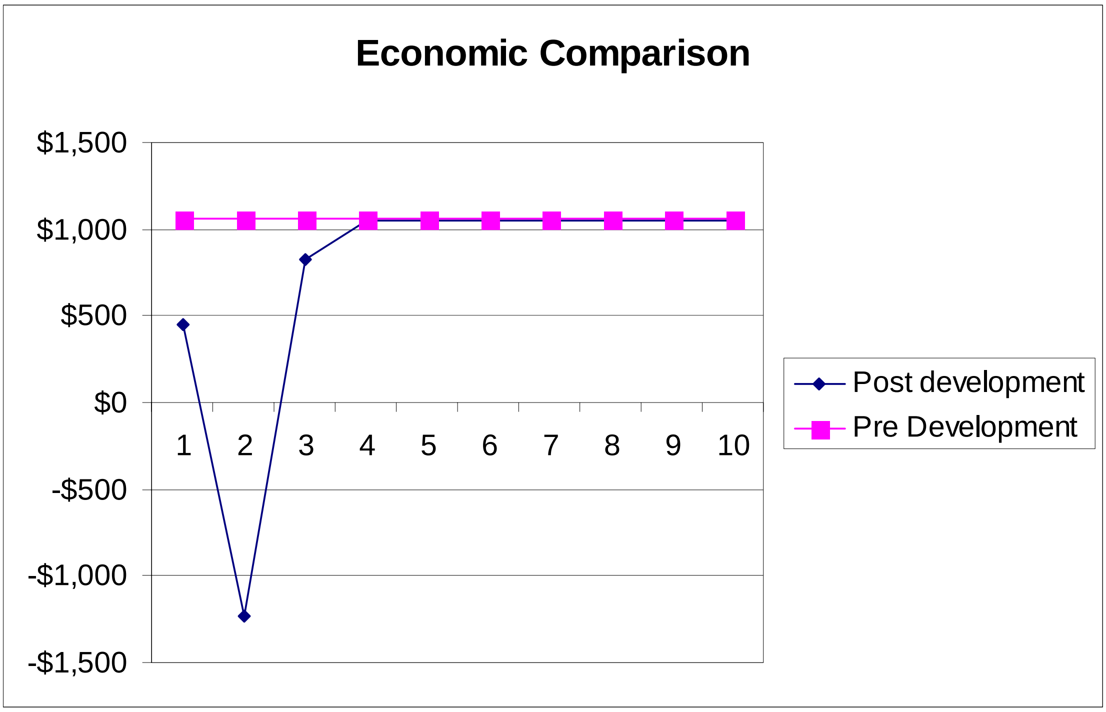
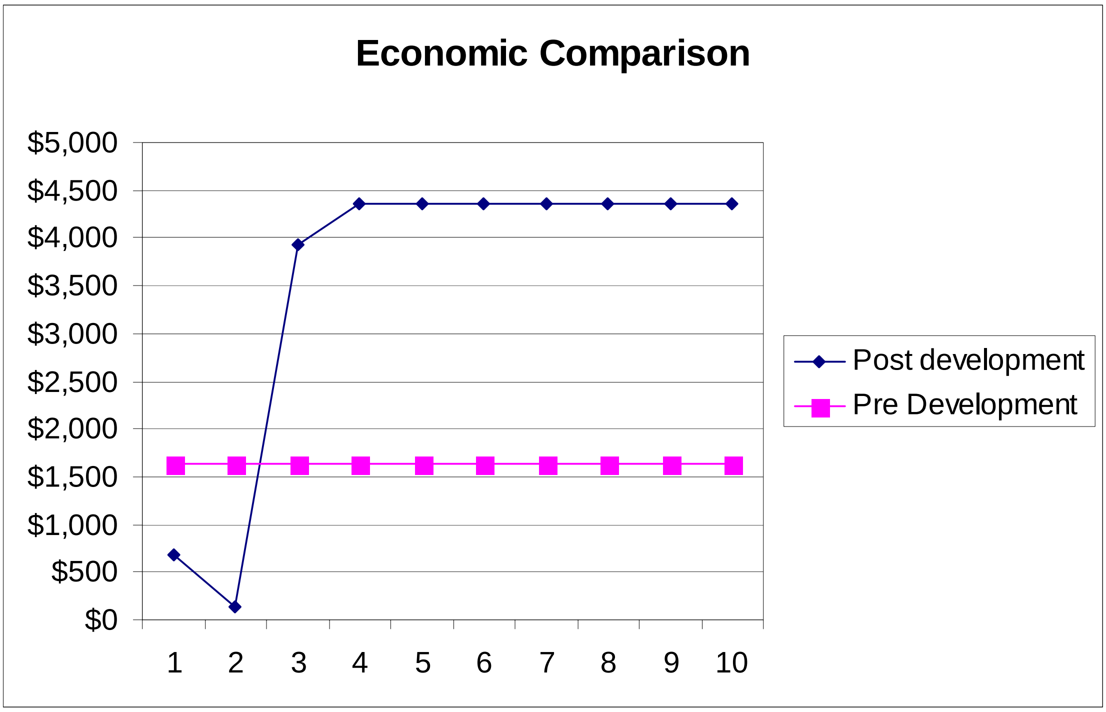


Figure 7. Financial result of development returns at $19.50/stock unit (breakeven).



<u>Figure 8</u>. Financial result of development returns at $30/stock unit.



Main Points and Conclusions from Winiata's Development Exercise

It could easily be argued that that the farm has been fortunate with kind seasons and relatively good product prices since development, remembering also that this work was financed from farm income rather than borrowings. However, based purely on economic analysis, some would conclude that this is a low return investment. Compound that again with a view that conservation needs should be met out of development capital and financial results can look very poor. The hill country farmers view differs significantly though, due to perhaps; the power of human effort, vision and the long- term nature of a farm enterprise. Some of the intangibles not taken account of are:

- This is a reasonable return from existing cash-flow (for a farm business)
- Clear paddocks are easier to manage
- Capital value improvement
- Aesthetic improvement – especially combined with strategic tree planting
- Long term business income is more secure – better use of resources
- Is it viable long-term to <u>not</u> develop pastoral areas such as this?

On the negative side, there are aspects, which could count against this type of project:

- Increased real erosion risk until conservation trees take hold
- Perceptions of some community interests about poor stewardship
- A knowledge that there may still be a need to establish forestry on very steep areas sometime in the future

Soil Mapping

A soil map was prepared for the McRae Trust by Murray Jessen from Landcare Research. Various individuals from within the discussion group, as well as others with particular interests, were invited to accompany Murray in his soil survey work. An example of this was the inclusion of a cropping farmer to assist with the assessment and discussion of soils of the flats. A copy of this completed map has been submitted as part of the report filed after that quarter.

Figure 9. McRae Trust Soil Surveyor and Trainee

<u>Figure 10.</u> Murray Jessen presenting the McRae Trust Soil Map at the Field Day

The main objectives of the soil mapping exercise were firstly to prepare a solid planning resource for the McRae Trust (for sustainable farming and demonstration purposes) and secondly to show local farmers the benefits of better understanding their soil resource. So, it was decided to add further value by implementing a programme of soil mapping for group members and other interested individuals.

An initial meeting of all interested farmers was held, where an introduction of the programme was presented by Tony Rhodes (Wrightson,) Murray Jessen and Peter Manson. At this point, those who were still interested in participating agreed to a schedule of farm visits. As a result, eleven farmers agreed to take part. The programme was named *'Growing Business From The Ground Up'*
The farm visits (see attached schedule and notes from the first farm visit) took place from January through August 2004. It was intended that each visit would entail a tour of the property, soil profiles of each main soil type and discussions at each site with regard to soil properties and sustainable management implications. This process worked very well. Each person was responsible for developing their own soil map with the help of the facilitators and it was intended that at least one farmer would have the opportunity to see their resource map used to produce some 'enterprise options' complete with financial analysis.

All eleven farms were visited and a very good range of soil types, including those of a dairy farm were included in the programme. Participation level was very high.
The property chosen for further analysis was Waiau (Dave Read/Judy Bogaard). A feature of the land management units of this farm is the predominance of steep shallow soils over silt/mudstone. These contributed to a mix of winter warm northerly aspect and cooler southerly faces that more effectively retain soil moisture and pasture production into summer. Areas of easier contoured ash ridges were invariably separated by steeper mudstone derived faces, making it very difficult to utilize the inherent differences in moisture retention, soil nutrient requirements and resilience to pugging. A high priority for the owners has been management of pasture quality through late spring/early summer. The commitment of the owners to the programme, the high quality of their soil map data and existing extensive subdivision enabled a range of options to be considered. Detailed notes on soils, geology and climate for Waiau Station are seen in appendix 3. In the analysis, emphasis was placed on minimizing the risk of treading damage across the steep soils, and this was reflected in a reduction in breeding herd numbers, retaining finishing cattle to provide early flexibility with stock numbers in a dry summer. Reducing breeding herd numbers and utilizing the change in feed availability with the breeding ewe flock, and selling lambs store at weaning offered the potential to reduce the risk of soil damage and increase farm profitability (see appendix 5).

<u>Figure 11.</u> Farmer soil survey and mapping group on the Read/Bogaard property.

Attached as appendix 4, is a copy of the soil map of 'Waiau', which has been drafted professionally from the owners base map. Also included, is a copy of the comprehensive notes written by Murray Jessen, for the property, summarising soils and environment. These were provided for every property visited.

The previous soil mapping undertaken on McRae Trust was the basis for evaluating a range of opportunities. Options included cattle wintering systems, development of high performance pastures on the river flats, differential fertiliser application on shallow summer-dry northerly slopes, and investment in improved soil fertility on the ash soils.

Exploiting the potential for favourable winter pasture growth with a late summer and winter-lamb finishing enterprise was discarded due to risks with facial eczema and other mycotoxins. A key decision rule adopted was cows comprising 10% of total stock units. Emphasing high sheep performance (150% lambing), a minimum of 125 breeding cows and cattle finishing provided policies that emphasise both sustainable land management and profitable business performance.

Water Quality Monitoring
It was decided at an early stage to monitor water quality of run-off from the developed land. The difficulty was two-fold: Firstly, both Winiatas catchments were small and often not running in summer and secondly, how the data should be compared and what with. Eventually, with professional advice, it was decided to pursue the monthly water sampling of one of the Winiatas tributaries, a 10ha area of retired bush and scrub known as 'Trig' and the lower end of a well established riparian management area on the Waitahora Stream. All catchments were located on the property. The Waitahora riparian area comprised a single electric wire, which was designed to exclude cattle only. The initial results had been spectacular in terms of visual improvement of the stream banks as well as measurable habitat improvement. Chemical improvements were less conclusive. At the end of the three-year term, Brett Stansfield – Environmental Scientist/water quality, has made the following conclusions:

- Soluble Reactive Phosphorus (SRP) was higher in 'Trig' (bush area) runoff than in the Waitahora stream. This could possibly have been due to shading which reduces the algal growth required to control nutrient levels (see figure 12)
- SRP was also generally higher in the forestry areas of the Waitahora stream
- SRP in the bush and forest areas was not significantly different to the developed 'Winiatas' catchment
- Ammoniacal Nitrogen was lower in the forest area stream, than in 'Winiatas' (see figure 13)
- Ammoniacal N was also high in 'Trig' (bush) which is unexplained
- Ammoniacal N was not significantly different between 'Winiatas' and 'Trig'

Figure 12. Soluble Reactive Phosphorus (SRP) Concentrations in McRae Trust Waterways

	Multiple Comparisons z' values; SRP (mg/L) (Water Quality Data) Independent (grouping) variable: SiteDesc Kruskal-Wallis test: H (5, N= 145) =17.14432 p =.0042					
Depend.: SRP (mg/L)	Within Forestry R:86.607	Below Forestry R:70.563	u/s of Riparian Strip R:48.682	Within Riparian Strip R:65.804	Trib to Waitahora R:93.522	Winiatas trib R:83.104
Within Forestry		1.043815	2.641092	1.622629	0.485651	0.247996
Below Forestry	1.043815		1.585516	0.390312	1.679111	0.925169
u/s of Riparian Strip	2.641092	1.585516		1.572657	3.579843	2.776571
Within Riparian Strip	1.622629	0.390312	1.572657		2.584050	1.635714
Trib to Waitahora	0.485651	1.679111	3.579843	2.584050		0.849997

Figure 13. Ammoniacal Nitrogen Concentrations in McRae Trust Waterways

	Multiple Comparisons z' values; NH3 (mg/L) (Water Quality Data) Independent (grouping) variable: SiteDesc Kruskal-Wallis test: H (5, N= 122) =26.10644 p =.0001					
Depend.: NH3 (mg/L)	Within Forestry R:43.393	Below Forestry R:33.781	u/s of Riparian Strip R:57.659	Within Riparian Strip R:64.684	Trib to Waitahora R:75.781	Winiatas trib R:88.500
Within Forestry		0.742707	1.180026	1.925819	2.502712	3.485514
Below Forestry	0.742707		2.055099	2.932332	3.359328	4.376625
u/s of Riparian Strip	1.180026	2.055099		0.741548	1.559724	2.654391
Within Riparian Strip	1.925819	2.932332	0.741548		1.052980	2.259842
Trib to Waitahora	2.502712	3.359328	1.559724	1.052980		1.017297
Winiatas trib	3.485514	4.376625	2.654391	2.259842	1.017297	

These results give an indication, that the impact of this type of pastoral development, may not be negative in terms of chemical effects on runoff, compared to existing forest or bush areas. More work is required on a larger scale and over more seasons, to give more certain results, however current data is encouraging.

Soil Conservation

Poplar and willow pole planting has been carried out in the 'Winiatas' paddocks each year. Over 500 poles have now been planted in the area to reduce the risk of soil slip and gully erosion. Willow sawfly has been active in the area, making this programme more difficult, however Japanese willow has been used wherever possible. Generally however, there has been an emphasis on poplars. Further planting work is planned, with up to 400 more poles required to complete the protection of the 'Winiatas' area. Costings are approximately $11.70 per pole, in the ground. This equates to around $10,500 worth of pole planting required for a steeper development area such as 'Winiatas'. This cost can be reduce by half in the Hawkes Bay region with assistance from the Hawkes Bay Regional Council, however no part of the conservation input has been included in the financial analysis of the development exercise.

Appendices

Appendix 1.

FACILITATORS REPORT:

SUSTAINABLE FARMING FUND HILL COUNTRY DEVELOPMENT PROJECT; THE MCRAE TRUST, WAIROA DISTRICT.

Introduction:

In the year 2000 the The McRae Trust (the trust) embarked on a hill country development to outline the benefits (or otherwise) of developing steep Wairoa hill country with a view to increasing bottom line farm returns. The project consisted of identifying a steep, woody weed covered hill country block on the property and working through a process of clearing the weeds, burning, over sowing with a modern pasture, subdivision and water reticulation. Dry matter quantities have been monitored and compared to other parts of the property. There has also been water testing to determine quality (or lack of) comparing the developed blocks water course with a QE2 blocks water. There has also been a desire to have a good knowledge of the environmental effects of the development. More recently the question of woody weed reversion has been monitored. The costs and returns of the whole development have also been measured.
Farmer groups have been encouraged to be a part of this process and a very useful working group has been established as a result. One aspect of the process involved a farmer led group making management suggestions based on a comprehensive soil analysis carried out by Murray Jesson of land care research. It was discovered that farmers involved lacked all the tools needed to make informed decisions based on the knowledge of soils and their values. This led to the formation of a 'growing business from the ground up' soils group. This group did a working analysis of their own farms and, with this greater working knowledge, there were many recommendations for the trust based on the soil information with a view to dividing the property into land use units.

What is the McRae Trust?

The trust is a 615 hectare property that was bequeathed to the people of New Zealand in 1975 (This includes a recent acquisition of 28 hectares). It is situated in the Wairoa District on the east coast of the North Island, Northern Hawkes Bay. Included in the Trust Deed was the requirement to 'demonstrate for the purposes of the betterment of farming on East Coast type hill country'. It also included the preservation of land and native flora and the use of trees for conservation. In 80's and 90's programmes of scrub clearing, pasture development, water supplies, tracks and improvement to stock performance were implemented.

The trust property has been the focus of a sustainable land management project since 1994. It has addressed both farm production/profitability and environmental goals during this time. Dramatic improvements in pasture and livestock performance have been achieved in some areas, including lambing percentage and growth rate of young cattle. After achieving some of the more important production targets, a new set of targets have now been set.

Alongside this work, has been the consistent input into environmental activities, including soil conservation planting, riparian management, forestry and native flora preservation. Riparian management in hill country has already proven to be less costly than expected, with significant improvements to surface water quality achievable by using very simple techniques. It is now time for the wider community to learn the benefits of keeping livestock out of some waterways and improving biodiversity in those areas for the betterment of water quality.

Forestry on 'pastoral' hill country has been a contentious issue for some time in the Wairoa area, certainly creating debate amongst the original community group. The forestry potential was discussed during the soil group meetings and is still being recognised by the trust as part of the trust deed requirements.

There is considerable scope in the Wairoa district, for the wider uptake of both more productive pastoral practices as well as more environmentally sustainable land use on some classes of land. Extension has been an issue for the trust as a result of an extended period of community group activity. It is one of the challenges of this type of work, getting the information to the greater community. Recent meetings on the future direction of the trust and the appointment of a new farm manager go a long way, in my opinion, to reinvigorating community interest in the property and its activities.

The Process:

The hill country development began with identification of 30 hectares of class six and seven land - with erosion potential – that was considered typical of Wairoa hill country farm land. It had minimal carrying capacity, and was covered in blackberry and regrowth scrub. The southwest facing block was sprayed with Answer, which leaves all the broadleaf species and totara. The land was then burnt and over sown with permanent pasture. It was then fenced into four blocks with electric fencing and had reticulated water fed to each new paddock. Approximate paddock size is equal; i.e. seven to eight hectares in size. There has also been some shade reintroduced for livestock by planting conservation trees.

Monitoring was set up to include:
- Pasture growth rates
- Fertility levels using soil transects
- Photo points with pictures every three months
- Health of native remnants
- Testing runoff for faecal contaminants
- Sediment traps to collect silt
- Phosphate levels in water
- Measurements of vegetative cover, species, and bare ground
- Worm counts
- Soil carbon levels
- Compaction

Subsequently farmer groups also suggested monitoring speed of regeneration of woody weeds (if any) and persistence of the new pasture.

The farmer group was reluctant to spend every meeting at the trust due to the length of time the sustainable land management project had been running before the hill country project and the extension issue discussed here earlier in this report. With the help of Hilton Collier from Ag-First another existing farm discussion group was used to bounce ideas off regarding the project. One criterion that was recognised as a must for any hill country development was the need for year round easy access. Without the access the long term success of hill country development was questioned because timeliness of management decisions were seen as crucial to harvest the extra pasture as well as negate reversion problems. Another issue encountered was the lack of real understanding of the soil capabilities of the district. The 'grow your business from the ground up' soils group was a huge success and underpinned the recommendations for the trust based on individual land units. This has been the major success of the whole project with many farmers now having skills that are crucial for the future of their individual businesses.

The Future:

After three years involvement and some very successful fielday's, it is obvious to me the trust should persist with local farm extension work and continue to be a vehicle for farm related projects in the Wairoa District. In relation to the hill country development project outlined here, it is paramount there is continued monitoring of

- water quality
- woody weed reversion
- soil stability/compaction
- new pasture persistence
- pasture growth rates

This will fully determine the effectiveness of the development and will certainly answer crucial questions regarding the merits of spending large amounts of funding on capital development of steeper hill country blocks.

Fenton Wilson
Project facilitator

Appendix 2. Winiatas Development Costs and baseline farm returns

Winiata Development

Activity		
Scrub Sprayed	16-Dec-01	$9,600
Desiccate Paddock for Burning	12-Mar-02	$3,153
Burn	28-Mar-02	$1,255
Sow seed	09-Apr-02	$7,146
Fertiliser	07-May-02	$4,550
Thistle Control	07-May-02	$3,053
Fencing	Nov-02	$4,250
Water	Nov-02	$2,250
Total Capital Investment		$35,257

Stock Units Carried	su/ha	Total su carried in Block	Cost to Develop	Cost of additional Stock	Net Cashflow Contribution (Additional EFS)
Pre Development	2.3	23			$872
Year 1	3.5	130	$35,257	$9,842	-$1,536
Year 2	8.0	296		$12,654	$116
Year 3 on	8.5	315		$1,406	$299

Performance and Pricing Levels

Farm Pricing levels are:	Lamb Price	$74.57	
	Steer Price	$911	
	Wool Price	$3.35	
	Lambing	121.0%	
	Calving	86.0%	
	Wool Production Level	5.5	kg/ssu

Appendix 3.

Notes on climate, geology and rock type, soils and landforms, following a field reconnaissance, 16 June 2004, Dave Read and Judy Bogaard, Waiau (Visit 9) — 'Growing Business from the Ground Up'

Murray Jessen, Landcare Research, PB 11052, Palmerston North, 06 356 7154 (wk), 06 358 8677 (hm), 027 295 4334 (cell). jessenm@landcareresearch.co.nz

---

Purpose of these notes

These notes record impressions gained from our field-day reconnaissance, and from existing information (including published geology and soil maps, and LENZ climatic datalayers). Your own investigations are expected to confirm/modify/or dispute ideas in these notes. You will be your own 'expert' at the end of the project!

The notes use a lot of technical (and unfamiliar) terms for describing aspects of geology, soils, and climate. These terms are used because soil science and geology, like other disciplines (including agronomy/economics, etc.), have a special vocabulary to convey complex ideas more simply than would otherwise be possible. The laminated sheets and previous notes use and explain many of these terms. In short time, you will be using the terms naturally and easily, in the same way as describing your latest animal health issue to your vet. No more will we describe all grey coloured rocks as 'papa' and all soils as 'dirt' or 'clay'!

Location

Waiau, Awamate Rd, grid ref InfoMap W19 2885725E, 6241355N.

Climate

Table 1 gives Land Environments of New Zealand (LENZ) level 4[1] categories on the property. It reveals warm temperatures, high levels of solar radiation, low water deficits accumulated through a normal year, but high vapour pressure deficits in October (low humidity) due to removal of water from the prevailing westerlies. Overall, climatic factors point to favourable conditions for plant growth.

Very broadly for reporting on climate, Waiau has three level 3 land environments: 1. easier hillslopes on soft calcareous mudstone with a cover of tephra and with coarsely textured topsoils (LENZ level 4 category D3.3c); 2. steep hill country on soft calcareous mudstone and sometimes sandstone, lower fertility (D3.2b); and 3. flood plain (valley bottoms) with imperfectly drained soils (G3.2c).

---

[1] Ministry for the Environment 2002: Land Environments of New Zealand, Technical Guide. 237p.

Table 1. LENZ level 4 climate layers covering Oruru

LENZ climate layers	Rolling mudstone hills with tephra and coarse-textured soils D3.3c	Mudstone hills with little tephra, finer-textured soils, lower fertility D3.2b	Flood plains G3.2c
Mean annual temp (°C)	13.1 (warm)	12.5 (mild-warm)	14.0 (warm)
Mean minimum temp July (°C)	3.8 (mild)	4.2 (mild)	4.6 (mild)
Mean annual solar radiation ($MJ/m^2/day$)[2]	14.8 (high)	14.7 (high)	14.7 (high)
Mean June solar radiation ($MJ/m^2/day$)	5.6 (high)	5.7 (high)	5.6 (high)
October vapour pressure deficit (kPa)[3]	0.50 (high)	0.45 (mod-high)	0.44 (high)
Annual water deficit (mm)[4]	38.0 (low)	4.1 (slight)	41.44 (low)
Monthly water balance ratio[5]	2.8 (low)	2.6 (low)	2.9 (low)

Rock types and soil parent materials

Waiau is covered by a broad-scale geological map (1:250 000) published in 1960. The Institute of Geology and Nuclear Physics (IGNS) will publish a significant upgrade in about a years time, similar to the map used for our more easterly farms. Our own fieldwork reveals the basic geology at a more suitable scale for this project.

The local basement is mainly massive, slightly calcareous silty mudstone laid down under the sea in late Miocene times (5.3–11.2 m y.b.p.), then raised to their present position by tectonic processes. They have the typical characteristics of young rocks in that they are ‘soft’ (can be carved with a knife–not ‘indurated’). They comprise fossiliferous (contains shelly material) massive, grey, coarse (silty) mudstones[6] and tuffaceous (contains volcanic debris) soft sandstones. A large block sloping off to the northwest comprises slumped mixed material that appears to be sliding off a dip slope, but is presently relatively stable.

[2] Energy provided by the sun for all living organisms. Directly related to productivity potential
[3] Another way of describing humidity. Drier areas have higher vapour pressure deficits.
[4] From a simple rainfall/evaporation model. If rainfall exceeds evaporation, the monthly deficit is assumed to be zero, but where monthly evaporation exceeds rainfall, the shortfall is accumulated through the year to give the annual total.
[5] The rainfall to evaporation ratio is computed for each month, and the average for 12 months given
[6] Mudstone is a general term to describe material finer than 0.063 mm diam (63 µm). It includes claystone (most material finer than 0.002 mm, 2 µm) and siltstone (most material 0.002–0.063 mm). Most of our rocks are siltstones, but the term mudstones cover these, esp. if we describe them as silty mudstones

In much of New Zealand's hill country, the local basement rocks (described above) are also 'parent materials' for the soils. However, in recent times (over say, the last 100 000 yrs there have been a succession of volcanic ash showers from the Taupo and Okataina (Rotorua) volcanic centres and these have deposited 'tephra' over the local basement rocks and the Wairoa area lies at the fringe of this tephra coverage. Mostly, these have washed off the steeper hillslopes and soils here have formed from the local basement rocks, but on the easier slopes (flat to strongly rolling, and some moderately steep hillslopes), tephra layers are the new soil parent materials. These occur in small and scattered areas of throughout the hill country of Waiau, and a larger area on the dipping slumped block and associated lowest terraces leading to Mangawhero Stream. The differences between these tephric soils and non-tephric soils (those from mainly mudstones and sandstones) are major across all soil properties (chemical and physical). The main tephras[7] we expect to find are described in Table 2.

Alluvium forms the soil parent material on the lowest terrace (floodplain) of the Tutaekuri River (only seen from a distance). It is rich in material eroded from the mudstones mainly, although it also contains tephric materials (Taupo and Waimihia) eroded from nearby slopes.

Soils according to soil landscape units

Our study is lucky to have access to a good soil map and report[8]. We can 'borrow' soil names from this publication. The scale of the map is broad (1:100 000) and can provide a guide to the likely soils, but we need to interpret soils at our farm scales of about 1:10 000.

Soils to watch for are listed and described below—but you should know that this list is not exclusive and relies on our very rapid field impressions of selected parts of the farm during the field day. I use technical names from the 'New Zealand Soil Classification'[9] because it helps to focus on actual soil properties, and allows us to assume accessory properties important for land use and management. Soils are listed under a number of 'soil landscapes'. These landscapes could provide a first cut of the way the farm may be mapped into soil units and ultimately, land management units.

I introduce a new soil name in this review (not in the Rijkse soil map and report), and it is '*Pouawa loamy silt or sometimes silt loam'* (and we can refer to it more generally as the Pouawa hill soil). It is a soil that would have been used frequently in the previous farm

---

[7] None of the tephras have been verified in our study area by analyses, but we can be reasonably confident

[8] Both can be purchased as a single publication comprising a report and map from Manaaki Whenua Press. **E-mail**: mwpress@LandcareResearch.co.nz. **Phone:** +64 3 325 6700, **Fax**: +64 3 325 2127

Rijkse, W.C. 1978: Soil map of part Tiniroto–Wairoa area (sheets X18/19/20, Y18/19/20), North Island, NZ, Scale 1:100 000. *N.Z. Soil Bureau Map 110*.

Rijkse, W.C. 1979: Soils of part Tiniroto–Wairoa area, North Island, New Zealand. *N.Z. Soil Survey Report 48*. 24 pp. plus extended legends of soils.

[9] Hewitt, A.E. 1998: New Zealand soil classification. *Landcare Research Science Series 1*, 2nd ed. Lincoln, Manaaki Whenua Press. 133 p. Available from Manaaki Whenua Press.

reviews (I should have introduced it earlier – whoops!). Think about Pouawa hills soils as being associated with Pahiatua steepland soils or Hangaroa steepland soils, but in ‘less severe’ hill country (that is, where most slopes lie between 16^{o} and 25^{o} – we describe as strongly rolling to moderately steep hill country – the class VI hill country). Like Pahiatua steepland soils, Pouawa hill soils have many properties derived from the underlying silty mudstone but it can also have a thin veneer of Taupo/Waimihia material showing in A-horizons (but, not enough tephra to form a Pumice Soil). In previous reviews I have mentioned ‘Pakarae hill soils’, but I now think these are more associated with ‘slumped’ and generally unstable class VI hill country areas and so far, we have not seen too much of this. The profiles of Pouawa and Pakarae are nevertheless quite similar, and apart from the erosion, should receive similar management. I think we should record Pakarae soils on the slumped block on Waiau, but this seems to be the only area where Pakarae soils are the better choice.

I provide a typical profile description of the Pouawa below (adapted from a description given in the Soils Of McRae Trust Farm report, but using the terms on your laminated sheets). The description is rather more complete than any of you will have to generate, but you would be pleasantly surprised how well your field notes on the supplied forms would translate to something quite similar!

Soil:	**Pouawa silt loam, hill soil (PwH)**
Derivation:	Pouawa silt loam, hill soil (25bH) (NZ Soil Bureau 1954 – all this says is that the soil name comes from somewhere!)
Classification:	Typic Immature Pallic Soil (PIT); moderately deep soils on rock, soft mudstone; sandy over skeletal; rapid
Location:	Western margin of the Pylon paddock, in a cut bank beside track. E. 2893237E; 6239595N (this is where this description comes from, on McRae Trust farm)
Landform/slope:	Hillslope, slope 16^{o} (at site), 16–25^{o} (typical for soil)
Drainage:	Well
Vegetation:	Unimproved pasture
Parent Material:	Siltstone with veneer of Taupo ash and lapilli.

Representative profile:

Ap	0–20 cm	very dark black brown (O 2a) loamy silt; non-sticky; non-plastic; peds very weak with very friable failure; moderately well developed structure with few fine nutty peds and abundant very fine nutty peds; many extremely fine roots; very slightly gravelly, fine, fresh and rounded Taupo tephra (lapilli sized); indistinct wavy boundary,

AB	20–24 cm	very dark black brown (O 2a) and greyish light orange (O 2e) silt loam (50/50 mixed material from A and B horizons); slightly sticky; moderately plastic; peds weak with friable failure and other peds firm with semi-deformable failure; moderately well developed structure with few medium, common fine, and many very fine nutty peds; common extremely fine roots; slightly gravelly, fine, fresh, rounded (Taupo tephra, lapilli sized) and medium, moderately weathered, angular, siltstone; distinct wavy boundary,
Bw	24–34 cm	greyish light orange to greyish pale strong orange (O 2e–SY 2f) silt loam; slightly sticky; moderately plastic; peds weak with semi-deformable failure; moderately well developed structure with few medium, many fine and many very fine nutty peds; common extremely fine roots; very gravelly (40%), coarse, medium to fine, moderately weathered, angular siltstone; distinct wavy boundary,
C	34 cm–on	greyish light orange to greyish pale strong orange (O 2e–SY 2f) silt loam; slightly sticky; slightly plastic; peds weak with semi-deformable failure; weakly to moderately well developed structure; few medium, few fine and few very fine peds; common extremely fine roots; extremely gravelly (83%), coarse, medium to fine, moderately weathered and fresh, angular siltstone.

Soil mapping tips: 1. Split-off the level flat land beside the Tutaekuri River and map out the lowest tephra covered terraces and rolling land adjacent to Mangawhero Stream. 2. Work out if there are ‘mappable’ areas of ‘tephra soils’ (e.g., Gisborne soils) nested in the hill country on broader ridge areas (these should have in excess of 60 cm depth of tephra consistently). 3. Map the dipping slumped block to the northwest. 4. In the remaining areas, separate the easier hill country (VIe land – Pouawa hill soils with some Gisborne) from the steeper hill country (VIIe land – Hangaroa or Pahiatua steepland soils). 5. Discover how much tephra remains on typical side slopes, then make soil decisions using the notes below – Hangaroa with plenty of tephra, Pahiatua if just a veneer.

1. <u>Soils of the Tutaekuri floodplain (IIIw1[10])</u>

GOT–Typic Orthic Gley Soils: (*Awamate silt loam–Aw*). Grey colours throughout[11] (reduced forms of iron abundant), poorly drained, poor aeration, high groundwater-tables, shallow rooting depth (restricted due to drainage) and few roots below topsoil, high bulk densities ('heavy' soils), limited trafficability and highly susceptible to pugging, can respond well to drainage although drainage options are limited due to terrain position, nitrogen requirement is high. Cutoff drains are an excellent way to reduce the impact of naturally poor drainage.

There is considerable local variation in soil materials and drainage. The above notes might imply soils that are more poorly drained. These need to be checked out.

---

[10] These codes are Land Use Capability units taken from the regional map of LUC used by HBRC for planning purposes (refer to the Council for further information). They can supply detailed information about LUC units on your farm from their own experience and from technical descriptions in the 'regional bulletin' (Page, M.J. 1988: Land Use Capability Classification of northern Hawkes Bay Region: a bulletin to accompany the New Zealand Land Resource Inventory Worksheets).

[11] The colours we looking for, occupying >50% of the soil, are e.g., SO 1f or 1g; O 1f or 2g; WO 1f or 2g, etc. Colours a to e are generally too strong, and so too are numbers 2 to 5. SO, O or WO 2f or g might qualify.

2. <u>Soils of the rolling country leading down to Mangawhero Stream, with thick tephra (IVe2)</u>

MOT–Typic Orthic Pumice Soils: (*Gisborne sandy loam–Gi, slopes<16^o IVe2; Gisborne sandy loam, hill soils–GiH, slopes >15^o and <26^o VIe1*). Pumice Soils have at least 25 cm depth of loamy sand or sandy loam (>40% sand) comprising mostly volcanic glass and in this case it is from Taupo tephra in the A horizons (characteristically blackish grey or black colours), clay contents very low (<10–15%) in A horizons and upper B horizons (very 'light' soils), low soil and ped strength, weakly developed soil structure (not many peds), very friable to loose topsoils, pumice is fresh (unweathered), very high macroporosity in upper horizons, droughty (encouraged by the very high macroporosity, water-repellency, and very low clay contents), non-plastic with low strength when disturbed (can be broken up easily by animal hooves) and soils subject to wind blow when devegetated, low reserves of major nutrient elements (S, K, N, P, Mg all low), traces deficient (possibly Co, Cu, Mo, Bo, I, Se). Subsoils (B horizons) are quite pale with sandy textures to considerable depths in the profile.

These soils can cope with higher numbers of heavy-hoofed animals over a much greater range of soil moisture contents than soils on steeper parts (largely due to the very high macroporosities and high organic matter in topsoils). While pugging might not be an issue, care is still required because soil structure is poorly developed.

MOL–Allophanic Orthic Pumice Soils? Note: Gisborne soils might classify as MOL's if, within the layer of sandy material (usually the Waimihia tephra), there is strong reactivity [i.e. strong to very strong reaction to the 'reactive aluminium test' (see note under table 2.)]. These were found on McRae Trust farm and might well occur in Oruru. For all practical purposes, the general management requirements of MOT and MOL will be the same, although one MOL soils will store more water than MOT's.

3. <u>Soils of the slumped block, with a complex mix of Taupo and Waimihia tephra and other parts where tephra is absent (VIe10)</u>

Soils are complexly distributed across this block, and slumping movements that are reported to be associated with large earthquakes have caused this. There are a few tunnel gullies where Waimihia tephra is thick and this further complicates the soil pattern. I suggest mapping two soils, the Gisborne (with tephra) and the Pakarae (with less tephra and with pale coloured subsoils).

MOT–Typic Orthic Pumice Soils: (*Gisborne sandy loam–Gi, slopes<16^o IVe2; Gisborne sandy loam, hill soils–GiH, slopes >15^o and <26^o VIe1*). (see above)

PIT–Typic Immature Pallic Soils: *(Pakarae silt loam–Pc, slopes<16^o; Pouawa silt loam, hill soil–PcH, slopes >15^o and <26^o).* (see below)

4. Soils of the strongly rolling to moderately steep hills on massive silty mudstone, with a veneer of Taupo and perhaps some Waimihia tephra in topsoils and upper subsoil horizons (VIe7)

This soil landscape is common closer to the northeast corner of the farm (closest to the house), on slopes to the northwest beside the area that is not part of the slumped block, and hillslopes facing the Tutaekuri River in the southeast corner. Elsewhere, slopes appear to be far too steep (class VII steepland).

PIT–Typic Immature Pallic Soils: *(Pouawa silt loam, hill soill–PwH).* Pale colours[12], P retention low (<30%) in topsoils, high base status (>50% saturation), slowish permeability, can have perched water tables esp. in slight hillslope depressions, plant rooting slightly limited by a denser subsoil horizon although this is not a major consideration, strongly worm mixed, high slaking and dispersion potential (erodible by running water), dry summers and moist winters, low extractable sulphate. 'Immature' means these Pallic Soils are youngish and do not have a well developed fragipan (hard pan) in the B horizon. Note that Pouawa soils have a veneer of Taupo and Waimihia, but properties are dominated by the silty mudstone.

Note: If there is >25 cm depth of sandy loam or loamy sand textures (with more than 40% sand), black topsoil colours, very weakly developed structure, etc. (typical of Taupo/Waimihia tephra), the soil is better classified as a Pumice Soil (Gisborne hill soil).

Mapping tip: Where slopes exceed 25^{o} (steep) and soils are shallower and less well developed in the mainly moderately steep hill country, use Hangaroa or Pahiatua steepland soils as secondary soils (e.g., PwH+HaS, or PwH+PahS). My brief assessment is the steepland parts of this soil/landscape unit are more likely to have Hangaroa soils (below).

5. Soils of the steep to very steep hills on massive silty mudstone, with or without a veneer of Taupo and perhaps some Waimihia tephra in topsoils and upper subsoil horizons (VIIe4)

Note: Our brief inspections suggested that Pahiatua soils are more likely than Hangaroa, but read these descriptions and dig a few holes and decided for yourself. This steep and very steep hill country should occupy a very large percentage of the farm, once the mapping is completed.

BLT–Typic Allophanic Brown Soils: *(Hangaroa sandy loam, steepland soil–HaS).* Note: the published soil map has recorded these soils on practically all of the central steep parts of the farm (except across Kauhauroa Stream)—*but this needs to be confirmed!* The key requirement of Hangaroa steepland soils is the presence of a fair bit

[12] The colours we looking for in Pallic Soils are, e.g., SO 2f or 2g; O 2f or 2g; WO 2f or 2g, etc. Colours a to e are generally too strong, and so too are numbers 3 to 5. SO, O or WO 3g might squeak into Pallic

of tephra in the A and upper B horizons (Taupo in the A, and significant pockets of Waimihia in the upper B horizon), extending down the profile to at least 30–35 cm depth, and these tephric materials should be very common in the landscape (not just here and there). This means that the major part of the grass rooting mass is being strongly influenced by the qualities of tephra, and not the underlying mudstone. If it is assessed that these requirements of Hangaroa soils are absent, then the better soil to record is Pahiatua (below). By mapping Hangaroa steepland soils, we are in effect saying that the erosion history has not been as severe because a lot of tephra remains. Brown soils have much more development in their B-horizons, and can be considered more mature than the ROT and ROW profiles of Pahiatua soils.

BLT's have brown colours in subsoils and P retention is moderately high (above 30%), base saturation is low in subsoils, parent materials are somewhat weakly weathered, good drainage, biologically active, relatively stable topsoils with well developed structure, moist climate with rainfalls >1000 mm/yr, and 'Typic Allophanic' means there is a layer in the subsoils to 60 cm depth that meets the requirements of 'allophanic soil material' (strong of reactivity to the reactive aluminium test), with crumb structure or very low bulk density, or weakly pedal to apedal fabric (brown tephra material)—this material would normally be Waimihia tephra in our study area.

ROW–Weathered Orthic Recent Soils: (*Pahiatua silt loam, steepland soil–PahS*[13]). Use where there is very little tephra and where the mudstone is massive. Little time for development due to erosion processes and they are found where soils slips and surface wash have been relatively recently active (say, in the last half century), weak soil development (with most development in the topsoils), some B horizon expression in colour or weak structure, base status generally high, fresh parent rock in subsoils, good drainage, low P retention, quite high fertility, shallow soil depth and plant rooting restricted with angular fragments of mudstone rock being close to the soil surface, lowish total available water contents and can be droughty, 'Weathered' Orthic Recent Soils denote B horizons with more development (more structure, more colour) than many ordinary (or Typic) Recent Soils. Note: **WO–Orthic Raw Soils** may be recorded as a second soil to ROW in completely eroded sites where there is little to no topsoil and parent rock is exposed (on landslide scars <15–20 yrs old).

ROT–Typic Orthic Recent Soils: (*Pahiatua silt loam, steepland soil–PahS*). As above, but without quite the degree of development in subsoils. On steeper and generally more eroded sites, with significant angular mudstone rock fragments in subsoils.

[13] See sample field sheet (end of report) I filled out quickly at one of our stops

Table 2. Tephras likely in the Wairoa farm study group area

Tephra and source (Ok=Okataina, Tp=Taupo)	Approximate age in yrs before 1950	Occurrence	Characteristics and significance for our farming businesses
Kaharoa Tephra (Ok)	770±20	1–5 cm, in upper topsoil, difficult to detect	White grains (glints) in topsoils, brown to grey sand. Not really significant
Taupo Tephra (Tp)[14]	1850±10	40–50 cm forming the bulk of topsoils on most slopes less than about 20^o, and a very thin or highly mixed veneer on steeper slopes	Black sandy loam and loamy sand with pale yellow soft large angular lapilli (>2 mm diam.). The major soil-forming material on easier slopes except the modern floodplain. Very weak reactivity[15]
Waimihia Tephra and Lapilli (Tp)	3280±20	30–50 cm in subsoils on most slopes less than about 20^o, and occasionally as pockets on micro-depositional sites in steeper hill country	Comprises 2 layers: upper layer is sandy tephra, dark brown to light olive; the lower layer is loose, uniform, rounded lapilli, strong brown, and moderate to strong reactivity. Fixes P, but processes are below most of the grass roots. Tunnel gullies can form in the lapilli member
Rotoma Tephra (Ok)	8530±10	Thin and difficult to recognise. There could be thin younger Whakatane Tephra (4830±20) over the Rotoma but its presence is doubtful (Whakatane would appear similar to Rotoma – i.e, whitish and fine sandy)	White to greyish white compact fine sandy layer, often with iron-stained zone above or beneath the Rotoma Tephra, mottling within the Tephra (Fe and Mn). A compact, tough layer that is difficult to dig when dry, and can perch water (called 'pipe clay' in Gisborne area, although it is not 'clay')
Waiohau Tephra (Ok)	11 850±60	Thin and patchy (usually not present, but is sometimes seen deep in soil profiles in stable sites). Can underlie Waimihia materials where Rotoma is absent	Very distinctive because it is greasy/slippery silty material (loamy silt) with much iron staining. It is full of 'allophane' and has very strong reactivity
Omateroa Lapilli (Ok)	28 220±630	A possible, although reasonably unlikely and rare tephra in the district, very deep in profiles	Very distinctive as it will underlie the equally distinctive silty Waiohau Tephra but comprises medium to coarse lapilli, loose (can be dug easily with bare hands), with orangish or creamy pale colours, widely known for susceptibility to form tunnel gullies

[14] We 'lump' the separate Taupo showers and name them 'Taupo Tephra' for simplicity. We also name Waimihia deposits collectively as Waimihia Tephra to cover both the sandy ash and the coarser lapilli

[15] Field test for the amorphous clay material called allophane is called the 'reactive-aluminium test' and is performed by placing a drop of saturated sodium fluoride (NaF) solution on a small sample of soil placed on phenolphthalein indicator paper. Rapid development of strong red colours indicate the high presence of hydroxy-aluminium groups such as those found in soil material rich in allophane and aluminium-humus complexes. Soils with moderate to very strong reactivity within the rooting zone of plants can be expected to fix (lock away) substantial proportions of phosphorous.

Table 3. A list of land qualities and notes to help decide the opportunities (strengths) and cautions (weaknesses) of the various land management units and their associated soils once mapping is completed

Land qualities		Comments related to land use
Land qualities that mainly affect production potential	Short-term waterlogging	Influences non-arable horticulture, arable uses, and forestry uses on the floodplain surface
	Soil water deficit	Influences pastoral uses in a poor climatic year, but not greatly in a normal year
	Root penetrability	Influences pastoral and forestry uses in the steepland units, but only moderately due to the presence of 'soft' rocks
	Landslide erosion	Influences pastoral use. Pastoral productivity is permanently influenced on soil slip scar sites (takes 80 years to recover just 80% of original production, and will not recover more than this)
Land qualities that mainly limit management	Slope angle	Influences non-arable horticulture, and precludes arable uses on slopes >15^{o}. Influences pastoral and forestry uses on steepest slope segments >25^{o}. Tracking is intrusive where cut across steep slopes and tracks are more difficult to maintain
	Nutrient reserve capacity	Influences pastoral use. Reserves are very low in soils from the tephra, while they can be medium for soils from mudstone. Good responses from added fertilizer are anticipated
	Potential flood/sedimentation risk	Influences non-arable horticulture and arable uses on the floodplain
	Tunnel gully erosion	Influences animal safety
	Soil slip erosion	Influences tracking and fencelines in the hill country
Land qualities that mainly affect environmental vulnerability	Topsoil structural compaction vulnerability	Influences arable, pastoral and forestry uses *where there is no tephra* (steep hill country and terrace). The floodplain is vulnerable to structural degradation from wheeled traffic and cultivators, and is prone compaction from animal treading during wet periods
	Topsoil erodibility by water	Influences arable and pastoral uses. Problem only where slopes >12^{o}, or on Taupo tephra covered units when soils are exposed to wind and water
	Soil loss by slip and tunnel gully erosion	Influences pastoral and forestry uses. Much of the hill country is vulnerable to erosion, with both onsite and offsite impacts. Management by conservation tree planting
	Vulnerability to soil organic matter loss	Influences arable use on the floodplain. Elsewhere, influences are limited if a good pasture cover is maintained

Appendix 4. Waiau Station – Soil Map

<u>Appendix 5.</u> Waiau Station – Land Managent Units and Livestock Policy Scenarios

Waiau Station

Scenarios

1. The current situation farming 5319 sheep and 1360 cattle. Ratio = 41:59.

2. Option 55A. Recognising the potential for high cattle numbers to contribute to pasture and soil damage during through mid-winter to early spring, a reduction in cattle in favour of sheep. Ratio = 57:43.

3. Option 55B. The changes note in 55A with numbers optimised to balance feed supply and demand. A total of 7208 sheep (1967 ewe hoggets and 5207 ewes) and 958 cattle (509 cows plus 117 R2 in-calf heifers and 255 weaner heifers).

4. Option 55K. Applying 30 kg of nitrogen in May to 397 ha of the sunny drier hill country.

5. Option 55L. Utilising the benefits of nitrogen through increased stock numbers and performance within the same policies and ratios as farmed in 55K.

Designing options and implications - how we can use this to shape the business?

- The Farm's vision and goals:
  - ⇒ profitable, sustainable, enjoyable business
  - ⇒ stock policies that work with the different constrains of the farms soils

- Challenges
  - ⇒ an environment that is summer variable and generally dry, has favourable winter growth, and is at risk of facial eczema.

- Identifying what to do first
  - ⇒ integrating different areas
  - ⇒ learning how to work with the positive aspects
  - ⇒ making a negative into a positive

- The result
  - ⇒ more informed business about what works and what isn't
  - ⇒ looking at how each land management area can contribute to the whole business
  - ⇒ working to the strength of areas
  - ⇒ identified financial implications and the opportunities for fine tuning
  - ⇒ evaluated opportunities and the impact of investment in fertiliser
  - ⇒ increased sustainability and profitability by between 12% and 42%

Waiau Station
Financial Summary

FARM	0	55A	55B	55K	55K1
Description	Status Quo	57% sheep:43% cattle	Incr feed utilisation resulting from change	30 kg N/ha on 397 ha	Incr utilization of extra feed
INCOME	$ Total	$ Total	$ Total	$ Total	$ Total
Sheep	241348	359551	399271	399271	408609
Wool	48675	63756	70818	70818	72490
Beef	317538	220815	245468	245468	252092
Total	**$607,561**	**$644,122**	**$715,557**	**$715,557**	**$733,191**
EXPENSES					
Shearing	21178	27248	30260	30260	30978
Velveting	0	0	0	0	0
Cropping	0	0	0	0	0
Feed	0	0	0	11910	11910
An.Health	39805	33723	37401	37401	38292
Capital @ 8%	0	-16480	-8509	-8509	-6570
Total	**$60,983**	**$44,491**	**$59,152**	**$71,062**	**$74,610**
MARGIN	**$546,578**	**$599,631**	**$656,405**	**$644,495**	**$658,581**
DEVELOPMENT COST		Cost of Debt Servicing (interest and principal)			
Awamate	**14 ha**				
		$0	$0	$0	$0
Good Hill	**474 ha**				
		$0	$0	$0	$0
		$0	$0	$0	$0
Steep Dry	**397 ha**				
		$0	$0	$0	$0
Shady Steep	**256 ha**				
		$0	$0	$0	$0
Total Development	$0				

Land Management Unit

Land Management Unit No: 1______ LMU Name Pahiatua Steepland

Map Colour:___________ Area (ha): _________

Features:

- 15 cm A horizon over silt/mudstone with a mix of southern and northerly aspect. Differences in soil moisture retention influenced by aspect.

- Steep with slope angle 28^0. Significant broaching due to slope evident as sheep tracks. Significant historic erosion evident in slip and gully forms.

- Generally a white clover pasture system, but will revert to annual sub clover system if a series of dry summers.

- Moderate fertility P=14

- Well subdivided – average 8-10 ha

Weaknesses	*Strengths*
Difficult to hold fence lines	Northerly aspect gives good winter production <u>if</u> a good autumn
Narrow ridges	Winter growth rates are reliable
Well tracked, but high maintenance input	
Limited access to water across the top half of the slope	
Weed reversion, particularly blackberry and manuka	

Potential Uses (highlight preferred use):

- Cows and ewe mating.

- Calving mid October with single ewe lambing

- not suited for lamb finishing
- ______________________________
- ______________________________

Land Management Unit

Land Management Unit No: 2 _______ LMU Name Pouawa/Gisborne Hill _____________________________

Map Colour:___________ Area (ha): _________

Features:

- Moderately steep – 15-25^0
- Moderately well drained, strong rolling knobs and ridges with residual ash cover. Pugging 3/5
- North and northwest aspect. White clover. P=22
- Easy access and reasonably well subdivided – 5-10 ha
- Some seepages____

Weaknesses	*Strengths*
Easy to lose feed quality in both spring and autumn, especially autumn	Largely warm winter country
Widely contrasting soils through the landscape	Well watered for stock
Patchy distribution of soils make area hard to manage	Grows grass well
Lower content of white clover in pasture	Good level of subdivision and access
Exposed to southwest for lambing	Good fertiliser responsiveness

Potential Uses (highlight preferred use):

- Avoid heavy mob stocking of cattle - June to September
- Ongoing pole planting
- Improved pasture control and quality ______________________________________

Land Management Unit

Land Management Unit No: 3   LMU Name Gisborne Hill and Pakarae

Map Colour:___________ Area (ha): _________

Features:

- Easier slope – 12-20$^{0.}$ Pugging 3/5
- Very fragmented. I
- Imperfectly drained
- High risk of tunnel gully erosion and susceptible to erosion following any earthworks.
- North and northwest aspect. White clover. P=22
- Easy access and reasonably well subdivided – 5-10 ha

Weaknesses	*Strengths*
Easy to lose feed quality in both spring and autumn, especially autumn	Largely warm winter country
Widely contrasting soils through the landscape	Well watered for stock
Patchy distribution of soils make area hard to manage	Grows grass well
Lower content of white clover in pasture	Good level of subdivision and access
Exposed to southwest for lambing	Good fertiliser responsiveness
	Good access

Potential Uses (highlight preferred use):

- Pair planting gullies
- Improved pasture quality – palatability and lime

- Overcoming variability in pasture production.
-

Land Management Unit

Land Management Unit No:________4 LMU Name Hangaroa steepland & Pahiatua

Map Colour:___________ Area (ha): _________

Features:

- Steep – 25-33^0 with very small pockets of Pouawa/Gisborne soils – 30-40 cm of ash on broad ridges ____________________
- Shallow A horizon with limitations on water holding capacity
- largely southerly aspect which reduces soil moisture loss and mitigates the shallow A horizon
- P=14-20____________________
- ____________________

Weaknesses	*Strengths*
Limited availability of water in the top half of slopes	Good fertiliser responsiveness
Difficult access	Reliable stock water in a drought
Scrub cover and reversion	
Majority of paddocks are greater than 10 ha – typically 12-15 ha	

Potential Uses (highlight preferred use):

- ____________________
- ____________________
- ____________________

- ____
-

Land Management Unit

Land Management Unit No: 5 LMU Name Gisborne

Map Colour:___________ Area (ha): _________

Features:

- Largely one block – airstrip 12 ha, but fragmented patches ________________________________

- P=25 easy contour
- hold on into a dry spell 2-3 weeks later than the SE hill country
- ash top soil >1 metre deep with deep plant rooting
- well developed soil structure but has low structural strength and is susceptible to damage
- very well drained
- susceptible to wind and water erosion though under pasture very stable
- Pugging risk 3/5
- Broaching risk 2/5

Weaknesses	*Strengths*
Small area	
Disjointed blocks	

Potential Uses (highlight preferred use):

- ____
- ____
- ____
- ____
-

Land Management Unit

Land Management Unit No: 6 LMU Name Awamate ________________

Map Colour:___________ Area (ha): 6

Features:

- Imperfectly/poorly drained so winter wet
- Flat
- Silty with low clay content so susceptible to pugging and slow ability to recover from pugging damage
- Hold moisture into summer and maintain pasture growth
- Expect reasonable P levels
- Deep plant rooting 20-30 cm
- Pugging risk 5/5
- Broaching risk 0/5

Weaknesses	*Strengths*
scattered	

<u>Appendix 6.</u> Acknowledgements

The success of the project has been due to the generous support of many people and organizations both financially and in terms of advice and time spent in discussions, particularly the following:

- Sustainable Farming Fund – MAF
- McRae Trust Trustees
- McRae Trust Community Group 1994 – 2004
- *'Growing Business from the Ground up'* participants
- Fenton Wilson – Project Coordinator
- Localsh Agriculture
- AGFIRST Consultants
- Murray Jessen – Landcare Research
- Tony Rhodes – Wrightson
- Hawkes Bay Regional Council