Lincoln University
Te Whare Wānaka o Aoraki
CHRISTCHURCH•NEW ZEALAND
New Zealand's specialist land-based university

Lincoln University- Arable Field Trip (3)

Tuesday 22nd March 2011

Field Trip Leaders: Barry Croucher, Anton Nicholls

Focus for the Day: Intensive arable production

Programme:

8.00 am Depart Methven Resort

8.45 am Arrive David and Hilary Wards "Radfield Farm"
- Introductions to a New Zealand Mixed Cropping System
- Topic 1 – Seed Multiplication, particularly forage crops
- Topic 2 – Fertiliser and Integrated Pest management
- Topic 3 – Stock Integration

12.00 pm Depart for lunch venue (Ashburton Aviation Museum)

1.30 pm Arrive Eric and Maxine Watsons
- Introductions
- Topic 1 – Irrigation
- Topic 2 – Crop Policies
- Topic 3 – Panel Discussion

5.00 pm Depart Farm

5.30 pm arrive Methven Resort

In the spirit of the OCCUPATION, HEALTH AND SAFETY ACT the Owners have taken all reasonable care in making your visit to the property as safe as possible, they clearly point out, you enter the property at your own risk.

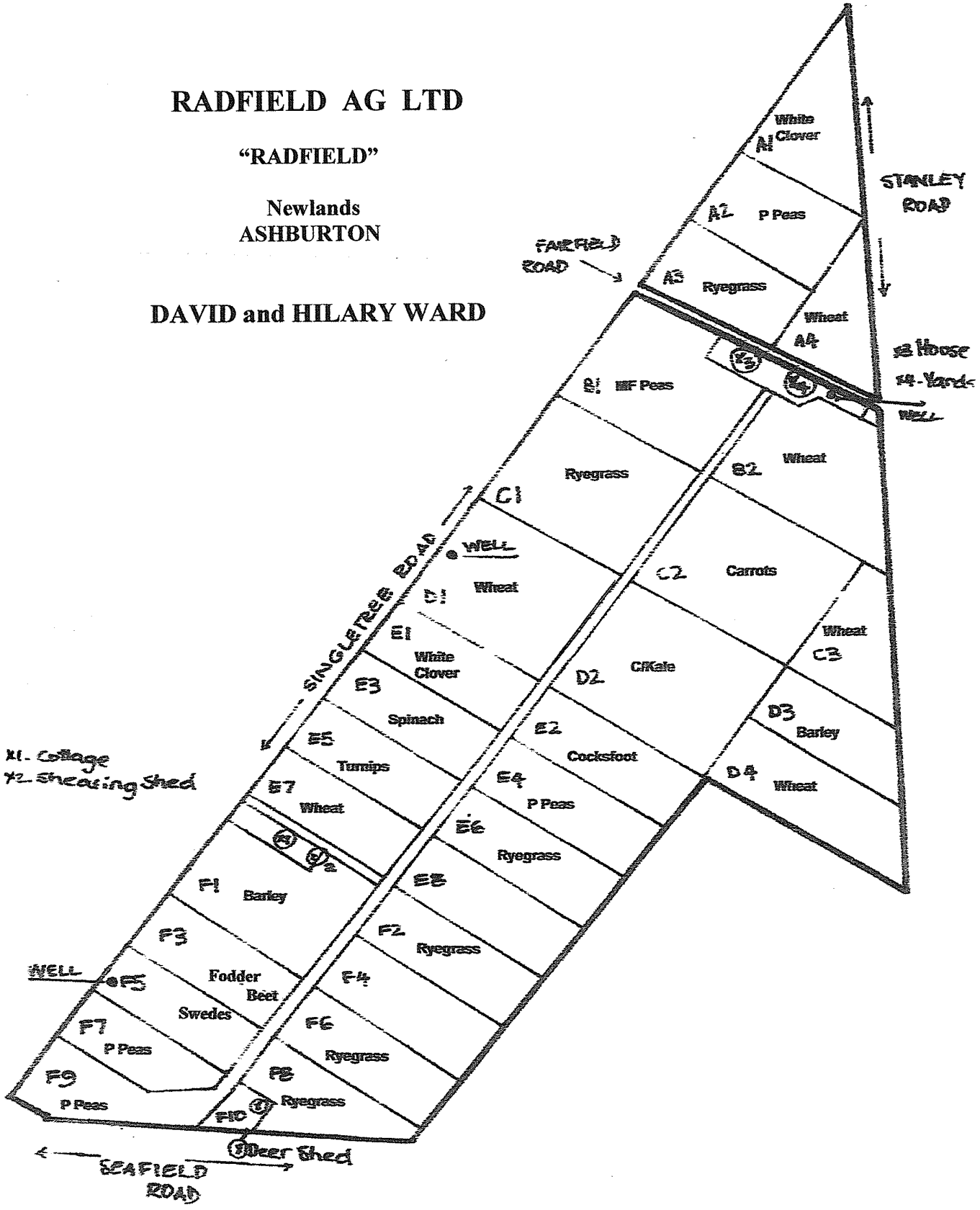
The Owners and IFMA Congress organising committee will accept no responsibility for any incident or injury to any person or property that takes place while you are visiting the property.

RADFIELD AG LTD

"RADFIELD"

Newlands
ASHBURTON

DAVID and HILARY WARD



David and Hilary Ward – Radfield Farm, Newlands

Farming Policy:

"To farm as profitably and as efficiently as possible, using sustainable practices and techniques, to improve soil quality, and therefore increasing moisture and nutrient retention."

Location: 362 Fairfield Rd., Newlands

Within 10 Kms of Ashburton a large rural servicing town with a high degree of educational, cultural and agricultural servicing. These services include processing, marketing, technical and maintenance companies.

It is only 1hour from the main city in the south island, with an international airport and sea port. Also agricultural research centres, plant breeding facilities and an Agricultural University.

Area: 425 hectares (385 ha owned,40 ha leased)
390 hectares are cropped (90%)

Soils: Medium to Light - Lismore and Eyre Stony Silt Loams
These soils are free draining , with a stony top soil of around 180 to 200 mm, on a sub soil of a light gritty clay in shingle to a further 150 to 200 mm on running stony shingle.
The moisture holding capacity of these soils is around 60 to 80 mm.

Climate:

Rainfall 638mm (25.5'') range 400 to 875 (over 50 years)
Effective summer rainfall 220mls

Other weather features:

Low summer rain, often dry right into autumn.
Hot Norwest winds, removing 5mm to 7mm moisture per day by ET.
Some hail risk in late spring to mid summer.
Frosts through from April to October, (isolated frosts into December).
Winters generally overnight frosts, with cool but clear days, bracken by cold southerly wind patterns bringing cold rain.
Snow will fall 2 to 4 times a winter but generally is only light 100mm and only lies for 2 to 8 days.

Water/Irrigation

1 bore at 65meters
1 bore at 95 meters
1 bore at 102 meters
Total water take of 230 lts/sec. 5mm per hectare per day

Seasonal allocation

Approx. 530 mms per hectare Total allocation (Cap) 2,252,500 cubic meters per year at 5mm per day, it equates to 106 days water.

Irrigators: 510 m. Zimmamatic Laterals (2)
Briggs Rotorainers (2)
Briggs Linear booms (2)

Labour: Owners plus 2 fulltime permanent employees make up the team.

Buildings: There is a full range of farm buildings including on farm storage for 700 tones of grain, and a further 800 tones is leased off farm. Four grain trailers are set up with drying floors, for both drying and cooling of grass seeds and grain**.**

Machinery: 230 HP Tractor
19 Run Cross Slot Drill
130 HP Tractor
Normal cultivation equipment which has not been upgraded since the move to No Till and therefore is small for the size of Farm and Tractors.
2188 Axial Flow Combine
40.40 New Holland
Sam spray rig
Heavy roller

Capital:

Land:	**385 has**	**@ $ 35,000 /ha**	**$13,475,000**
	Irrigators -$ 750,000 (incl. in Land valuation)		
Plant/ Vehicles:	**Total Plant/Vehicles**		**$ 1.000.000**

Financial:

	2008		**2009**		**2010**	
Gross Farm Income (GFI)	(000)		(000)		(000)	
Cereals	498	43%	662	54%	457	34%
Pasture seeds	413	35%	413	34%	701	21%
Break crops	83	7%	67	5%	225	21%
High Value	173	15%	88	7%	363	20%
Total Crop	**1,158**	**74%**	**1,230**	**62%**	**1,746**	**77%**
	2.724 /ha		2,894 /ha		4.108 /ha	
Deer	136		243		83	
Lambs	281		515		444	
Total stock	**417**	**26%**	**758**	**38%**	**527**	**23%**
	.981 /ha		1.784 /ha		1.240 /ha	
Combined Total (GFI)	**1,575**		**1,988**		**2,273**	
	3.705 /ha		4.678 /ha		5,348 /ha	
Farm Working Expenses	**1,218**		**1,361**		**1,323**	
(Incl. WOM no Depr.)	**77%**		**68%**		**58%**	
Farm Surplus	**357**		**627**		**950**	
	.840 /ha		1.475 /ha		2.235 /ha	
Return on Capital					**6.9%**	

Arable Crops Grown:

Cereals	Wheat (feed and milling)	25%	)	
	Triticale	5%	)	40%
	Barley	10%	)	
Pasture Seeds	Ryegrass/ Cocksfoot	20%	]	
	Clover	10%	]	30%
Break Crops	(Pulses, Brassica's, Herbs etc.)			
	Process Peas	7%	]	
	Winter Feed Brassica's	8%	]	20%
	Pasture	5%	]	
Specialist Crops	(also break crops but high input high risk)			
	Carrots	5%	]	
	Brassica's	5%	]	10%

Production Performance:

		Tones /ha Kgs /ha
	Milling Wheat	8.5 -9 t
	Feed Wheat	10 -11 t
	Feed Barley	8 – 9 t
	Process peas	?
	Ryegrass Perennial	2200 – 2400 kgs
	Annual	2000 – 2200 kgs
	Cocksfoot	1000 – 1200 kgs
	White Clover	600 - 800 kgs

Winter Feed	Ex Ryegrass	4,000 kgs DM
	Green feed Oats	3,500 kgs DM
	Kale	14,000 kgs DM
	Swedes	12,000 kgs DM
	Fodder Beet	18,000 kgs DM

Soil Health

No Tillage: Fully NO tillage since 1995, excluding some surface cultivation for Vegetable seed production.
Better technology for direct drilling of these crops is currently being researched.
(Maize was direct drilled this year with good results)

Crop Residues:

All harvest crop residues are returned except for Pea Vine and some Ryegrass
The exception to this policy, where the value of the Straw royalty greatly exceeds the fertility value of the straw returned.

The return of residues on the surface post harvest, as good moisture can be maintained this with good aeration and soil biological activity allows rapid breakdown of this residue.
The use of some Nitrogen to assist the process until the organic nitrogen is released , is used to limit nitrogen tie up.

Insecticides: The use of Integrated Pest Management strategies.
To limit the use of insecticides to minimize their detrimental effect , to protect the soil organisms.
By the use where possible of
Crop selection (AR1 Ryegrass),
Resistant varieties (Kale and Swedes instead of turnip or Rape)
Management practices (allowing a dry period to increase mortality of Grass grub and Porina Larvae)
The selection of less harmful insecticides, if that is the only economic means of control.

Nitrogen: Using plant agronomy knowledge to target of N timing to get the best results from the least amount of N
Manipulating the plant by timing N to target grain or seed yield, or vegetative growth.

Organic Matter

Following the changes in Organic matter content of the property for the last 20 years, looking at the effect of Direct Drilling.

- In 1992 in pasture 4.2% – 4.9% Organic Matter (OM)
- In 1992 after 20 yrs. Conventional cropping 3.06% Organic Matter(drop of 30%)
- in 2001 in the same paddock 5.44% (increase of 78%)
  (after 8 to 9 years No Till Barley W/C W/C BAR W/C)
- in 2007 after 15 to 20 years No Till 5.6% - 6.1% (increase of 3 to 12%)
  (increased crop residue retention

Moisture Retention:
In the early stages of irrigation a good crop of Barley under Water monitoring required 8 to 10 day return, when getting up to 6mm evapo-transpiration.
In the last couple of years the improvement in the soil is allowing to stretch the return time out by around 2 days, now 10 to 12 days is more realistic, if this is the case and this is observation not research, then the soil must be holding another 10 to 12 mm of moisture that previously.

Soil Fertility:

	1995	**2007**	**Range**
Ph	6.0	5.9	5.8 to 6.2
Phosphate (Olsen P)	19	32	30 to 40
Potash	11	8	5 to 10
Sulphate Sulphur	6	12	10 to 20

Stock Integration

Stock: Flexible policy - All finishing 500 – 800 Weaner Deer
6000 – 8000 Lambs

Feed Grown

The sowing of one to two specialist winter feed crops (at least one on the Deer fenced area), one Kale and one Swede crop, has developed in the last couple of years. These take arable crop areas, so have to compete economically in supplying winter feed to trading stock.

These crops have to perform, at least 10,000 kg. DM per hectare, preferably up to 15,000 kg DM per hectare.

The use of all the ex White Clover and ex Ryegrass seed areas, these supply large amounts of early feed, to enable purchasing of the trading stock early.

The establishment of early winter feed from the process pea areas not required for establishment of early vegetable seed crops ie. Carrots.

The early establishment of white clover and ryegrass crops, to maxamise stock feed in the late winter and spring.

The sowing of Green feed in all available areas that are able to bulk up 2500 – 3000 kg of DM before being required for late winter and spring crops.

Feed Calculated

In March each year the total supply of winter feed able to be grown through the autumn, winter and spring is calculated. This is re assed in May to finalise winter numbers.

This is done separately for the Deer fenced area and the balance of the property.

The growth rate of all classes of stock to be traded is assessed based on the weight required at marketing.

The required growth rates per head are matched to required feed rates per head to achieve the planned results.

Weaner Deer are fed constantly throughout the 180 to 200 days, to achieve good killing weights early in the spring on the higher schedules, they will require 500 to 550 kgs. DM per head, at high ME's.

Lambs are often held at low growth rates and finished later to get the higher contract prices in the spring. In some cases calculating holding feed levels for a extended period, and finishing feed levels prior to sale. They require 160to 180 Kgs. DM per head at reasonable to high ME values.

A requirement is to have sufficient stock on hand in the spring to cope with the high production of both Ryegrass and White Clover till November.

Economics:

The target is to clear $ 750 per hectare **that is stock sales less stock purchases,** for each hectare on the property.

i.e. Stock sales less stock purchases = $750 per hectare

Alternative stock policies

1. **Diary grazing** @ 24c per kg DM Quality feed . **24.0c per /Kg DM**

2. **Lambs**

Buying @ 26 Kgs Live Wieght (LW) @ $2.65 per Kg LW landed				$68.90
Costs:	Interest on capital 150days @ 10%	$1.55		
	Animal health @$2.00 per head	$2.00		
	Wool breakeven on shear/crut.			
	Total costs			$3.55
			Total	$72.45

Holding 150days 100days @ maint + 1.0 Kg DM
50days @ growth 1.5 KgsDM
Eaten 175 Kgs DM

Selling @ 46 Kgs LW @ 43% kill out = 19.8 Kgs CW @$6.00 per Kg $118.70

Margin net of costs $46.25
Return per Kg DM = **26.4c/Kg DM**

3. Weaner Deer:

Buying at 62 Kgs LW @ $5.00per Kg LW landed				$310.00
Costs:	Interest on capital 220 days $8%	$15.00		
	Animal Health $15.00 per head	$15.00		
	Killing cost $34 per head	$34.00		
		Total costs		$64.00
			Total	$374.00

Holding for 220 days @growth 2.7Kgs DM
Eaten 540 Kgs DM

Selling @ 62 Kgs CW @ $8.50 per Kg CW $527.00

Margin net of costs $217.00
Return per Kg DM **40c/Kg DM**

Future Farming Objectives:

Further improving water efficiency;

By using the New Lateral irrigation system upgrade.

Water monitoring to be done ourselves, with the Frizzel probes and computer program.

To improve Nitrogen and Fertility efficiency;

Currently nitrogen testing every high requirement crop

Trialed Eco N on second year white clover, not convinced of benefit

Looking at the later spraying out of clover to hold the N in organic form longer.

Research and improvement of Integrated Pest Management strategies, is ongoing.

Be smarter with all inputs, timing, quantities, and pricing.

Continue to encourage staff to pursue further Agricultural Education and Personal development.

Continue to encourage the use of no tillage techniques.

Finish development of the farm and home.

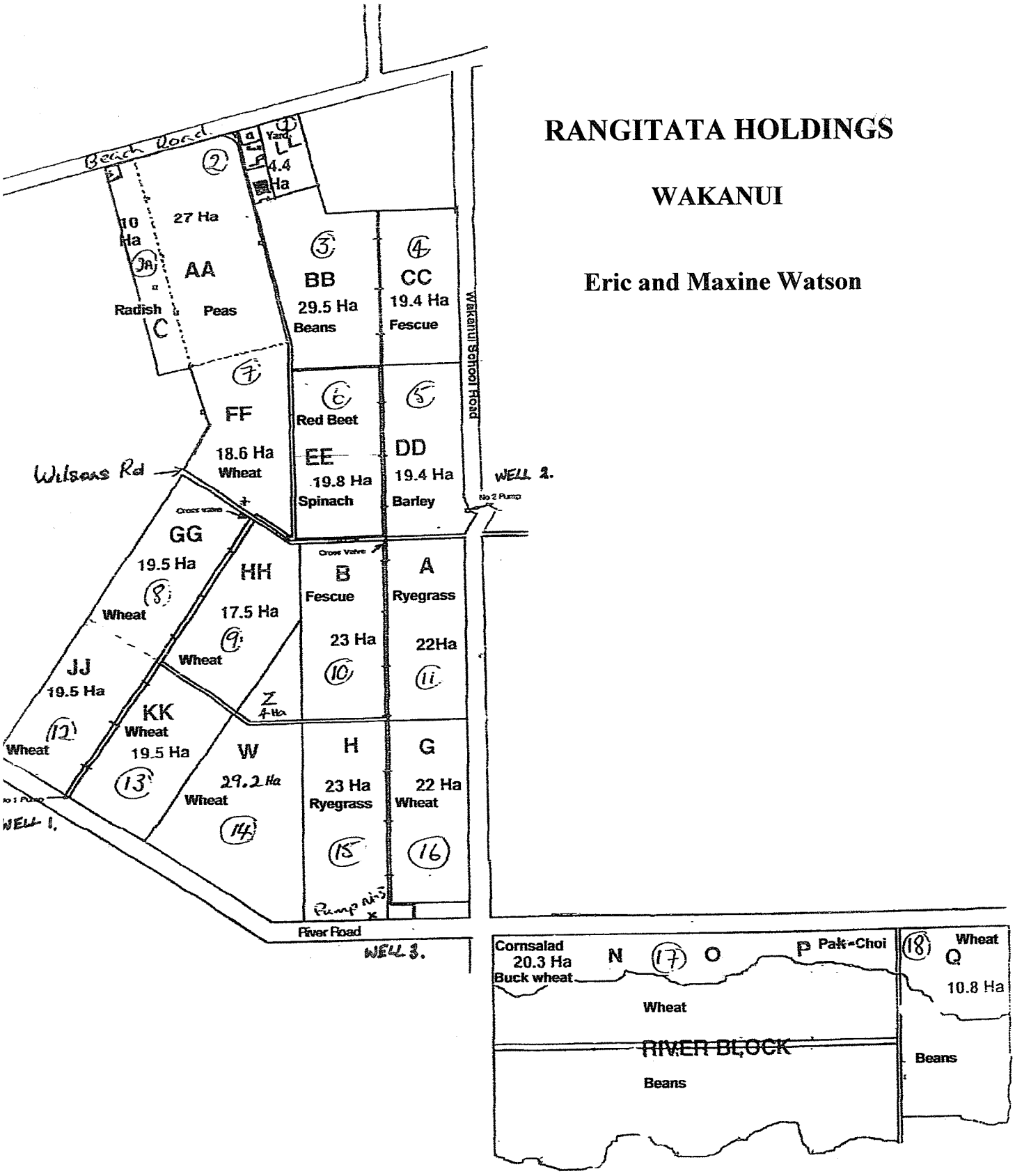
Have spread the risk in farming (i.e. equity ownership in a Dairy farm)

To extend off farm investments and develop commercial projects, utilising knowledge and assets.

RANGITATA HOLDINGS

WAKANUI

Eric and Maxine Watson



"RANGITATA HOLDINGS LTD" - Eric and Maxine Watson - Wakanui

Goals:

If there is an overall philosophy behind our Operation it is: to farm as efficiently, as productively and as profitably as possible, being open to new ideas and practices that achieve these, by continuing to learn, by paying attention to detail and being timely, and to care for the land leaving it at least as good, and if possible better than we found it.

Area: 490 hectares

Farming type: Arable growing a full range of cereal, grass and vegetable seed crops

Soil types and Soil Moisture Holding Capacity (SMHC) to 650mm

386 hectares	Wakanui Clay Loam	140 - 160mm
and	Wakanui Silt Loam	120 - 140mm
104 hectares	Waimakariri Shallow Stony and Sandy Loams	40 – 60 mm

Climate:

Rainfall 638mm (25.5'')
400 to 875 range (over 50 years)
Effective summer rainfall 220mls

Other weather features:

* Low summer rain, often dry right into autumn.
* Hot nor'west winds, removing 5mm to 7mm moisture per day by evapotranspiration
* Some hail risk in late spring to mid-summer.
* Frosts from April to October, with some isolated frosts into December.
* Winters generally overnight frosts, with cool but clear days, broken by cold southerly wind patterns bringing cold rain.
* Snow falls 2 to 4 times a winter, generally less than100mm, lies 2 to 8 days.

Water:

* 97% irrigated
* 3 Wells (2x40m, 1x87m)
* 232 litres per sec over 460 hectares 4.4 mm per ha per day

Seasonal allocation:

Approx. 311 mm per hectare, Total allocation (Cap) 1,432,792 cubic meters at 4.4 mm / day, it equates to 84 days water

Return time of the laterals on the Wakanui soils, 14 days applying 51mm, or 32% SMHC.

Return time of the laterals on the Waiamakariri soils, 6 days applying 15mm, or 25 to 50% SMHC

NOTE: The use of variable rate technology and soil mapping, allows the irrigation application to be limited to not exceed the SMHC on area of these very variable soils.

Irrigation:

History: 1992 - moved to Wakanui. The farm, an amalgamation of three separate blocks, had been laid out specifically for lateral irrigation.

- 2 Bisley laterals (Canterbury-made, from US components)
- Watered 12 ha/day, @ 40-45mm in 24hr period, 14-15 day return
- 2 irrigation blocks: each irrigator travelled between Beach Road & River Road along one run, side shifted to the second run to travel back to Beach Road.
- One exception, large triangular paddock, required a series of pivots and straight runs.

Irrigation development till 2011

- 9 lateral irrigators, including 6x320m, 1x480m and 1x100m, cut-down Bisley
- 97% irrigated
- Minimum return period: Waimaks, 6 days @ 25-30mm/pass, Wakanui, 12-14 days @ 45mm/pass
- 5 machines fitted with Variable Rate technology
- Whole farm EM mapped, 50% ground-truthed for soil moisture holding capacity
- This season 2 machines will be watering to soil moisture holding capacity maps using VRI

Labour 1 Full time employee plus Owners Maxine and Eric

Buildings:

There are a full range of farm buildings including 4 drying floors, with cereal capacity of 1500 tonne. This along with shed and silo storage of 2500 tonne of grain or small seed equivalent.

Machinery:

Cultivation: Based on non-inversion tillage, aim to get everything in at 1 hour/ha, including wheat, ryegrass and green-feed.

1 tractor, 270 HP Cat Challenger 745B tracked with:

- Flatliner 3.8m deep ripper, deep press
- Simba SL, 4.0m with Press and Roller for wheat, peas and beans
- Combi-Dan 4.0m , Cambridge Roller for smaller seeds
- 8m Horsch Cultivator Drill

Combine New Holland C90.80
Windrower Mc Don 9500
Spray Rig Household AR 3600 32m boom
Fertiliser speader Bredal B4

Capital:

Land:	490 ha	400ha @ $ 40,000 /ha 90 ha @ $25,000 / ha (Land Value Includes 9 lateral irrigators)	**$18,250,000**
Plant/ Vehicles:	Total Plant/Vehicles		**$1,800,000**

Financial:

	2008		**2009**		**2010**	
Gross Farm Income (GFI)	(000)		(000)		(000)	
Cereals	865	45%	601	30%	830	34%
Pasture seeds	549	29%	629	32%	521	21%
Break crops	129	7%	271	14%	526	21%
High Value	275	14%	275	14%	486	20%
Stock feed	103	5%	190	10%	108	4%
Total GFI	**1,921**		**1,966**		**2,471**	
	4.271 /ha		4.369 /ha		5.491 /ha	
Farm Working Expenses	**1,426**		**1,460**		**1,419**	
(Incl. WOM no Depr.)	**74%**		**74%**		**57%**	
Farm Surplus	**495**		**506**		**1,052**	
	1.100 /ha		1.124 /ha		2.337 /ha	
Return on Total Capital					**5.26% RTC**	

Crop Selection

Cropping Programme

Crops grown: wheat, ryegrass, fescue (tall & amenity), peas & beans for seed, plantain, phacelia, & vegetables for seed production – spinach, radish, pak-choi, red beet, corn salad, edible chrysanthemum, buckwheat.

Rotation:

'Normally': Grass – Break crop – Wheat – Grass

After fescue (down 5-6 years): Break crop – Wheat – Break crop – Wheat -Grass

Crop Selection Criteria:

The mix of crops grown is dependant on balancing the following criteria:

1. **Profitability**

2. **Risk**

Disease	Growing the same crop consecutively risks the transfer of disease.
Climate	
Pollination	a risk if hybrid matching, and if dependant on bee pollination
Harvest	needs to be spread of crop grown to spread the use of machinery and minimize weather risk.

3. **Cereal/ Restorative / Break crop balance**

   Cereals are harder on the soil particularly where the straw is not returned to the soil.

   Pasture seed production fescue, cocksfoot, ryegrass and white clover with strong fibrous root systems are structure restorative

   Pulse, brassica's and other vegetable and oil producing crops are structure neutral, but essential to break cereal disease buildup.

4. **Weed control** Cereals - to control broadleaf weeds
   Pulse and brassica's - to control grass weeds

5. **Contamination** Risk of hard seed persistence through to following seasons.

6. **Isolation** Proximity to other foreign pollination sources

7. **Availability** Area required at a price that represents the yield and risk

Arable Crops Grown

			2011 area		2011%	Average%
Cereals	Wheat (feed and milling)		198	]		
	Barley		19	]217	48%,	30%
Herbage Seeds	Ryegrass		68	]		
	Fescue		43	]111	25%	40%
Break Crops	(Pulses, Brassicas, Herbs etc.)					
	Peas		22	]		
	Beans		54	]86	19%	20%
	Brassicas	Pak-choi	10	]		
Specialist Crops	(also break crops but high input high risk)					
	Radish		10	]		
	Spinach		9	]		
	Red Beet		9	]		
	Plantain / Chrysanthemum			]		
	Corn salad		10	]38	8%	10%

Production Performance

	Tonnes /ha Kgs /ha
Milling Wheat	9 – 10 t
Feed Wheat	12 -15 t
Feed Barley	9 – 10 t
Peas	3.5 – 5 t
Beans	4 - 8 t
Ryegrass Perennial	2500 - 3300 kgs
Fescue	1000 – 1400 kgs

Water Usage on Feed Wheat and Ryegrass.

Irrigation applied on 160mm SMHC soils 2009/10

Wheat (aim 14 Tonne)		**Ryegrass (aim 3000 kgs)**	
22/9	20mm irrigation	17/10	30mm irrigation
11/11	40mm	29/10	35mm
25/11	50mm	16/11	10mm (for N appl.)
15/12	50mm	19/11	30m
28/12	45mm	4/12	45mm
10/01	45mm	23/12	45mm
		7/01	45mm
Total	**250mm**	**Total**	**240mm**

NITROGEN

Wheat
80 kg residual nitrogen, ex-faba beans

21/9	69kg N	GS30
5/10	92kg N	GS32
12/11	103kg N	GS37
01/12	92kg N	GS 39-40 (post flag emergence)
Total	356 kg N	

(Achieved protein of 10.9)

Full management see Appendix 1.

Rye grass
20-40 kg residual N ex-Wheat

12/4	30 N at sowing
10/9	40 N
15/10	69N Closing date
15/11	92N
Total	231N

(200N spring)

Full management appendix 2.

Monitoring

Soil N Testing
All wheat is tested in August for residual soil nitrogen to a depth of 60cm, and amount of N applied is based on these test results. All ryegrass and fescue also tested, down to 40cm and amount applied based on these results to bring total N applied up to 185-190kg.
Total amount of N required for grass has been arrived at after a number of years' work by FAR to optimise seed production.
Some leaf tissue analysis is done to diagnose trace element deficiencies, mostly in vegetable seed crops.
General soil tests conducted every 2 years – aim to run PH levels up to 6.4, Olsen P at about 25-35
Looking at crop scanning for variable rate application of nitrogen
Irrigation – neutron probes, read weekly; also telemetered technology for continuous instant read out of soil moisture levels; running AquaTrac irrigation programme developed by FAR & Crop & Food

Stock Integration

- **No stock** built into the system, the potential for soil compaction is too high,
- however lambs are grazed when conditions allow.
- Silage is used to control bulk on ryegrass and fescue

Research Involvement

- FAR trials: wheat cultivar evaluation, N management and disease control, Faba bean cultivar and disease management, ryegrass seed PGR.
- FAR and Centre for Precision Agriculture: remote sensing for N management
- FAR and Landcare: variable rate irrigation
- Plant and Food Research: disease nurseries
- FAR Grass-to-crop trials: comparing different cultivation techniques

* BASF Fungicide trials

* Syngenta Fungicide and Herbicide trials.

Variable Rate Irrigation (VRI)

Introduction
Irrigation plays an important role in agricultural productivity and is a major contributor to the New Zealand economy.

Commercial uptake of VRI in New Zealand over the last two years has enabled research to be conducted to assess its environmental and cost benefits.

Irrigation scheduling is being varied according to soil differences, using a soil moisture status map. This map is derived from a soil EM (electromagnetic) map which is produced using an EM sensor with very accurate RTK-DGPS and field computer attached to a farm bike for simultaneous collection of positional and topographically located soil electrical conductivity data. The EM map defines soil variability on a basis of soil texture and moisture differences, and is used to define "irrigation management zones".

Soil available water holding capacity of each soil zone is determined. Soil moisture sensors are installed into each zone to monitor when it reaches the point where irrigation is required. The sensors are part of a wireless soil moisture sensor network (WSN) which transmits real-time data via a base station and router to a website for remote access by farmer and researcher simultaneously.

VRI Trial
Site
Rangitata Holdings

- Linear move sprinkler with VRI modification, irrigating 110 ha.
- Soils range from deep Wakanui silt loams (available water = 163mm/m) at one end of the irrigator to Rakaia very stony sandy loams (available water = 67 mm/m) at the other end.
- Land use is mixed cropping, and this season beans, wheat, pakchoi, and either buckwheat or corn salad crops have been irrigated simultaneously under this system.

Method
EM mapping and Irrigation Management Zones
Four irrigation management zones were defined using the EM map. Zone 1 (very stony), Zone 2 (stony), Zone 3 (mixed stony/silty), and Zone 4 (deep silty). Zones 1, 2 and 3 were planted into beans and wheat, and Zone 4 was planted into shallow rooting seed crops (pakchoi, corn salad and buckwheat).

Irrigation scheduling, yield and drainage
Trial plots were established in Zones 1, 2 and 3 to compare the effects of varying irrigation on crop yield. A uniform rate of irrigation (URI) to all zones was compared with variable scheduling according to soil differences. Irrigation schedules and yield are being monitored in the trial plot areas this season. Drainage of any irrigation water past 50 cm was monitored using the WSN website.

Preliminary Results and Discussion
Irrigation commenced on 8 October, with 15mm applied to the trial plots on the very stony and stony soils (Zones 1 and 2); and 10 mm to the trial plots on finer textured Zone 3 soils, which have larger water storage capacity. No irrigation was applied to the deeper Zone 4 soils at this stage. As the soils dried out irrigation amount was increased to 30 mm in Zone 3, but was reduced to 25 mm in Zone 2 and 20 mm in Zone 1. This gave a water saving of about 15% in these more stony soils, and

also reduced the risk of drainage and nutrient leakage past the root zone. Drainage past 50 cm was sometimes observed during an irrigation event in these very stony and stony zones. Yield is also being assessed in each trial plot so that water use efficiency (kg/mm/ha) can be estimated after harvest. Zone 4 was irrigated less frequently and usually with smaller amounts due to the nature of crops grown in this Zone.

Multiple Uses of VRI

- Varying irrigation according to soil differences, for example:
- reducing irrigation to freely draining very stony zones, which in turn minimises risk of drainage and nutrient leaching
- delaying irrigation to soil zones with larger water storage
- Reducing irrigation into wet, low-lying poorly drained areas
- Excluding irrigation from drains, and other areas such as irregular field boundaries and the area around the pivot
- Varying irrigation according to crop differences
- Eliminating overlaps on the linear move irrigators

APPENDIX: 1.

WHEAT 14 - plus tonne yield "Cassius" Feed Wheat

Sowing mid April. (March to end May)

Sowing rate varies according to variety, time of sowing, seed size and seed bed preparation. – c. 60kg/ha. Aim for 100 plants and 600 ears per m^2

Spray programme:

29/4	1.5 l Gardoprim – post drilling, pre-emergence herbicide	(terbuthylazine)
11/6	100 mls Quantum – broadleaf herbicide (mostly pansy)	(diflufeican)
	1 l Duplusan KV – broadleaf herbicide	(mecaprop p)
25/7	20 mls Karate Zeon – synthetic pyrethroid, aphid control for BYVD	
	250 mls Hasten – oil	
16/9	40 mls Karate Zeon - aphid control	
	750 mls Puma – herbicide for wild oats	(fenoxaprop-p-ehtyl)
	500ml oil	
2/10	1.5 l Cycocel – plant growth regulator, GS 30-31	(chlormequat)
	200 mls Moddus – " " "	(triexapac-ethyle)
	2 l Mantrac - manganese	
21/10	750 mls Cycocel – GS32, leaf three	
	100 mls Moddus	
	400 mls Proline – fungicide	(prothioconazole)
24/11	600 mls Starane – herbicide for cleavers	(fluroxypyr)
27/11	400 mls Opus – fungicides, GS39, flag leaf	(epoxicanzole)
	350 mls Comet	(pyraclostrobin)
7/12	400 Proline – fungicide, "ear-wash"	
	250 mls Amistar - " "	(azoxystrobin)
3/1	250 Opus – fungicides, "T4", green leaf retention, protection	
	150 mls Amistar against brown & yellow rusts	

Nitrogen

80 kg residual nitrogen, ex-faba beans

21/9	69kg N	GS30
5/10	92kg N	GS32
12/11	103kg N	GS37
01/12	92kg N	GS 39-40 (post flag emergence)

Total 356 N

Achieved protein of 10.9

Irrigation

22-Sep	20mm	
11-Nov	40mm	
25-Nov	50mm	
15-Dec	50mm	
28-Dec	45mm	
10-Jan	45mm	**250mm total**

APPENDIX: 2. RYEGRASS - 3000 kg potential, "BASE" a late tetraploid perennial

Sowing mid April. (March and April)

Sowing rate 6Kgs per ha.

Spray programme:

20/4	4 lts Nortron	(post drill pre emergence for hairgrass)	[ethofumesate]
3/6	60gms Preside	(brassica's]	[flumetsulam]
13/9	Jaguar + Bromoxinil		[diflufenican]
	Starane	for Pansy, wireweed, speedwell	
4/11	1.1 lts Moddus +200 mls Folicur	growth stage 31	(triexapac-ethyle)
16/11	1.6 lts Moddus = 200 mls folicur		
4/12	350mls Proline		
	250 mls Amistar		
18/12	400 mls Proline		
	250 mls Amistar		
29/12	500 mls Proteck		[carbenzamine]

Nitrogen

20-40 kg residual N ex-Wheat

12/4	30N at sowing
10/9	40N
15/10	69N Closing date
15/11	92N
Total	**231N**
	(200N spring)

Irrigation

1/10	30mm applied
29/10	35mm
16/11	10mm (N application]
19/11	30mm
4/12	45mm
23/12	45mm
7/01	45mm
Total	**240mm**