A whole farm comparison of irrigated cotton rotations in the Lower Namoi Valley, NSW

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A whole farm budget for a representative farm in the Lower Namoi Valley in northern NSW was used to analyse the financial implications of a comparative rotational experiment of four cotton-based rotations conducted in recent years at the Australian Cotton Research Institute, near Narrabri. The model was used to compare the rotations, which highlighted the importance of crop selection for the financial performance of the business. Apart from providing a broad brush picture of financial performance, the model also had a stochastic component which was used to analyse the effect of variable commodity prices on the whole farm profitability of each rotation.

Mean results indicated a positive return for all rotations within the representative farm budgets for the Lower Namoi Valley, indicating that given restricted irrigation water availability and average commodity prices, each rotation would ensure that the business returned a profit. The rotations varied in resilience to commodity price variability from 74% to 99.5% probability to return a positive farm operating surplus.

1. Introduction

It is important to understand the farm level impacts of cotton industry research. Our objective was to understand the whole farm profitability of four rotations and gain an understanding of the impact commodity price variability has on each of the rotations at a whole farm level.

A recently developed whole-farm budget for a representative farm in the Lower Namoi Valley was used for the analysis. The whole farm budget provided an indication of the financial performance at a particular point in time of a farm with a particular set of resources. Within this analysis water resources were severely restricted to reflect license allocations at the time. While the representative farm model presented in this Report may give a broad indication of the financial performance of many farms in the Lower Namoi Valley, it may be quite different for farms with markedly different resources or enterprise rotations to those of the representative farm.

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Farm decision makers may have several objectives which they try to achieve simultaneously. Other than an economic return, objectives to ensure the long term sustainability of the farm may include management of soils, pests, weeds & disease. Economic evaluations of alternative rotations use profit as the primary incentive for decisions, because this is considered to be an important consideration for many farm decision makers. The rotational comparison presented here assumes the profit objective. However, we recognise that this is not the only possible motivation, and consider the results of such analyses to be only partial in providing information to farmers.

Financial budgeting can be used to estimate the change in profits from new technologies or management strategies. Profit changes can be considered at the enterprise level (eg gross margin budgets for alternative crops, partial budgets, cash flow budgets), for crop sequences (eg winter and summer crop sequence budgets), and at the whole-farm level. Enterprise and whole-farm budgets are presented in this report to represent a common farming system in the Namoi Valley. However, all models are simplified representations of reality. The value of a model depends on how it is used, and the results of analysis with models need to be interpreted carefully.

2. Namoi Valley

2.1 Physical characteristics of the region

The Namoi Valley is situated in northwestern NSW and is a part of the Murray-Darling Basin Drainage System. The catchment region covers an area of 41,350 square kilometres, representing 5.4% of the total area of NSW and 4.1% of the Murray-Darling Basin (Hope and Bennett 2002).

The major water course in the catchment is the Namoi River, which flows west until it joins the Barwon River at Walgett. The major water storages in the valley include Chaffey, Keepit and Split Rock dams.

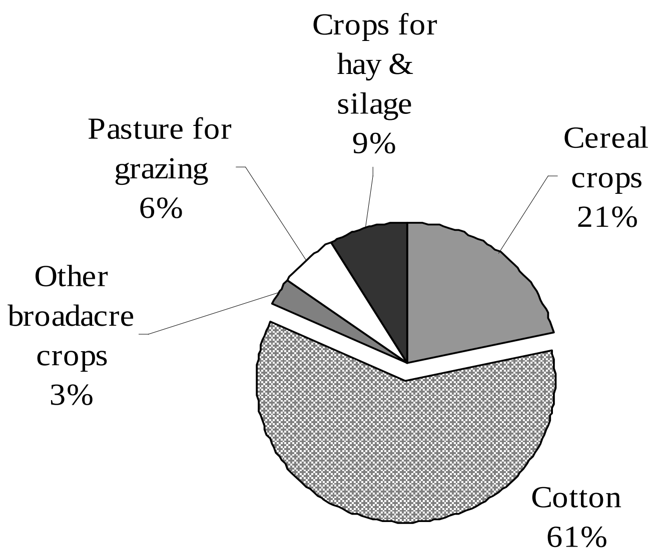
The riverine plains are the area extending from Narrabri to Walgett, also known as the Lower Namoi Valley. This area contains a complex system of tributary systems and the flatter topography makes it conducive to surface or furrow irrigation (Hope and Bennett 2002).

Soils vary throughout the catchment, reflecting its complex topographic and geological characteristics. The best cropping soils in the region range from neutral to alkaline grey clays to black and red earths, often self-ameliorating due to their shrink-swell properties (Marcellos and Felton 1992). Soil in the riverine plain is dominated by self mulching grey cracking clays also known as Vertosols (Isbell 1996). Australia has the greatest area and diversity of cracking clay soils of any country in the world.

2.2 Land Use

The Namoi Catchment supports a variety of land uses. The opening of Keepit Dam in October 1960 was followed by rapid development of an irrigated agriculture industry in the Namoi Valley with the first commercial cotton crop in the valley grown at Wee Waa in 1961. In the 2005/06 season, cotton was the fourth largest crop in terms of land use in the Catchment, accounting for 9% of total crop land (ABS 2008). In terms of irrigated land use, cotton has consistently been the dominant crop planted for irrigation in the Namoi Valley. According to the ABS (2008), in 2005/06 cotton dominated irrigated land use in the Valley, accounting for 61% of the irrigated crop area (Figure 2.1).

Figure 2.1: Irrigated Land Use, Namoi Valley 2005/06 (ha)



Data Source: (ABS 2008)

3. Representative Farm Model

3.1 Resources

The recently developed representative farm model is based on available data, local consensus and assumptions about the size of a typical farm and other resources such as labour, overhead costs, assets and liabilities and the nature of the cropping rotation used. The whole farm budget was constructed from these assumptions and from information on enterprise gross margin budgets.

Assumptions made for characteristics of the representative farm were determined via consensus in consultation with various agribusiness service providers and farmers in the Lower Namoi. Details of the representative farm including all assumptions are outlined in the forthcoming Economics Research Report (Powell and Scott 2011). A summary of the representative farms resources are outlined in Table 3-1.

Table 3-1: Resource Characteristics

Farm Area	**Unit**	**Size**
- Total Farm area	Ha	1203
- Area developed for irrigation	Ha	782
- Area irrigated annually	Ha	Variable
- Area farmed - dryland	Ha	180
- Area grazed	Ha	120
Water Resources		
- Groundwater License	ML	750
- Regulated surface water License	ML	1600
- Water storage capacity	ML	900
Farm Labour		
- Owner manager	No. of weeks	50
- Permanent employee	No. of weeks	48
- Casual labour	No. of weeks	Variable

Water assumed available for the analysis, is based on allocation levels in recent years, is the 750ML of groundwater, 25% of the 1600ML river license and 15% of the 900ML dam capacity to give a total of 1285ML.

The typical farm in the Lower Namoi Valley is owned by a single family where the owner-operator works full-time on the farm. The typical farm would also require one full time employee plus casual staff, dependant on green hectares (hectares planted to crop). According to the Boyce & Co (2006) report, the average number of green hectares per labour unit (person) was 184. These labour requirements take into account the use of contractors for the farming practices of agronomy, aerial spraying, root cutting and mulching, cotton picking, module carting and grain harvest. Within the model, labour requirements are linked directly to green hectares, however it is not included within the crop gross margins. Although casual labour is considered a variable cost, it is calculated within the overhead costs to illustrate at a whole farm level the extra labour requirements to operate various rotations.

3.2 Commodity Prices

The volatility of commodity prices has a significant effect on farm profitability. In order to accurately report the potential range of financial outcomes a risk analysis package called @RISK (Palisade 2009) was embedded within the representative farm model. Where there is uncertainty for a value, @RISK determines the most representative distribution using a set of historical data (price series).

@RISK uses Monte Carlo stochastic simulation which uses a process that samples random numbers from the distributions, whilst considering correlations, to generate results for various outcomes (in this case gross margins and net farm cash income). The program repeats this process approximately fifty thousand times to create probability distributions for each outcome. The distributions clearly reflect the range of possible outcomes and the probability of them occurring. Prices for all rotational crops are based on distributions as are fertiliser and diesel prices. All other prices are considered deterministic for the purpose of the budgets.

4. Representative farm application 1 – Rotation and tillage trials

4.1 Trial background

In agricultural systems, healthy soil is often defined as productive land that can maintain or increase farm profitability. Best practice soil management therefore underpins the economic viability of future farming generations. Management practices which can improve soil health include no tillage or minimum tillage farming systems and strategic crop rotations. A major proportion of Australian cotton is grown on vertosols (about 75%), of which almost 80% is irrigated. These soils have high clay contents and strong shrink–swell capacities, but are frequently sodic at depth (which can result in poor drainage and waterlogging) and prone to degradation if managed incorrectly.

Due to extensive yield losses caused by widespread deterioration of soil structure and declining fertility associated with tillage, trafficking, and picking under wet conditions during the middle and late 1970s, a major research program was initiated with the objective of developing soil management systems which could improve cotton yields while concurrently ameliorating and maintaining soil structure and fertility. An outcome of this research was the identification of cotton–winter crop sequences sown in a 1:1 rotation as being able to sustain lint yields while at the same time maintaining soil physical quality and minimising fertility decline. Consequently a large proportion of Australian cotton is now grown in rotation with winter cereals such as wheat, or legumes such as faba bean, chickpea or vetch as a green manure crop (Hulugalle and Scott 2008).

A second phase of research on cotton rotations in vertosols was initiated during the early 1990s with the main objective of identifying sustainable cotton–rotation crop sequences which maintained and improved soil quality, minimised disease incidence, facilitated soil organic carbon sequestration, and maximised economic returns and cotton water use efficiency in the major commercial cotton-growing regions of Australia (Hulugalle and Scott 2008).

The representative Lower Namoi Valley whole farm budget is used to analysis the whole-farm implications of a comparative experiment of four rotations conducted in recent years at the Australian Cotton Research Institute, near Narrabri.

4.2 Cotton rotation study

The research project entitled ‘Maintaining profitability and soil quality in cotton farming systems III’, led by Dr Nilantha Hulugalle and funded by the Cotton CRC is currently in its third phase. The project developed comparative rotation trials that measure soil quality, yield (cotton lint and rotation crop grain yield, fibre quality), economic returns and management constraints, conducted in a furrow-irrigated experiment at the Australian Cotton Research Institute, near Narrabri. All rotations (referred to as treatments) were sown on permanent beds and were based around cotton-wheat or cotton-vetch. The soil is a medium-fine, self-mulching, grey vertosol. The treatments were;

Table 4-1: Experiment treatments

	Summer	Winter	Summer	Winter
Treatment 1 (T1)	Cotton	Vetch	Cotton	Vetch
Treatment 2 (T2)	Cotton	Fallow	Cotton	Fallow
Treatment 3 (T3)	Cotton	Wheat	Fallow	Fallow
Treatment 4 (T4)	Cotton	Wheat	Fallow	Vetch

4.3 Methods

Gross margin results for each trial have been kept and details have been previously published in (Hulugalle *et al.* 2002; Hulugalle *et al.* 2003; Hulugalle *et al.* 2005; Scott and Hulugalle 2007) among others. Due to the robust record keeping throughout the trials, gross margins were able to be reproduced, accurately reflecting the relative economic benefits of various rotations. The vetch within the trial has been managed as an experimental system, where the costs have been significantly higher than a commercial enterprise. The vetch gross margin used within the model represents approximate costs faced by commercial growers.

The average yield over the past five years for each treatment was used within the gross margins, along with current input costs (as per the base results). During this period, the rotations were grown with restricted water with the cotton only receiving five ML and the wheat one. Yields for the wheat and cotton are reflective of the reduced irrigation water, had this comparison being conducted on the rotations during a period of full irrigation entitlement the results may have been significantly different. In each treatment, the cotton variety used changed over time to keep up with industry best-practice. As with the base results, to ensure an accurate comparison, one hectare of cotton represents 95% cotton and 5% pigeon peas. This accounts for the required refuge area for Bollgard II® cotton, as per the resistance management plans audited by Monsanto.

As shown in Table 4-2, the gross margins have a direct relationship with yield. The highest cotton yields were T3 and T4 with yields of 10.3 and 10.2 bales per hectare respectively. The highest cotton gross margin however is T4 with $3246/ha, this is due to a reduction in fertiliser costs attributed to the vetch within the rotation. The highest average twelve month gross margin per hectare was T1, with $2486/ha. Although T1 had a lower yield than T2, it had lower fertiliser costs due to the vetch within the rotation. In terms of gross margin per megalitre, T3 was considerably higher than the other treatments at $546/ML, attributed to its significantly lower water use (ie. 6ML/ha per 2 year rotation).

The representative Lower Namoi Valley whole farm budget assumptions for farm size, debt level, overheads costs as well as assets and liabilities were used as a basis to compare the whole farm returns for each rotation.

Table 4-2: Indicative Yields, Gross Margins and Water Use

Treatment	**Summer**	**Winter**	**Summer**	**Winter**	**12 month Treatment average**
T1	Cotton	Vetch	Cotton	Vetch	
Yield	*8.8 bales/ha*	-	*8.8 bales/ha*	-	
Gross Margin/ha	*$2656*	*-$170*	*$2656*	*-$170*	*$2486*
ML/ha	*5*	*1.4*	*5*	*1.4*	*6.4*
Gross Margin/ML	*$531*	*-$121*	*$531*	*-$121*	*$388*
T2	Cotton	Fallow	Cotton	Fallow	
Yield	*8.9 bales/ha*	-	*8.9 bales/ha*	-	
Gross Margin	*$2503*	*-$47*	*$2503*	*-$47*	*$2456*
ML/ha	*5*	-	*5*	-	*5*
Gross Margin/ML	*$501*	-	*$501*	-	*$491*
T3	Cotton	Wheat	Fallow	Fallow	
Yield	*10.3 bales/ha*	*2.7 t/ha*	-	-	
Gross Margin	*$3122*	*$366*	*-$179*	*-$31*	*$1639*
ML/ha	*5*	*1*	-	-	*3*
Gross Margin/ML	*$624*	*$366*	-	-	*$546*
T4	Cotton	Wheat	Fallow	Vetch	
Yield	*10.2 bales/ha*	*2.95 t/ha*	-	-	
Gross Margin	*$3246*	*$427*	*-$179*	*-$170*	*$1662*
ML/ha	*5*	*1*	-	*1.4*	*3.7*
Gross Margin/ML	*$649*	*$428*	-	*-$121*	*$449*

To compare the rotations at a whole farm level, cropping area was determined by the scarcest resource (ie. irrigation water 1285ML). Land was allocated to each rotation to use all irrigation water, as each rotation used different amounts of water, the land allocated to each rotation varied (see Table 4-3). Two year rotations were compared by assuming the farm had two of the rotations active, in offset years (Table 4-4). This was particularly important for treatments 3 and 4 to ensure a twelve month snapshot captured the entire rotation.

Table 4-3: Land allocated to rotational crop

	ML/ha	Ha of rotation
T1	12.8	100
T2	10	128
T3	6	214
T4	7.4	173

Table 4-4: Example of offset rotations

	Summer	Winter	Summer	Winter
	12months		12 months	
Treatment 1 (T1)	Cotton (100ha)	Vetch (100ha)	Cotton (100ha)	Vetch (100ha)
T1 - offset	Cotton (100ha)	Vetch (100ha)	Cotton (100ha)	Vetch (100ha)
Treatment 4 (T4)	Cotton (173ha)	Wheat (173ha)	Fallow (173ha)	Vetch (173ha)
T4 - offset	Fallow (173ha)	Vetch (173ha)	Cotton (173ha	Wheat (173ha)

By allocating land to the rotation in this way, it meant that in all of the rotations there would be a lot of unallocated land, unable to be irrigated due to the restricted water availability. As with the representative farm, dryland winter crops were allocated and 200ha per rotation was kept fallow (in addition to any fallow area already assumed to be within the rotation systems). Gross Margins used for dryland crops and the cattle enterprise are as per the Lower Namoi Valley farm budget assumptions.

4.4 Results of the rotations

4.4.1 Financial performance of individual rotations

Utilising the above mentioned method for allocating area to the rotations, for each treatment within the whole farm comparison the area under crop can be seen in Table 4-5 to Table 4-8.

The highest irrigation total gross margin was for T3 at $700,108, followed by T2 at $656,793. Sixteen percent lower than T3 was T4 at $587,719 and T1 was significantly lower than all the treatments at $534,211. Considering return per hectare from the 782 hectares of irrigation land available, this is equivalent to an annual gross margin of $683, $840, $895, $752/ha for treatments one through to four respectively. When considering the gross margin return from the 1285 megalitres of water available, this is equivalent to $416, $511, $545, $457/ha respectively.

Table 4-5: Area allocated to crop: Treatment 1

Ha	Crop	Water Applied ML/ha	Total Water Use (ML)	GM/ ha	GM/ ML	TOTAL GM
T1: IRRIGATION (12 month) TOTALS:			**1280 ML**	**$ 683**	**$ 417**	**$ 534,211**
200	BT Cotton (95% cotton, 5% pigeon peas)	5	1,000	$2,656	$ 531	$ 531,200
582	Summer Fallow (irrigated paddocks)	0	-	-$ 79	-	-$ 45,978
782 ha	**Summer Total**		**1,000**			**$ 485,222**
200	Vetch	1.4	280	-$ 170	-$ 121	-$ 34,000
127	Dryland Wheat (on irrigation paddock with no irrigations)	0	-	$ 188	-	$ 23,876
127	Dryland Chickpea (on irrigation paddock with no irrigations)	0	-	$ 336	-	$ 42,672
127	Dryland Faba bean (on irrigation paddock with no irrigations)	0	-	$ 226	-	$ 28,702
201	Winter Fallow (irrigated paddocks)	0	-	-$ 61	-	-$ 12,261
782 ha	**Winter Total**		**280**			**$ 48,989**

T1 (Table 4-5) had the lowest annual irrigation gross margin at $534,211. This treatment grew 200 hectares of cotton annually, which was the second lowest; this is due to 1.4 megalitres per hectare being allocated to Vetch within the rotation. Despite the inclusion of vetch into the rotation, T1 had the lowest cotton yields at 8.8 bales/ha. Whilst the rotation gross margin is the highest per hectare (Table 4-2), within this whole farm comparison both the return per hectare of $683 and the return per megalitre of $416 are lowest of all treatments.

T2 (Table 4-6) grew the most cotton with 256 hectares allocated to the rotation. This is a result of the rotation being a monoculture, so water did not have to be allocated to any other crops. Whilst yields were approximately 13% lower compared to T3 and T4, resulting in gross margins being 25% lower, T2 returned the second highest annual gross margin of $840/ha (after T3 at $895/ha). Despite the lowest cotton gross margins, by growing 20, 28 and 47 percent more cotton than T3, T1 and T4, respectively, T2 was able to outperform T1 and T4 in terms of annual irrigation gross margin. This is attributed to all irrigation water used on the crop that returned the highest gross margin per megalitre.

Table 4-6: Area allocated to crop: Treatment 2

Ha	Crop	Water Applied ML/ha	Total Water Use	GM/ha	GM/ML	TOTAL GM
T2: IRRIGATION (12 month) TOTALS:			**1280 ML**	**$ 840**	**$ 513**	**$ 656,793**
256	BT Cotton (95% cotton, 5% pigeon peas)	5	1,280	$2,503	$ 501	$ 640,768
526	Summer Fallow (irrigated paddocks)	0	-	-$ 79	-	-$ 41,554
782 ha	**Summer Total**		**1280 ML**			**$ 599,214**
256	Winter Fallow - Rotation	0	-	-$ 47	-	-$ 12,032
109	Dryland Wheat (on irrigation paddock with no irrigations)	0	-	$ 188	-	$ 20,492
109	Dryland Chickpea (on irrigation paddock with no irrigations)	0	-	$ 336	-	$ 36,624
109	Dryland Faba bean (on irrigation paddock with no irrigations)	0	-	$ 226	-	$ 24,634
199	Winter Fallow (irrigated paddocks)	0	-	-$ 61	-	-$ 12,139
782 ha	**Winter Total**		**0 ML**			**$ 57,579**

Table 4-7: Area allocated to crop: Treatment 3

Ha	Crop	Water Applied ML/ha	Total Water Use	GM/ ha	GM/ ML	TOTAL GM
T3: IRRIGATION (12 month) TOTALS:			**1285 ML**	**$ 895**	**$ 545**	**$ 700,108**
214	BT Cotton (95% cotton, 5% pigeon peas)	5	1,071	$3,122	$ 624	$ 668,628
214	Summer Fallow - rotation	0	-	-$ 179	-	-$ 38,336
354	Summer Fallow (irrigated paddocks)	0	-	-$ 79	-	-$ 27,940
782 ha	**Summer Total**		**1071**			**$ 602,353**
214	Wheat - semi irrigated	1	214	$ 366	$ 366	$ 78,385
214	Winter Fallow - rotation	0	-	-$ 31	-	-$ 6,639
51	Dryland Wheat (on irrigation paddock with no irrigations)	0	-	$ 188	-	$ 9,588
51	Dryland Chickpea (on irrigation paddock with no irrigations)	0	-	$ 336	-	$ 17,136
51	Dryland Faba bean (on irrigation paddock with no irrigations)	0	-	$ 226	-	$ 11,526
201	Winter Fallow (irrigated paddocks)	0	-	-$ 61	-	-$ 12,241
782 ha	**Winter Total**		**214 ML**			**$ 97,755**

The second highest allocation to cotton with 214 hectares, T3 (Table 4-7) had the highest annual irrigation gross margin at $700,108. This can be attributed to this treatment achieving the highest cotton yields and the second highest cotton gross margin (marginally less than T4). Within this rotation wheat was grown, which gave a positive return of $366/ha.

T4 (Table 4-8), had the second lowest annual irrigated gross margin at $587,719. This was 16% lower than T3. T4 had the smallest hectares allocated to the rotation at 173ha. This was due to water being allocated to not only cotton, but also wheat and vetch. Although T3 and T4 both had the highest cotton gross margin per hectare, T4 performed significantly worse due to the reduction in hectares of cotton and also due to the cost of growing vetch within the rotation.

Table 4-8: Area allocated to crop: Treatment 4

Ha	**Crop**	**Water Applied ML/ha**	**Total Water Use**	**GM/ ha**	**GM/ ML**	**TOTAL GM**
T4: IRRIGATION (12 month) TOTALS:			**1280 ML**	**$ 752**	**$ 459**	**$ 587,719**
173	BT Cotton (95% cotton, 5% pigeon peas)	5	865	$3,246	$ 649	$ 561,558
173	Summer Fallow - rotation	0	-	-$ 179	-	-$ 30,967
436	Summer Fallow (irrigated paddocks)	0	-	-$ 79	-	-$ 34,444
782 ha	**Summer Total**		**865**			**$ 496,147**
173	Wheat – semi irrigated	1	173	$ 427	$ 427	$ 73,871
173	Vetch	1.4	242	-$ 170	-$ 121	-$ 29,410
79	Dryland Wheat (on irrigation paddock with no irrigations)	0	-	$ 188	-	$ 14,852
79	Dryland Chickpea (on irrigation paddock with no irrigations)	0	-	$ 336	-	$ 26,544
79	Dryland Faba bean (on irrigation paddock with no irrigations)	0	-	$ 226	-	$ 17,854
199	Winter Fallow (irrigated paddocks)	0	-	-$ 61	-	-$ 12,139
782 ha	**Winter Total**		**415 ML**			**$ 91,572**

As the land was allocated to use all of the 1285 mega litres of irrigation water available, this resulted in each treatment having varying land allocated to the rotation (due to varying water use). This resulted in each treatments return per megalitre influencing the whole farm results.

Had the comparison allocated equal hectares to each rotation, the results would have reflected profitability of the treatments as per Table 4-2.

Other key factors in the performance between treatments, came down to area grown to cotton and cotton yields, as the financial performance of the farm is most sensitive to cotton (Figure 4.6). The importance of allocating water to non incoming generating crops like vetch is highlighted. Whilst the inclusion of vetch into a rotation may improve the overall gross margin per hectare, the gross margin per mega litre is significantly reduced.

4.4.2 Whole farm financial performance of cotton rotation study

Within the steady state analysis, whole farm financial performance of the four treatments varied significantly, as displayed in Table 4-9. The irrigation income varied according to the crops grown and the area allocated to the rotation. Overheads common to all four treatments are consistent with the representative budgets, with the exception of casual labour which varied dependant on the hectares of crop grown. All other financial characteristics remained constant between the four treatments. Operating costs are also consistent with the representative budgets, with remuneration for the farm owner not included within this analysis. T2 and T3 have significantly reduced casual labour costs (as indicated in Table 4-9) this is due to these treatments growing considerably less green ha within the rotations.

Farm operating surplus is an indication of a businesses ability to meet farm costs whilst maintaining assets (depreciation). The surplus was greatest for T3 and T2 at $374,755 and $331,180 respectively. T4 and T1 still returned surpluses, however these were significantly less than the other treatments at $235,122 and $177,715 respectively. T1’s operating surplus is just under half of T3’s. A positive farm operating surplus for all four treatments indicates that each rotation was able to meet farm costs and maintain assets. However, as debt repayments and owner living expenses need to taken from the farm operating surplus, it is evident that T3 and T2 are most likely to cope with these costs.

The business return on equity ranged from 7.52% for T3 to 3.57% for T1. A business with a high return on equity has a greater capacity to generate funds within a business. This in turn gives the business a greater ability to repay debt and re-invest within the business.

Table 4-9: Financial Performance

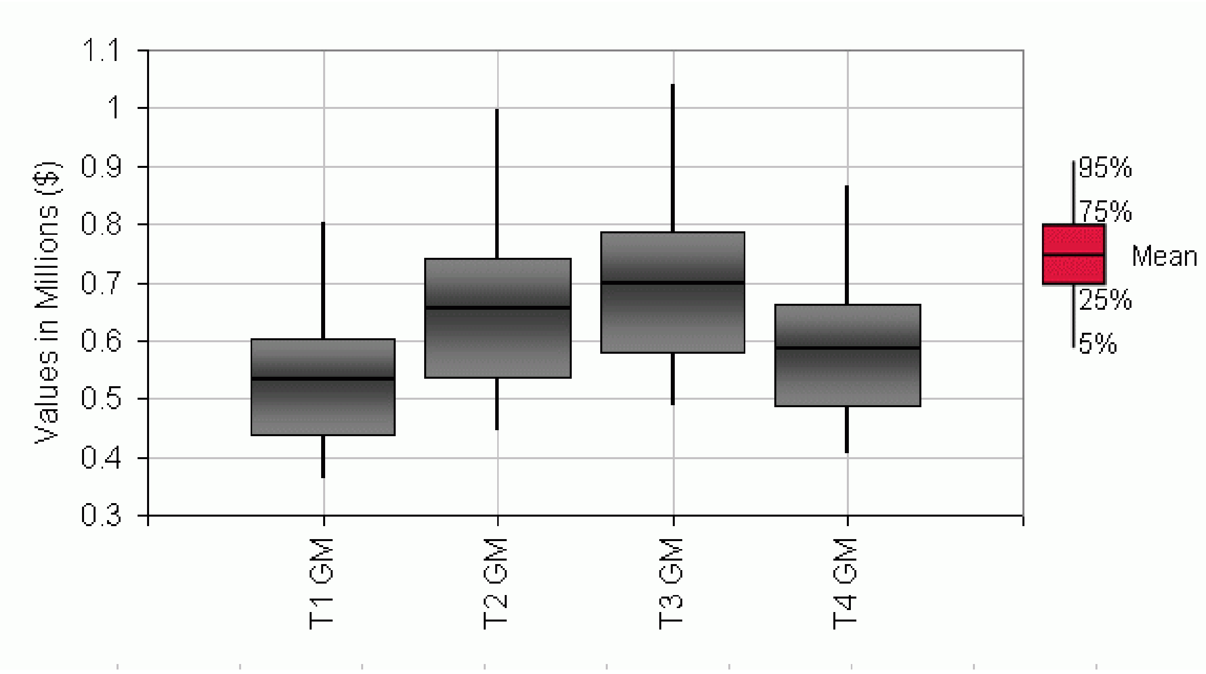
Enterprise Gross Margins			T1	T2	T3	T4
Irrigation			534,211	656,793	700,108	587,719
Dryland			31,295	31,295	31,295	31,295
Grazing			19,507	19,507	19,507	19,507
Total Farm Gross Margin:			**$585,013**	**$707,595**	**$750,910**	**$638,521**
Overhead Costs						
Common Overhead costs			151,066	151,066	151,066	151,066
Labour (variable depending on green ha's)						
	• Casual	**$20.00 /hr** x FTE @ 55 hrs/week	35,094	4,211	3,951	31,195
Total Overhead Costs			$186,160	$155,278	$155,018	$182,261
Net Farm Cash Income (Gross Margin less Overhead Costs)			**$398,853**	**$552,317**	**$595,892**	**$456,260**
Operating Costs						
Total Operating Costs			221,138	221,138	221,138	221,138
Farm Operating Surplus (Net Farm Cash Income less Operating Costs)			**$177,715**	**$331,180**	**$374,755**	**$235,122**
%Return on total assets and operator labour (Operating Surplus/Total assets)			2.61%	4.86%	5.50%	3.45%
%Return on equity and operator labour (Operating Surplus/Total equity)			**3.57%**	**6.65%**	**7.52%**	**4.72%**

4.4.3 Impact of price variability on cotton rotation study

Commodity price variability has a significant impact on the profitability of each rotation. As the mean results were discussed and compared in the previous section (4.4.1 Financial performance of individual rotations), this section will compare the financial performance when price variability is taken into account. Each rotation is affected differently by the varying prices, depending on their reliance on particular commodity prices. The affect is depicted within a gross margin comparison in a box & whisker graph (Figure 4.1).

The median result for each treatment is represented by the horizontal line in the middle of the box. The top of the box is the upper quartile with 75% of results occurring below these lines. The bottom of the box represents the lower quartile with 25% of results occurring below these lines, the upper vertical lines end at the 95th percentile and the lower line ends at the 5th percentile with 5% of results occurring below this point. This particular box & whisker graph removes any outlying results by not reporting the top or bottom 5% or results.

Figure 4.1: Gross Margin comparison by treatment



Initially obvious is the shift of the data or the height of each box in comparison to the others. T1 is significantly lower than the other treatments and T3 is the highest. A lower placement of data indicates a probability of lower gross margin results. As seen in Table 4-10, T1 has a 48% probability of total gross margin under $500,000, whilst T3 has only a 6% likelihood of achieving a total gross margin under $500,000. Therefore the cotton-wheat rotation appears to be the most resilient to price variability.

The spread or variability of the graphs is quite similar, each with short lower quartiles, similar length mid quartiles and all with longer upper quartiles. Each graph is skewed with the mean result lower than the median. This indicates that the gross margin results are most likely to be in the lower half of the range of results. Whilst the range of the results can suggest the size of risk, in this instance T2 & T3 have the widest range of potential gross margin results, however these ranges start higher and have topside potential (longer upper quartiles), indicating that there is opportunity to return significant gross margins.

Table 4-10: % Probability of Gross Margin result occurring below, above or between $500K and $700K

Treatment	<$500,000	> <	>$750,000
T1	48	44	8
T2	16	61	24
T3	6	62	31
T4	31	56	13

The net farm cash income comparison as shown in Figure 4.2, indicates how much income remains once operating and overhead costs are covered. It is desirable for net farm cash income to be as high as possible to ensure that there are enough funds available to cover operating costs (including interest and depreciation), owner living expenses, debt repayments or even re-investment in the business. There is an 81% probability that T1 will return a net farm cash income of under $500,000 whilst T3 has a 66% probability of returning a net farm cash income of over $500,000.

Figure 4.2: Net farm cash income comparison

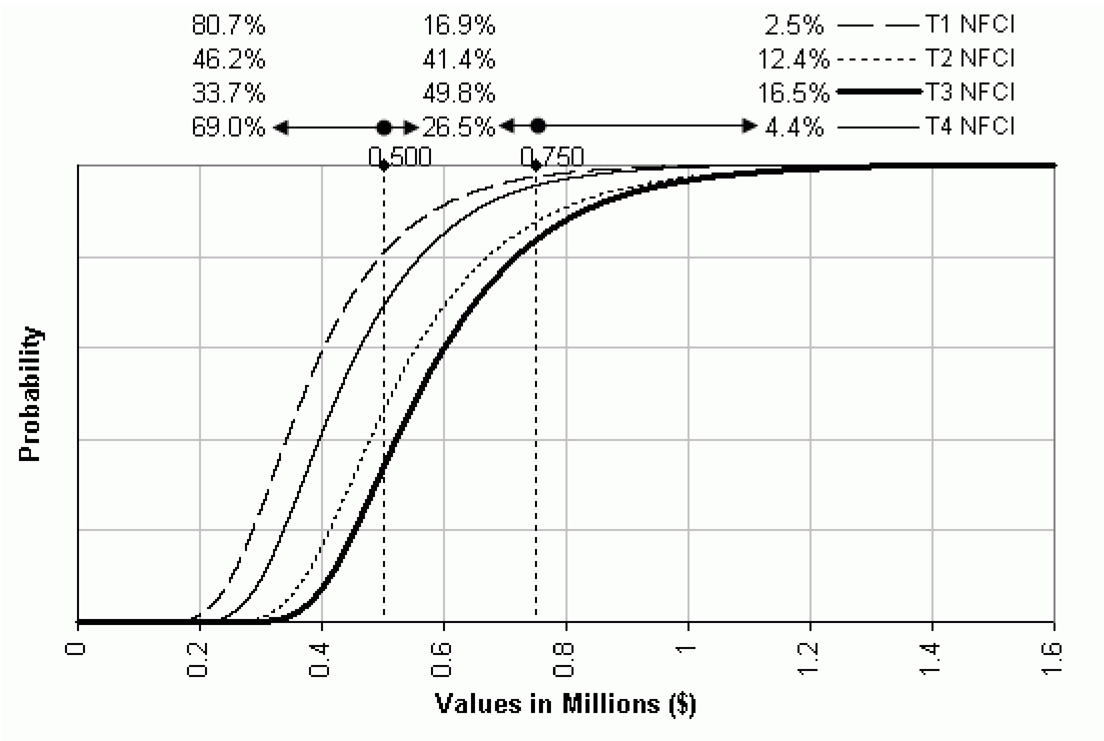
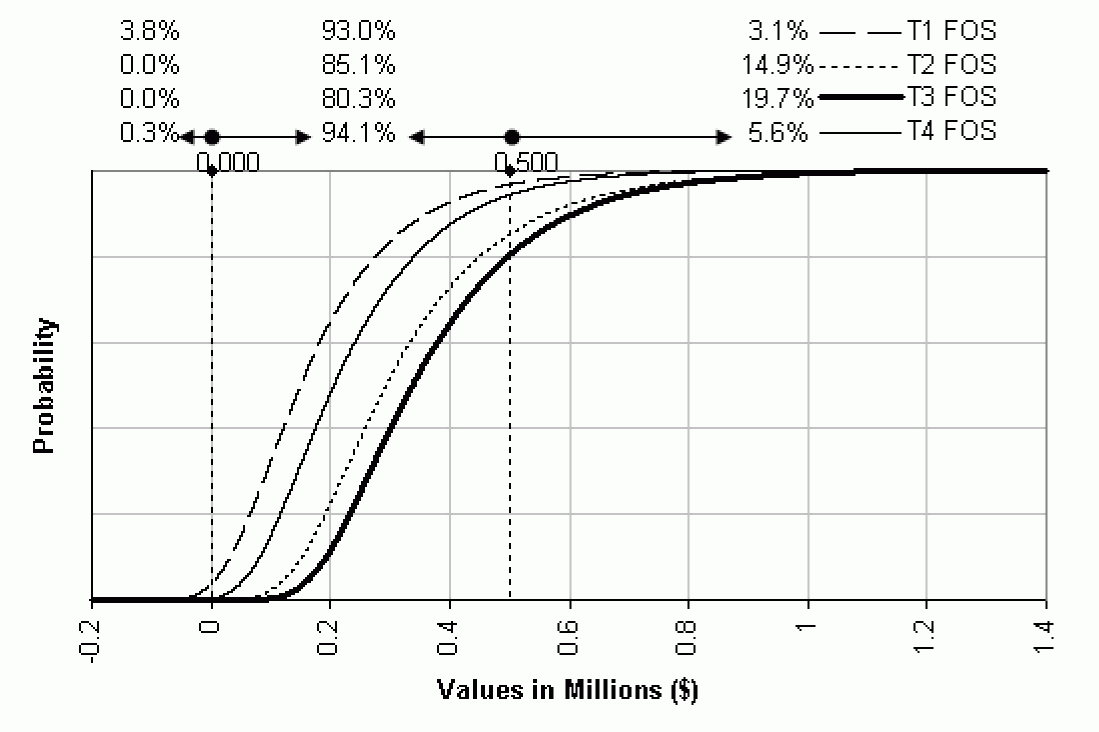
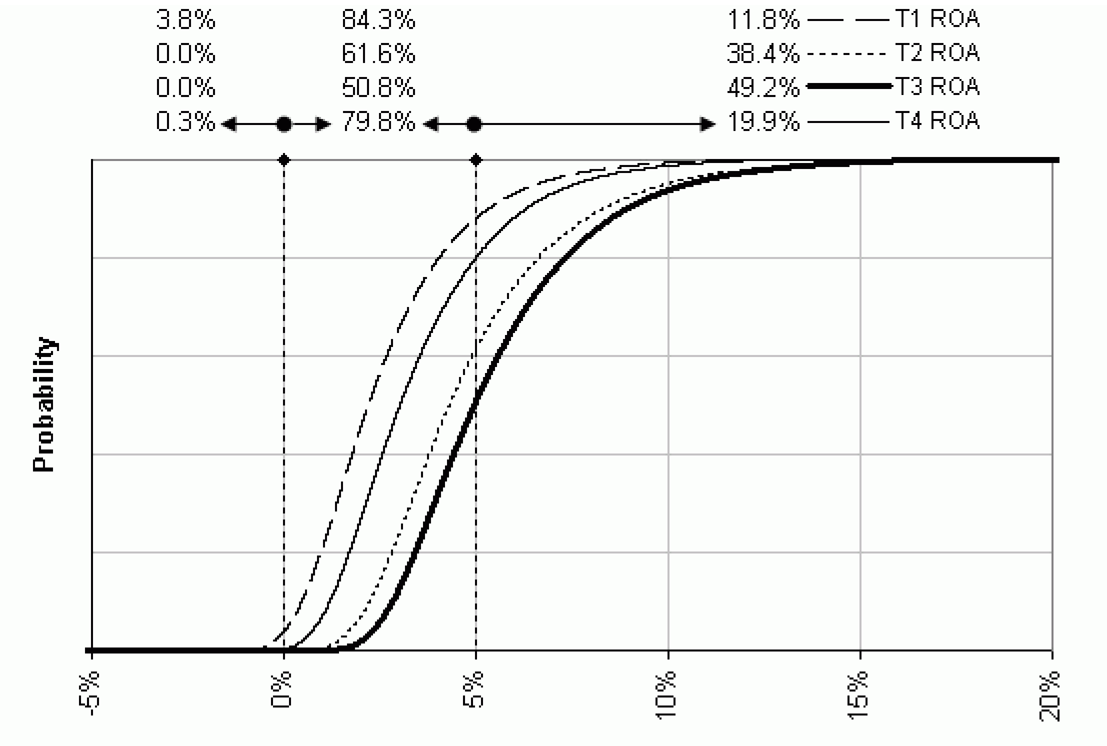


Figure 4.3: Farm operating surplus comparison



Farm operating surplus (net farm cash income less operating costs of interest and depreciation) comparison is displayed in Figure 4.3. Normally this surplus would be used to fund principal loan repayments and the owners living expenses. All treatments are likely to return an operating surplus. T3 is the most likely to achieve a positive surplus in excess of $500,000.

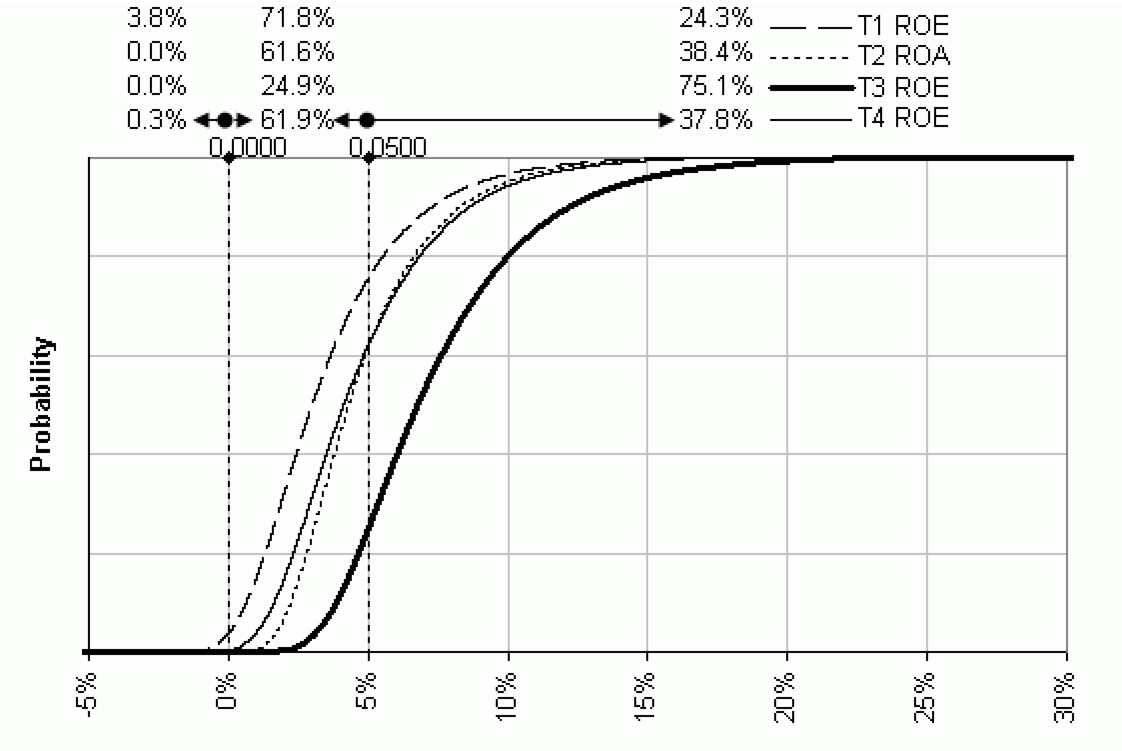
Figure 4.4: Return on assets comparison (%)



The treatment comparison of return on assets (operating surplus/total assets) shows how effective each treatment is at generating a profit for the business (Figure 4.4). All treatments are likely to return a positive return on assets, with T1 and T4 are most probably going to achieve a return on assets between 0 and 5%. T3 is the most likely to generate a significant profit with a 50% probability of achieving over 5% return. T2 closely follows with a 39% probability of achieving over 5% return on assets.

The treatment comparison of return on equity (operating surplus/total equity) shows how much profit each treatment generates as a percentage of the business owners funds (or equity) (Figure 4.5). T1 and T4 are likely to generate a profit between 0 and 5%. T3 is the most likely to generate a significant profit with a 75% probability of achieving over 5%. T2 closely follows with a 38% probability of achieving over 5% return on equity.

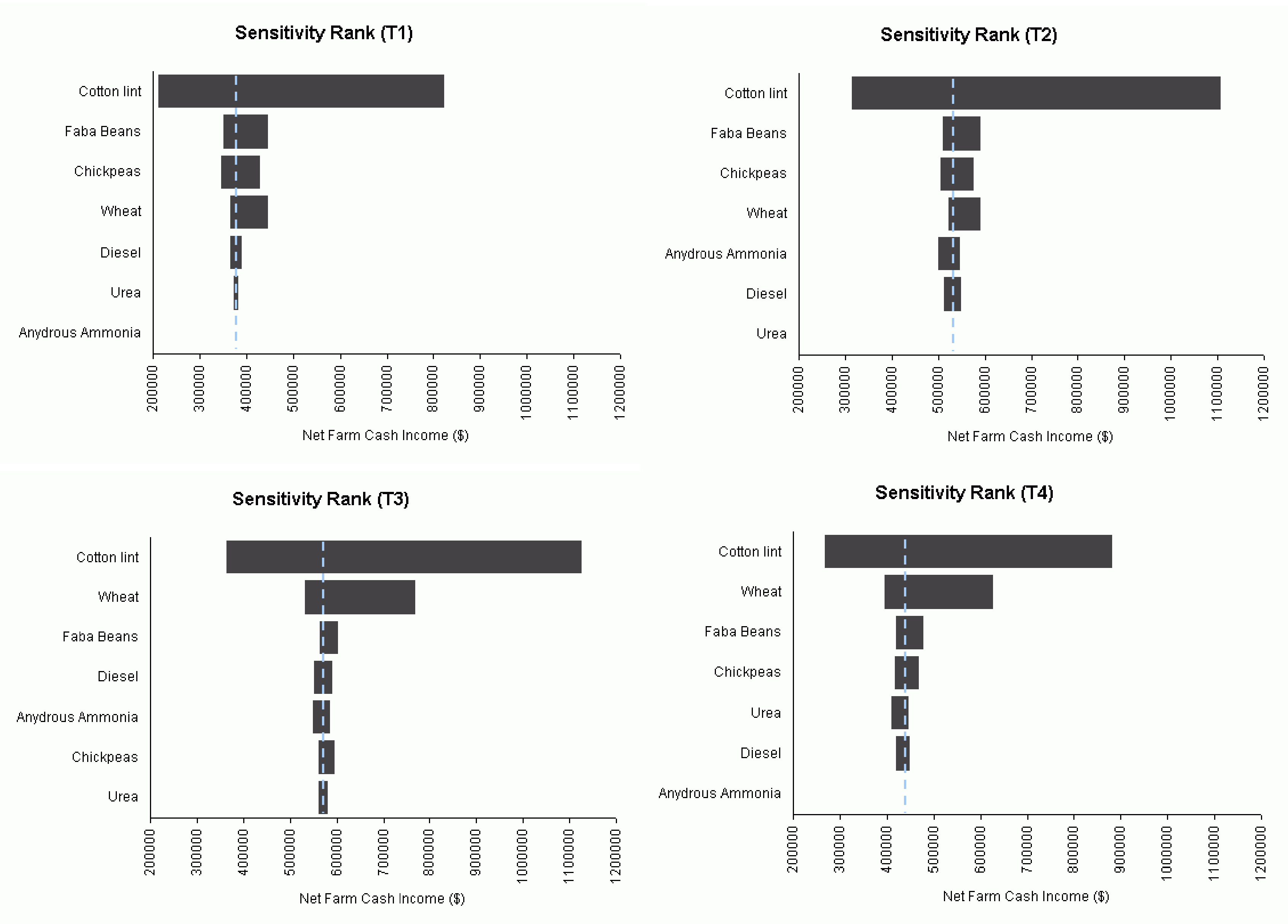
Figure 4.5: Return on equity comparison (%)



To understand which variables have the greatest effect on profitability (irrigation gross margin), further sensitivity analysis was conducted. Figure 4.6 shows the results on how the profitability of the treatments vary with changes in specific variables, (in this case commodity prices including cotton lint, wheat, faba bean, chickpea, urea, anhydrous ammonia and diesel), while all other variables are held stable (at the mean). The tornado charts rank each input in terms of its impact on the profitability for each treatment.

The variable with highest impact (indicated by the length of the bar) is at the top of the chart followed by other variables in descending impact order. The bar ends indicate the low and high value of the impact. In this comparison, the profitability of all treatments is most sensitive to the price of cotton lint. The analysis also indicates that the prices of the commodities being produced have more of an impact on profitability than the price of the various inputs such as fertiliser and fuel. In practice this means that the profitability of a farm is largely dependent on the price received for the commodities.

Figure 4.6: Sensitivity Charts (T1 to T4)



5. Conclusions

5.1 Whole farm impacts of rotations and tillage

The whole farm comparison snapshot of the four cotton-based rotation trials highlights the importance of crop selection in terms of financial performance. Mean results indicated a positive return for all rotations within the representative farm budgets for the Lower Namoi Valley. Farm operating surplus ranged from $177,715 to $374,755 indicating that in restricted irrigation water availability scenarios, assuming average commodity prices, each rotation would generate a profit. The two year rotation of cotton, wheat, followed by summer and winter fallows was the treatment able to generate the highest business return. The same rotation was most resilient to commodity price variability, 100% likely to return a positive farm operating surplus and 20% likely to return over $500,000.

The two rotations including vetch were the least resilient to variable commodity prices. As land was allocated to use all of the irrigation water available, each treatment’s return per megalitre influenced the whole farm results. The use of irrigation water on a non income crop (in this case vetch), reduced the rotations return per megalitre. Had the comparison allocated equal hectares to each rotation, the results would have reflected the profitability of the treatments as per Table 4-2.

This analysis assumed restricted availability of irrigation water. During periods of increased water availability, the wheat crop would receive more irrigation applications to increase yield which would positively affect the gross margins of those treatments.

The development of the whole-farm model has been profitability focused. However, it is important to note the other considerations of crop selection which affect the long term sustainability of the irrigation farming business. Science has proven the numerous benefits of including various crops in rotation with cotton from management of pests, weeds and disease through to improved soil nutrition and structure. A budget snapshot does not take into account the longer-term benefits in terms of improved soil and agronomic sustainability.

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