A Representative Irrigated Farming System in the Lower Namoi Valley of NSW: An Economic Analysis

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Abstract

This report presents a description of the Lower Namoi Valley of NSW and representative whole-farm budgets for the region based on subregional characteristics and the related farming systems. Agronomic and agricultural production characteristics are included as technical parameters in a transparent financial framework. A computer spreadsheet is developed to allow risk analysis of alternative technologies and management scenarios. Alternative crop rotations in a whole-farm context were compared.

Keywords: Cotton; Irrigation; Whole farm model; Namoi Valley; economic; evaluation; Australia

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Acronyms and Abbreviations Used in the Report

AA	Anhydrous Ammonia
ABARE	Australian Bureau of Agricultural and Resource Economics
ABS	Australian Bureau of Statistics
AIP	Australian Institute of Petroleum
ANRA	Australian Natural Resources Atlas
ASW	Australian standard white (this is a common wheat grade)
AUD	Australian Dollar
BOM	Bureau of Meteorology
BT	*Bacillus thuringiensis* (genetically engineered cotton plants have insect tolerance by expressing crystal proteins genes from *B. thuringiensis*. When insects ingest toxin crystals the alkaline pH of their digestive tract causes the toxin to become activated.)
BMP	Best Management Practice
CIF	Cost Insurance Freight
Cotton CRC	Cotton Catchment Communities Cooperative Research Centre
CRDC	Cotton Research and Development Corporation
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DAP	Di-Ammonium Phosphate
ETS	Emissions trading scheme
GL	Giga litre (1 million cubic metres or 1,000 ML, water volume)
GM	Gross Margin
I&I NSW	Industry and Investment NSW (formerly the NSW Department of Primary industries)
IWUI	Irrigation Water Use Efficiency
ML	Mega litre (1,000 cubic metres or 1 million litres, water volume)
NSW	New South Wales
ROA	Return on assets
ROE	Return on equity
USD	United States Dollar

Executive Summary

This report presents a description of a whole-farm budget for a representative farm in the Lower Namoi Valley. This is used to give a 'snapshot' of the financial performance of the model farm and to analyse the financial implications of changes in cropping rotations or changes in management practice.

The 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.

The whole farm budget provides 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.

Apart from providing a broad brush picture of financial performance, the model was used to analyse comparisons of alternative crop rotations in a whole-farm context. While simple gross margin analyses are useful at the enterprise scale, invariably a more thorough analysis at the whole farm scale is required to assess financial impacts of different cropping rotations over a longer period.

Results from the representative farm budgets for the Lower Namoi Valley indicate that even with restricted water entitlements the business would return an operating surplus of $152,070. This is equivalent to a return on equity of 3.1 per cent. The representative farm is vulnerable to commodity price variability. Results suggest that one year in five, the farm is unlikely to return a positive cash surplus.

Using the model to compare four rotational trials highlighted the importance of crop selection for the financial performance of the business. 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 given restricted irrigation water and average commodity prices each rotation would ensure that the business returned a profit. The rotations varied in resilience to commodity variability, however all treatments were likely to return a profit with the worst performing treatment at a 96% probability to return a positive farm operating surplus.

An important objective of our work was to develop some tools which can help in assessing the change in farm profit from new ideas and technologies generated by the research and advisory activities of Industry and Investment NSW. The models can also be used to give an assessment of the impact on farm profit of policy changes with respect to the management of natural resources.

Our work has been aimed at developing whole-farm representations or models that can be utilised, by researchers and extension officers, to assess potential changes. Such models can be used in at least two ways – to rank technologies and management practices while they are being developed or prior to release, and as a tool to strengthen extension programs by demonstrating to farmers that there may be sufficient financial advantage in a technology to warrant adoption. Of course we acknowledge that there are other aspects of new technologies (apart from the financial) that influence adoption decisions. We hope that economic analyses at the enterprise and farm levels will provide information which assists sound decision making.

1. Introduction

It is important to understand the farm level impacts of cotton industry research. Our objective in this report is to describe how farmers in the Lower Namoi Valley typically combine crop and livestock enterprises in a whole farm context and to assess the financial performance of such farming systems. This is achieved by the development of a whole-farm budget for a representative farm. The resulting whole-farm budget is used to give a snapshot of the financial performance of the model farm and to analyse the financial implications of changes in cropping rotations. These models can be used to analyse changes in farm profit from other technologies or changes in policy with respect to the management of natural resources.

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 technologies use profits as the primary incentive for decisions, because this is considered to be an important consideration for many farm decision makers. The farm model 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.

1.1 *Use of Representative Farm Analysis*

A whole farm budget was developed for the Lower Namoi Valley. It is broadly representative of a typical farming system within the region, although we must be careful when interpreting the results for individual farms. We propose that the model be used as the basis for face-to-face discussions and interaction between researchers, advisors and farmers. This would include generating and analysing ‘what if’ scenarios. Chapter 8 also contains an example application of the model to a particular farming system. The results from such analyses, together with personal interactions will hopefully lead to improved understandings on the part of all participants. The models and model results are a means to an end of improved knowledge and communication, rather than ends in themselves.

This Report presents a description of an irrigated farming system in the Lower Namoi Valley region of NSW and an indication of its profitability and financial viability. The representative farm model and associated gross margin and whole farm budgets can be used as templates allowing variations from the representative farm model to be examined.

The whole farm budget provides a snapshot at a particular point in time of a farm with a particular set of resources. Hence while this report may give a broad indication of what is happening on many farms in the northern cropping region of NSW, it may be inaccurate for farms with markedly different soil type, climate and resources to those of the representative farm.

Additionally while the whole farm budget can be manipulated to indicate the change in farm income from a new technology or resource management strategy, again we only get before and after pictures. If, for example, the change in technology has an impact on soil fertility that may take many years to work through the system, then a simple before and after comparison of whole farm budgets is an inadequate basis for such an important investment decision. More sophisticated budgeting tools that allow the impact of such changes over many years to be estimated and aggregated may be required, such as cash flow development budgets.

2. Namoi Valley

2.1 *Physical characteristics of the region*

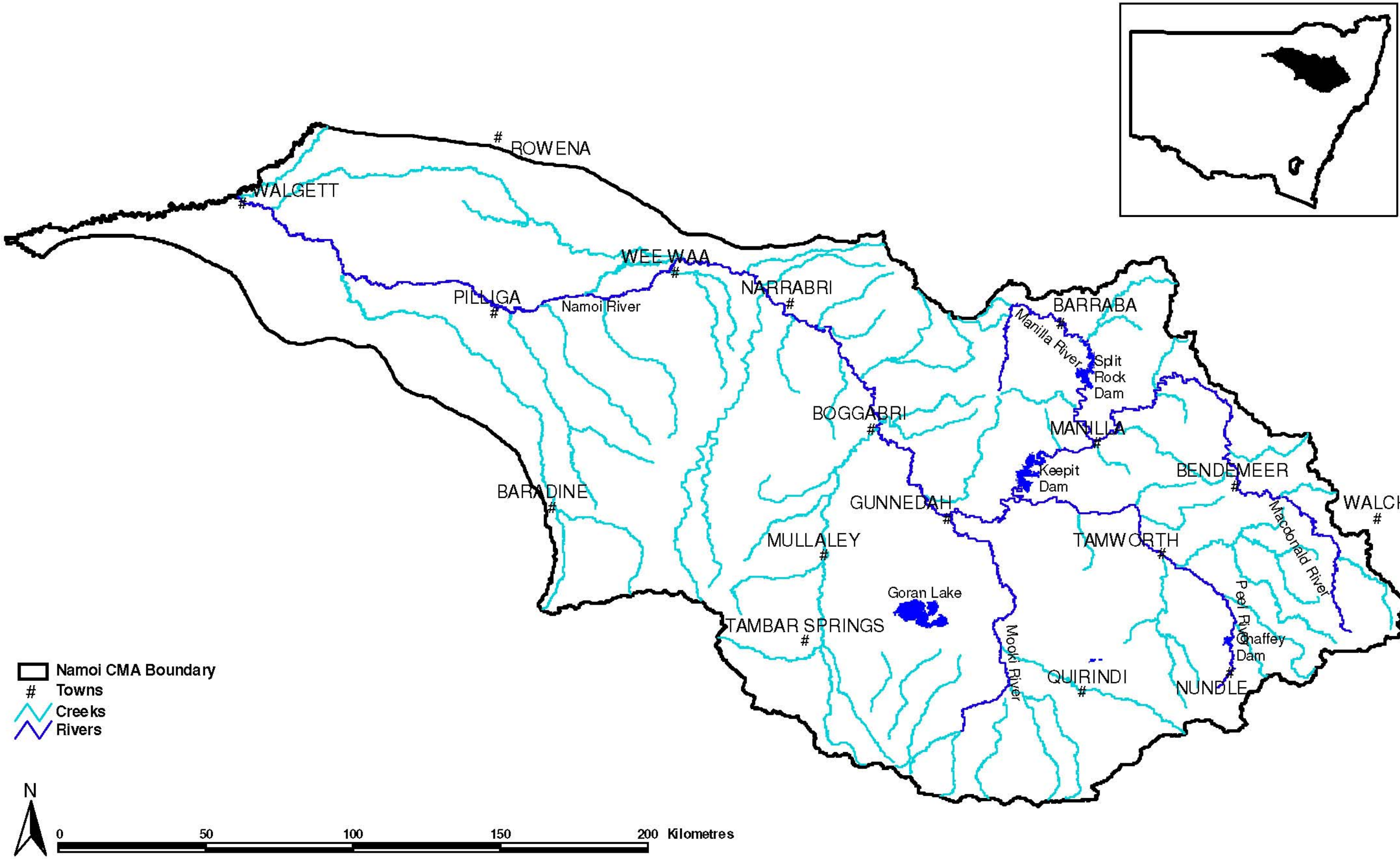
The Namoi Valley is situated in northwestern NSW (see Figure 2.1) and is a part of the Murray-Darling Drainage System. The Catchment is bordered by the Great Dividing Range in the East, the Liverpool Ranges and Warrumbungle Ranges in the south, and the Nandewar Ranges and Mt. Kaputar in the North. The 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. Tributaries include Coxs Creek and the Mooki, Peel, Cockburn, Manilla, and McDonald Rivers, all of which join the Namoi upstream of Boggabri. The Namoi River 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 Namoi Catchment can be broken down into three distinct geographical areas. As described by Donaldson and Heath (1997), these are tablelands, riverine slopes and riverine plains. The tablelands include the area above Keepit Dam including the fertile alluvial plains surrounding Tamworth. The riverine slopes are the undulating low hills and level plains extending from Keepit Dam to Narrabri. 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.

Figure 2.1: Map of the Namoi Catchment, NSW Australia



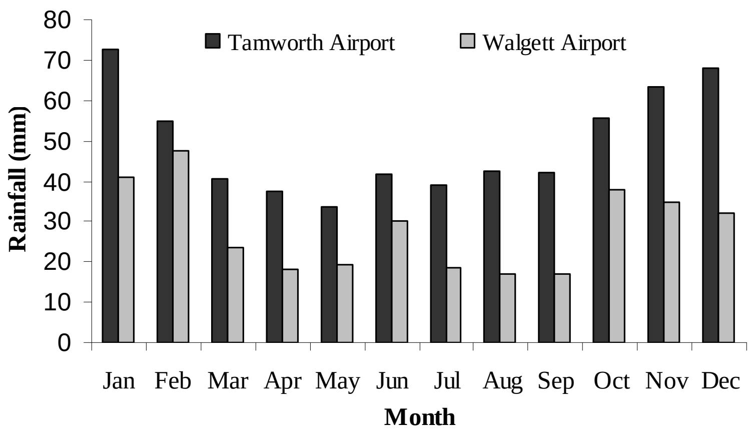
Source: (Namoi CMA.)

2.2 *Climate*

Climate characteristics vary from the tablelands to the riverine plains. In the upper slopes at Tamworth average summer temperatures range from 17.4°C to 31.9°C, in winter from 2.9°C to 15.5°C, whilst in Walgett summer temperatures range from 20.4°C to 35.4°C and in winter from 3.3°C to 18.3°C.

Rainfall in the region is variable and decreases from east to west. Yearly averages range from approximately 470 mm in the riverine plains around Walgett to more than 800mm on the higher parts of the tablelands. Overall, rainfall is highest in the summer months, November through February (Figure 2.2), and usually consists of short duration heavy falls. Flooding in the catchment can occur both in summer and winter, however summer flooding is generally more severe.

Figure 2.2: Mean Monthly Rainfall



Data Source: (BOM 2009)

Frosts are common in the Namoi Catchment during winter, and some snowfalls occur on the tablelands. Frost incidence decreases from East to West.

Table 2-1: Climate indicators Namoi Valley

	Tamworth (Tablelands)	**Narrabri** (Riverine Slopes / Plains)	**Walgett** (Riverine Plains)
Mean maximum temperature (°C)	24.3	26.5	27.5
Mean minimum temperature (°C)	10.2	11.7	11.9
Mean number of days > 35°C	14.1	unknown	63.9
Mean rainfall (mm/y)	673.2	657.1	440.6
Mean monthly Pan Evaporation (mm/day) *	5.4	6	6.6

Data Source: (BOM 2009)

2.3 *Land Use*

The Namoi Catchment supports a variety of land uses. The first settlers in the Namoi Valley engaged in sheep and cattle grazing as well as wool production. As land was cleared, many of these enterprises diversified into dry land broad acre farming. Results from the 2005/06 Agricultural Census indicate land use continues to be dominated by the livestock and broad acre farming industries, as can be seen in Table 2.2.

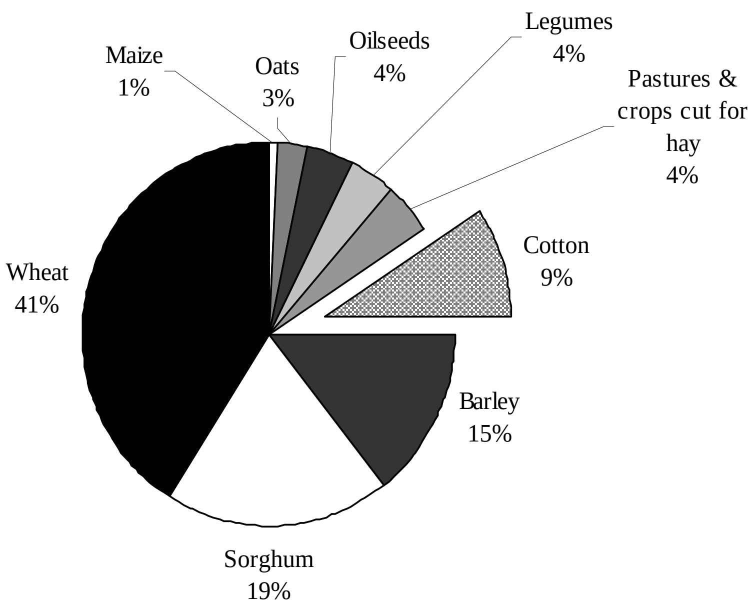
Table 2-2: Agricultural Land Use in the Namoi Valley - 2005/06

Agricultural Land Use	Ha	% of Total Area
Grazing	2,117,272	64%
Crop / Fallow	949,783	29%
Remnant vegetation and woodland	117,895	4%
Not Reported	82,878	2%
Houses, sheds and other agriculturally unproductive land	28,762	<1%
Commercial forestry plantations	24,185	<1%
Wetlands / swamps & other environmentally areas not suitable for grazing	8,798	<1%

Data Source:(ABS 2008)

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 (Figure 2.3).

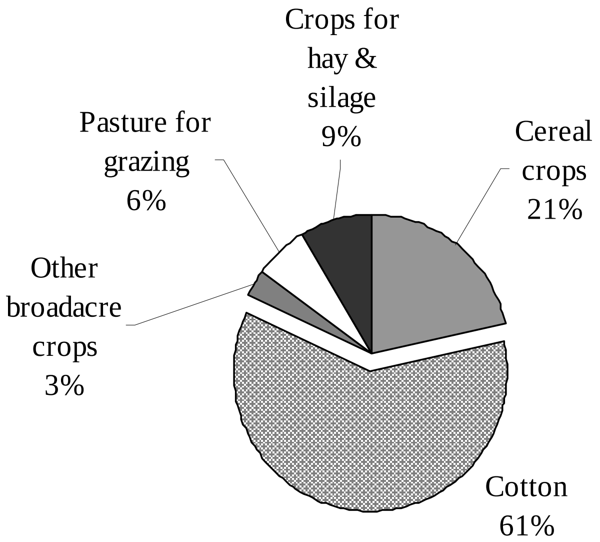
Figure 2.3: 'Crops' breakdown, 2005/06 (ha)



Data Source: (ABS 2008)

In terms of irrigated land use, cotton has 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 2.4).

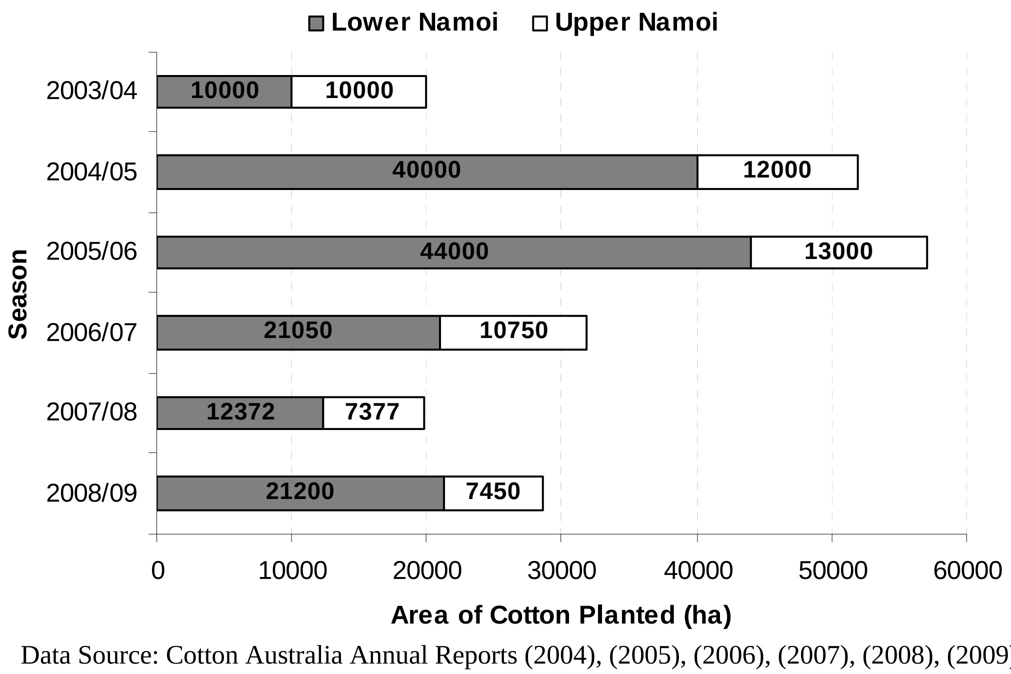
Figure 2.4: Irrigated Land Use, Namoi Valley 2005/06 (ha)



Data Source: (ABS 2008)

According to the ABS (2008), in the 2005-06 season in the Namoi Valley there were approximately 94,000 hectares of irrigated area operated by 701 businesses. In the same season, Cotton Australia (2006) estimated there were 140 businesses growing cotton on 57,000 hectares in the Namoi Valley. Among these, 100 businesses and 44,000 hectares were in the Lower Namoi Valley (Figure 2.5).

Figure 2.5: Cotton Planting, Namoi Valley 2003/04 to 2008/09 (ha)



Data Source: Cotton Australia Annual Reports (2004), (2005), (2006), (2007), (2008), (2009)

3. Irrigation

The Namoi Valley is unusual in the fact that it has several irrigation water sources including groundwater, regulated river, supplemented flows and unregulated rivers (Baillie *et al.* 2008).

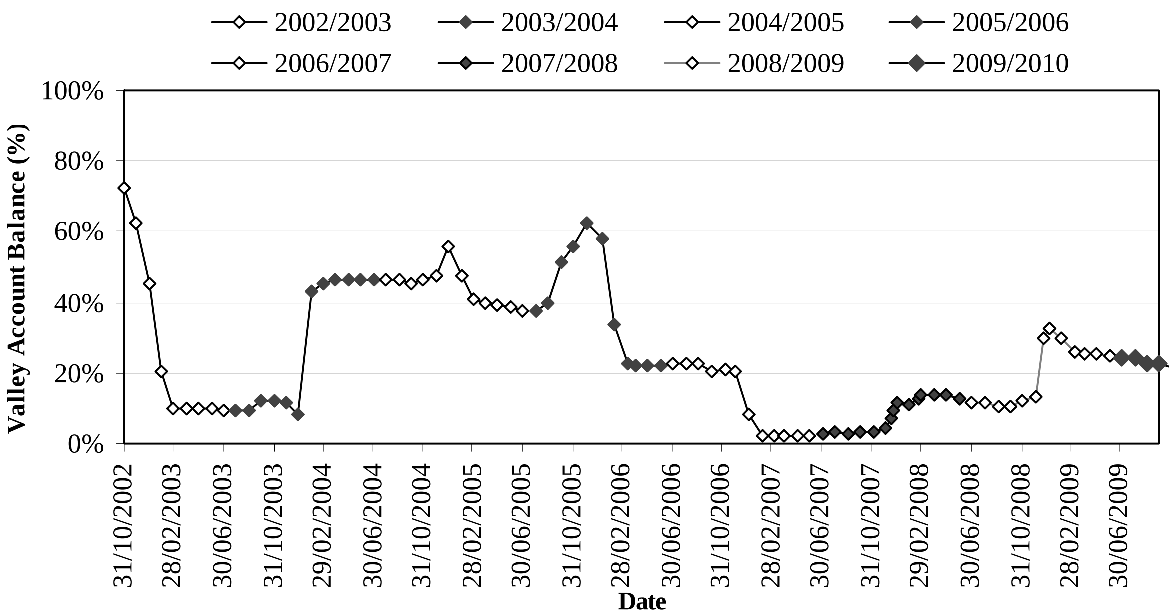
The Namoi River is regulated by Keepit Dam which was the first major water supply dam constructed in the Northern Murray Darling Basin and has a storage capacity of 423,000 megalitres (ML). Split Rock Dam on the Manilla River has a storage capacity of 397,000 ML (ANRA 2009). Chaffey Dam in the south-east of the catchment supplies irrigators on the Peel River with a capacity of 62,000 ML.

Regulated water in the catchment is broken into three sections; the regulated sections of the Peel River, Upper Namoi and Lower Namoi sections of the Namoi River. The regulated sections of the Lower Namoi include downstream of Keepit Dam to the Barwon River, including the regulated sections of the Gunidgera/Pian system.

Regulated surface water licences are managed by the NSW State Government and seasonal allocations are announced periodically as inflows occur. Continuous accounting (introduced in 1999), allows carryover of unused seasonal allocation. The continuous accounting system currently has a limit of 200% of the licensed entitlement.

Prolonged drought has reduced water available for irrigation. Since 2002 the long term average seasonal balance for regulated surface water licences on the Namoi River has been 25%. Coincidentally in September 2009 the balance was also 25% (Figure 3.1).

Figure 3.1: Namoi Valley Account Balance, by Season



Data Source: http://www.waterinfo.nsw.gov.au/ac

Many Namoi irrigation enterprises have adapted to supply variability by investing in water storage infrastructure. Both regulated and unregulated water licence holders have invested in on farm water storages to harvest storm water, capture off allocation flows (supplementary water), and to buffer against supply interruptions. In addition to these surface water resources, the Namoi valley has also a number of groundwater aquifers that provide a significant source of irrigation water (see Table 3-1 below). The reliance on these groundwater resources for agricultural production is especially high during times of low river allocations.

In the nine seasons from 2000/01 to 2008/09, an average of 209 gigalitres (GL) of river diversions and an average of 210 GL of groundwater was extracted by irrigators in the Namoi Valley (Table 3-1). The Namoi Valley is the only valley in the Murray Darling Basin to have such similar water use of groundwater and river water, with most areas having access and thus reliance on either river or ground water.

Table 3-1: Annual water extractions (GL)

Namoi Valley	2000/1	2001/2	2002/3	2003/4	2004/5	2005/6	2006/7	2007/8	2008/9	Avg
Regulated (Lower & Upper Namoi)	182	266	194	30	62	141	114	39	61	121
Regulated (Peel)	7	15	22	13	11	15	ND	ND	ND	14
Supplementary	48	0	0	52	35	18	0	29	63	27
Unregulated	78	78	78	78	78	78	ND	ND	ND	78
Total River Diversions	***315***	***359***	***294***	***173***	***186***	***252***	***114***	***68***	***124***	***209***
Groundwater	***279***	***253***	***246***	***199***	***183***	***165***	***253***	***187***	***146***	***212***

Data Source: 2006/07 to 2008/09 (DWE 2009), 2000/01 to 2005/06 (Baillie *et al.* 2008)
ND = No data

Furrow irrigation remains the dominant irrigation method for the industry. Furrow irrigation is where syphons are set by hand for each irrigation to draw water from the channel into every second contoured furrow (Roth 2006). Whilst other irrigation methods such as overhead and drip are more water use-efficient, the significant capital cost of conversion has been a barrier for most irrigation enterprises.

There are other methods to improve water use efficiency (WUE), 72% of respondents of the Cotton Consultants Australia post season survey (2008) responded that they had implemented management practice changes to improve WUE. Types of improvements included;

- Utilising an objective irrigation scheduling technique
- Evaluating surface irrigation performance with *Irrimate*
- Determining storage efficiency
- Installing water meters

The industry’s improving WUE is evident by the improvement in the ‘Irrigation Water Use Index’ (IWUI), which is the number of bales produced by the industry divided by the volume of water used by the industry. In the six seasons from 2002-03 to 2008-09, there was 39% improvement by the cotton industry (Table 3-2).

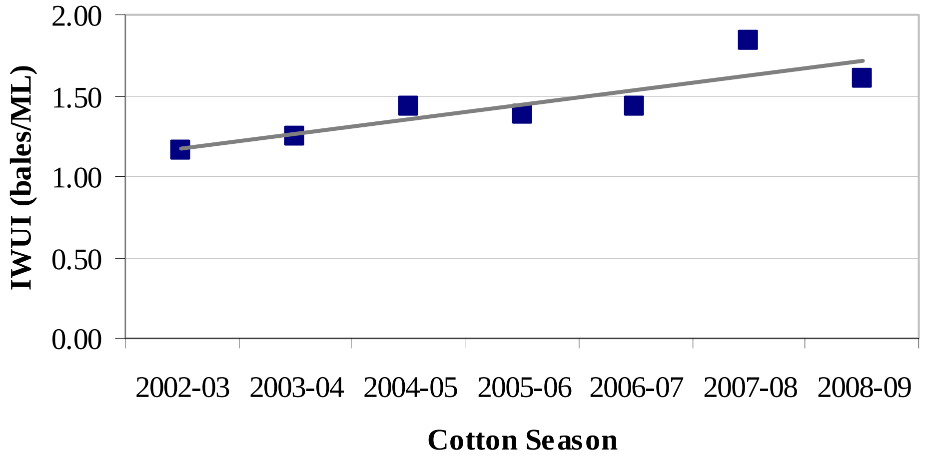
It is important to note that IWUI is influenced by seasonal conditions, with the volume of water applied to a cotton crop very dependant on the amount of in crop rain fall. Despite seasonal considerations, the trend indicates definite improvements in IWUI over time (Figure 3.2).

Table 3-2: Irrigation Water Use Index

Cotton Season	Irrigated Production (227kg bale)	Volume of Water Applied (ML)	IWUI (bales/ML)	IWUI Change from previous season	IWUI Change from 2002-03
2002-03	1,766,090	1,525,504	1.16		
2003-04	1,554,718	1,248,924	1.24	8%	8%
2004-05	2,598,392	1,819,315	1.43	15%	23%
2005-06	2,410,037	1,746,386	1.38	-3%	19%
2006-07	1,240,100	867,662	1.43	4%	23%
2007-08	568,330	309,442	1.84	29%	59%
2008-09	1,416,800	880,003	1.61	-13%	39%

Production Data Source: The Australian Cotton Grower Yearbooks (2003; 2004; 2005; 2006; 2007; 2008) Water Consumption Data Source: (ABS 2009)

Figure 3.2: Irrigation Water Use Index Trend line



4. Irrigated crop selection

Choosing rotations for a farming system is a complex decision making process. Managing limited and specific resources, volatile input and output prices whilst maintaining soil health and ensuring the long term sustainability and profitability of a farming business is a challenging task.

Some of the things farmers need to consider when choosing which crops to plant include; climate, soil type, soil structure, soil moisture, insect pressure, weed pressure, disease pressure, nutrition, cash flow requirements, water availability and available resources.

Traditionally, typical cotton rotations involved cotton with winter fallow planted year after year, sometimes with a wheat crop planted (S. Madden, Steve Madden Agriculture, pers. comm., 2009). These rotations in time began to impact adversely on cotton yields due to declining soil fertility.

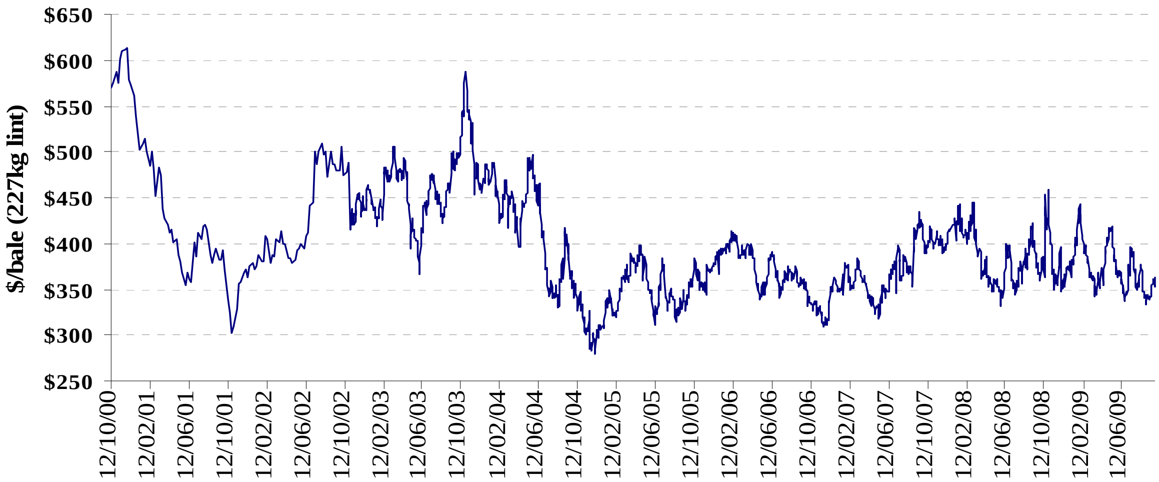
In response cotton farming system research has focussed on many areas including an understanding soil health and its impact on long term farm sustainability. Today cotton rotations have diversified to include green manure legume crops as well as pulse and cereal crops (Hulugalle and Scott 2008).

With the recent volatility in general commodity prices, and the prolonged period of limited water there are no ‘typical’ rotations in an irrigated farming system. Farmers are choosing crops season by season depending on available water, current commodity prices, pest and disease pressure and various soil health issues.

4.1 *Volatile commodity prices*

Recent exchange rate and commodity price volatility has added an extra consideration to the decision making process for irrigation farmers. In the past three years fertiliser, diesel and most grain crop prices have seen record highs before returning closer to long-term average levels. It is important to recognise that different rotations vary in terms of resilience to fluctuations of input prices (Hulugalle and Scott 2008).

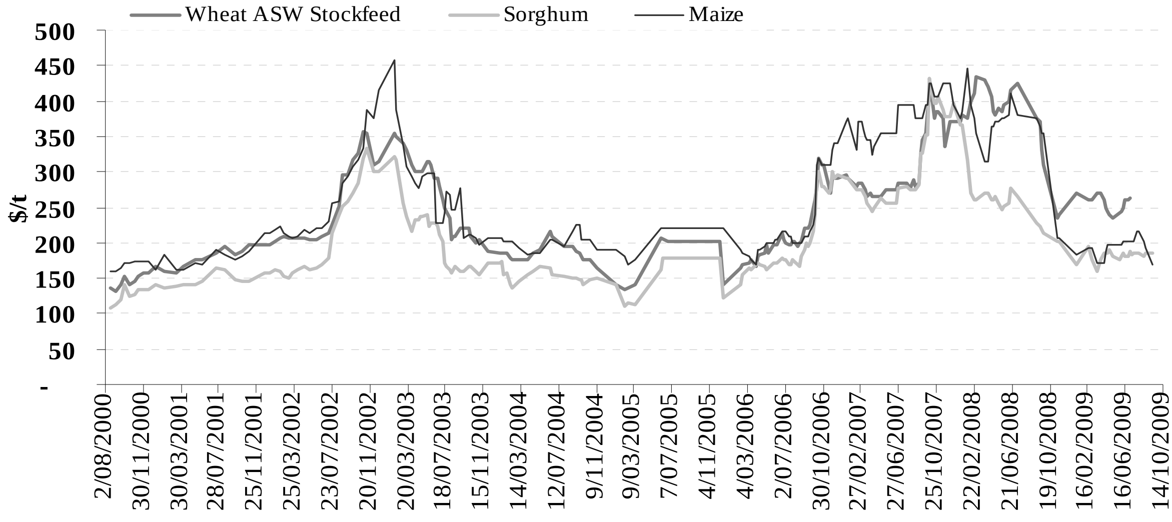
Figure 4.1: Average Cotton price, $(AUD) per 227 kg bale of lint, Dec 2000 to Dec 2009



Data: Namoi Cotton Co-operative

In the past nine years cotton prices have ranged from approximately $300/bale to $600/bale. Figure 4.1 charts the cotton price available for the ‘current’ season (prices farmers are offered when they are pricing the crop soon to be planted or already in the ground), it does not show prices that were offered to farmers to market forward (future year) cotton crops. Until recently, the past five years has provided limited opportunities for cotton farmers to market their crop above $450/bale. The effect on whole farm profit by pricing at $350/bale compared to $450/bale is significant. Increased input prices and depressed cotton prices have resulted in a cost-price squeeze for the cotton industry (Roth 2006). When cotton is trading under $350/bale, other irrigated crops may be more attractive in terms of return per ML or hectare.

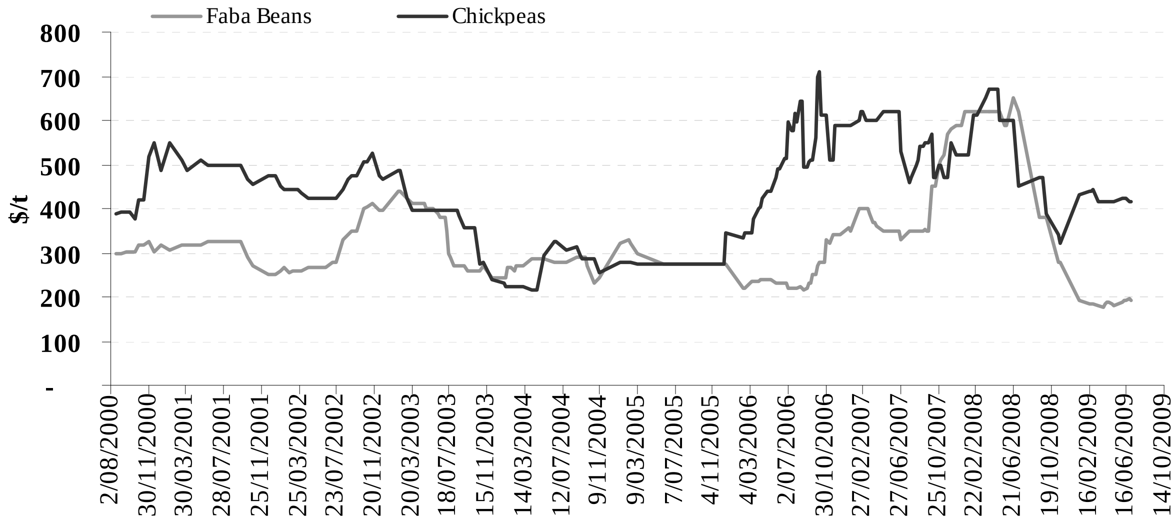
Figure 4.2: Cereal prices, Narrabri, $(AUD) per tonne, Aug 2000 to Oct 2009



Data Source: Rural Press Ltd

In the past nine years, cereal prices have also been volatile (Figure 4.2). The ASW stockfeed wheat price in Narrabri has ranged from a low of $132/t to a high of $435/t, sorghum prices ranged from $107/t to $432/t and maize prices have ranged between $160/t and $458/t. Pulse prices have experienced similar pricing fluctuations with prices in the Narrabri area for chickpea ranging from $215/t to $710/t and faba bean from a low of $178/t to $650/t (Figure 4.3). Whilst prices of substitutable commodities are generally strongly correlated (an indication of the strength of relationship between two variables), there are times when one crop will clearly out perform the others in terms of return per hectare or return per ML.

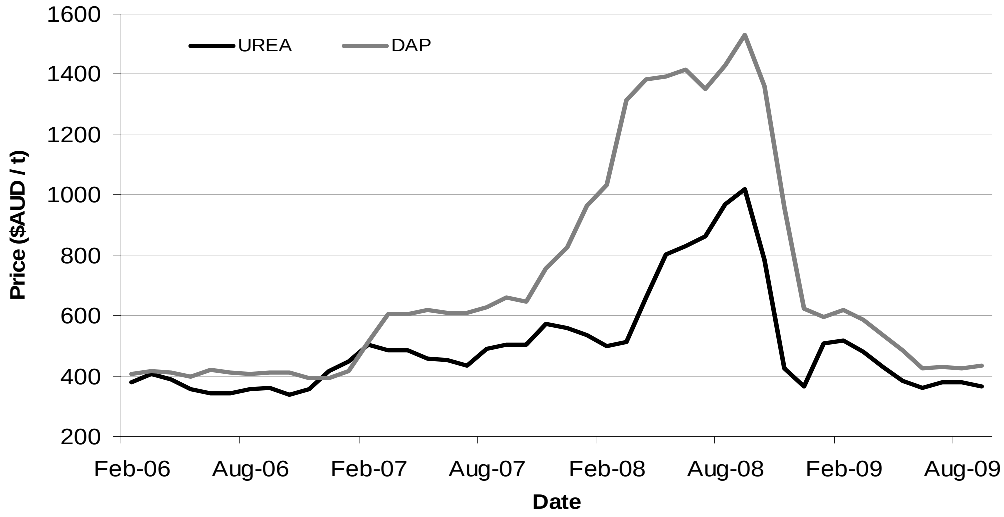
Figure 4.3: Average Pulse prices, Narrabri, $(AUD) per tonne, Aug 2000 to June 2009



Data Source: Rural Press Ltd

Enterprise gross margins are also directly affected by fertiliser price fluctuations, depending on the amount of fertilisers used. Figure 4.4 shows import parity prices for fertiliser (urea and di-ammonium phosphate (DAP)). These prices, compiled by Mr Paul Deane at ANZ Bank, are calculated as a US Gulf CIF (includes cost, insurance, freight), converted to Australian dollars. It does not include Australian wholesale or retail margins or freight charges. The urea import parity prices peaked at $1020/t in September 2008. ABARE (2008) reported the average price paid by Australian farmers in 2008 for urea as $852/t, a 66% increase on the previous years average of $512/t. DAP import parity prices peaked at $1530 in September 2008, with the average price paid by Australian farmers in 2008, $1353/t, which was a 108% increase on the average price paid in 2007.

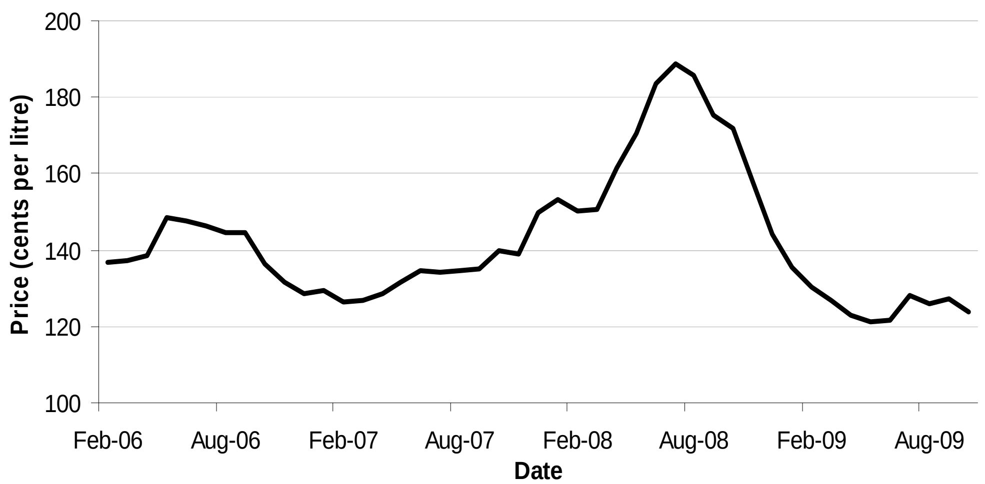
Figure 4.4: Fertiliser - Import Parity Prices



Data Source: (ANZ 2009)

Diesel prices also affect enterprise gross margins and depending on the number of tractor hours for each enterprise and if diesel-powered irrigation pumps are used. Weekly NSW regional average diesel prices collated by the Australian Institute of Petroleum (AIP 2009) in the past four years show a high of 191.2c/l in July 2008, before falling 27% to a low of 121.2c/l in May 2009 (Figure 4.5).

Figure 4.5: Weekly Average Retail Diesel Price (NSW Regional Average)



Data Source: (AIP 2009)

Farm gate prices and profits are largely determined by world prices and the value of the Australian dollar (ABARE 1997). The prices of many of the commodities discussed in the whole farm budgets are based on international prices, hence the Australian farm gate price is strongly influenced by the exchange rate. Exchange rate (AUD/USD) movements have an inverse relationship with AUD pricing. As the AUD strengthens, commodity prices offered to farmers weaken. A high exchange rate is not favourable in terms of output commodities (cotton, grain & pulses) due to the decrease in income received, however a high exchange rate is favourable in terms of imported input commodities (i.e. fertiliser and diesel), resulting in a reduction in receipts paid. The past two years have been a volatile period, with the AUD currently trading close to the levels seen since late 2007 (Figure 4.6).

Figure 4.6: AUD/USD Exchange Rate

Data Source: (RBA 2009)

4.2 *Soil health*

Soil health has long term implications on farm profit and sustainability. Rotation choice can affect a number of soil factors including soil organic matter and the amount of nitrogen fixed in the soil (Cotton CRC 2008).

Vetch for example, is a winter growing legume that is grown for its nitrogen fixing abilities. Like all legumes, vetch has a symbiotic relationship with rhizobia bacteria, which inhabit nodules formed on the roots of the plant. The rhizobia bacteria convert atmospheric nitrogen to a form which is used by the vetch plant for growth. Nitrogen-rich residues left by the crop contribute to the supply of nitrogen in the soil which is then available for subsequent crops to use (Rochester 2004). Grown as a green manure crop, the vetch plants are worked into the ground when the crop is still green and before viable seed is produced. There is no commodity harvested and no direct income from the crop. The benefit of growing vetch is the improvement of soil health by increasing organic matter and the amount of nitrogen in the soil, there is also evidence of increased yields of cotton crops grown after vetch crops (Cotton CRC 2008).

Legumes that produce a grain crop are known as pulse crops. Pulse crops are able to 'fix' nitrogen via root nodules populated with rhizobia bacteria and although most of this is stored in the grain and therefore removed when the crop is harvested, the plants have not taken this nitrogen from the soil and so the need for nitrogen fertilizers for subsequent crops is reduced (Rochester and Peoples 2005). The combination of higher soil nitrogen left after the crop and reduced root diseases is cumulative and can result in an increase in subsequent cereal yields

(Pulse Australia 2009). Recent work from southern Queensland has indicated that some residual nitrogen may remain in the soil after the pulse crop is removed, chickpea and mungbean contributed an average of 35 and 29 kg N/ha respectively in a field trial (Cox *et al.* 2010) forthcoming).

The majority of findings from studies on the benefits of using pulses in rotations indicated that when they are grown in rotation with cereal and oilseed crops, yields are increased by 0.5 to 1 tonne per hectare and protein by as much as 0.5 to 1.8% (Pulse Australia, 2009).

Compatibility with other rotation crops is a simple yet critical consideration. Canola residue is known to have an allelopathic (inhibitory) effect on a cotton crop planted immediately after canola harvest, potentially reducing cotton seedling vigour and cotton yield (Cotton CRC and CRDC 2009).

4.3 *Pests and disease*

Breaking pest and disease cycles is an important factor in the selection of a suitable rotation for any farming system. Selecting rotations that strategically allow the control of problem weeds, insects and diseases is important. In terms of weeds, it is difficult to control grasses such as black oats in wheat and broadleaf weeds such as wild turnip in chickpea and faba bean. Pests such as aphids and whiteflies can be managed by choosing rotations that are not an attractive host (Cotton CRC and CRDC 2009).

The careful selection of rotational crops is one tool for managing cotton disease. Evidence suggests adding cereals into a cotton rotation may decrease the severity of the disease verticillium wilt, whilst legume crops may increase the presence of black root rot in the following cotton crop (Cotton CRC and CRDC 2009).

4.4 *Water supply*

The amount of irrigation water available has a large influence on which crops and the area to plant to an irrigation rotation system. Different crops use different amounts of irrigation water, however selecting the crop that uses the least amount of water is not necessarily the solution. With limited rainfall, low river allocations and reductions in groundwater entitlement, in recent years water has been the most limiting resource in an irrigated farming system. To ensure the greatest return, a business needs to maximise the return of the scarcest resource. In this case, farmers should choose crops based on those with the highest return per ML of water. If land was the scarcest resource, the farmer would look at return per hectare.

One method used to utilise limited water is to deficit-irrigate crops. Deficit irrigation is a water management strategy that deliberately reduces the water available to the crop. Reduced yield under deficit-irrigation, may be compensated by an increased area of production (Ali *et al.* 2007). Depending on various commodity prices, at times it may be more profitable to deficit-irrigate one crop rather than fully irrigate another (Payero and Harris 2008). However, this requires careful management and good knowledge of how a crop will respond to deficit-irrigation. Cotton, for example, is highly responsive to water. A crop that has been deficit-irrigated may also be referred to as semi-irrigated.

Due to water shortages, it has also become more common for farms to grow dryland crops on paddocks that were previously used for irrigated crops. These crops receive reduced inputs and no irrigation water. This allows a farmer to utilise a paddock that would have otherwise been fallow due to lack of irrigation water.

4.5 *Climate Change*

Climate change is expected to adversely affect weather in Australia with warmer temperatures, declining rainfall and higher incidence of extreme weather events including, droughts extreme rainfall and bushfires (CSIRO 2006). By 2030, CSIRO (2006) predicts average temperatures in the Namoi valley to increase as much as 2.1^{o}C, and rainfall to decrease by up to 13%. These changes along with associated higher evaporation are likely to lead to less water in the rivers and streams, which would constrain future irrigation allocations and significantly reduce dryland farming yields. Livestock enterprises are also expected to be adversely affected with a likely increase in heat stress (CSIRO 2006). The sustainability of an irrigation farming system will depend on the businesses adaptability to farm in this hotter and drier environment.

4.6 *Carbon*

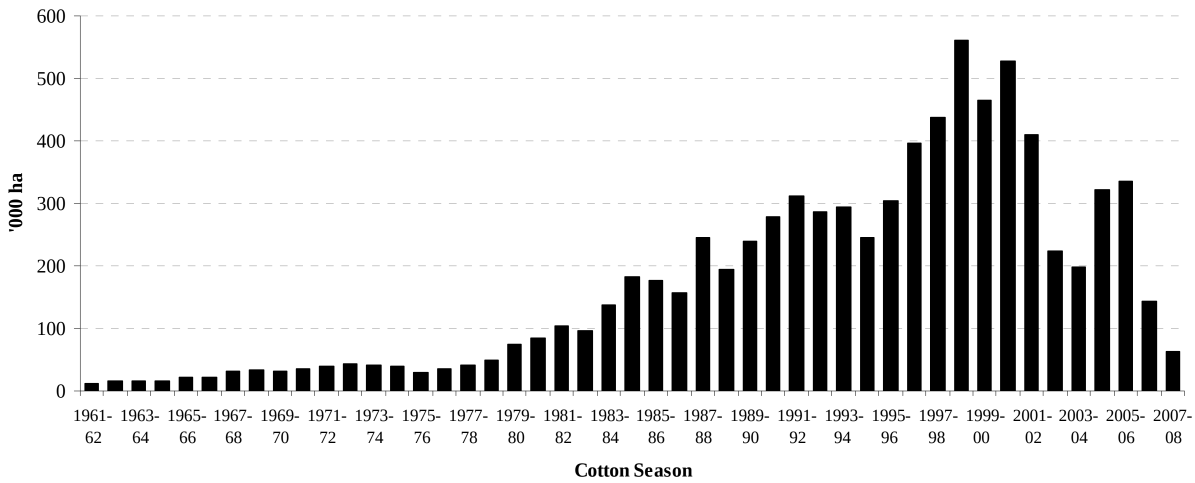
The long term profitability of irrigation farming systems is likely to be affected by evolving Australian government policy and continuing global discussion in terms of carbon. If an emissions trading scheme (ETS) were to be introduced into Australia the effect on farmers would depend on the level of inclusion of agriculture. If agriculture was excluded, gross margins would still be affected by an increase in various input prices, where industries affected pass on any costs to the consumer (Tulloh *et al.* 2009). If the agricultural sector were to be included within the ETS, there may be potential economic benefits for carbon sequestration in soils. The combination of these factors may have an impact on the profitability of future irrigation and dryland crops, however, a full assessment of the impact of the proposed ETS scheme is beyond the scope of this report.

5. Cotton Industry

5.1 *Overview*

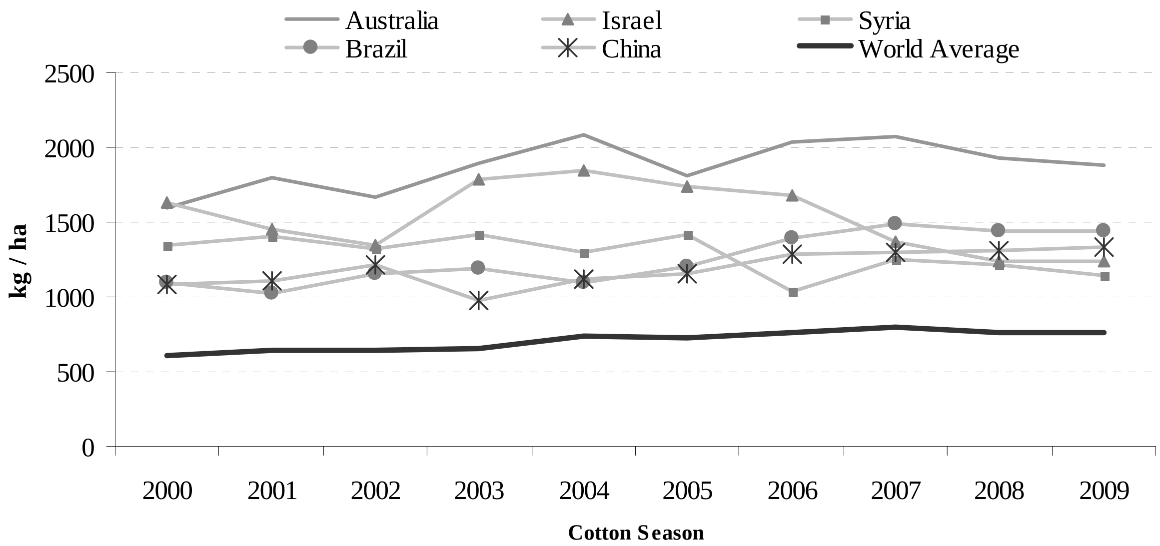
From its infancy in the 1960’s, the Australian cotton industry developed for 30 years before peaking in the 1998-99 cotton season with 561 thousand hectares harvested. Most cotton growing areas in Australia recently experienced severe drought, which is reflected in the reduced cotton area during 2006-07 and 2007-08. Due to increases in yield per hectare, the peak of lint production was in 2000-01 when 819 kilotonnes (3.61 million 227 kilo bales) were produced.

Figure 5.1: Australian Cotton Production (ha harvested)



Data Source: (ABARE 2008)

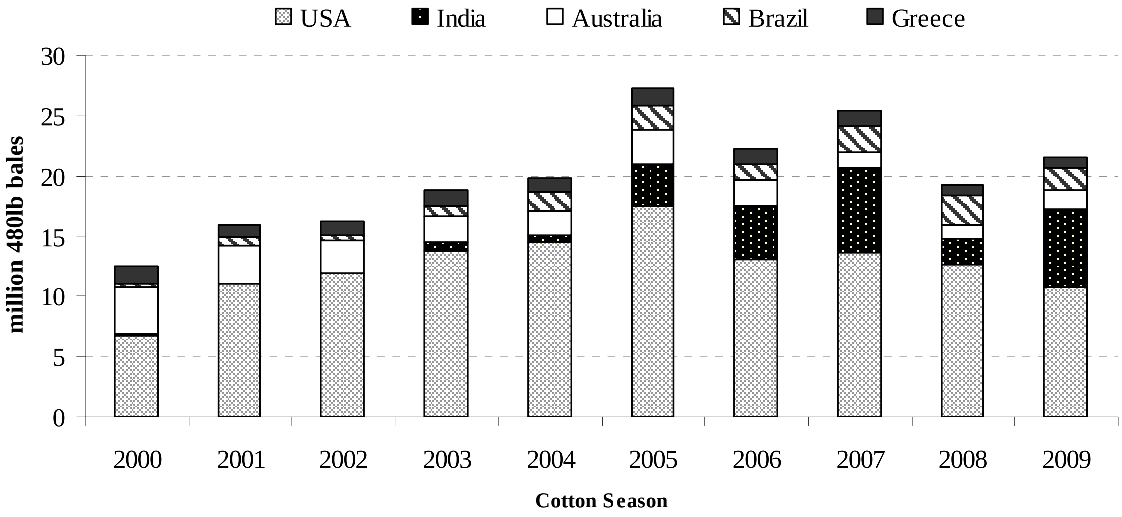
Figure 5.2: Comparative Cotton Yields by Country



Data Source: (ABARE 2008)

As the world leader in terms of cotton yield per hectare, Australia's average yield in 2008 season was 2.12 t/ha or 9.34 bales/ha (ABARE 2008). World average cotton yields have increased from an estimated 141 kg/ha in 1973-74 to a high of 796 kg/ha in 2007-08. Australian yields are consistently higher than all cotton producing nations as shown in Figure 5.2.

Figure 5.3: Top 5 exporters of cotton



Data Source: (USDA 2009)

In the past ten years, Australia's market share of world exports has declined significantly from 15% of world cotton exports in 2000 to an estimated 5% in 2009. The decline in Australia's export status is directly linked to the diminished production due to drought conditions in Australia's cotton growing regions. During the same period, India's exports increased from less than 1% of world cotton exports to an estimated 20% in 2009 (Powell 2009). The emergence of India as a major exporter is largely due to the significant increase in their cotton production. From 2000 to 2009 India's production increased from 12.3 million to 23.5 million bales with the increase mainly attributed to a rise in yields since the introduction of BT cotton (Bennett *et al.*).

5.2 *Best Management Practices Program*

The cotton industry's Best Management Practices (BMP) program is a voluntary farm management system. The aim of the program is to "achieve sustainability through improved farm efficiency and productivity along with protecting the environment and its natural resources". The program provides information and practical tools across a range of farm management areas including; Human Resources, Biosecurity, Soil Health, IPM, Greenhouse and Carbon, Water Management, Natural Resource Assets, Quality, Pesticide Management, Petrochemicals, Technology (Cotton Australia 2008). Also provided within the program are self assessment mechanisms and the option of an external audit to gain BMP certification.

Developed by the industry as a form of self regulation, the BMP program demonstrates how the industry manages the challenging balance of operating a sustainable business whilst preserving natural resources. The content of the program is a result of collaboration between cotton producers and industry research and extension bodies. A revision to the cotton industry's BMP Program has seen the printed manual be replaced with an easy to navigate 'myBMP' website (www.mybmp.com.au). This provides an information resource where users can keep track of their progress online and the industry can easily monitor and update the program contents. The BMP program has been extended to include both cotton ginning and classing organisations. This is one more step towards the BMP coving the entire Australian cotton industry.

6. Representative Farm Model

6.1 *Resources*

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. An economic survey of irrigation farms in the Murray Darling Basin (Ashton and Oliver 2008) found that the average farm size in the Namoi Valley is 1203 hectares. Consultation with the consensus group suggested that this figure is representative for a typical irrigation farm in the Lower Namoi Valley area. The breakdown of land use on the typical farm was also agreed upon during this consensus meeting (Table 6-1).

Table 6-1: 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

The area of the farm developed for irrigation is 782 hectares or 65% of the farm size. Actual irrigated crop plantings year to year are dependant on water allocation. In the model, crops may be selected depending on water allocation. The farm layout (i.e paddock size) is not considered within the model.

The dryland component of the representative farm is 180 hectares or 15% of the farm size. As the model is focused on the irrigated component, the dryland farming component has been developed with a fixed rotation system using no-till farming practices.

Approximately 120 hectares or 10% of the farm size is used for cattle grazing. The remaining 120 hectares or 10% of the area is under channels, drains, structures, roads and water storages.

The Ashton & Oliver (2008) report found the average regulated surface water license in the Namoi region was 684 ML, and the average groundwater license 547 ML. Whilst this information looks at the Namoi Valley as a whole, data from Crean (2001) was able to be broken down into sub-catchments. The average regulated surface water licence for the Lower Namoi Valley was 1712 ML (median 972 ML) and the average groundwater license as 1061 ML (median 758 ML). After consultation with the consensus group, the model was allocated

1600 ML of regulated surface water and 750 ML of groundwater. The median was used for groundwater because over half the irrigated farms in the valley do not have groundwater and groundwater licenses have faced cut backs since the water data base was created.

On farm water storages within the Lower Namoi Valley range from 40 year-old small, shallow, single cell structures, to new, large, laser levelled multi cell storages. The typical Namoi Valley farm according to Mr Bernard Martin (irrigation engineer, Aquatech, Narrabri), has enough water storage capacity to complete one full irrigation, this may take the form of one or more storage sites. Some farms within the flood plains have significantly more storage than this, in order to ensure that they have the opportunity to harvest overland water from flood events. Water required for one full irrigation of the Lower Namoi typical farm model is approximately 800ML of water. The water storage capacity within the model has been set at 900ML.

Water assumed available for the analysis, 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.

It is an industry Best Management Practice (BMP) requirement to have a farm plan that recirculates water and has water storage capacity to withstand a 15mm rainfall event after full irrigation and not lose water off farm. Water that has run-off a cotton field is known as tail water and may contain chemicals and nutrients best kept out of natural waterways. Tail water is required to be stored on-farm under the Protection of Environment Operations Act 1997. The typical farm in the Namoi Valley complies with this legislation and BMP; it is assumed all irrigation water is recirculated on farm.

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.

6.2 *Commodity Prices*

As discussed previously (Chapter 4.1) the volatility of commodity prices has a significant effect on farm profitability. In order to accurately report the resulting range of financial outcomes a risk analysis package called @RISK was used (Palisade 2009) . Where there is uncertainty for a value, this program can determine the typical distribution for the item. The distribution clearly reflects 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.

To determine an appropriate distribution, @RISK uses a set of historical data (i.e price series) and identifies the distribution with the best fit. The distribution graphs display the future probability of a price occurring. All prices were adjusted for inflation prior to fitting the distribution curve. Distributions used within the model can be found in Appendix A: Distribution graphs.

Crop prices (except cotton) are based on data from nine years of weekly prices for Narrabri collated from Rural Press Ltd data published in "The Land" newspaper and available online at http://theland.farmonline.com.au/markets.aspx. The probability distributions were truncated (limited) to reflect realistic minimums within the data range.

The cotton price is based on nine years of current crop, daily price data courtesy of Namoi Cotton. Cotton marketing enables farmers to price crops two or even three years before they are planted. These forward marketing strategies tend to increase the average price received for cotton farmers for their product. Forward marketing generally attracts a premium of $10 - $50 a bale, with a seasonal average of $25/bale (pers. communication D Lindsay, Marketing Manager, Namoi Cotton January 2010). Given the distribution was based on spot prices (ie. excluding forward contract prices), the distribution was adjusted $25 to the right (ie upwards) to account for forward marketing premiums.

Two input prices that have a significant impact on the profitability of various crops are fertiliser and diesel (Hulugalle *et al.* 2008). The probability distribution for diesel is based on 42 months of data supplied by the Australian Institute of Petroleum as the NSW Regional weekly average (retail diesel) price. The urea and DAP price distributions are based on 42 months of fertiliser prices (personal communication, Mr Paul Deane at ANZ Bank), calculated as a US Gulf CIF (cost, insurance, freight), converted to Australian dollars. The series was altered to include retail margins and domestic freight. Anhydrous Ammonia prices are based on 42 months of on farm prices courtesy of Incitec Pivot.

The strength of a linear relationship is measured by the coefficient of correlation, with values ranging from -1 for a perfect negative correlation (inverse relationship), to +1 for a perfect positive correlation (Levine et al. 2005). Whilst overall grain prices are correlated, this tends to vary in strength. Maize, faba bean and sorghum are strongly correlated; this is understandable considering they can all be used as stock feed and can be substitutes. Fertiliser prices are strongly correlated to that of diesel pricing. The correlations used within the whole farm budgets are shown in Appendix B: Commodity Correlations.

@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. Commodity and input (fertiliser and diesel) price distributions are assumed independent.

The distribution mean is used to report the base farm results. The mean can be interpreted as the expected value of the data set (Levine *et al.* 2005).

6.3 *Rotational Crops*

There is a wide range of cropping options suitable to the Namoi Valley. The rotational crops appropriate for the representative farm according to local farmers and agronomists are shown in Table 6-2.

The gross margins in the model were developed by using the I&I Northern NSW Farm Enterprise Budgets for Summer 2008-09 and Winter 2009 series as a base before consulting with local agronomists to make adjustments to reflect the Lower Namoi Valley. Each gross margin reflects industry best management practice for that particular crop. Gross margin results are analysed in terms of return per megalitre, as this is currently the scarcest resource.

Typical yields were determined via consensus in consultation with various agribusiness service providers and growers in the Lower Namoi.

Table 6-2: Farming Enterprises

Season	Crop	Applied Water (ML/ha)	Yield (t/ha)	Price ($/t) #	Gross Margin ($/ha)#	Gross Margin ($/ML)#
Summer	Cotton (BT, irrigated)	8	9.5*	538**	2,606	326
Summer	Cotton (conventional, irrigated)	8	9.5*	538**	2,878	360
Summer	Maize (irrigated)	7.15	9	287	1,478	207
Summer	Sorghum (irrigated)	4.5	8	242	1,113	247
Summer	Sorghum (semi irrigated)	1.5	5.5	242	600	400
Summer	Soybean (irrigated)	5.8	3	350	441	76
Winter	Chickpea (dryland)	-	1.3	468	335	-
Winter	Faba bean (irrigated)	2.7	5	348	1,176	436
Winter	Faba bean (dryland)	-	1.4	348	225	-
Winter	Wheat (bread, dryland)	-	1.8	244	187	-
Winter	Wheat (bread, semi irrigated)	1.5	4	244	334	223
Winter	Wheat (bread, irrigated)	3.6	7	244	790	219
Winter	Wheat (durum, irrigated)	3.6	7	275	1,005	279
Winter	Vetch ^ (irrigated)	1.4	-	-	-188	-134

Price and gross margin reflect the distribution mean
*Bales/ha **$/Bale, $461/227kg bale lint + $77/bale ($248/t) seed
^Grown as green manure crop to promote soil health

Commodity price volatility is highlighted by the significant range of potential gross margin returns between the various crops. Whilst interpreting these results it is important to remember that the commodity and input prices are the only stochastic variables. All other values are constant, including yield, for the purpose of highlighting the impact of price variability. Using a distribution for output and key input and commodity prices ensures that the results are also given as a distribution. Figure 6.1 shows the range of potential gross margin results per megalitre for the most typical rotational crops in the Lower Namoi valley.

Table 6-3: Probability of Gross Margin occurring below x$/ML

Rotational Crops	95%	75%	50% (Mean)	25%	5%
BT Cotton	547	389	**326**	243	165
Sorghum - fully irr	478	302	**247**	160	115
Sorghum - semi irr	876	515	**400**	221	126
Maize	418	267	**207**	124	73
Wheat - fully irr	518	258	**219**	129	95
Wheat - semi irr	633	276	**223**	99	51
Faba bean	**868**	**542**	**436**	**282**	**167**

Price volatility can have a large impact on gross margin. Table 6-3 illustrates the high variability of possible gross margin outcomes. Semi-irrigated sorghum has the largest range with 90% of potential gross margin results falling between \$126/ML and \$876/ML. Maize has the smallest variability and Faba beans have the highest starting lower percentile with 95% of gross margin results likely to occur above \$167/ML (Table 6.4).

A comparison of gross margins per megalitre is shown in Figure 6.1. The median results for each treatment are represented by the horizontal line in the middle of the box, these results were discussed in the previous section. 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 quartiles with 25% of results occurring below these lines, the upper vertical lines end at the 95 percentile and the lower line ends at the 5^{th} 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.

The way a farmer may use this information depends on their attitude towards risk. Those wanting to minimise downside risk would consider that cotton has the highest possibility of returning \$200/ML (Table 6-4). However those wanting to maximise upside potential may look at the possibility of a crop returning \$500/ML, in this case faba bean is the most likely with 31% of gross margin results likely to exceed \$500/ML, compared to cotton with only 8%.

Table 6-4: Probability (%) of returning above x\$/ML

Rotational Crops	>\$200/ML	>\$350/ML	>\$500/ML
BT Cotton	**98**	36	8
Sorghum - fully irr	58	16	4
Sorghum - semi irr	80	49	27
Maize	44	11	2
Wheat - fully irr	39	14	6
Wheat - semi irr	38	17	9
Faba bean	91	**60**	**31**

When considering gross margin return per ML, cotton would be the crop of choice if downside risk was critical, however faba bean would be the crop selected to optimise maximum potential returns per ML.

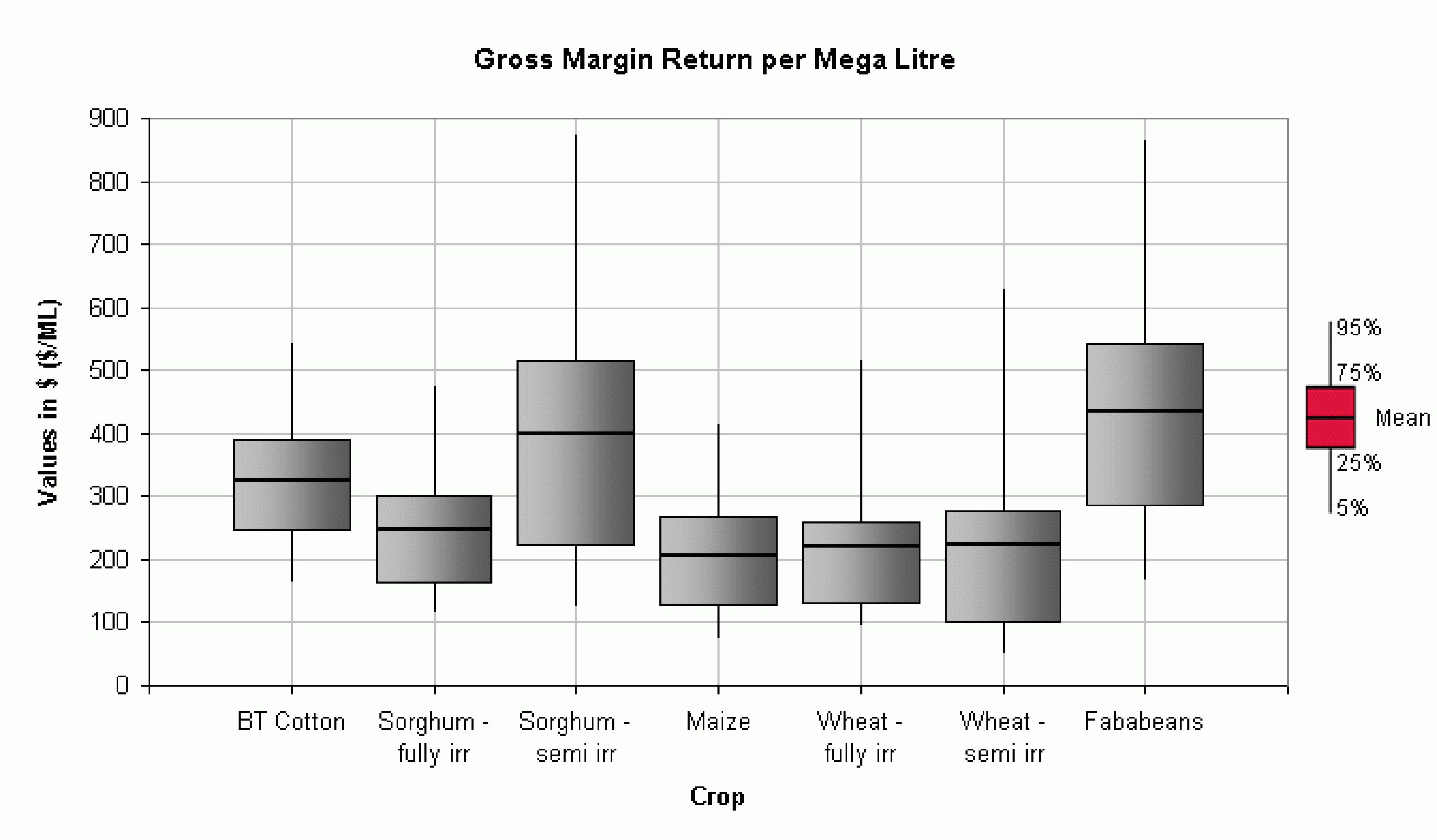


Figure 6.1: Gross Margin Returns per megalitre

As water is currently the most limiting resource of the typical farm, crops were selected on the basis of; GM/ML return to ensure best use of the scarcest resource (Table 6-5), and typical rotation. The local consensus group agreed that a typical sustainable rotation was BT cotton, wheat and faba bean and that all available irrigation water would be used throughout the year to gain maximum returns for the farm. When all irrigation water is utilised, there is a significant area of fallow land, unable to be irrigated due to the restricted water availability. Using the consensus group, it was decided that a typical farm would grow dryland winter crops on most of this land rather than keeping it fallow, to gain some income from the land. However some of the land would be kept fallow in water in case of an increase in water allocations the following season, for this scenario 200ha was kept fallow.

Table 6-5: Selected Irrigation Enterprises

	Ha	Irrigation Paddocks	GM/ HA	GM/ ML	TOTAL GM
SUMMER	100	BT Cotton (irrigated)	2,606	326	260,600
	5	Refuge - Pigeon Peas (irrigated)	-456	-79	-2,280
	677	Summer Fallow (irrigation paddocks)	-79	-	-53,483
	782				***204,837***
WINTER	160	Faba bean (irrigated)	1,176	436	188,160
	200	Wheat (on irrigation paddock with no irrigations)	187	-	37,400
	200	Chickpea (on irrigation paddock with no irrigations)	335	-	67,000
	40	Faba bean (on irrigation paddock with no irrigations)	225	-	9,000
	182	Winter Fallow (irrigation paddocks)	-61	-	-11,102
	782				***290,458***
		TOTAL IRRIGATION GM			**495,295**

The smaller dryland area has a typical dryland rotation of wheat, faba bean and chickpea (see Table 6-6). It is assumed that no summer crops are grown on the dryland enterprise, although at times, local farms may opportunity crop sorghum.

Table 6-6: Selected Dryland Enterprises

	Ha	Dryland Paddocks	GM/ HA	TOTAL GM
SUMMER	180	Dryland Summer Fallow	-74	-13,320
	180			***-13,320***
WINTER	60	Dryland Wheat	187	11,215
	60	Dryland Chickpea	335	20,095
	60	Dryland Faba bean	225	13,483
	180			***44,792***
		TOTAL DRYLAND GM		**31,472**

6.4 *Financial Characteristics*

As of the 30 June 2007, the average Namoi Valley irrigation enterprises debt was $980,169 and the average farm capital was $5,797,688 according to Ashton & Oliver (2008). Included in the farm capital is the market value of the assumed licence of 1603 ML of $1,624,207. Land and water values for the typical Namoi Valley irrigation farm were arrived at after considering recent property sales and discussion with local property agents (Table 6-7).

Table 6-7: Statement of Assets and Liabilities

Assets				
Value of Land and Fixed Improvements				$ 6,185,000
Irrigation	782	ha @	$2500 /ha	
Dryland	180	ha @	$1250 /ha	
Grazing	120	ha @	$600 /ha	
Water Licenses				
Groundwater	750	ML @	$1500 /ML	
Regulated River Water	1600	ML @	$1800 /ML	
(Valuation as at 10/02/2009)				
Plant & Equipment				$ 568,878
(see register for details Appendix C: Plant & Equipment Register*)*				
Livestock – Cattle				$ 54,972
Total Assets				**$ 6,808,850**
Liabilities				
Term Loans	CORE DEBT			$ 1,700,000
Overdraft for	$125,000	($500,000 limit, 12 Months)		$ 125,000
Lease & Hire Purchase				$ -
Total Liabilities				**$ 1,825,000**
Equity				
Equity (Assets - Liabilities)				**$ 4,983,850**
Equity percentage (Equity / total assets)				**73%**

The total finance cost includes interest on the core debt and over draft. An average equity percentage for a typical Lower Namoi irrigation enterprise is generally between 70-80%, but could be anywhere from 55% to 98% (personal communication, David Kidd, Senior Agribusiness Manager, Westpac Moree, September 2010). In general, in the early 2000s, Australian farms usually have an equity of 85% or higher, however during the life of the business it may be as low as 50% (Malcolm *et al.* 2005).

Farm costs have been accounted for as either variable or overhead costs. Variable costs change in proportion to the level of activity for an enterprise, and are accounted for within each enterprise gross margin. Examples include crop inputs such as planting seed, water, fertiliser and machinery operating costs. Overhead costs remain relatively fixed no matter what the enterprise mix or activity. Examples include administration, labour and rates. All costs vary significantly from farm to farm. In this analysis the value of operators labour has not been accounted for. We assume overhead costs in Table 6-8 are representative of a typical farm in the Lower Namoi Valley (personal communication, Mr David Maxwell of Carrigan & Co Accountants).

Table 6-8: Whole Farm Budget

					GM	$
Enterprise Gross Margins					**GM**	**$**
Irrigation					495,295	
Dryland					31,472	
Grazing					19,507	
Total Farm Gross Margin:						**546,274**
Overhead Costs					**$**	
Administration (accountant, phone, stationary, postage, bank charges)					11,000	
Labour • Casual	**$20.00 /hr**	(20 weeks	@ 55 hrs/week =	1100 Hrs)	22,000	
• Permanent labour (employee, not owner/operator)					70,000	
Farm Electricity					5,000	
Fuel & oil (farm vehicles not including general maintenance)					12,000	
Insurance (vehicle, building)					6,000	
Rates & Land Taxes (RLPB, Local Government, Water)					20,000	
Registration and licences					3,000	
Repairs and Maintenance @ 3% of value of plant and equipment					17,066	
Weed control (not including general maintenance)					2,000	
Other					5,000	
Total Overhead Costs						**173,066**
Net Farm Cash Income (Total Gross Margin less Overhead Costs)						**373,208**
Operating Costs						
Interest @	9%	of liabilities			164,250	
Depreciation @ 10% of value of plant and equipment					56,888	
Operator and family labour					-	
Total Operating Costs						**221,138**
Farm Operating Surplus (Net Farm Cash Income less Operating Costs)						**152,070**
%Return on total assets (Operating surplus/Total assets)						**2.2%**
%Return on total equity (Business return/Equity)						**3.1%**

7. Results

7.1 *Financial performance of the Representative Farm*

Based on the information assembled, the statement of assets and liabilities for the representative farm is shown in Table 6-7. Total assets exceed $6.8 million and the equity percentage is 73%. The corresponding annual operating budget is shown in Table 6-8, with total farm gross margin as $546,274 and overhead costs at $173,066. Note that the irrigation water available for the analysis was restricted to 1285ML of a potential 3250ML. The area under each crop shown is in Table 6.3 and 6.4. Hectares and the yield assumptions used are shown in Table 6.2.

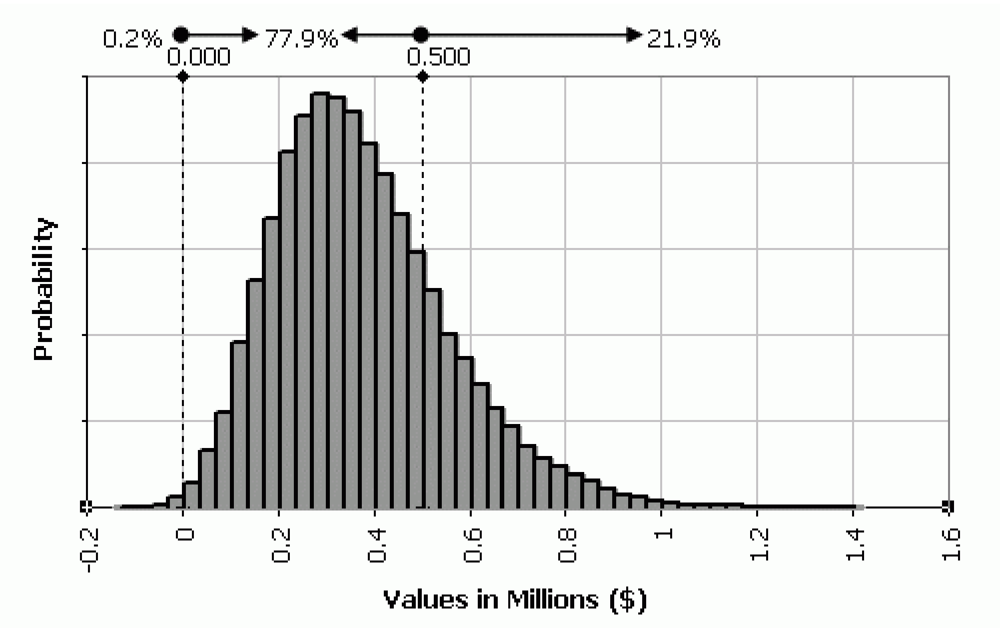
The net farm cash income (farm gross margin less overhead costs) was $373,208, and after the deduction of operating costs (interest and depreciation), farm operating surplus was $152,070. The business return on owner equity was 3.1%.

A positive farm operating surplus means that in this example, the business provided enough funds to meet all overhead and variable costs whilst maintaining assets (depreciation) and meeting interest payments. The remaining farm operating surplus needs to be sufficient to cover owner and family living expenses, debt repayments and off-farm investments. The level required to meet these commitments will vary greatly, depending on loan terms and the requirements of family needs and off-farm investments.

7.2 *Impact of price variability on whole farm returns*

The average net farm cash income (farm gross margin less overhead costs) is $373,208, however due to price variability and the use of pricing distributions as discussed in Section 6.2, the range of net farm income is shown in Figure 7.1.

Figure 7.1: Net Farm Cash Income distribution

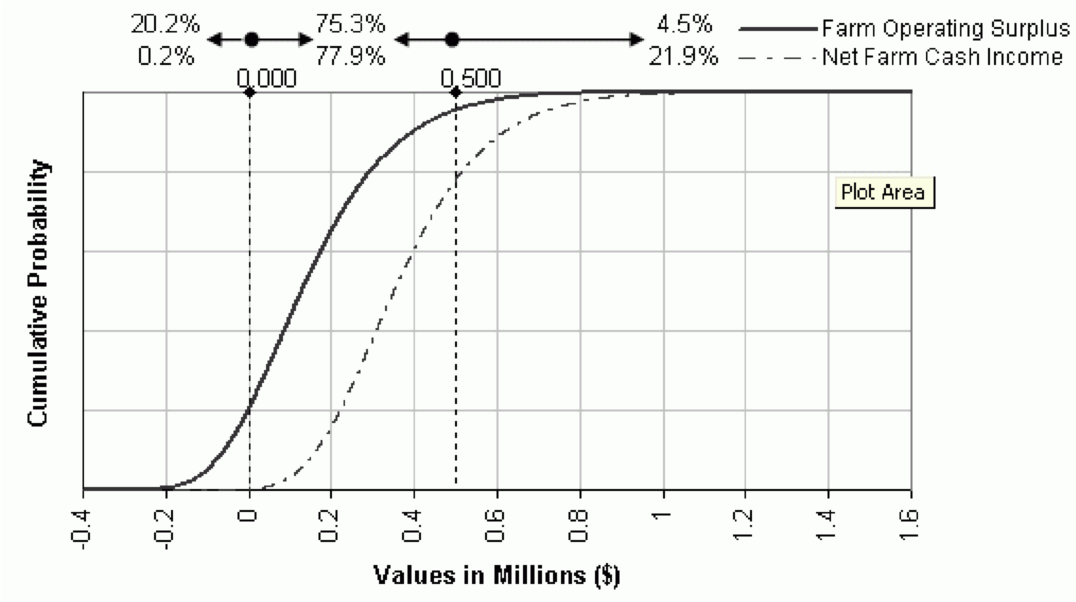


These results show that based on price variability estimates, there is a probability of .2% of returning less than $0 cash income, a probability of 77.9% that the cash income will be between $0 and $500,000 whilst there is a 21.9% probability of exceeding $500,000. There is a 90% probability of the net farm cash income being between $121,343 and $706,529.

Within the model the farm operating surplus (net farm cash income less operating costs of interest and depreciation) has an average return of $152,070. There is a probability of 20.2% of returning less than $0 operating surplus, a 75.3% probability that the surplus will be between $0 and $500,000, with a 4.5% chance of exceeding $500,000 (Figure 7.2). There is a 90% probability of the operating surplus being between -$99,794 and $485,391.

This demonstrates that 20% of the time the representative farm can not meet farm costs while maintaining assets (depreciation), and at this point they have still not covered debt repayments or owner living expenses. Considering the restricted water allocation within the scenario, these results do not indicate an unviable business.

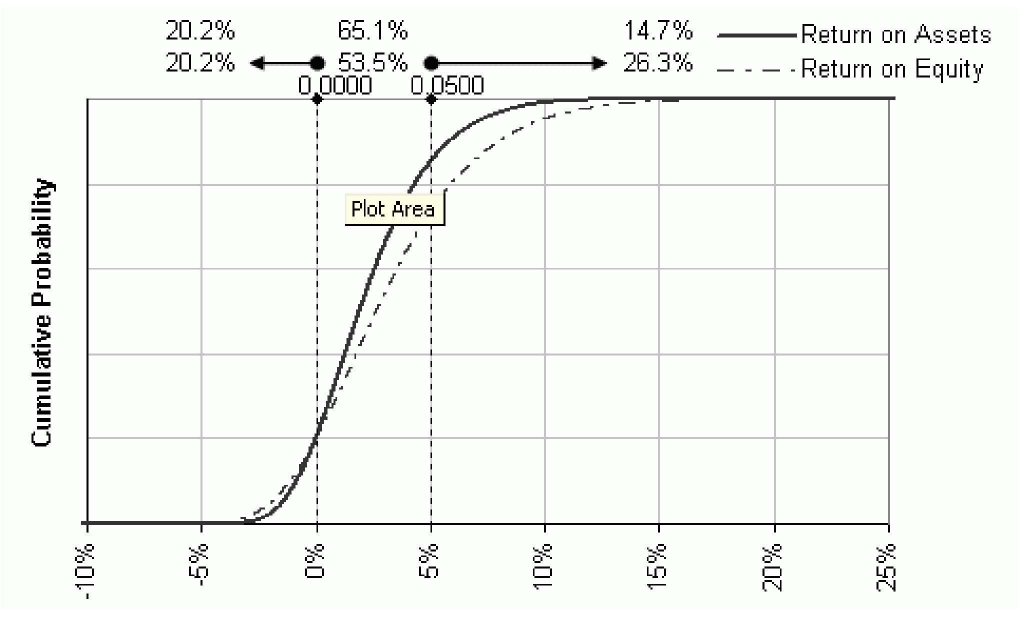
Figure 7.2: Farm Operating Surplus and Net Farm Cash Income



Return on assets (ROA) (Operating Surplus/Total Assets) gives an indication of how effective the business is in generating a profit. The representative farm had an average ROA of 2.2%, considering these results as a distribution (Figure 7.3) there was 90% probability of falling between -1.5% and 7.1%, 20% of being below 0, 15% chance of being above 5%. With an 85% probability of ROA under 5%, this indicates an asset heavy business. Whilst rural land provides a low return on assets, land values tend to appreciate in the long-term and are usually not that volatile (Blackburn and Ashby 2007).

The return on equity (ROE) (Operating Surplus/Total Equity) averages 1.9%, with a 90% probability of being between -2% and 9.7%, and a 20% probability of being below 0 and a 26% probability of being over 5% (Figure 7.3). In the long run, the average Australian farm achieves lower returns than most off-farm investments (Blackburn and Ashby 2007), however there may be other reasons for investing in a farm such as the lifestyle it brings.

Figure 7.3: Return on Assets and Return on Equity



8. Application 1 – Rotation and tillage trials

8.1 *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 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.

8.2 *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 8-1: 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 (stubble incorporated	Fallow	Fallow
Treatment 4 (T4)	Cotton	Wheat (stubble retained)	Fallow	Vetch

8.3 *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, 1ha of cotton represents 95% cotton and 5% pigeon peas. This accounts for required refuge area for Bollgard II® cotton.

As shown in Table 8-2, 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 8-2: 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 8-3). Two year rotations were compared by assuming the farm had two of the rotations active, in offset years (Table 8-4). This was particularly important for treatments 3 and 4 to ensure a twelve month snapshot captured the entire rotation.

Table 8-3: 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 8-4: 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 (Table 6-8).

8.4 *Results of the rotations*

8.4.1 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 8-5 to Table 8-8.

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 8-5: 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 8-5) 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 8-2), 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 8-6) 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 8-6: 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 8-7: Area allocated to crop: Treatment 3

Ha	Crop	Water Applie d 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 8-7) 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 8-8), 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 8-8: 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 8-2.

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 8.6). 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.

8.4.2 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 8-9. 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 steady state analysis (Table 6-8), 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 steady state analysis (Table 6-8), with remuneration for the farm owner not included within this analysis. T2 and T3 have significantly reduced casual labour costs (as indicated in Table 8-9) this is due to these treatments growing considerably less green ha within the rotations.

Table 8-9: 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%**

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.

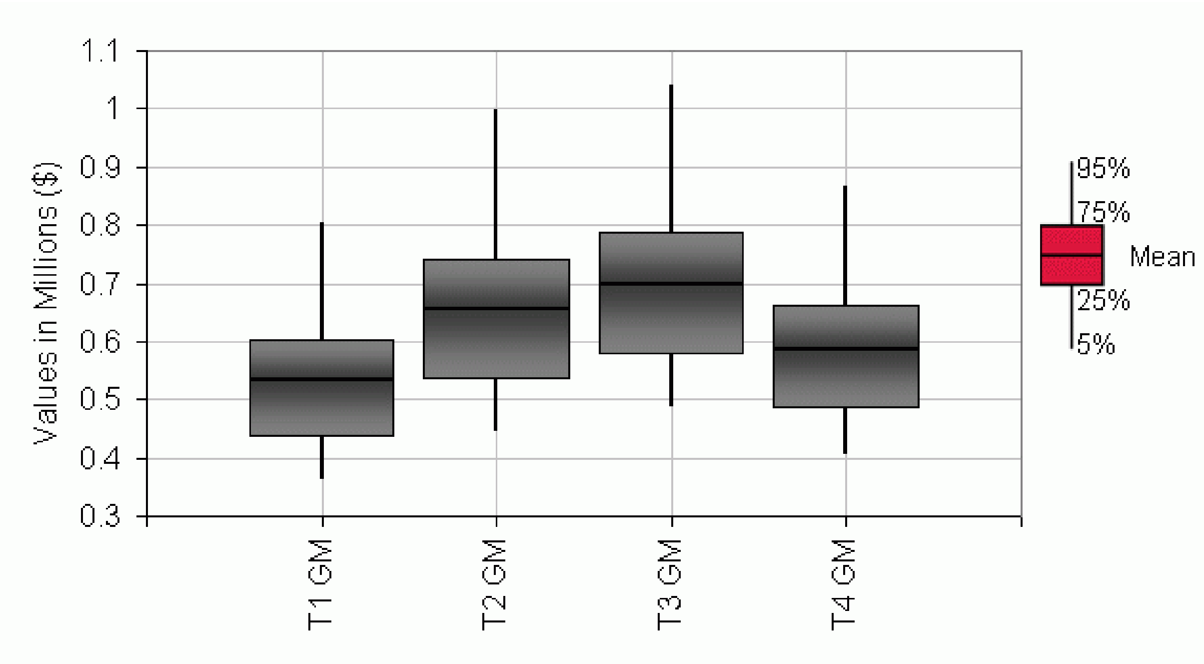
8.4.3 Impact of price variability on cotton rotation study

Similar to the steady state representative farm results, price variability has a significant impact on the different rotations. As the mean results were discussed and compared in the previous section (8.4.1 Financial performance of individual rotation), 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 8.1).

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 8.1: 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 8-10, T1 has a 48% probability of total gross margin under $500,000, whilst T3 has only an 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 8-10: % 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

Net farm cash income comparison as displayed in Figure 8.2, 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 8.2: Net farm cash income comparison

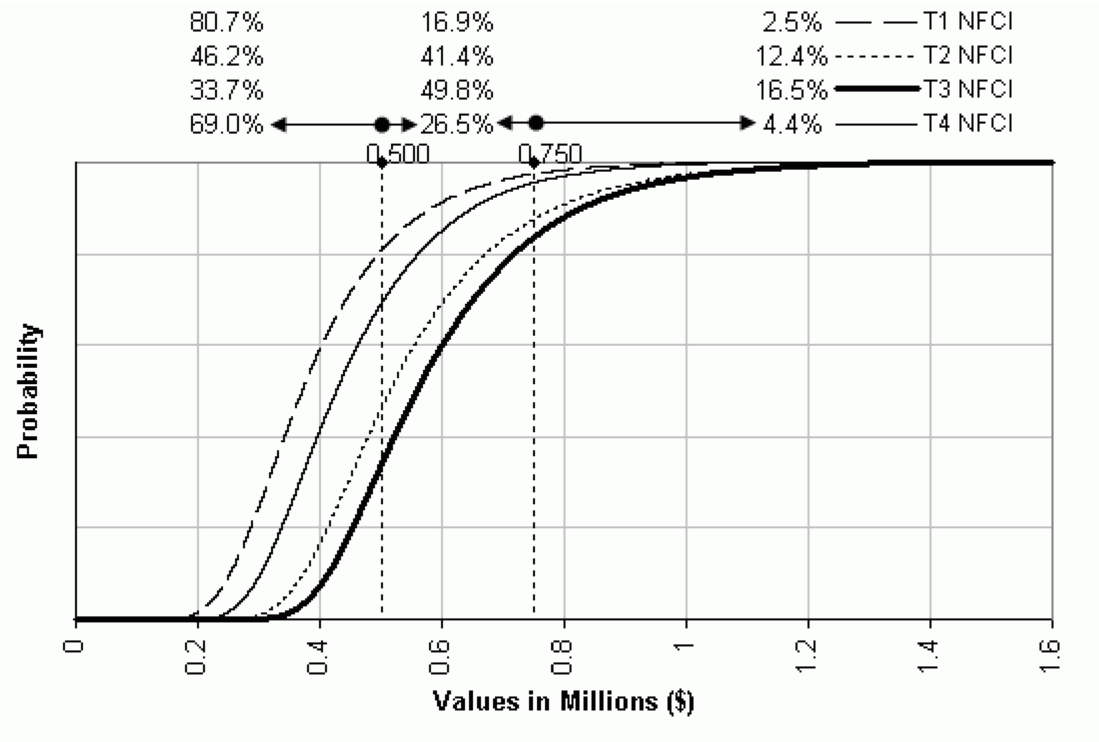
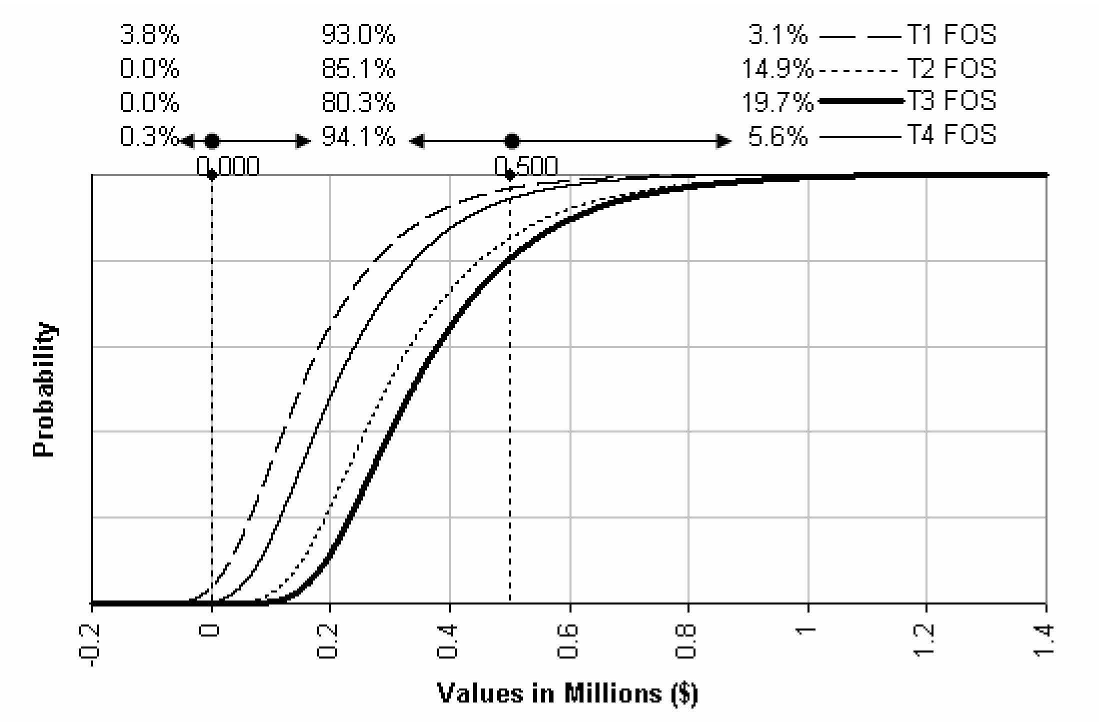
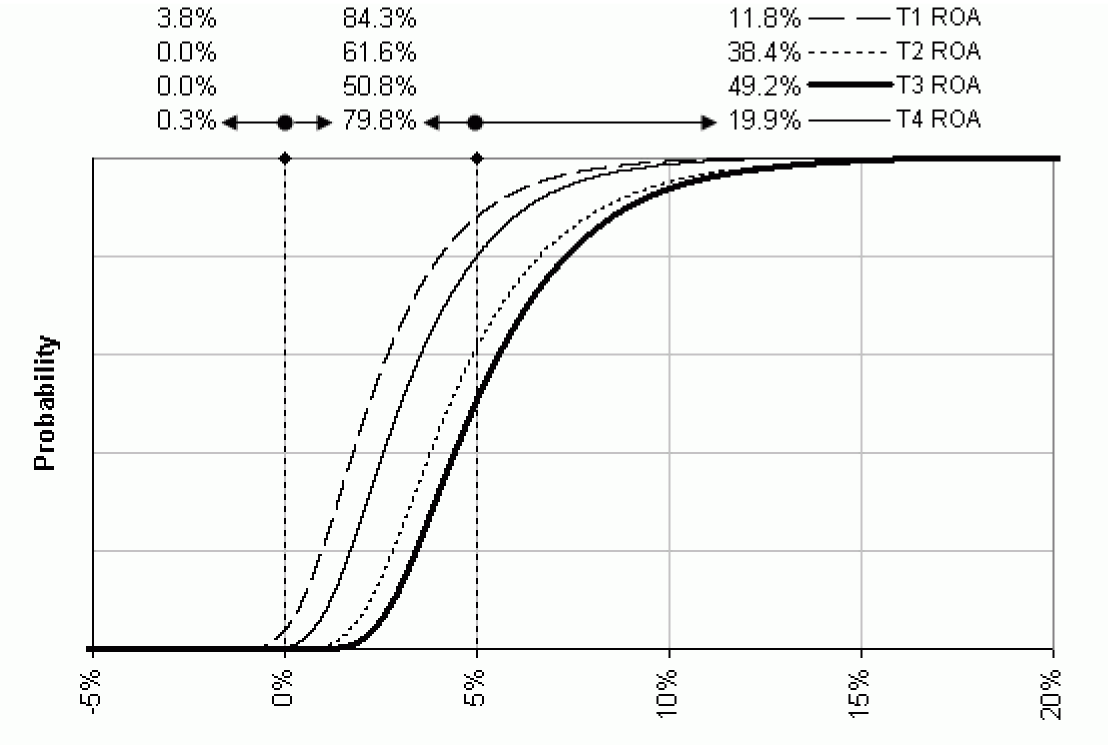


Figure 8.3: Farm operating surplus comparison



Farm operating surplus (net farm cash income less operating costs of interest and depreciation) comparison is displayed in Figure 8.3. 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.

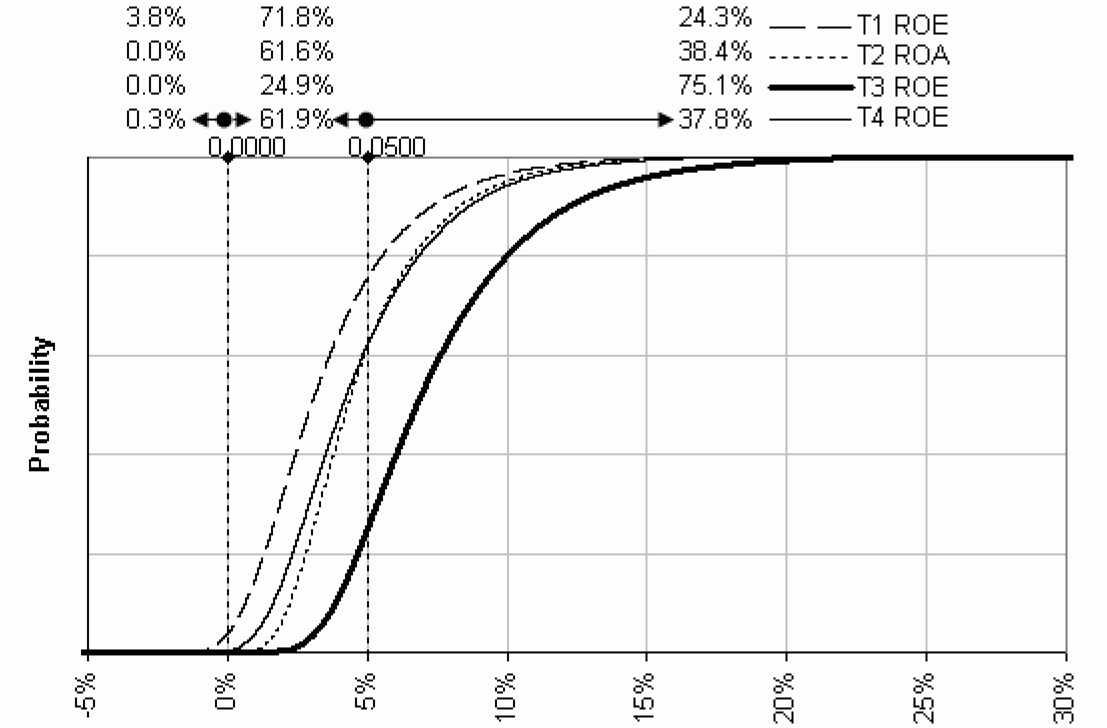
Figure 8.4: Return on assets comparison (%)



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 8.4). 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 8.5). 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.

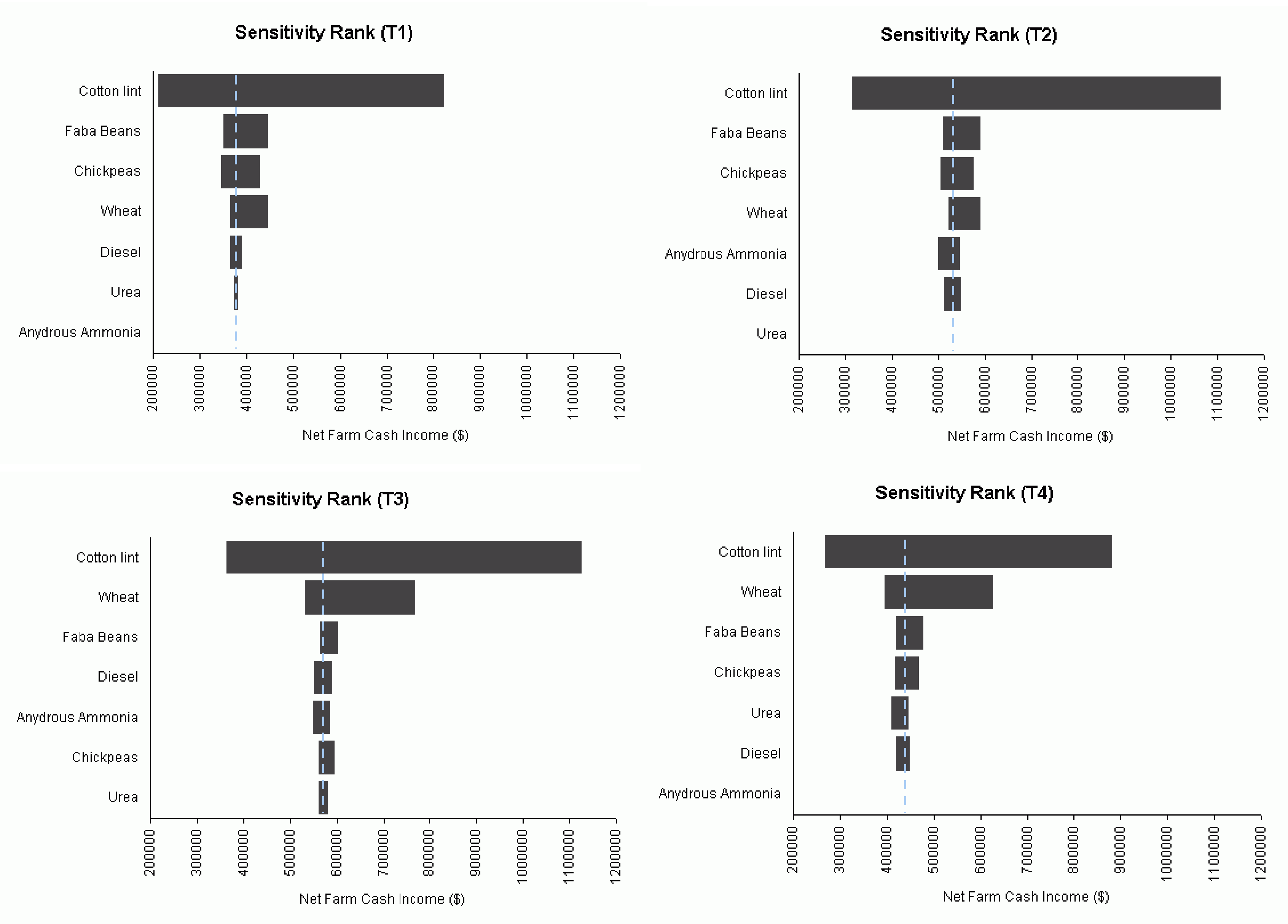
Figure 8.5: Return on equity comparison (%)



To understand which variables have the greatest effect on profitability (net farm cash income), further sensitivity analysis was conducted. Figure 8.6 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 8.6: Sensitivity Charts (T1 to T4)



9. Conclusions

9.1 *Representative farm*

This report presents a description of a representative farm in the Lower Namoi Valley and was developed and used to give a ‘snapshot’ of the financial performance of the model farm and to analyse the financial implications of changes in cropping rotations. The whole farm budget provides a snapshot of the financial performance at a particular point in time of a farm with a particular set of resources.

The representative farm budget for the Lower Namoi Valley suggest that given restricted irrigation water availability and average commodity prices the business could return a profit. The $152,070 operating surplus indicates that after family living expenses minimal debt could be repaid in that twelve month period. If the business was to begin making off-farm investments, a considerably higher operating surplus would have to be achieved. The farm operating surplus achieved as a percentage of the owner’s equity is 3.1 per cent.

The representative farm is resilient when it comes to poor commodity prices. Results suggest that in one year in five, the farm is unlikely to return a positive cash surplus due to pricing fluctuations. As the farm is 99% likely to return positive net farm cash income, this suggests that the debt levels assumed may be too high for the income earning capacity of the business, during sustained periods of low water allocation. This is also given the assumed commodity prices as listed in Chapter 6. Improvement in the cotton price as a result of better farm marketing strategies or improving world prices would make a significant difference to farm profitability.

Recent trends in crop selection have seen farmers moving away from fixed rotations and making planting decision based on commodity values. This ability to adapt crop selection should increase the long term profitability of the typical farming system providing soil health is not compromised and best practice agronomy is adhered to.

9.2 *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 8-2.

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 described in this Report has been profitability focused. 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 these agronomic benefits.

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11. Appendix A: Distribution graphs

@Risk distribution graphs as discussed in section 6.2 Commodity Prices

Figure 11.1: Cotton lint price distribution

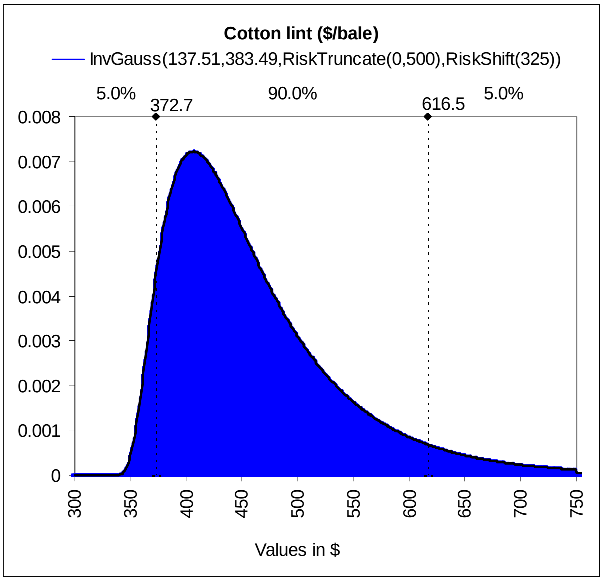


Figure 11.2: Cotton seed price distribution

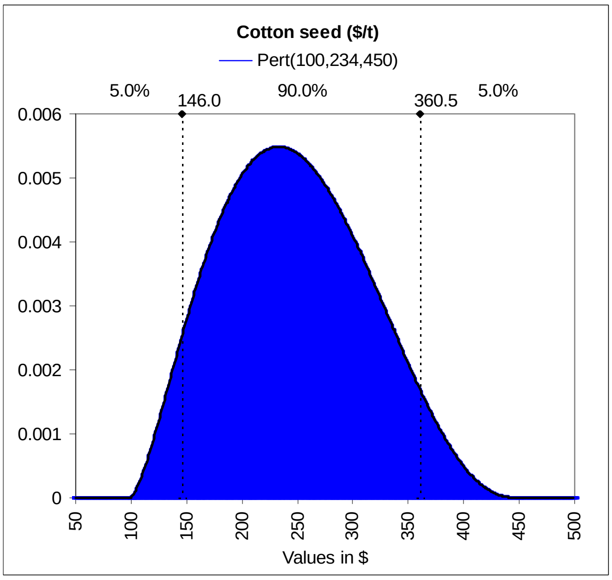


Figure 11.3: Chickpea price distribution

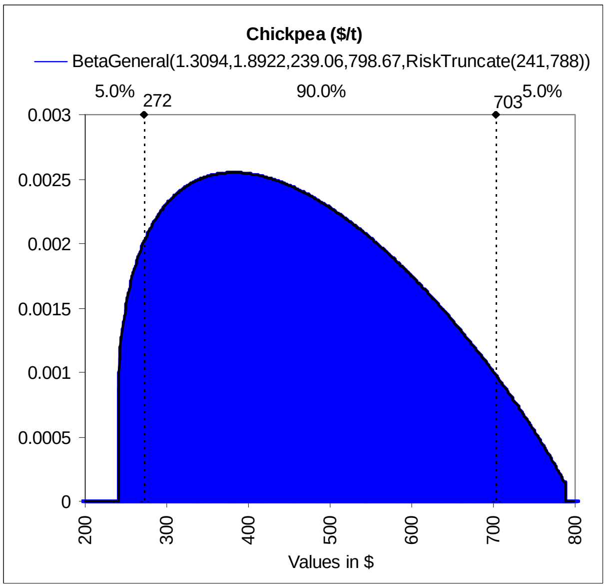


Figure 11.4: Wheat price distribution

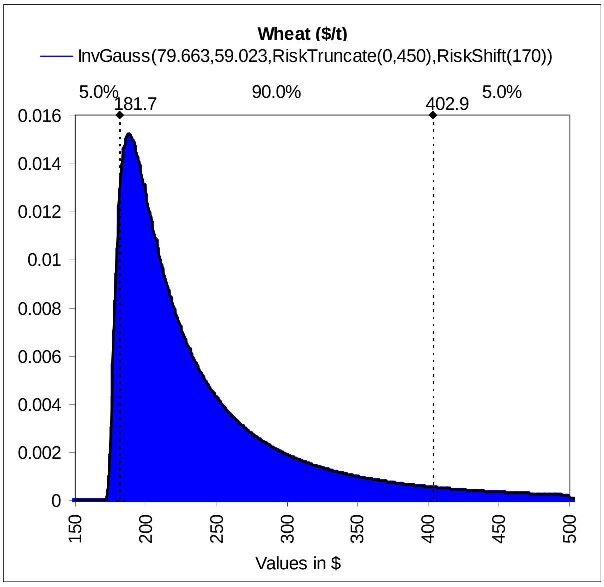


Figure 11.5: Faba bean price distribution

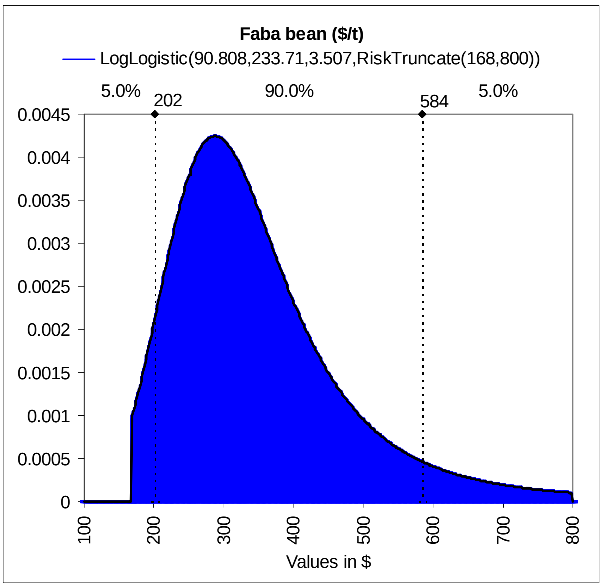


Figure 11.7: Sorghum price distribution

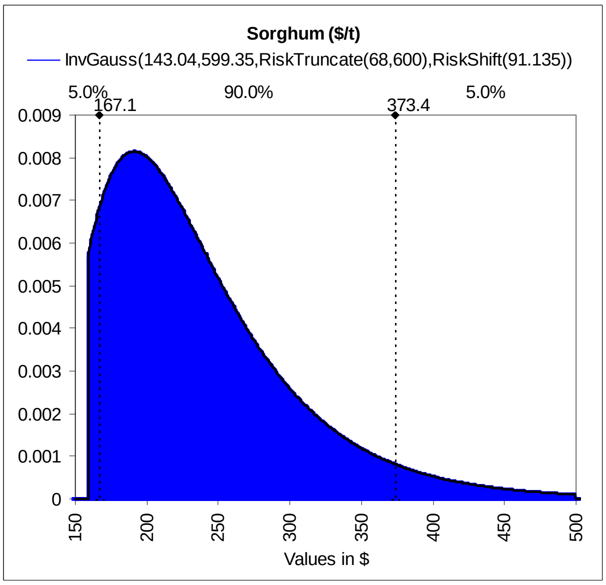


Figure 11.6: Maize price distribution

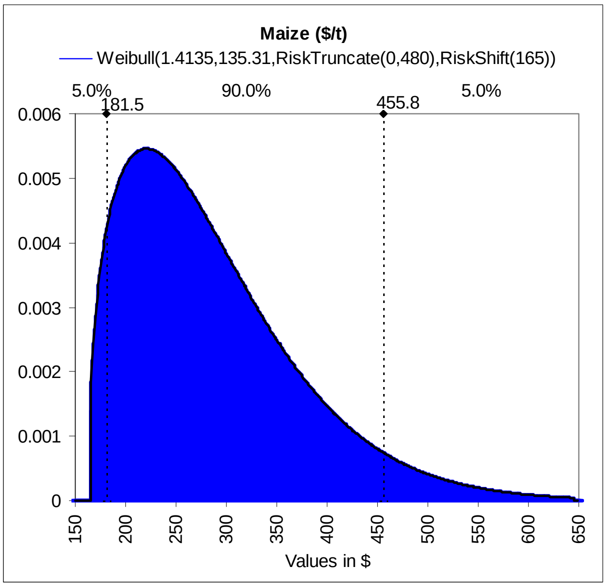


Figure 11.8: Anhydrous Ammonia price distribution

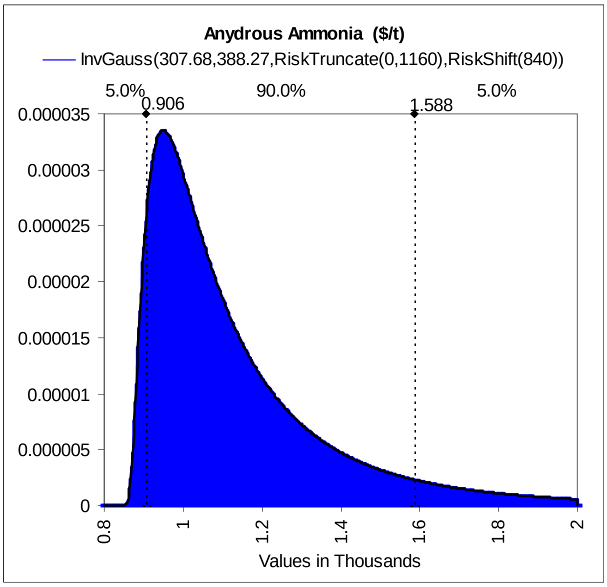


Figure 11.9: Di-Ammonium Phosphate (DAP) price distribution

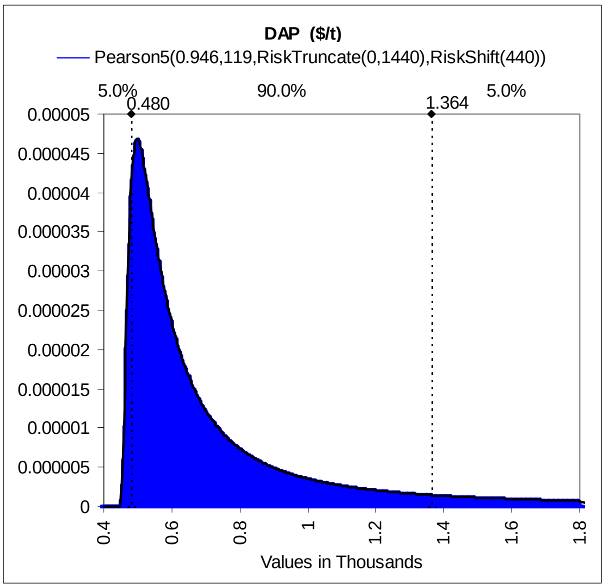


Figure 11.10: Urea price distribution

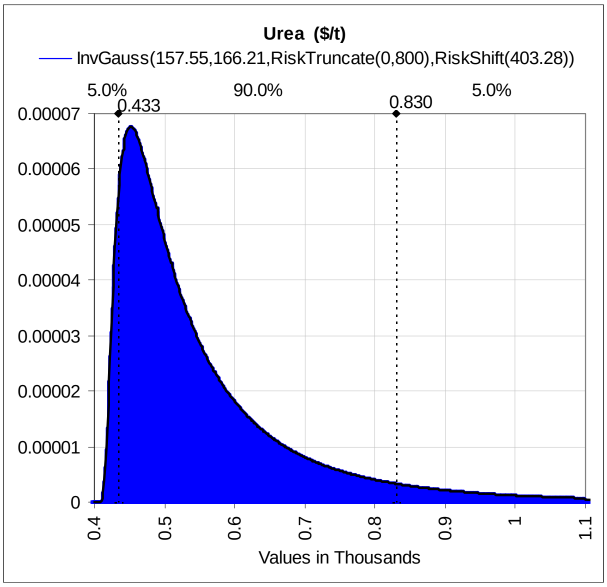
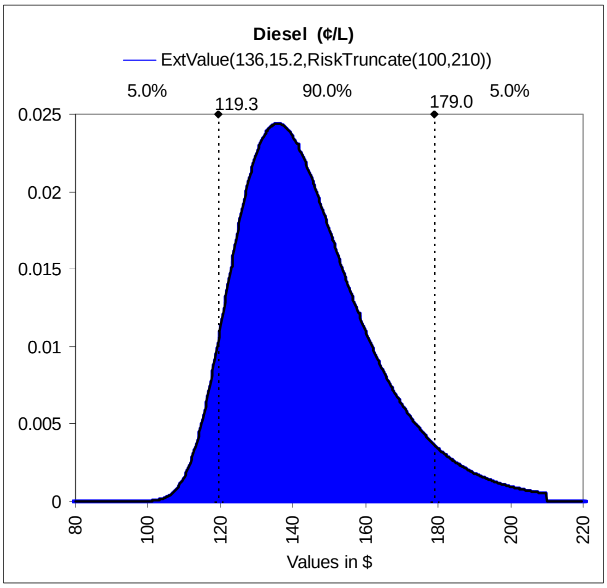


Figure 11.11: Diesel price distribution



12. Appendix B: Commodity Correlations

Table 12-1: Grain and legume price correlations

	Hard Wheat 11.5 ESR	*Chickpea*	*Maize*	*Faba bean*	*Sorghum*
Hard Wheat 11.5 ESR	1.00				
Chickpea	0.22	1.00			
Maize	0.36	0.60	1.00		
Faba bean	0.55	0.45	0.80	1.00	
Sorghum	0.29	0.60	0.89	0.69	1.00

Table 12-2: Fertiliser and diesel price correlations

	Urea	*AA*	*DAP*	*Diesel*
Urea	1.00			
AA	0.75	1.00		
DAP	0.89	0.78	1.00	
Diesel	0.83	0.73	0.88	1.00

13. Appendix C: Plant & Equipment Register

PLANT & EQUIPMENT REGISTER			
	Item	**Market Value**	**Salvage Value**
Tractor 1	JD 6230 - 57 KW PTO (76 HP) AND 70 KW ENGINE (95 HP)	$60,824	$21,288
Tractor2	JD 6230 - 57 KW PTO (76 HP) AND 70 KW ENGINE (95 HP)	$60,824	$21,288
Tractor 3	JD 8230 - 149 KW PTO (200 HP) AND 177 KW ENGINE (240 HP)	$178,875	$62,606
Tractor 4	JD 8430 - 186 KW PTO (250 HP) AND 217 KW ENGINE (295 HP)	$235,146	$82,301
Machine 1	4WD ute	$28,000	$16,800
Machine 2	4WD ute	$28,000	$16,800
Machine 3	Landcruiser ute	$56,990	$34,194
Machine 4	Back hoe	$15,000	$9,000
Machine 5	Roberville Auger	$15,000	$9,000
Machine 6	Semi tipper	$25,000	$15,000
Machine 7	Min-till Air seeder+harrows: 12.2m width: 10km/ha: 8.54ha/hr	$152,000	$91,200
Machine 8	Spray unit: 24m width: 18km/ha: 36.72ha/hr	$38,000	$22,800
Machine 9	Cultivator: 8m width: 12km/ha: 8.64ha/hr	$29,000	$17,400
Machine 10	Mulcher with root cutters:8m width: 15km/ha: 5.1ha/hr	$54,000	$32,400
Machine 11	Interrow cultivator: 8m width: 9km/ha: 6.48ha/hr	$35,000	$21,000
Machine 12	Middle busting rig: 8m width: 6km/ha: 4.32ha/hr	$30,000	$18,000
Machine 13	Planter: 8m width: 10km/ha: 7.2ha/hr	$59,000	$35,400
Machine 14	Shielded spray rig: 8m width: 15km/ha: 10.8ha/hr	$11,000	$6,600
Machine 15	Spray unit: 18.2m width: 12km/ha: 18.564ha/hr	$19,000	$11,400
Machine 16	Bed renovator: 8m width: 6km/ha: 3.84ha/hr	$34,000	$20,400
Workshop	Contents of workshop	$30,000	$4,000
	Total	$1,194,659	**$568,878**

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