Farming Systems in the Central West of NSW: An Economic Analysis

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Acronyms and Abbreviations Used in Report

ABARE	Australian Bureau of Agricultural and Resource Economics
ABS	Australian Bureau of Statistics
AH	Australian Hard - Wheat
LGA	Local Government Area
LF	Long-fallow
LP	Linear Programming
MIDAS	Model of an Integrated Dryland Agricultural System
PH	Prime Hard – Wheat
pH	Measure of soil acidity
PRISM	Profitable Resource Integration Southern MIDAS
SF	Short-Fallow
SLA	Statistical Local Area
TE	Transpiration Efficiency

Farming Systems in the Central West of NSW: An Economic Analysis

Executive Summary

The objectives of this report have been to describe important farming systems in the Central West of NSW, to gain some insights into current financial performance and to examine in more detail the role of pastures in these farming systems at a time when the profitability of wool growing has been low relative to grain growing.

While farms and farming systems vary considerably across the region, a majority can be broadly grouped into a mixed livestock and cropping category. Although there is also significant variability within this category, two representative farms and farming systems were developed for the region with the assistance from a small group of farmers and extension staff from NSW Agriculture. One represents the farms and farming systems east of Condobolin and the other represents the farms and farming systems to the west of Condobolin.

Whole-farm budget models have been developed for each to provide a description of the farms in this region and an indication of their current profitability. They are useful to give an indication of how farm income might be altered by the introduction of some new technology, a new enterprise such a pulse crop, or an alternative management practice. This report presents some examples of their application but importantly it has provided a template for the development of additional whole-farm budgets for alternative farming systems in this and other regions.

Using the whole-farm budget representing farms east of Condobolin, and a linear programming model, PRISM Condobolin, this report shows that the optimal length of pasture is fairly insensitive to changing market signals for both cropping and livestock commodities. It also shows that although length of pasture is insensitive, the optimal mix of enterprises does change, highlighting the importance of considering the interactions between enterprises in whole-farm analysis.

1. Introduction

1.1 Introduction

In this report a 'broad brush' picture of farming in the Central West region of NSW is presented. The region is defined and described in terms of its resources, climate and the nature of agriculture. The main enterprises that farmers choose between are described and gross margins budgets for these enterprises are presented.

The choice of enterprises is influenced not only by their profitability as independent enterprises but also by their contribution to other enterprises or to the farming system. The labour and capital resources of the farm also have an influence on the choice and size of enterprises.

These interrelationships mean that proposed changes within enterprises require examination in a whole-farm context. Hence an important part of this report is the presentation of a "model" farm that represents a common farming system in the Central West. This representative farm is described in terms of its land, labour and machinery resources and its enterprises and their rotation within the farm. That information, together with gross margin and overhead cost information, has been used to develop a whole-farm budget.

In the final section of the report, the whole-farm budget is used to examine how the profitability of the farm responds to changes in the length of the pasture phase.

The enterprise and whole-farm budgets are all available as spreadsheet models which can be manipulated by someone with reasonable skills in EXCEL.

1.2 Use of representative farm analysis

This report presents a description of farming in the Central West and an indication of its profitability. The representative farm model and associated gross margin and whole-farm budgets can be used as a template allowing variations from the representative farm to be examined. Individual farmers may wish to adapt them for their own farms. They can also be used to give an **indication** of how farm income might be altered by some new technology, the introduction of a new enterprise such as a pulse crop or farm forestry, or some long term change in soil fertility for example. However, it is only an indication as the particular circumstance of individual farms would give them different outcomes.

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 Central West, it may be misleading 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 a view of "before" and "after" the new technology. If the change in technology has an impact on soil fertility for example, that takes 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 are required.

2. Agriculture in the Central West

2.1 The Region

The Central West region of NSW as described in this report includes the Lachlan, Bland, Narromine, Parkes, Forbes, Weddin, Gilgandra, Dubbo and Wellington local government areas. Figure 2.1 displays these local government areas within Region 122 as defined by the Australian Bureau of Agricultural and Resource Economics. Rainfall across the region varies between 400 and 700mm and is generally non-seasonal in nature. The region was first settled in the early 1820s and produces a range of grain and livestock products including food grains, feed grains, wool, mutton, lamb and beef. However, management emphasis has shifted since first settlement mainly between sheep and wheat production depending on changing market conditions, government policy, new technology and establishment of infrastructure.

A majority of the agricultural land in the region is used for dryland agricultural activities but irrigation activities make a major contribution to the region's agricultural production. The focus of this report is on the dryland farms in the central west.

2.2 Sources of information

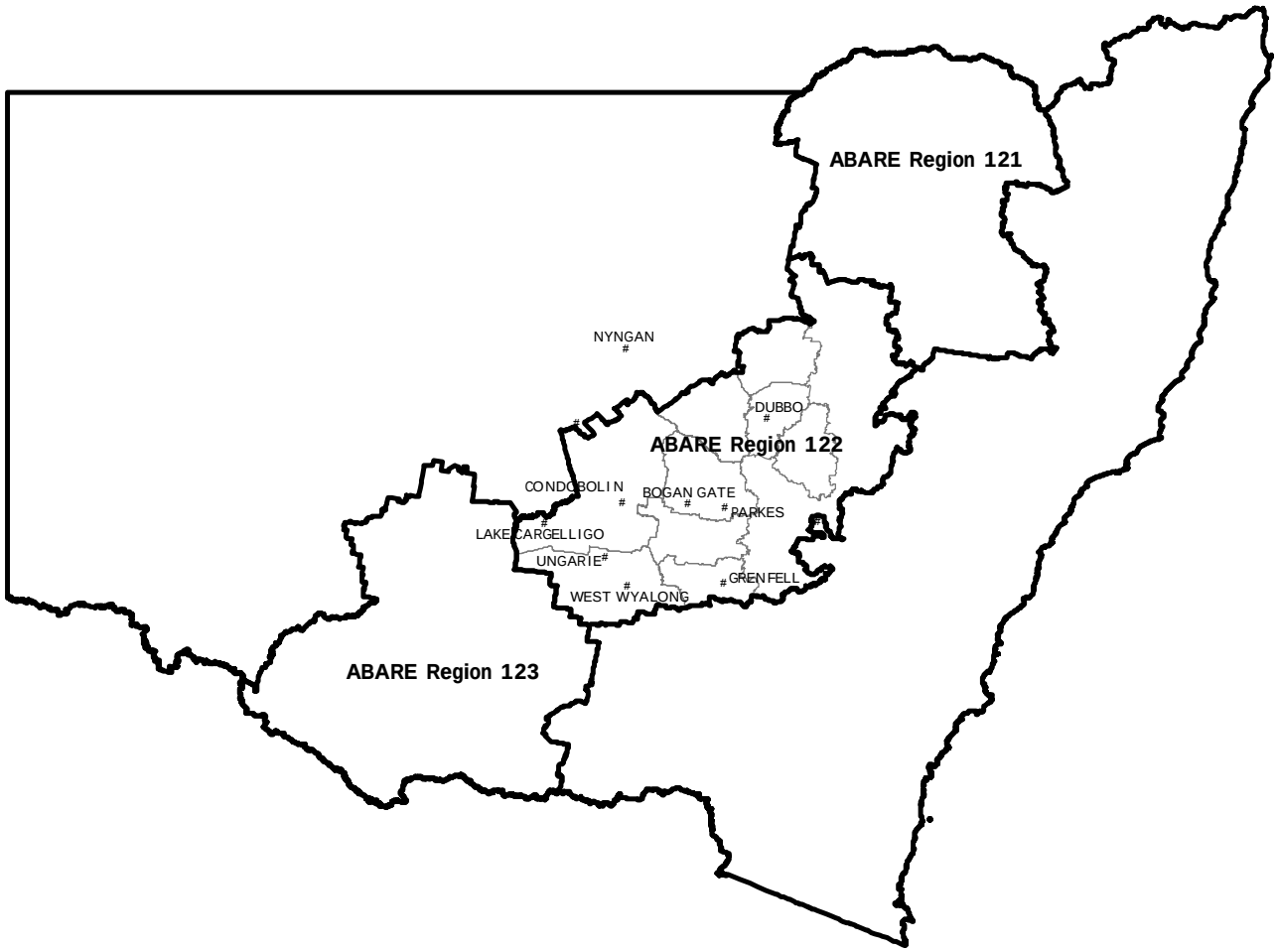
Typically, population data from the Australian Bureau of Agricultural and Resource Economics (ABARE) and the Australian Bureau of Statistics (ABS) survey statistics form the basis for constructing representative farm models. In addition to these sources, which are spelled out in the text, a small group of farmers and extension staff from NSW Agriculture were consulted about the characteristics of typical farms and the important economic issues faced by farms and farmers in the region. The group of farmers, based around the Condobolin district, assisted by providing insights into the characteristics of and issues affecting farms in south west of the Central West bounded by Bogan Gate in the east, Euabalong in the west, Ungarie in the south and Bobadah in the North.

2.3 Common Enterprises

Common cropping enterprises adopted on farms in the Central West include, bread wheat, barley, oats, canola, triticale and pulse crops such as lupins and field peas. Less common cropping enterprises include chickpeas, fababeans, durum wheat, safflower, linseed and opportunity seed harvesting and hay production from clover and lucerne pasture. There are a number of specialist seed growers for various winter crops. Very few dryland summer crops are grown in the region.

Wheat and canola are the primary crops grown following a pasture phase, usually in a long fallow situation. Long fallow typically starts with a chemical spray or mechanical cultivation in spring, 8 to 10 months before planting. This technique allows moisture to be stored, seedbed preparation to be carried out and problem weeds such as barley grass and saffron thistle to be controlled before they flower and set seed. Farms in the east of the Central West would normally consecutively crop during a cropping phase, whereas farms in the west might utilise long fallow for each crop in a cropping phase. Pastures are normally undersown with the last crop in the cropping phase, usually a cereal.

Figure 2.1: The Central West Region, Selected LGAs in Region 122.



Source: NSW Agriculture.

Common livestock enterprises include sheep for wool production, merino ewes and wethers, and cattle for yearling and bullock beef production. Less common livestock enterprises include store first cross lamb production, lamb and mutton trading, vealer production, beef feedlot backgrounding and cattle trading. These enterprises are usually undertaken opportunistically, when buying and selling thresholds are reached. Some farmers who have sheep for wool production also join cast-for-age ewes to either a dorset or border leicester ram to produce first cross store lambs or replacement breeders for second cross lamb producers. There are a number of sheep and cattle studs and some second cross lamb producers in the region.

Although farms may adopt similar enterprises, performance varies between farms depending on the farmer's management skills. Those skills are reflected in choices of breed, bloodline, joining times, tillage technique, sowing date, fertiliser application, and weed and disease control. Some typical gross margins for the most common crop and livestock enterprises, including long fallow (LF) wheat, short fallow (SF) wheat, barley, 21 micron wool, and yearling cattle are presented in Appendix C.

2.4 Farming Systems in the Central West

The combination of enterprises adopted on farms in the Central West is influenced not only by their profitability but also by farmers' skills (eg animal husbandry, mechanical), their perception about the future, their experience, attitude to risk, culture (family influence), proportion of arable and non-arable land, the quantity and quality of information available and the interactions between enterprises.

Farms in the Central West have traditionally adopted a mixed farming system incorporating both cropping and livestock. However, a wide variety of farming systems are adopted. At one extreme there are farms with only livestock whereas at the other extreme some farms intensively crop and exclude livestock.

Farms that adopt a traditional mixed cropping and livestock farming system typically base cropping activities around wheat production. The primary purpose is to produce high protein bread wheat, sold into the domestic and world markets. Additional cropping activities including malt and feed barley and feed oats are usually grown when the soil fertility status is low, also allowing grain reserves to be replenished. Livestock production has traditionally been based around a self-replacing merino ewe flock and/or wether enterprise. Wool prices have been low since the demise of the wool reserve price scheme in the early 1990s, and financial pressure has forced landholders to shift away from woolgrowing towards cattle and sheep for meat production.

Farms that are dominated by livestock activities may sow barley or oats crops for grazing or grain recovery. Cropping phases tend to be as short as two years and only a small proportion of the farm is under crop at any one time. These farms would typically sow or manipulate grazing management to promote perennial grass based pastures, which might be maintained for 10-15 years. Paddocks with native pastures are not intermittently cropped but rather manipulated through grazing management.

Farms that are dominated by cropping activities and do not include livestock tend to adopt reduced tillage farming practices and make good use of rotation crops such as pulses and oilseeds. Opportunity cropping based on the amount of stored moisture and paddock history, rather than fixed rotations are more common on these farms. In some areas summer crops have been tried. Some farms use continuous cropping whereas others may still incorporate a lucerne and/or clover pasture phase which may remain ungrazed.

Livestock-only and crop-only farms make up only a small proportion of all farms in the Central West. Most farms are mixed with large variation between farms in this category. The remainder of this report concentrates on the mixed livestock/crop farms in the region.

2.5 Key Management Issues

Important issues identified by farmers and extension specialists in the region include low farm business profit, low business equity, land degradation, and limited economic information to assist in making decisions about complex management problems.

The major issue is that, on average, farms in the Central West return low farm business profits. This is supported by ABARE survey data presented in Table 2.1. Factors thought to affect farm business profit include commodity prices, business equity, ability to maximise returns in good years, marketing skills and attitude to issues such as borrowing, marketing and change. Profit is highly variable between farms as evidenced by the large standard errors for farm business profit reported in Table 2.1. Therefore, some farms and farmers have been highly profitable, whether by good fortune or good management, in a period of relatively low commodity prices.

Table 2.1: Selected financial estimates, Region 122(a), Region 121 and Region 123, 1997/98

Financial estimates	Region 122 (a) (Central West)	Region 121 (North)	Region 123 (South)
Farm business profit (less depreciation, operator labour)	$416 (2166)	$31,736 (35)	$3,530 (232)
Rate of return excluding capital apprec. %	1.9 (52)	3.4 (19)	1.6 (43)
Equity ratio at 30 June %	78.8 (7)	86.9 (4)	86.9 (2)

Region 122 (a) – excluding Coonabarabran, Coolah, Mudgee, Cabonne, and Cowra LGA's.
( ) – relative standard errors
Region 121 – Barraba, Bingara, Gunnedah, Inverell (part), Manilla, Moree plains, Narrabri, Nundle, Parry, Quirindi, Tamworth and Yallaroi LGA's.
Region 123 – Berrigan, Carrathool, Conargo, Corowa, Deniliquin, Griffith, Hay, Jerilderie, Leeton, Murray NSW, Murrumbidgee, Narrandera, Urana, Wakool, Windouran LGA's.
Source: ABARE (1999).

During the 1990s, income was primarily derived from cropping, and farm business profit appeared to be highly correlated with the ability to produce high protein wheat. Factors that affect wheat quality include cropping history leading to fertility decline (farms east of Condobolin have a longer and more intense cropping history than farms in the west), timing of operation, management of the pasture phase, and rate of fertiliser application, both nitrogen and phosphorus. Farms located in the east of the region are less likely to produce prime hard (PH) wheat which, in addition to the above factors is also a function of the relatively cooler and moister conditions during the ripening period, "softer finish".

An additional issue related to low farm business profit is low business equity. As a consequence of low equity levels, farmers are constrained in their ability to invest in new technology and may be reluctant to adopt alternative management practices with which they have limited experience. Viability in the short-term is dependent on generating short-term cash flows. The 'problem' is that management practices employed to generate short-term cash flows may differ from management practices considered sustainable in the long term. These desirable practices include investments in pasture establishment and reduced tillage technology, applying additional inputs to pastures, incorporating alternative crops to cereals

into crop rotations and resting paddocks from grazing. Although most are practised to some degree, many are not applied to the extent which most farmers consider desirable.

Land degradation, particularly soil fertility decline, is considered a significant issue for all farms in the Central West, but especially on farms that continuously crop cereals or do not establish perennial legume based pastures. Soil acidification is considered an important problem already impacting farm productivity in the Central West. Other forms of land degradation, for example soil erosion, are being addressed through adoption of stubble retention practices, late stubble burning, etc, but the extent of adoption has been mixed.

Another issue, mainly affecting farms to the north west of Condobolin, is the clearing restrictions imposed by native vegetation legislation. For these farms, characterised by higher proportions of uncleared timber, opportunities for additional cropping and pasture improvement are limited. At recent low wool returns these farms are experiencing low farm cash income and equity levels which limits their adjustment into the currently more profitable livestock enterprises such as beef cattle.

Economic information to assist landholders evaluate the issues as outlined, and future consequences of alternative management strategies, is also limited. This report will contribute economic information likely to be valuable in assessing farming options, and will provide a framework for analysis of alternative systems and technologies.

3. Representative Farm Model

3.1 How was it developed?

In statistical terms, the Central West region can be described according to the statistical local areas (SLAs) used by the ABARE or the local government area (LGAs or shires) used by the ABS. SLAs in the Region are large relative to LGAs. For example Region 122 incorporates the local government areas (LGA) of Bland, Cabonne (part), Coolah, Coonabarabran, Cowra, Dubbo, Forbes, Gilgandra, Lachlan, Mudgee, Narromine, Parkes, Weddin, and Wellington. Detailed data are available for farm financial and physical characteristics but high relative standard errors prevent reliable estimates being derived for individual LGA's within the SLA (Appendix A).

Data collected on an LGA basis by the ABS include various physical estimates such as farm size, area of crop sown, numbers of livestock, commodity prices etc. The advantage over ABARE data is that more farms are surveyed allowing some interregional differences in farms to be detected but the disadvantage is that there is insufficient detail to describe a representative farm. Appendix B provides some of the ABS data for the Central West.

Data provided from both the ABARE and the ABS typically form the basis for constructing representative farm models. However, as has been identified above, these data alone do not provide sufficient detail about the production system at the farm level to allow the development of representative farm models for use in economic analyses of farming system issues.

To gather the level of detail required, discussions were held with a small group of farmers and extension staff from NSW Agriculture. The aim of discussions with the group was to collect details about the farming system, which together with ABARE and ABS statistics would assist in the development whole-farm budgets for representative farms. The group of farmers, based around the Condobolin district (Lachlan LGA), assisted by providing insights into the characteristics of farms in south west of the Central West.

This group determined that representative farm models would be required for both the east and west of the Central West. Characteristics which make them different include size of holding, amount of rainfall and carrying capacities.

3.2 Physical and economic resources available

ABS data suggests that farms in the west are on average larger than farms in the east. Table 3.1 shows that farms in the east average less than 900 hectares whereas farms in west average more than 1900 hectares, with those in the Lachlan LGA averaging 2500 hectares. In discussion about the Lachlan LGA, local farmers and extension staff from NSW Agriculture suggested that farms east of Condobolin would average approximately 1500 hectares, whereas farms west of Condobolin would average approximately 5000 hectares, with large variation in farm size in both portions. As many of the farm and farming systems details were provided by these farmers and extension staff, it was decided that their farm size estimates would be used for the representative farms east and west rather than the ABS average.

Table 3.1: Variation in farm size by local government area, 1999.

Local Government Area	Average area per holding (ha)	Annual Rainfall	
		Median (mm)	Co-efficient of Variation[a] (%)
East			
Weddin – Grenfell	779	624	28
Parkes	901	564	31
Forbes	892	511	30
West			
Bland – West Wyalong	1283	456	28
Lachlan – Condobolin	2544	437	32

[a] Coefficient of variation equals the standard deviation divided by the mean.
Source: ABS 1999, Clewett *et al.* 1999.

Rainfall data, analysed using Australian Rainman (Clewett *et al.* 1999) and presented in Table 3.1, show that farms in the west of the region receive a lower annual median rainfall than farms in the east. However, using the coefficient of variation as a measure of rainfall reliability, little difference is detected between the farms in the east and farms in the west. This conclusion remained unchanged when analysing annual rainfall, seasonal rainfall and growing season rainfall. One exception was summer rainfall, where farms in the west consistently received less reliable rainfall than did farms in the east.

These differences in rainfall are not expected to limit the cropping options available to farms in the west but it is considered that cropping is more risky in the west. Cereals dominate the cropping phase on farms in both the east and west.

Although soil and landscape types varied, sometimes within paddocks, they are broadly homogenous across the region and are not expected to limit enterprise choices. Farms are generally 90% cleared, apart from shelterbelts and some hilly portions. The exception is farms to the north-west of Condobolin where less clearing has occurred resulting in less cropping and pasture improvement options.

Farmers mentioned that labour, although not considered a major limiting factor, was a problem when specific skills, operating precision and attention to detail were required such as at sowing and harvest, for example. Some form of casual or permanent labour is employed on most farms in the Central West.

Farmers also mentioned that farms have limited capital resources available. Statistics collected by the ABARE show that when compared to farms in the northern and southern cropping zones of NSW, the Central West is characterised by low equity ratios and low farm business profits (Table 2.1). This has implications for further investment in and adoption of new technology and practices.

3.3 Enterprise combination, farming system and crop rotation

Farms in the east have longer cropping histories, usually adopt more intensive cropping programs, have shorter pasture phases and run higher stocking rates than farms in the west of the region. Tables 3.2 and 3.3 present the characteristics of farms in the east and west respectively. Livestock were considered an important component of most farming systems in the region and unlike farming systems in northern NSW (Farquharson and Scott 2000) there is a high level of interaction between livestock and cropping enterprises interact (for example

livestock are used for fallow weed control). The primary livestock enterprise is sheep but cattle are increasing in importance.

Table 3.2: Characteristics of a typical farm east of Condobolin

Characteristics	Description
Farm area	1000 to 2000 ha – Generally smaller as progress east
Title	Freehold
Cropping options	Wheat (AH – some PH after lucerne), Barley, Oats Pulse crops – option but lower profitability as move west Oilseeds – Canola, Mustard
Pasture phase	3 – 4 years
Cropping phase	2 – 4 years, high proportion of cereals, consecutive crops
Typical rotation	4 years pasture – long fallow wheat/canola – short fallow wheat – short fallow barley undersown (8 years)
Problems	Long cropping history has led to soil fertility decline and reduction in pH. Land value increase has led to low return to capital.

Farms in the east tend to employ pasture phases of 3-4 years in length. Pastures are generally undersown with the last crop in the cropping phase, usually a cereal. Opening crops in the crop phase are usually long fallow wheat or canola. Long fallow commences with either a spray or cultivation in August/September. Crop options include Australian Hard wheat (AH), barley, oats, canola, peas and lupins. Combinations of these crops are grown usually in consecutive years in a cropping phase that lasts between 3-5 years. Farms are predominantly cleared of standing vegetation, however there is usually scattered timber and some shelter belts.

In this report it is assumed that pastures in rotation with crops are improved, generally being lucerne or clover dominant. Recent pasture composition surveys conducted in the Central West both support and challenge this assumption. Roesner *et al.* (1998) concluded that legume dominant pastures only make up 28% of the paddocks sampled whereas Bowman (2001) suggests that 68% of survey points are made up of lucerne based pasture. Whatever the outcome, a significant portion of pastures in the Central West is not legume based and hence has not been considered in this report.

Farms in the west tend to employ longer pasture phases of 5-7 years in length. Perennial grass based pastures may last for 10-15 years. Lucerne pastures are generally adopted in rotation with crops. Crop options include wheat (PH), barley, oats and canola. Pulses and in some cases, canola, are considered marginal in this region. Crops tend to be grown on long fallow throughout the cropping phase often dominated by cereals, for example two wheat crops in 4 years with the second wheat crop being undersown with pasture. Stocking rates are lower than for farms in the east.

Table 3.3: Characteristics of a typical farm west of Condobolin

Characteristics	Description
Farm size	2500 to 5000 ha – Generally larger as progress west
Title	Freehold, but some Western Lands Lease
Cropping options	Wheat (PH on long fallow), Barley, Oats Pulse crops – considered risky and low profitability Oilseeds – Canola considered risky
Pasture phase	5 – 7 years
Cropping phase	2 – 4 years, high proportion of cereals, mainly long fallow crops
Typical rotation	6 years pasture – long fallow wheat – long fallow wheat undersown (9 years)
Problems	Clearing restrictions have restricted more profitable cropping and pasture improvement options for some farms.

3.4 Whole-farm budgets

3.4.1 Basis of whole-farm budgets

Whole-farm budgets for representative farms in the east and west of the region have been prepared. The whole-farm budgets have two components: a statement of assets and liabilities, and an annual operating budget.

The statement of assets and liabilities provides information about the capital value of the farm business, for example the value of land, machinery, stock on hand, cash and the owners equity as a percentage of the capital value. Equity is one measure of the health of a business and its ability to finance new investments.

The annual operating budget is a snapshot of the mix of enterprises within one year on the representative farm and their individual contribution to the cash surplus for that year. Little is to be gained by comparing individual enterprises using these figures, as interactions between enterprises are not obvious. For instance, the cost of pasture establishment and maintenance to the farm is recognised as a cost but the benefits to the crop and livestock activities are not identified separately. However, the combined returns from all enterprises can be used to calculate a business return on capital, a measure of capital use efficiency. The business return is useful for comparing alternative uses of capital (Makeham and Malcolm 1993).

For both representative farm models, reduced tillage techniques are practised in the cropping phase. This influences the characteristics of machinery investment and variable cost of crop establishment. The models are based on a particular combination of livestock and cropping enterprises. As will be shown in the next section, they can be adjusted for quick and informative insights into the economic consequences of alternative enterprise combinations, adjusting resource constraints and investing in new technologies. Price assumptions are presented in Table 3.4.

Table 3.4: Commodity price assumptions used in analysis

Commodity	Grade	Price $/t on-farm
Wheat	PH	150
	AH	135
	APW	125
	ASW	120
Barley	Feed	110
Oats	Feed	90
Canola		300
Lupins		170
		c/kg clean
Wool price		640

3.4.2 Whole-farm budget for Central West: East

Table 3.5 presents the statement of assets and liabilities for the representative farm in the east of the Central West. This statement provides indicators of the market value of current assets and existing debt. The value of land and stock, the amount invested in machinery and other plant, and the level of debt in the form of an overdraft, term loans and other loans have been based on estimates for a typical farm. These assumptions are based on discussions with the farmer groups, extension staff and observations on markets for agricultural assets. It should be noted that there is large variability between farms with regard to these assumptions.

The proportion of owner's equity in the total farm assets is referred to as the equity percentage. In this example, the equity percentage is 77% of capital value. Lending institutions require security for additional lending so this percentage is important to determine the ability of a business to fund additional investments into new technology, property purchase, etc.

In Table 3.6, estimates of the individual enterprise gross margins, the overhead and operating costs of managing the farm, the operating cash surplus and return to equity for the representative farm in the east of the Central West are presented. In this example, 100% of the farm is arable and is involved in a seven year rotation, four years of pasture followed by a wheat-wheat-barley cropping phase. The area under long fallow wheat, for example, is one seventh of the 1500 ha or 214 ha returning an estimated gross margin of $171.92 per ha, contributing $36,840 to the total farm gross margin of $83,130. From the total gross margin the operating and overhead costs are deducted to determine the farm operating cash surplus ($10,430) and business return on equity (1.5%).

Tables 3.5 and 3.6 present a picture of the farm's current financial performance. These figures suggest that business returns provided sufficient funds to meet all variable and overhead costs associated with operating the farm while maintaining its assets (depreciation) and meeting interest payments. However, the remaining funds (operating cash surplus) still need to meet the owner's personal living expenses, debt repayments and off-farm investments. In this case, $10,430 is unlikely to cover personal living expenses alone, threatening the long-term viability of the current farming system if these levels are maintained.

Table 3.5: Whole-farm budgets: Representative farm for Central West – East: Statement of Assets and Liabilities

Statement of Assets and Liabilities

ASSETS					
Land	1500	hectares @	$370 per hectare	$555,000	
Total value of land					$555,000
Livestock	1048	ewes @	$30 per ewe	$31,440	
	451	ewe hoggets @	$20 per hogget	$9,020	
	21	rams @	$200 per ram	$4,200	
	450	wethers	$25 per wether	$11,250	
Total value of livestock					$55,910
Plant and Equipment					
		Machinery (Average value)			
		Tractor		$130,000	
		Implements		$85,000	
		Vehicles (car, ute, truck)		$40,000	
		Other (auger, motorbike, wool press, etc.)		$40,000	
Total value of plant and equipment					$295,000
TOTAL ASSETS					**$905,910**
LIABILITIES					
		Overdraft (Max. $60,000)		$20,000	
		Term Loans		$150,000	
		Other loans		$42,000	
					$212,000
TOTAL LIABILITIES					**$212,000**
Equity (Assets - Liabilities)					$693,910
Equity percentage (Equity / total assets)					77%

Table 3.6: Whole-farm budgets: Representative farm for Central West – East: Annual Operating Budget

Annual Operating Budget

1500	ha	Total farm	
7		Rotation years	
Enterprise Gross Margin (P P P F W W B)			
214	ha	Long Fallow Wheat after pasture	$171.92	$36,840
214	ha	Short Fallow Wheat	$101.87	$21,829
214	ha	Short Fallow Barley	$22.96	$4,920
214	ha	Pasture establishment	-$26.50	-$5,679
1048		Ewes	$20.29	$21,264
450		Wethers	$8.79	$3,956
		Total Farm Gross Margin:		$83,130
Overhead Costs				
		Casual wages	$6,000	
		Rates	$2,500	
		Registration	$3,000	
		Insurance (vehicle, building)	$1,500	
		Other R&M (fencing, tools, pumps, etc)	$1,500	
		Other fuel costs	$2,500	
		Other (elect., phone)	$5,000	
		Total Overhead Costs:		$22,000
Farm Cash Income				**$61,130**
Operating Costs				
		Depreciation @ 10% of value of plant and equipment	$29,500	
		Interest	$21,200	
		Operator and family labour	$0	
Farm Operating Surplus				**$10,430**
Business return on Owners Equity				**1.5%**

3.4.3 Whole-farm budget for Central West: West

In Table 3.7, the statement of assets and liabilities for the representative farm in the western portion of the Central West is presented. For this representative farm sheep and cattle enterprises are run primarily as a self-replacing flock and herd respectively.

Table 3.7: Whole-farm budgets: Representative farm for Central West – West: Statement of Assets and Liabilities

Statement of Assets and Liabilities

ASSETS					
Land	8000 hectares @	$190 per hectare	$1,520,000		
	Total value of land				$1,520,000
Livestock	1600 ewes @	$30 per ewe	$48,000		
	160 ewe hoggets @	$20 per hogget	$3,200		
	32 rams @	$200 per ram	$6,400		
	133 cows @	$500 per cow	$66,667		
	13 heifers @	$400 per heifer	$5,333		
	3 bulls @	$2,000 per bull	$6,000		
	Total value of livestock				$135,600
Plant and Equipment					
	Machinery (Average value)				
	Tractor			$200,000	
	Implements			$150,000	
	Vehicles (car, ute, truck)			$60,000	
	Other (auger, motorbike, wool press, etc.)			$140,000	
	Total value of plant and equipment				$550,000
Cash					$10,000
TOTAL ASSETS					**$2,215,600**
LIABILITIES					
	Overdraft (limit $120,000)			$100,000	
	Term Loans			$250,000	
	Other loans			$50,000	
					$400,000
TOTAL LIABILITIES					**$400,000**
Equity (Assets - Liabilities)					$1,815,600
Equity percentage (Equity / total assets)					82%

Table 3.8 presents the annual operating budget for the representative farm in the west of the Central West. In this case only 56% of the total farm area is suitable for cropping hence the six year rotation refers to that area. The remaining land is extensively grazed. Gross margin returns per hectare for the cropping enterprises are lower than in the east however livestock returns per head are similar. The farm cash operating surplus is $67,818 and the business return on owner's equity is 3.7%.

Table 3.8: Whole-farm budgets: Representative farm for Central West – West: Annual Operating Budget

Annual Operating Budget			
8000	ha	Total farm	
4500	ha	Area arable	
6		Rotation years	
Enterprise Gross Margin (P P P P/F W B)			
750	ha	Long Fallow Wheat	$149.62 $112,215
750	ha	Short Fallow Barley	$31.03 $23,273
750	ha	Pasture (undersown with barley)	-$26.40 -$19,800
1600		Ewes	$20.29 $32,464
133		Cattle	$350.00 $46,667
		Total Farm Gross Margin:	$194,818
Overhead Costs			
		Casual wages	$8,000
		Rates	$6,300
		Registration	$3,000
		Insurance (vehicle, building)	$1,200
		Other R&M (fencing, tools, pumps, etc)	$4,000
		Other fuel costs	$3,500
		Other (elect., phone)	$6,000
		Total Overhead Costs:	$32,000
Farm Cash Income			**$162,818**
Operating Costs			
		Depreciation @ 10% of value of plant and equipment	$55,000
		Interest	$40,000
		Operator and family labour	$0
Farm Operating Surplus			**$67,818**
Business return on Owners Equity			**3.7%**

A comparison of Tables 3.6 and 3.8 reveals that farms west of Condobolin return a greater total gross margin, incur higher overhead and operating costs, and still return a higher farm operating cash surplus and business return on equity than farms east of Condobolin. This result was forecast in discussions with farmers. Although the returns per hectare for crop production reduce from east to west as a result of lower annual rainfall influencing yield, the reduction in land value reduces at a disproportionately higher rate. In addition, overhead costs increase disproportionately. The analysis in this report does not compare the viability of farming in the east versus the viability of farming in the west. To do that, more sophisticated techniques than those applied in this report which relies on expected values for important variables such as stocking rate, price and yield are needed.

4. Analysis of the Role of Pastures in Mixed Livestock/Crop Systems

An important question being asked by landholders in the Central West relates to the role of pasture in farming systems in the Central West, considering that the returns from livestock are low when compared with those from cropping. For example, Tables 3.6 and 3.8 suggest that crop income accounts for 70 % and 60 % respectively of the total gross margin but utilises only 43 % and 19 % respectively of the farm. Considering that both farms are characterised by a low operating cash surplus, in many cases leaving little to cover personal living expenses, there is significant pressure to raise farm profitability. A likely conclusion when analysing these figures would be to increase the area under crop.

The dilemma for landholders is that increasing the proportion of land under crop reduces the proportion of land under pasture, and the expectation is that reducing the length of the pasture phase will eventually have an adverse impact on crop yields and returns. Although this is essentially a private (or individual-farm) decision, the outcomes may also have significant public (or society) consequences with respect to issues such as accessions to groundwater.

Therefore, the ability to evaluate the financial consequences of a change in the length of the pasture phase will not only assist landholders make an informed decision but will also provide Government agencies with a tool to determine the likely farm-level consequences of alternative natural resource management policy options, and hence the likelihood of these options being adopted by farmers.

4.1 The decision problem

The issue for landholders is that in a period of poor returns from the dominant livestock enterprise, sheep for wool production, whether the length of pasture phase should be reduced and/or the length of crop phase be increased to increase profitability. In some cases continuous cropping strategies are being adopted. Analysis using whole-farm models, such as those developed in this report, in conjunction with more sophisticated models such as PRISM Condobolin, has allowed this issue to be at least partially evaluated.

The issue for society is that if shorter pasture phases are more profitable, their adoption, reasonable from the viewpoint of farmers, may be at a cost to society in the long run if the consequences of the land degradation that follows are borne by others. A potential for market failure arises where the objectives of society differ to that of the individual. Therefore this type of analysis can provide insights into the likely financial outcomes at the farm level of various farming practices and alternative natural resource management policies which may have better environmental outcomes.

4.2 Method of analysis

In addition to the whole-farm models developed above, this analysis applies a more sophisticated linear programming (LP) model, PRISM Condobolin (Faour *et al.* 1999) developed for the Central West of NSW, to determine the optimal length of pasture. The LP model is able to compare a combination of enterprises or rotation with an alternative combination of enterprises or rotation. The optimal solution being the rotation that satisfies all the constraints imposed, such as land, labour and capital limitations, and the profit objective is maximised. Having characteristics similar to the model farm developed to represent farms east of Condobolin, PRISM Condobolin specifically relates to farms in the east of the Central West but the insights are relevant to the much wider region.

PRISM Condobolin has 52 mixed crop and livestock rotations represented, which are of interest to landholders in the Central West. In all cases rotations are made up of both a pasture phase and a crop phase. The length of the pasture phase may be as short as 2 years or as long as 6 years whereas the length of crop phase can as short as 1 year or as long as 5 years. For example, a six year rotation might have 2 years of pasture followed by 4 years of crop or alternatively 5 years of pasture and 1 year of crop. In addition whole rotations can be as short as 4 years or as long as 11 years. Crop options include wheat, canola, lupins, barley and oats and livestock options include merino wethers, self-replacing merino ewes and a first cross lamb enterprise. A mixed pasture sward of lucerne, rose clover and annual medics is assumed in all rotations, being undersown with the last crop in the cropping phase.

By applying LP techniques important interactions between enterprises can be captured in detailed biological and economic functions for each rotation. Some of the interactions that we would like to be able to represent in the model include: the trade-off between the length of pasture and the amount of nitrogen fixed; the resultant crop yield and quality; changes in labour requirement; livestock numbers and length of pasture phase; returns to scale from capital equipment (woolshed and machinery); and fertility decline, disease build-up and potential weed herbicide resistance build-up during the cropping phases.

There are many well-documented examples where LP models have been successfully applied (Pannell 1997, Kingwell and Pannell 1987). It is not the intention of this report to explain LP in great depth. However, it is important that the results are interpreted with an understanding of the limitations of the methodology.

One aspect of this type of analysis is the use of expected values for input prices and rotation interactions. In reality, commodity price and many of these interactions are uncertain. For example future commodity prices are a function of future supply and demand which will be determined by unknowable future events such as drought and floods. Future crop yields and the amount of nitrogen fixed by lucerne are uncertain, responding to unknowable seasonal fluctuations. Pannell (1997) provides a more detailed discussion of the assumptions and limitations of LP techniques.

Sensitivity analysis was applied to partially assess the robustness of the optimal length of pasture for changes in wheat and canola price. In addition to changing cereal and canola prices, the sensitivity of the optimal length of pasture phase was tested for increases in livestock returns and adopting a new wheat variety that converts rainfall to grain more efficiently. In the case of increased livestock returns, wool prices were increased from 640c/kg to 770c/kg (20% increase) and 895c/kg (40% increase). In the case of adopting a new wheat variety, the water use efficiency of converting effective rainfall to yield increased from 20kg/mm rainfall to 30kg/mm (50% increase) and 40kg/mm (100% increase). These additional analyses are included to test the sensitivity of optimal rotations for changes in factors, albeit optimistic in some cases, other than grain prices.

This analysis has not attempted to assess the dynamic implications of adopting particular rotations which are likely to change a resource over time. For example, a rotation with a short pasture phase, say 2 years, followed by a long cropping phase, say three years, dominated by a cereal monoculture may never be in a state of static equilibrium. The benefits associated with the pasture phase such as building soil structure, building soil organic matter and drying down water tables may be outweighed by the costs incurred in the cropping phase such as disease buildup, herbicide resistance, fertility decline and groundwater accessions. Therefore, the results should be considered as an indication of the likely outcomes rather than a definitive prescription for land managers and a forecast of producer behaviour.

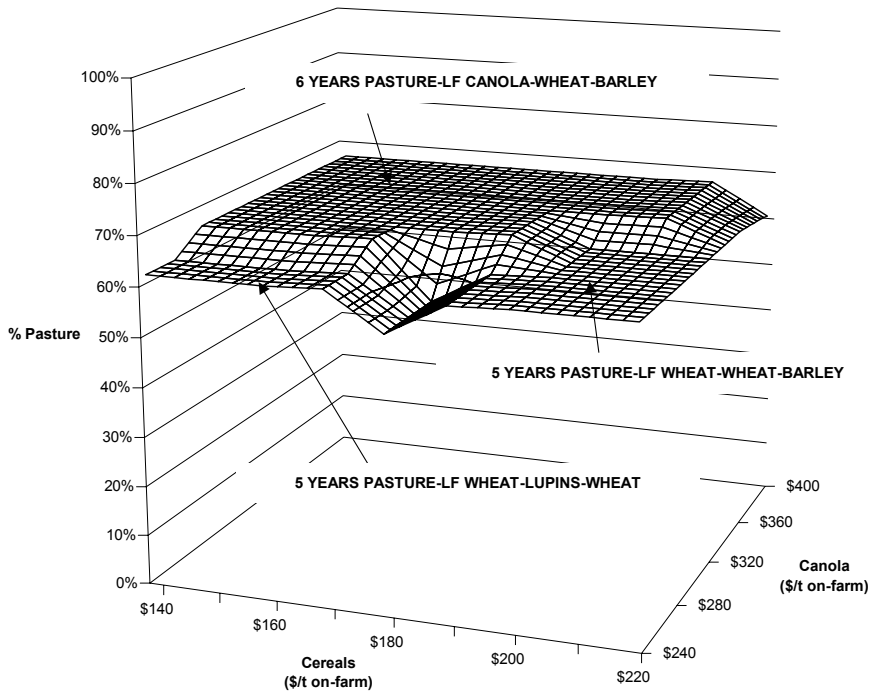
4.3 Results

Based on expected values, presented in Table 3.4, PRISM Condobolin selected 6PCaWB (6 years of pasture followed by canola-wheat-barley) as the optimal rotation from the 52 available. The robustness of this rotation can be measured, in this case, for changing cereal and canola prices, changing wool prices and increased crop yields.

4.3.1 Results for changing cereal prices using PRISM Condobolin

The optimal rotations for a range of PH wheat and canola prices are presented in Figure 4.1. Each square represents a point relating to the area of pasture as a percentage of the whole-farm in the optimal solution, represented on the vertical axis, for a particular combination of wheat and canola price. For example, if the wheat price is $160/t on-farm and the canola price is $240/t on-farm, the optimal rotation is 5PWLW (5 years of pasture followed by wheat-lupins-wheat). Being an eight-year rotation, of which five years is pasture, 62.5% of the farm is under pasture at any one time.

Figure 4.1: Optimal area of pasture as a % of whole-farm (1500 ha) for changing cereal and canola prices



Where there is a flat surface the area of pasture hence rotation in the optimal solution is unchanged for prices in that range. Therefore the rotation is robust for the price changes bounded by the flat surface. For example, the 5PWLW (5 years of pasture followed by wheat-lupins-wheat) rotation is optimal for wheat prices between $140 and $170/t on-farm and canola prices below $260/t on-farm. However if canola price rose to above $260/t on-farm and wheat price stayed at $160/t on-farm then the six years of pasture canola-wheat-barley rotation is optimal. The important point to note is that although the crops in the cropping

phase change in response to their relative profitability, a pasture of five to six years in length is robust for all price combinations tested.

4.3.2 Results for changing cereal prices using whole-farm budgets

The whole-farm budget presented in Table 3.6 can be used to present similar results in more detail. Table 4.1 presents whole-farm budgets for four rotations using the current expected values, presented in Table 3.4.

Table 4.1: Whole-farm budgets for alternative rotations, PH Wheat $150/t.

Annual Operating Budget

1500 ha Total farm

Enterprise Gross Margin:	**5PWWB**	**3PWWB**	**5PWLW**	**3PWLW**
Long Fallow Canola	$0	$0	$0	$0
Long Fallow Wheat	$34,523	$33,318	$34,523	$33,318
Short Fallow Wheat - After Cereal	$21,939	$6,189	$0	$0
Short Fallow Wheat - After Canola	$0	$0	$0	$0
Short Fallow Wheat - After Lupins	$0	$0	$22,387	$19,461
Barley	$4,683	-$1,006	$0	$0
Lupins	$0	$0	$11,456	$15,275
Pasture Establishment	-$4,969	-$6,625	-$4,969	-$6,625
Ewes	$24,936	$13,087	$24,936	$0
Wethers	$4,500	$0	$4,500	$18,292
Total Farm Gross Margin:	$85,612	$44,963	$92,834	$79,721
Overhead Costs				
Casual wages				
Rates				
Registration				
Insurance (vehicle, building)				
Other R&M (fencing, tools, pumps, etc)				
Other fuel costs				
Other (elect., phone)				
Total Overhead Costs:	$22,104	$24,568	$22,104	$24,568
Farm Cash Income	**$63,508**	**$20,395**	**$70,730**	**$55,153**
Operating Costs				
Depreciation				
Interest				
Operator and family labour	**$50,700**	**$50,700**	**$50,700**	**$50,700**
Farm Operating Surplus	**$12,808**	**-$30,305**	**$20,030**	**$4,453**
Business return on Owners Equity	**1.8%**	**-4.3%**	**2.8%**	**0.6%**

5PWWB – (5 years of pasture followed by wheat-wheat-barley)
3PWWB – (3 years of pasture followed by wheat-wheat-barley)
5PWLW – (5 years of pasture followed by wheat-lupins-wheat)
3PWLW – (3 years of pasture followed by wheat-lupins-wheat)

Table 4.1 shows that the 5PWLW (5 years of pasture followed by wheat-lupins-wheat) rotation is the most profitable, returning an operating cash surplus of $20,030 and a return to owners equity of 2.9%. This is consistent with the findings concluded from Figure 4.1 using PRISM Condobolin. The important factors to consider when comparing these whole-farm budgets are the effect the length of pasture phase has on the returns in a cropping phase. Table 4.1 suggests that reducing the length of pasture from five years to three years may increase the area of land under crop but the total value of that crop is less, because of the interactions between crop yield and quality and the length of pasture.

Comparing results of the two rotations that have a wheat-wheat-barley crop phase with those from Table 3.6, shows that as the length of pasture decreases, these rotations become progressively less profitable. Along with the increased labour requirement and the reduced

livestock numbers, the reduction in yield and quality is not compensated for by the increase in crop area. For example, Table 4.1 shows a five-year pasture phase will return an operating cash surplus of $12,808, whereas Table 3.6 shows a four-year pasture phase would only return $10,430. This is despite the area of crop increasing from 563 ha to 642 ha. When the pasture phase is reduced to three years (Table 4.1) increasing the area of crop to 750ha, the return drops to -$30,305. This reinforces the perception that to be profitable farmers need to be producing high quality wheat, which in this case means maintaining the length of pasture phase of at least 4 years. It also demonstrates that interactions between pastures and crops are vitally important when evaluating alternative enterprises or rotations.

Table 4.2: Whole-farm budgets for alternative rotations, PH Wheat $200/t.

Annual Operating Budget

1500 ha Total farm

Enterprise Gross Margin:	**5PWWB**	**3PWWB**	**5PWLW**	**3PWLW**
Long Fallow Canola	$0	$0	$0	$0
Long Fallow Wheat	$54,491	$58,193	$54,491	$58,193
Short Fallow Wheat - After Cereal	$38,720	$23,814	$0	$0
Short Fallow Wheat - After Canola	$0	$0	$0	$0
Short Fallow Wheat - After Lupins	$0	$0	$36,543	$36,586
Barley	$17,714	$12,744	$0	$0
Lupins	$0	$0	$11,456	$15,275
Pasture Establishment	-$4,969	-$6,625	-$4,969	-$6,625
Ewes	$24,936	$13,087	$24,936	$0
Wethers	$4,500	$0	$4,500	$18,292
Total Farm Gross Margin:	$135,394	$101,213	$126,959	$121,721
Overhead Costs				
Casual wages				
Rates				
Registration				
Insurance (vehicle, building)				
Other R&M (fencing, tools, pumps, etc)				
Other fuel costs				
Other (elect., phone)				
Total Overhead Costs:	$22,104	$24,568	$22,104	$24,568
Farm Cash Income	**$113,290**	**$76,645**	**$104,855**	**$97,153**
Operating Costs				
Depreciation				
Interest				
Operator and family labour	**$50,700**	**$50,700**	**$50,700**	**$50,700**
Farm Operating Surplus	**$62,590**	**$25,945**	**$54,155**	**$46,453**
Business return on Owners Equity	**8.9%**	**3.7%**	**7.7%**	**6.6%**

5PWWB – (5 years of pasture followed by wheat-wheat-barley)
3PWWB – (3 years of pasture followed by wheat-wheat-barley)
5PWLW – (5 years of pasture followed by wheat-lupins-wheat)
3PWLW – (3 years of pasture followed by wheat-lupins-wheat)

Table 4.2 presents the whole-farm budgets for the same rotations but assumes that cereal prices rise to $200/t on-farm for PH wheat. In this case the most profitable rotation is now 5PWWB (5 years of pasture followed by wheat-wheat-barley). This is also consistent with the findings in Section 4.3.1 using PRISM Condobolin. Again, although the cropping phase may change in response to the relative profitability of alternative cropping enterprises, the optimal length of pasture phase remains unchanged.

4.3.3 Results for changing wool price using PRISM Condobolin

When wool price was increased from a base price of 640c/kg clean to 770c/kg clean, (a 20% increase for 21 micron wool) the sheep enterprise was more profitable but the optimal rotation remained unchanged. Increasing the wool price further to 895c/kg clean, (a 40% increase) on

the base price still did not alter the optimal solution. Rather, increasing the profitability of the sheep enterprise only further increased the overall profitability of the farm business, increasing the operating cash surplus by $27,000. Therefore, a five year pasture phase based on these assumptions is robust for most feasible changes in wool price.

4.3.4 Results for increasing the transpiration efficiency using PRISM Condobolin

When the transpiration efficiency of wheat (TE) was increased from 20kg/mm of effective rainfall to 30kg/mm of effective rainfall, the cropping phase changed from a wheat-lupins-wheat cropping phase to a wheat-wheat cropping phase in the optimal solution. This may have important implications for research and extension programs. Simplistically, the allocation of funds into wheat breeding research may actually influence the adoption of messages that promote the rotational benefits of pulse crops.

Further increasing the TE of wheat to 40kg/mm of effective rainfall changed the optimal solution to four-years of pasture followed by a wheat-wheat cropping phase. In this case the length of pasture reduced from five to four years with the cropping phase remaining unchanged. As with an increase in TE to 30kg/mm, increasing the TE to 40kg/mm resulted in the optimal area of wheat increasing (to 500ha) but this time as a result of reduced length of pasture rather than dropping lupins out of the cropping phase. It is interesting to note that even at these optimistic research outcomes, the optimal length of pasture phase was only reduced to four years. Clearly the costs associated with a shorter pasture phase in disease and nitrogen effects on crop yields, reduced numbers of livestock and increased labour requirements, are greater that the increases in yield as a result of a higher TEs and the increase in the area of wheat.

4.3.5 Discussion of Results

The objective of this report was to develop whole-farm budgets with the assistance of landholders and NSW extension staff that represent farms in the Central West of NSW and present an example of their application. They can only give an indication of the likely income consequences of altering enterprise mixes. Additional analysis may be warranted to test the sensitivity of these results to the variability between enterprises based on their individual production and price risks. For example, the characteristics of production and price for the wheat enterprises are different to those of the self-replacing merino ewe enterprise or the lupin enterprise.

As mentioned, these budgets are intended to provide a “snapshot” indication of the income consequences of before and after introducing a new technology, an alternative management system or an alternative enterprise. Many rotational changes involve a transition period, where the system takes time to adjust. More sophisticated analytical techniques are required to incorporate the adjustment phase.

There are difficulties when comparing before and after snapshots, as there is no firm biological evidence that all of the rotations considered are sustainable as is assumed for a rotation in static equilibrium. For instance, at high cereal prices a cereal monoculture is most profitable when compared to all other alternatives. Although reasonable from a profit maximising landholder perspective, this rotation may be at a net cost to society in the long run. For analyses that consider the social perspective, more sophisticated techniques should be applied.

Therefore, there are advantages with using whole-farm budgets for this type of analysis such as their speed and simplicity but there are also disadvantages which limit their use. These include the use of expected values for many risky variables, such as commodity price, and rotations assumed to be in static equilibrium. A rotation in static equilibrium assumes that this

rotation will always achieve the production estimates for yield and pasture growth, etc, through time. Although a partial evaluation of commodity price variability was conducted, the characteristics of price risks for all commodities were not included. Also research data for the biological relationships of all rotations are limited hence these results should be continually tested as new data become available.

5. Conclusions

The objectives of this report were to describe important farming systems in the Central West of NSW, to gain insights into current financial performance, and to examine how farm income might be affected by alternative enterprise combinations, introducing a new technology or an alternative management practice. Two representative whole-farm models were developed with the assistance of local farmers and NSW Agriculture extension staff, one representing farms in the east of the Central West and the other representing farms in the west of the Central West region. In addition, linear programming models were used to consider some interactions, such as the interactions between the length of pasture, livestock numbers, labour requirements and crop yields and quality, where necessary.

While it was recognised that significant variability exists between farming systems in the Central West, a majority of landholders adopt a mixture of livestock and cropping enterprises. However, a small proportion of farmers adopt crop-only or livestock-only activities. The focus of this report was on the mixed systems. These farming systems are characterised by livestock activities dominated by sheep for wool production (although cattle are increasing in importance) and wheat production in the cropping phase.

Whole-farm budgets developed for the two representative farms indicated that farm income would be insufficient to cover the cost of personal living expenses, let alone fund debt repayments or an investment in a new technology. Although expected income was higher for farms in the west, farmers felt that in may be more variable than in the east. This report did not attempt to validate that perception.

Possible reasons for low farm income include low commodity prices, low equity levels and inability to produce high quality wheat. In a quest to lift farm income, land managers seek the combination of enterprises that maximises profitability. As a majority of farm income, primarily from wheat production, comes from a relatively small proportion of the property, land managers see increasing cropping intensity as a one way of achieving this goal. However, farmers understand that enterprise choice decisions are complex, based not only on the profitability of individual enterprises but the availability of resources, such as land, labour and capital, the contributions to other enterprises, and farmers' own personal goals, objectives and perceptions about the future. Rather, questions are being asked of the role of pastures in these farming systems as the profitability of wool growing has been low relative to grain growing. More specifically, given low wool prices could farm income be increased by reducing the length of pasture phase resulting in an increased area of crop production? In addition, how might the optimal length of pasture change when considering that commodity markets fluctuate?

An analysis conducted using the whole-farm budgets concluded that at current enterprise performance and knowledge, a 5 years of legume-based pasture is desired. In addition, it was also determined that a pasture of 5 to 6 years is robust, that is the optimal length is unchanged for most currently feasible increases in wheat, canola and wool prices. It was only when large productivity increases were assumed, such as increasing the efficiency of crops converting moisture to grain, that the desired length of pasture reduced in length.

While many of the interactions between enterprises can be partially analysed using representative whole-farm models, the resources, interactions and objectives vary between farms and farmers. It is impossible to prescribe a mixture of enterprises that is optimal for all farms. However, analyses using representative farm models having characteristics similar to farms in the Central West can provide significant insights into types of enterprise combinations likely to be adopted by farmers. By sensitivity testing some variables, such as

commodity prices, we are able to determine the robustness of optimal rotations and the likely response to the introduction of a new technology or policy.

Further analysis may also be required to consider strategies where rotations desirable from a private profit maximisation perspective are suspected to have environmental consequences that are not in the long term interests of society.

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APPENDIX A: ABARE survey data

A selection of the ABARE farm surveys estimates (ABARE 1999) are presented in Tables A.1, A.2 and A.3. These tables shows the mean and relative standard error of selected physical and financial estimates for farms in region 122, 1997/98, excluding the local government areas of Coonabarabran, Coolah, Mudgee, Cabonne, and Cowra. Estimates are also presented for the average of farms in cropping regions to the north (Region 121) and south (Region 123) of the Central West for comparison.

Table A.1 shows that cereals dominate the cropping phase and sheep are the primary livestock enterprise for farms in region 122. Farm business profit and equity ratio for these farms are low when compared to farms in other cropping regions of NSW.

Table A.1: Selected physical estimates, NSW by region, 1997-98.

AAGIS region		**122** ***(a)***		**121**		**123**	
		Central West		North		South	
Physical estimates							
Total farm area June 30	ha	1 215	(18)	2 227	(26)	1 263	(26)
Wheat sown	ha	177	(24)	236	(13)	66	(14)
Sheep flock at June 30	no	1 715	(15)	1 498	(27)	1 659	(12)
Beef cattle June 30	no	56	(38)	322	(20)	125	(21)
Area's harvested -							
wheat	ha	176.5	(24)	223.3	(12)	65.9	(14)
barley	ha	61.2	(37)	35.7	(30)	28.4	(20)
oats	ha	20.7	(90)	2.9	(38)	11.8	(36)
maize	ha	0.0		2.9	(63)	2.3	(84)
rice	ha	0.0		0.0		21.0	(17)
rye	ha	0.0		0.6	(92)	0.0	
sorghum	ha	3.6	(66)	37.3	(23)	0.4	(99)
triticale	ha	2.9	(145)	0.0		9.3	(36)
millet	ha	0.0		0.0		0.0	
grain legumes	ha	10.9	(34)	9.1	(33)	5.2	(33)
oilseeds	ha	21.1	(31)	3.2	(69)	21.1	(25)
Other cash crops	ha	-0.6	(335)	6.4	(38)	0.5	(89)
Total cash crop area harvested	ha	*296.4*	*(19)*	*321.3*	*(9)*	*166.0*	*(9)*
Wheat produced	t	315	(25)	512	(15)	165	(13)
Sheep sold	no	2 120	(37)	634	(27)	944	(12)
Beef cattle sold	no	34	(25)	122	(19)	75	(29)
Sheep and lambs shorn	no	2 517	(23)	1 574	(27)	1 841	(11)
Wool produced	t	8 888	(18)	7 139	(28)	8 175	(13)
Labour used	wks	95	(6)	101	(13)	95	(6)

Figures in parentheses are relative standard errors expressed as a percentage of the estimate.
Source: ABARE (1999).

Table A.2: Selected financial estimates, NSW by region, 1997-98.

AAGIS region		122 *(a)* Central West		121 North		123 South	
Financial estimates							
Cash receipts							
Sales -							
sheep	$	87 525	(42)	17 555	(29)	31 409	(15)
beef cattle	$	11 144	(25)	47 756	(21)	27 458	(33)
dairy cattle	$	0		0		0	
other lstock	$	2 165	(51)	48	(72)	122	(58)
wool	$	26 899	(17)	26 107	(29)	32 121	(12)
wheat	$	59 396	(25)	101 275	(13)	31 433	(15)
barley	$	16 497	(36)	10 298	(34)	6 007	(20)
oats	$	1 101	(204)	491	(71)	1 241	(77)
maize	$	622	(127)	5 786	(60)	3 400	(81)
rice	$	0		0		49 352	(16)
rye	$	0		191	(92)	0	
sorghum	$	6 607	(66)	14 308	(32)	313	(99)
triticale	$	92	(102)	0		2 356	(48)
millet	$	0		0		0	
grain legumes	$	1 889	(33)	3 677	(38)	1 679	(37)
oilseeds	$	10 110	(37)	3 610	(66)	10 643	(23)
Other crops	$	6 457	(44)	19 602	(35)	9 957	(64)
Total crop gross receipts	$	*102 769*	*(13)*	*159 238*	*(9)*	*116 381*	*(11)*
Off farm sharefarming	$	5 145	(94)	1 688	(158)	3 250	(55)
Off farm contracts	$	1 594	(67)	6 352	(49)	3 819	(40)
Other cash receipts	$	9 206	(25)	15 723	(34)	9 648	(11)
Total cash receipts	$	246 446	(13)	274 466	(10)	224 207	(9)
Cash costs							
Sheep purchases	$	42 006	(70)	4 010	(24)	7 625	(31)
Beef cattle purchases	$	2 025	(58)	6 231	(40)	7 681	(59)
Hired labour	$	4 924	(35)	11 798	(20)	5 933	(28)
Shearing and crutching	$	6 678	(17)	5 649	(38)	6 124	(12)
Fertiliser exp	$	13 114	(20)	15 037	(22)	17 043	(10)
Fodder	$	2 949	(29)	2 722	(47)	5 686	(41)
Crop and pasture chemicals	$	8 916	(13)	14 732	(18)	6 484	(11)
Fuel, oil and grease	$	15 677	(14)	13 469	(15)	12 856	(9)
Repairs and maintenance	$	19 170	(15)	18 938	(15)	15 052	(9)
Other materials	$	9 394	(9)	12 109	(15)	10 186	(14)
Contracts paid	$	9 857	(19)	11 456	(24)	9 415	(19)
Rates	$	6 700	(17)	6 359	(13)	14 321	(9)
Other services	$	36 971	(9)	47 121	(12)	34 499	(8)
Interest paid	$	15 700	(21)	16 322	(33)	12 846	(15)
Rent	$	1 358	(57)	2 273	(43)	1 504	(43)
Payment to sharefarmers	$	6 165	(71)	8 312	(48)	2 318	(60)
Other cash costs	$	274	(110)	1 929	(41)	56	(70)
Total cash costs	$	201 877	(16)	198 466	(12)	169 629	(9)

Figures in parentheses are relative standard errors expressed as a percentage of the estimate.
Source: ABARE (1999).

Table A.3: Additional selected financial estimates, NSW by region, 1997-98.

AAGIS region		122 *(a)* Central West		121 North		123 South	
Components of investment returns							
Total cash receipts	$	246 446	(13)	274 466	(10)	224 207	(9)
less total cash costs	$	201 877	(16)	198 466	(12)	169 629	(9)
Farm cash income	$	44 569	(27)	76 000	(14)	54 578	(17)
plus buildup in trading stocks	$	9 465	(105)	7 810	(96)	- 335	(952)
less depreciation	$	20 767	(31)	21 167	(14)	16 139	(13)
less operator and family labour	$	32 851	(10)	30 907	(14)	34 574	(6)
Farm business profit	$	416	(2166)	31 736	(35)	3 530	(232)
Profit full equity	$	18 162	(50)	52 607	(23)	18 647	(44)
plus capital appreciation	$	42 121	(28)	28 577	(51)	28 566	(52)
Profit at full equity incl. capital appreciation	$	60 283	(27)	81 184	(26)	47 213	(41)
Farm capital July 1	$	944 342	(10)	1 535 947	(12)	1 139 176	(7)
Rate of return - excl capital appreciation	%	1.9	(52)	3.4	(19)	1.6	(43)
Rate of return - incl capital appreciation	%	6.4	(32)	5.3	(23)	4.1	(39)
Other financial items							
Net capital additions	$	44 100	(55)	31 862	(31)	35 969	(50)
Farm capital June 30	$	999 185	(6)	1 556 753	(12)	1 162 089	(8)
Farm business debt June 30 ***a***	$	212 226	(22)	197 024	(33)	152 779	(15)
Change in debt over year ***a***	$	32 367	(93)	- 11 299	(104)	5 568	(112)
Farm business equity June 30 ***a***	$	786 959	(11)	1 305 748	(11)	1 009 311	(8)
Farm business equity ratio at 30 June ***a***	%	78.8	(7)	86.9	(4)	86.9	(2)
Farm liquid assets June 30 ***a***	$	20 130	(75)	65 426	(33)	86 591	(40)
Off farm income ***a***	$	17 341	(26)	17 698	(26)	10 973	(30)

p. Preliminary results

a. Includes only those farms responding to questions on debt.

b. Excluding the shires of Mudgee, Cowra, Cabonne, Coonabarabran and Coolah.

Note: Figures in parentheses are relative standard errors expressed as a percentage of the estimate.

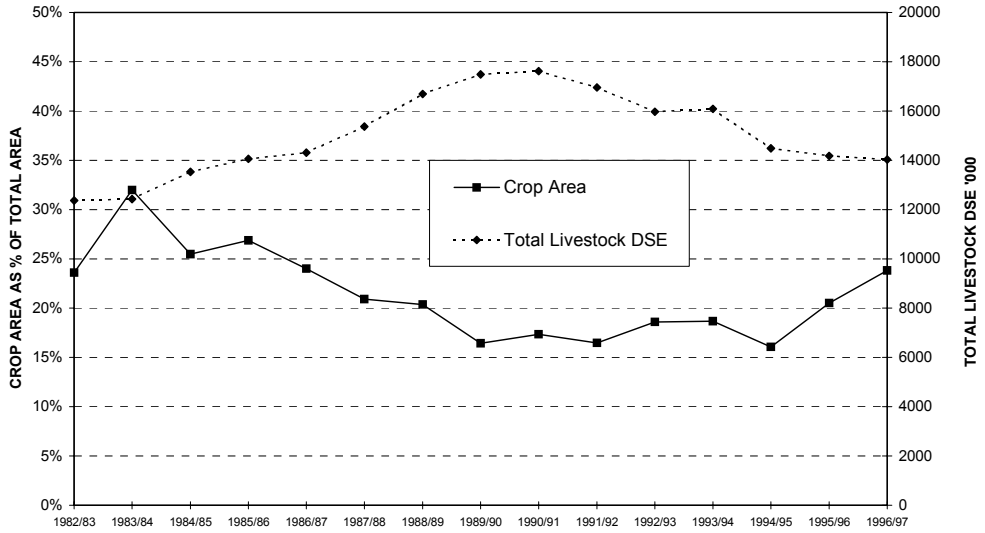
Source: ABARE (1999).

APPENDIX B: ABS survey data

The Australian Bureau of Statistics (ABS) collect primarily physical estimates on a LGA basis, including farm size, area crop sown, numbers of livestock, commodity prices, etc. The ABS survey, for each local government area, enables these estimates to be tracked over time, showing trends and changes in farming systems.

Figure B.1 shows the change in enterprise mix between cropping and livestock for the period between 1982/83 to 1996/97. The area of total crop declined during the 1980s as a proportion of the total farm with livestock replacing crop in the production mix, a trend that appears to have been reversed with the demise of the Wool Reserve Price Scheme.

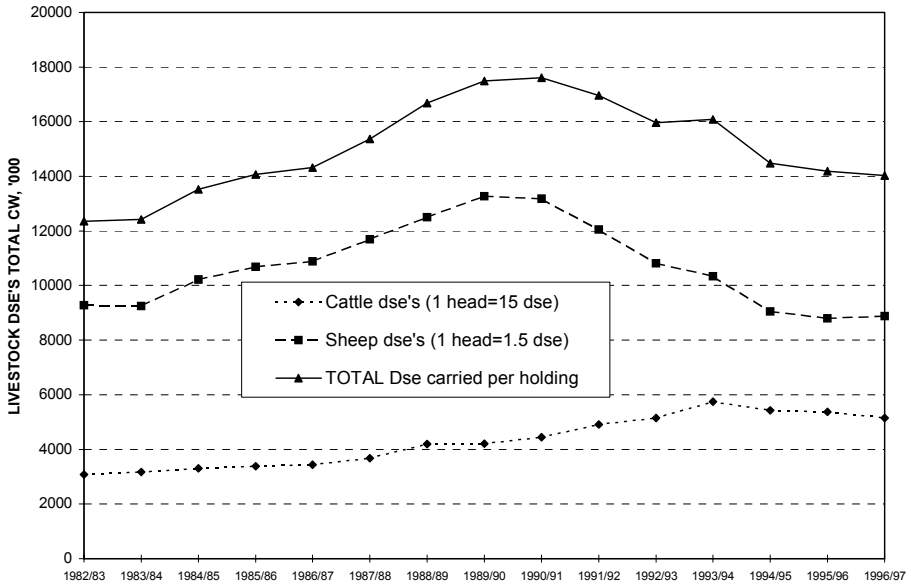
Figure B.1: Changes in enterprise mix on farms in the Central West, 1982-1997.



Source: ABS (1999)

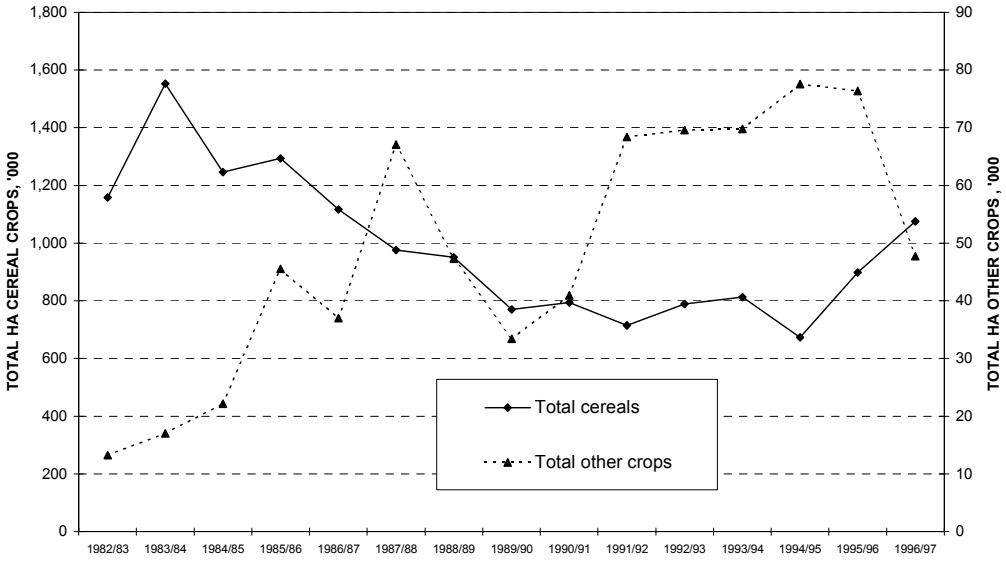
The decline in crop area has not been typical for all crop types. Figure B.3 shows the dominance of cereals in cropping phases while Figure B.2 shows the importance of cattle and sheep in the pasture phase. The area on non-cereal crops, including oilseeds and pulse crops, has been rising while area of cereals was falling. However, although non-cereal crops are becoming increasingly popular they still make up only a small proportion of the total crop area. Cattle, over the same period, have become an important component of livestock activities on farms in the Central West as shown in Figure B.2.

Figure B.2: Changes in livestock enterprise on farms in the Central West, 1982-1997.



Source: ABS (1999)

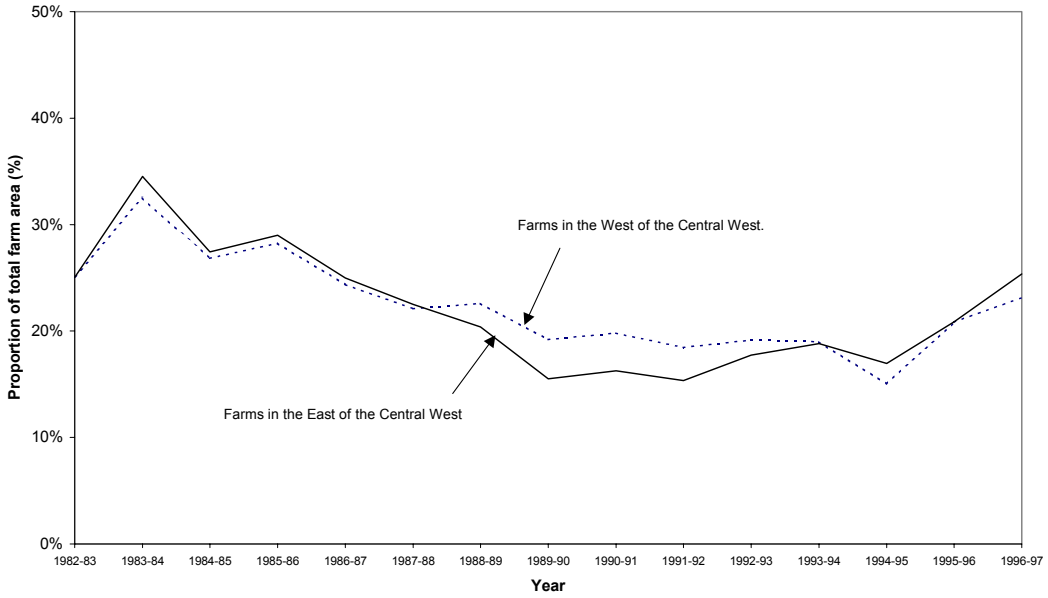
Figure B.3: Changes in cropping enterprise on farms in the Central West, 1982-1997.



Source: ABS (1999)

Figure B.4 shows the area of crop as a proportion of total farm area over the same period. Local government areas have been grouped into "west" including Lachlan and Bland and "east" including Forbes, Weddin, Parkes, Narromine, Dubbo, Wellington, and Gilgandra. This figure suggests that the cropping intensity between LGAs in the east is similar to that of the western LGAs since 1982/83.

Figure B.4: Changes in proportion of farm under crop in the Central West, 1982-1997[b].



Source: ABS (1999)

APPENDIX C: Enterprise Gross Margins

Following are enterprise gross margins for long-fallow wheat, short-fallow wheat, barley, 21 micron wool and yearling cattle production.

NSW Agriculture — **FARM ENTERPRISE BUDGET**

Wheat: Long Fallow
Central Zone - West

1. GROSS MARGIN BUDGET:

		Standard Budget $/Ha	Your Budget $/Ha
INCOME:			
2.40 tonnes/Ha@	$170.00 /tonne (on farm) (PH)	$408.00	
	A. TOTAL INCOME $/Ha:	**$408.00**	
VARIABLE COSTS:			
See opposite page for detail			
	Cultivation	$13.66	
	Sowing	$23.79	
	Fertilizer	$28.00	
	Herbicide	$44.50	
	Insecticide	$0.00	
	Contract harvesting	$36.80	
	Levies	$12.30	
	Crop Insurance	$4.18	
	Cartage, grading & bagging	$0.00	
	B. TOTAL VARIABLE COSTS $/Ha:	**$163.23**	
	C. GROSS MARGIN (A-B) $/Ha:	**$244.77**	

2. EFFECT OF YIELD AND PRICE ON GROSS MARGIN PER HECTARE:

YIELD	ON FARM PRICE ($/tonne)				
tonnes/Ha	$130 /t	$150 /t	**$170 /t**	$190 /t	$210 /t
1.40	$33	$60	$86	$113	$140
1.80	$83	$117	$152	$186	$221
2.20	$130	$172	$215	$257	$299
2.40	$153	$199	**$245**	$291	$337
2.80	$198	$251	$305	$359	$413
3.30	$254	$317	$381	$444	$507
3.80	$310	$383	$456	$529	$602

Gross Margin ($/Ha)

NSW Agriculture **FARM ENTERPRISE BUDGET**

Wheat: Short Fallow

Central Zone - West

1. GROSS MARGIN BUDGET:		PREVIOUS CROP:	CEREAL Standard Budget $/Ha	CANOLA Standard Budget $/Ha	LUPINS Standard Budget $/Ha	Your Budget $/Ha
After	**INCOME:**					
Lupins	1.90 tonnes/Ha@ $140.00 /tonne (on farm) (AH)				$266.00	
Canola	1.90 tonnes/Ha@ $140.00 /tonne (on farm) (AH)			$266.00		
Cereal	1.60 tonnes/Ha@ $140.00 /tonne (on farm) (AH)		$224.00			
	A. TOTAL INCOME $/Ha:		**$224.00**	**$266.00**	**$266.00**	
	VARIABLE COSTS:					
	See opposite page for detail					
	Cultivation		$3.53	$3.53	$3.53	
	Sowing		$23.79	$23.79	$23.79	
	Fertilizer		$53.39	$53.39	$24.00	
	Herbicide		$37.53	$37.53	$37.53	
	Insecticide		$0.00	$0.00	$0.00	
	Contract harvesting		$32.00	$32.00	$32.00	
	Levies		$6.75	$8.02	$8.02	
	Crop Insurance		$2.30	$2.73	$2.73	
	Cartage, grading & bagging		$0.00	$0.00	$0.00	
	B. TOTAL VARIABLE COSTS $/Ha:		**$159.29**	**$160.99**	**$131.59**	
	C. GROSS MARGIN (A-B) $/Ha:		**$64.71**	**$105.01**	**$134.41**	

NSW Agriculture **FARM ENTERPRISE BUDGET**

Barley: Short Fallow
Central Zone - West

1. GROSS MARGIN BUDGET:

		Standard Budget $/Ha	Your Budget $/Ha
INCOME:			
1.80 tonnes/Ha@	$115.00 /tonne (on farm) (feed)	$207.00	
	A. TOTAL INCOME $/Ha:	**$207.00**	
VARIABLE COSTS:			
See opposite page for detail			
	Cultivation	$3.53	
	Sowing	$21.89	
	Fertilizer	$39.14	
	Herbicide	$35.81	
	Insecticide	$0.00	
	Contract harvesting	$32.00	
	Levies	$4.80	
	Crop Insurance	$2.12	
	Cartage, grading & bagging	$0.00	
	B. TOTAL VARIABLE COSTS $/Ha:	**$139.29**	
	C. GROSS MARGIN (A-B) $/Ha:	**$67.71**	

2. EFFECT OF YIELD AND PRICE ON GROSS MARGIN PER HECTARE:

YIELD	ON FARM PRICE ($/tonne)				
tonnes/Ha	$75 /t	$95 /t	**$115 /t**	$135 /t	$155 /t
1.30	- $39	- $13	$12	$38	$63
1.50	- $24	$5	$34	$64	$93
1.70	- $10	$23	$57	$90	$123
1.80	- $3	$32	**$68**	$103	$138
2.10	$18	$59	$100	$141	$182
2.30	$30	$75	$120	$165	$210
2.50	$42	$91	$140	$188	$237

Gross Margin ($/Ha)

NSW Agriculture **FARM ENTERPRISE BUDGET**

BEEF CATTLE GROSS MARGIN BUDGET

Enterprise: Yearling (Southern/Central NSW)

Enterprise Unit: **100 cows**

Pasture: **Improved**

INCOME:				**Standard Budget**	**Your Budget**
42	steers 12-15 months @	485.85	$20,406		
22	heifers 12-15 months @	401.45	$8,832		
1	CFA Bull @	842.4	$842		
7	CFA cows @	484.5	$3,392		
11	Other culls @	484.5	$5,330		
83					
	A. Total Income:			**$38,801**	

VARIABLE COSTS:				
Replacements	1	Bull @	2700	$2,700
Livestock and vet costs: see section titled beef health costs for details.				$1,254
Ear tags @	$2.00			$40
Fodder crops				$0
Hay & Grain				$0
Pasture maintenence (194 ha improved pasture per 100 cows)				$4,850
Livestock selling cost (see assumptions on next page)				$3,125
B. Total Variable Costs:				**$11,969**

	GM including pasture cost	GM excluding pasture cost
GROSS MARGIN (A-B)	**$26,832**	**$31,682**
GROSS MARGIN/COW	**$268.32**	**$316.82**
GROSS MARGIN/DSE*	**$17.29**	**$20.41**
GROSS MARGIN/HA	**$138.31**	**$163.31**

NSW Agriculture **FARM ENTERPRISE BUDGET**

MERINO EWES - 21 Micron

					Standard Budget ($)	Your Budget ($)
Flock size:	**1000**	**Ewes**				
INCOME						
Wool	**number**	**class**	**kg /hd**	**$/kg**		
Shear	960	ewes	5.10	$3.62	$17,723.52	
	20	rams	6.00	$3.62	$434.40	
	408	ewe hoggets	3.80	$2.97	$4,604.69	
Crutch	1388	adults	0.40	$1.95	$1,081.30	
Sheep Sales	**number**	**class**	**$ /hd**			
	177	CFA ewes	$19.00		$3,363.00	
	4	CFA rams	$20.50		$82.00	
	425	weth weaners	$25.00		$10,625.00	
	191	ewe hoggets	$38.00		$7,258.00	
Fodder	**tonnes**	**type**	**value per tonne**			
Hay	0	lucerne hay @	$ -		$0.00	
Fodder crop grain	30	oats @	$ 90.00		$2,700.00	
			A. Total Income:		**$47,871.91**	
VARIABLE COSTS						
Sheep Health	**number**	**class**	**cost ($)**	**reps**		
Drenching following DrenchPlan						
Broadspectrum	1388	adults/hoggets	$0.20	2	$555.20	
	880	lambs	$0.12	4	$422.40	
Dipping	1388	adults/hoggets	$0.38	1	$527.44	
Jetting	1388	adults/hoggets	$0.21	1	$291.48	
	425	ewe weaners	$0.10	1	$42.50	
Vaccination- 6 in 1	1388	adults/hoggets	$0.33	1	$458.04	
	880	lambs	$0.33	2	$580.80	
Mules + Mark	880	lambs	$0.87	1	$765.60	
Scanning	960	ewes	$0.75	1	$720.00	
Wool Selling Costs						
Shearing	1368	ewes/hoggets	$3.15	1	$4,304.41	
	20	rams	$4.65	1	$92.93	
Crutching	1368	ewes/hoggets	$0.50	1	$685.37	
	20	rams	$1.50	1	$30.00	
Wool tax			4.00%		$953.76	
Commission, warehouse, testing charges			5.25%		$1,251.26	
Wool - cartage	40	bales	$9.41		$376.40	
- packs	40	packs	$7.00		$280.00	
Livestock Selling Costs						
Livestock cartage	797	sale sheep	$1.50		$1,195.50	
Commission on sheep sales				4.50%	$959.76	
Fodder						
Supplementary feed - 2 kgs of oats/hd/week over 3 weeks @ $120/tonne						
	960	ewes	$0.14	3	$388.80	
Grazing crops	20	hectares @	$180.00	per Ha	$3,600.00	
Agistment	0	hectares @	$0.00	per Ha	$0.00	
Pasture Maintenance	525	hectares @	$30.00	per Ha	$15,750.00	
		B. Total Variable Costs:			**$34,231.65**	
REPLACEMENTS:						
	number	**class**	**$ /hd**			
	4	rams	$750.00		$3,000.00	
		C. Total Replacements:			**$3,000.00**	

	excl. pasture costs	incl. pasture costs
GROSS MARGIN (A-B-C)	**$27,290.27**	**$10,640.27**
GROSS MARGIN /EWE	**$27.29**	**$10.64**
GROSS MARGIN /DSE	**$13.00**	**$5.07**
GROSS MARGIN /HA	**$51.98**	**$20.27**

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