Livestock Farming Systems in the Northern Tablelands of NSW: An Economic Analysis

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Acronyms and Abbreviations Used in the Report

ABARE	Australian Bureau of Agricultural and Resource Economics
ABS	Australian Bureau of Statistics
AMLC	Australian Meat and Livestock Corporation (now MLA)
AWE	Australian Wool Exchange
BEEF CRC	Cooperative Research Centre for Cattle and Beef Quality
CFA	Cast-for-age
DW	Dressed weight (or carcase weight)
FCI	Farm Cash Income
FOS	Farm Operating Surplus
LGA	Local Government Area (typically a shire or a municipality)
LP	Linear Programming
LW	Liveweight
ME	Metabolisable Energy
MIDAS	Model of an Integrated Dryland Agricultural System
MJ	Megajoules (of energy)
MLA	Meat and Livestock Australia
NFE	Net Feed Efficiency
NTLP	Northern Tablelands Linear Program
PTIC	Pregnancy tested, in calf
R&D	Research and Development
SHEEP CRC	Australian Sheep Industry Cooperative Research Centre
TGM	Total Gross Margin
TVC	Total Variable Costs

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Executive Summary

The Northern Tablelands region of New South Wales covers an area of approximately 3.12 million hectares including 2.11 million hectares occupied by some 2300 agricultural establishments producing agricultural commodities valued at more than $220 million. Sheep and wool production and cattle production are the dominant agricultural enterprises.

In this Report, a whole-farm model of a representative livestock farming system in the Northern Tablelands is developed. Whole-farm economic models of the relevant farming system are a useful first step in understanding the nature of the biological and economic constraints facing producers in their decision making in relation to their choices of inputs and outputs. Such models are also useful in relation to more general concerns such as the expected impacts of investments in new technologies applicable to grazing systems, or of external events such as drought conditions or a depreciation in the exchange rate.

A whole–farm budget for a representative farm includes a statement of assets and liabilities, based upon estimates of the various capital items including land, livestock and plant and machinery and farm structures. There is also an annual operating budget that includes the cash income and costs associated with each of the farm enterprises as well as the fixed costs incurred for running the farm over the year to derive the farm cash income. Allowances for depreciation and interest costs are deducted from farm cash income to determine farm operating surplus. No family labour allowance is subtracted, so the resulting farm operating surplus represents a return on owner-operated labour, management and farm assets. Pasture costs are not apportioned to the specific animal enterprises and therefore appear as separate negative gross margins. Similarly, supplementary feeding costs and fodder conservation activities are listed as a separate negative gross margin.

A representative farm model of the Northern Tablelands livestock farming system was developed based on ABS and ABARE data on the relevant industries, from simulations with a linear programming model, and from discussions with local graziers and extension officers. The farm comprises 920 ha of which about half is native pasture and about half is introduced pasture. This farm runs a flock of 1,108 first-cross ewes, a flock of 1,732 Merino wethers and a 127 cow herd producing 18 month old steers suitable for the heavy feeder steer market.

Using average prices and costs over an extended period of time, the annual operating budget for the farm shows a total gross margin of $86,191 and total overhead costs for the year of $24,720. This results in a farm cash income of $61,471 and a farm operating surplus of $37,471 after depreciation and interest costs. The statement of assets and liabilities shows total assets of the farm to be $1,498,060 and liabilities of $100,000 which equates to an equity level of 93.3 per cent. The farm operating surplus achieved on this model farm as a percentage of the owner's equity is 2.7 per cent. This represents a return on operator and family labour, management and equity. Low returns to equity are typical of Australian broadacre agriculture.

Other scenarios examined included whole-farm budgets based on 2002 actual market prices and on 2003 expected prices. Given the relatively high prices for sheep relative to cattle in these years, the representative farm would be more profitable running 1,558 first-cross ewes and 3,595 Merino wethers. Such an enterprise mix would achieve a farm total gross margin of $165,736. After overhead costs, depreciation and interest costs there would be a farm operating surplus of $111,818. Based on equity totalling $1,472,870, this operating surplus would represent a business return on operator labour, management and equity of 8.1 per cent.

However, while the Northern Tablelands representative farm model would suggest that greater profits could be achieved from changing enterprises as commodity prices change, in practice various biological lags, infrastructure, financial and management constraints prevent regular changes in farm enterprises. In fact, diversification amongst a variety of farm enterprises between various sheep and cattle enterprises as evidenced in the Northern Tablelands is one management response to this commodity price variability.

A hypothetical new improved-pasture technology suggested by researchers, involving the selection of pasture varieties with improved winter pasture growth, was examined using the whole-farm model. If the existing 450 ha of improved pasture was replaced by a new variety that gave a 10 per cent increase in winter pasture growth, this would result in a 4.9 per cent increase in farm total gross margin. This corresponds to an increase in farm cash income of 6.9 per cent. These improvements in the profitability of the representative farm would be achieved by increasing the investment in first-cross ewes and in cows producing heavy feeder steers (by 3.5 per cent and 7.8 per cent respectively) and by decreasing the Merino wether enterprise from 1,732 to 1,672 wethers. This indicates that the prime lamb and cow enterprises, under the current assumptions of the model, are better able to utilise the farm resources available given an increase in winter pasture growth.

The main conclusions from the analysis are that:

- Returns to equity are quite low in the Northern Tablelands livestock farming system;
- Variable commodity prices, largely determined in world markets, result in variable levels of profitability of the farming system over time;
- The optimal farm plan is quite sensitive to small changes in the relative prices of the different outputs produced;
- In practice farm plans do not change very much as prices change, with most farms maintaining a range of cattle and sheep enterprises;
- Thus a "representative year" is a more realistic basis for assessing potential changes in farm plans; and
- New technologies can potentially have large impacts of farm profits and on the mix of resources used and outputs produced.

1. Introduction

1.1 Overview

This report provides a description of farming systems that are typical of the Northern Tablelands of New South Wales. The Northern Tablelands region is defined and an overview of its land resources, climate and the major farm enterprises is provided. Given the topography and the land and water resources available, mixed grazing farms of sheep and beef cattle dominate the Northern Tablelands farming system.

A whole-farm perspective is a central principle of this commentary and while individual gross margins for a range of sheep and beef enterprises are detailed, how these enterprises might be combined within the whole-farm business is emphasised. This is achieved by the development of whole-farm budgets for a representative farm that enables the examination of farm activities within physical, financial and labour constraints.

The resulting whole-farm budgets and the associated whole-farm linear program (LP) can be applied to various policy and management questions. In this report the representative models are used to examine the potential farm level benefits, in the Northern Tablelands, of specific agricultural research targeted at the pasture base.

1.2 Representative Farm Analysis

Whole-farm modelling may be undertaken using a representative farm or a case study farm approach. A representative farm is constructed from survey information from various sources and is designed to represent the average or typical farm, in terms of the physical, financial, labour and management resources available to it, for a defined region of interest. Alternatively a case study approach might be used, where a real farm is identified and described in detail. Following the approach adopted in other reports in this series (Patton and Mullen, 2001; Singh *et al*., 2003), the representative farm methodology is applied here.

The whole-farm budgets presented provide a picture of the profitability of the representative farm, for a particular set of prices and costs and a particular suite of resources. As such they may differ significantly from any actual farm regarding differing resource endowments, climatic influences, management skills, market prices and costs and the farmer's goals, preferences and attitude to risk. Therefore, this report provides only a general perspective of farm profitability and a description of a feasible farm enterprise mix.

Another caveat on the use of these whole-farm budgets is that they are static while many problems related to assessing the profitability of different or new management strategies or technologies in the farm system are time dependent. Development budgets and cash flow budgets are required to fully examine the economics of dynamic problems in farming systems, such as pasture development, fertiliser carryover, weed and pest control, and anything to do with genetic improvement in livestock.

2. Northern Tablelands Agriculture

2.1 Area and Topography

The Northern Tablelands region of New South Wales as described in this report consists of the Walcha, Uralla, Armidale-Dumaresq, Guyra, Severn, Glen Innes and Tenterfield local government areas (LGAs), an area of approximately 3.12 million hectares. Some 2.11 million hectares are occupied by agricultural establishments (ABS, 1998). This essentially equates to the northern portion of ABARE Region 131, the NSW Tablelands (ABARE, *pers com*). Figure 1 shows the selected LGAs, and identifies relevant regional boundaries that ABARE use for farm surveys.

As defined the Northern Tablelands is located between the latitudes of 28°15'S and 31°30'S and has an average elevation of 800 meters. Topography is undulating to hilly with rises to 1400 meters (Ayres, McPhee, Turner and Curll, 2000; Hartridge, 1979), which is a limitation to the broad adoption of cropping enterprises in the region.

2.2 Climate

The climate of the Northern Tablelands is characterised by high rainfall with a summer dominant pattern. In contrast, the Central and Southern Tablelands differ in their annual rainfall distribution with rain being evenly spread in the central districts and winter dominant rainfall occurring in the southern region. However, high evaporation rates during summer limit the potential growth of pastures in the Northern Tablelands. Cold winter conditions including a 200-day frost interval limits growth from April through October (Hobbs and Jackson, 1977). Rainfall is variable with frequent seasonal droughts (ie, those extending for at least a six month period). For example, such droughts occur 1 in every 3.5 years in the Glen Innes and Tenterfield districts. Severe droughts occur 1 in every 10 years on average across the region. Table 1 summarises key climatic details for several Northern Tableland centres.

2.3 Soils

The major geological parent material from which soils in the Northern Tablelands are derived consist of granites and older Paleozoic rocks predominantly classified as greywackes and tertiary basalts (Harrington, 1977). From these parent materials the major soil groups include Yellow, Grey and Red Podzolics from granites and Yellow Podzolic and Yellow Solodic soils from greywackes. Basalt derived soil groups include the Black Earths, Praire, Euchrozem and Krasnozems (Murphy and Eldridge, 1991). Apart from the basalt derived soils, poor structure, drainage, and fertility of Northern Tablelands soils make them less suitable for cropping (McGarity, 1977), which along with climate and topography, limit the potential for cropping activities in the region. Further, the occurrence of high intensity rainfall from summer storm activity on the undulating to hilly topography increases the risk of erosion potential and thus the need for adequate ground cover.

The major limiting nutrients for plant growth in soils on the Northern Tablelands are phosphorous and sulphur (Hartridge, 1979), while acidity particularly in red podzolics and Krasnozem soils may limit the growth of susceptible species (McGarity, 1977).

Figure 1. The Northern Tablelands region of New South Wales

Source: NSW Agriculture

2.4 Pasture Base

The expansion of pasture improvement activities through the period 1950 to 1970 was important in improving the productivity of agriculture in response to the declining terms of trade of farmers, post-1953 (Crofts, 1997). This was especially so for Northern Tablelands producers who had few diversification opportunities away from sheep and cattle grazing. Such activities included the application of superphosphate and the widespread introduction of new pasture species including legumes.

An estimated 50 per cent of Northern Tablelands pastures are based upon natural pastures, a higher proportion than exists on the Central and Southern Tablelands (34 per cent). This is partly a consequence of the relatively high productivity of these pastures and grazing practices that favour the growth of cool season perennial native grasses (Duncan, 1995; Lodge and Whalley, 1989). Archer (1995) estimated that introduced pasture species occupy only 23 per cent of the total farm area in the Northern Tablelands.

A comparison can be made of typical pasture growth rates between Northern, Central and Southern Tablelands for two pasture types; a fertilised native pasture with introduced clovers (Figure 2) and a pasture with maintenance fertiliser provided which includes an introduced perennial grass and clovers (Figure 3). These graphs demonstrate the greater potential pasture growth achieved during summer and autumn in the Northern Tablelands as a consequence of

the summer dominated rainfall distribution pattern. Pastures in all three regions suffer during the cold winter months, resulting in the well-known "winter feed gap".

Table 1. Historical climatic data for Northern Tableland centres

Item	Armidale	Glen Innes	Tenterfield	Walcha	Ebor
Annual median rainfall (mm)	764	839	829	807	1113
Co-efficient of Variation[a] (%)	22	22	25	21	31
Av. Jan Temp range (°C)	13.8 - 26.7	13.6 – 25.9	14.7 - 26.5	na	na
Av. July Temp range (°C)	0.4 – 12.7	0.4 – 12.8	0.8 - 14.4	na	na
Frequency of Drought					
- seasonal[b]	31 in 129 yrs (0.24)	34 in 120 yrs (0.28)	38 in 130 yrs (0.29)	29 in 121 yrs (0.24)	30 in 113 yrs (0.27)
- severe[b]	11 in 129 yrs (0.09)	12 in 120 yrs (0.10)	12 in 130 yrs (0.09)	8 in 121 yrs (0.07)	14 in 113 yrs (0.12)

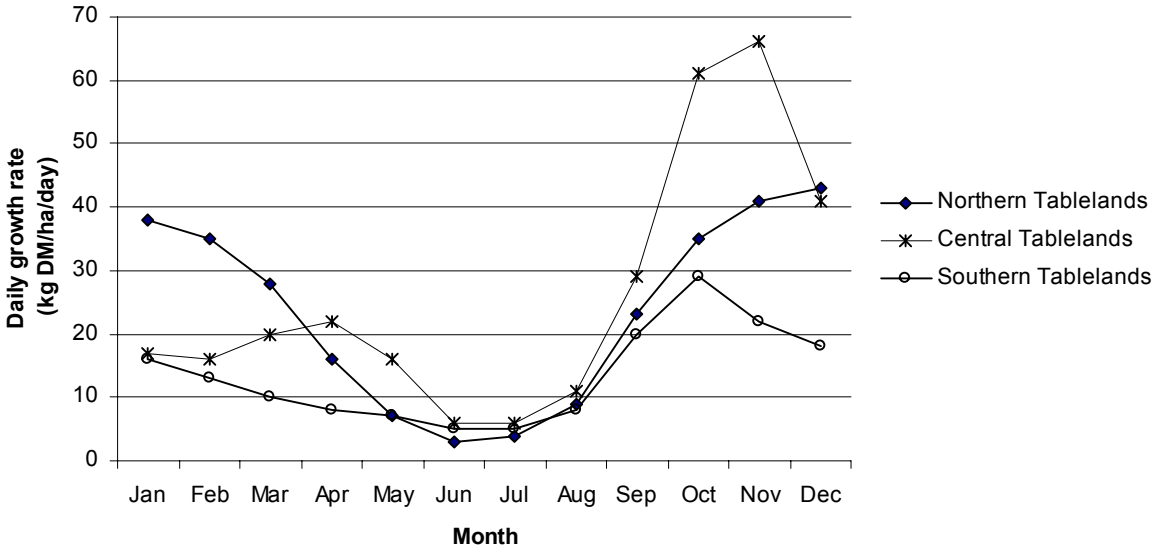
Source: **Rainman** software; latest data year 2000.
na not available
[a] Coefficient of variation equals the standard deviation divided by the mean.
[b] Drought occurrence is determined by Rainman© using a 'window' moving over the monthly rainfall totals to see if any test period has less than the threshold value for the lowest 10 per cent of years (10th percentile) or 5 per cent for severe droughts. The minimum test periods are 12 months (major), 24 months (extended), and 6 months (seasonal). Seasonal droughts have starting dates that exclude the dry season; in the case of the Northern Tablelands (March to July). Seasonal droughts are broken when the rainfall in the 6-month window exceeds the lowest 30 per cent of years
Clewett, J.F., Smith, P.G., Partridge, I.J., George, D.A. and Peacock, A. (1999).

2.5 Regional Agricultural Issues

From the latest available agricultural census data 1996/97 (ABS, 1998) there were 2295 establishments carrying out agricultural activities as defined by ABS in the Northern Tablelands region. These activities produced agricultural commodities to the value of $217.8 million in 1996/97. Sheep and cattle production were the dominant agricultural enterprises in the region, contributing 86 per cent of this total value including wool (41.7 per cent), beef cattle slaughterings (36.1 per cent) and sheep and lamb slaughterings (8.4 per cent).

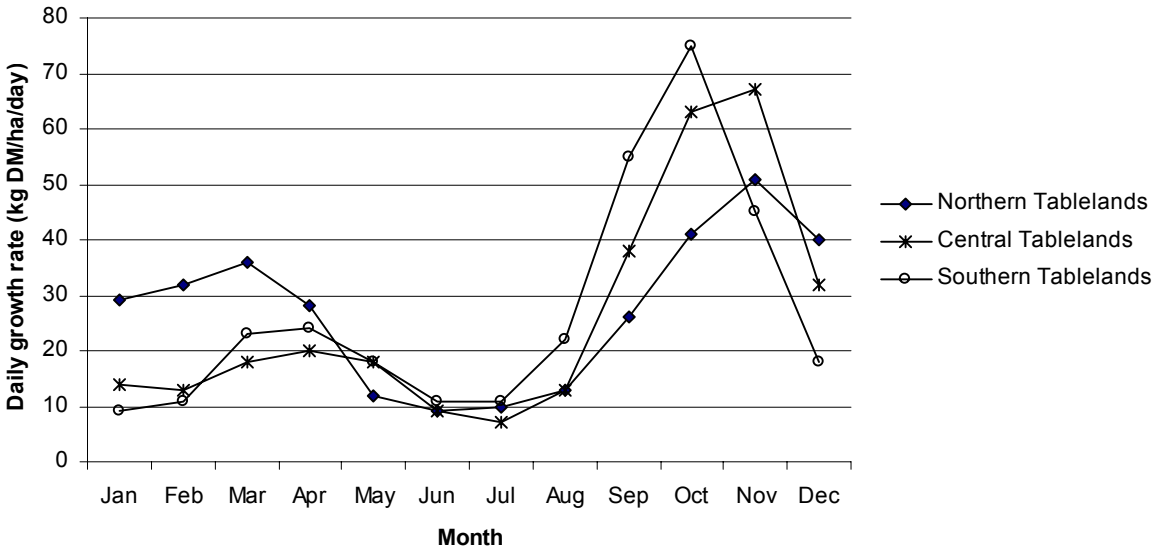
Major issues for Northern Tablelands agriculture relate mainly to the economic and environmental sustainability of this beef and sheep grazing system. Farm profitability is a necessary prerequisite for a sustainable agricultural sector. This was recognised by the Standing Committee for Agriculture and Resource Management (SCARM) as a key indicator for the sustainability of agriculture (SCA, 1991). The profitability of the Australian beef and sheep industries has, like most other agricultural enterprises, been highly variable.

Figure 2. Estimated pasture growth rate of Microlaena/clover pastures on the NSW Tablelands



Source: NSW Agriculture (1996).

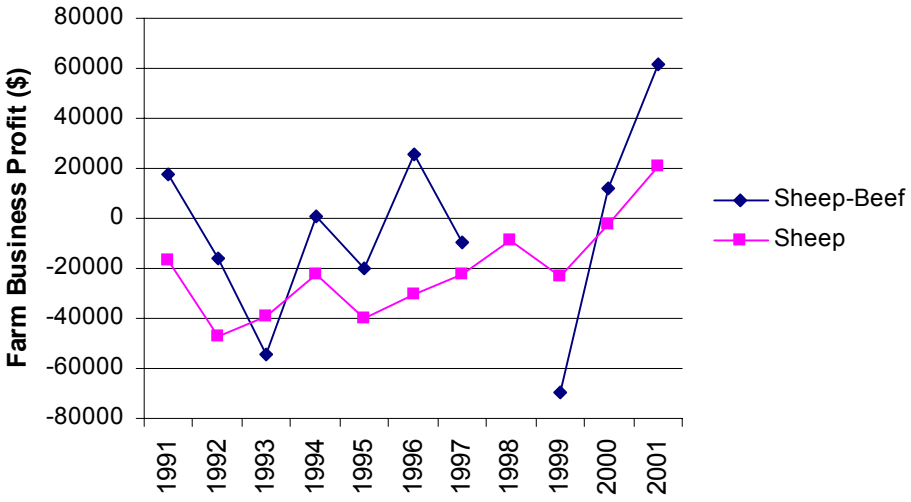
Figure 3. Estimated pasture growth rate of temperate perennial grass and clover pastures on the NSW Tablelands



Source: NSW Agriculture (1996).

Numerous general economic and farm specific factors contribute to the variability in annual profit amongst grazing properties including commodity prices and climatic variability. In the case of industry economic factors for example, the cyclical nature of beef prices are well recognized (Griffith and Alford, 2002), while the removal of the wool Reserve Price Scheme in 1990 and the existence of the wool stockpile throughout the 1990s would also have had an impact on the stability of prices that wool growers might face. The extent of variability in annual profits amongst Northern Tablelands producers is illustrated in Figure 4.

Figure 4. Comparison of farm business profit of Northern Tablelands sheep-beef and specialist sheep farms over the period 1990/91 to 2000/01



Source: ABARE data (insufficient sample size in sheep-beef properties in 1997/98, and in specialist beef properties over the whole sample period)

Environmental sustainability is an increasingly important concern for Northern Tableland farmers. Dieback in Eucalyptus trees on the Northern Tablelands was perhaps the first major environmental concern recognised as resulting from European agricultural practices (Hartridge, 1979). Subsequently, other sustainability issues relevant to Northern Tablelands producers have included the decline in pasture productivity as well as hydrological impacts on regional river catchments and some occurrence of dryland salinity and soil acidity in the region.

In relation to pasture productivity, a survey of producers in eastern temperate regions of Australia found that 35 per cent recognised declining pasture quality as a problem in their district. Specifically when Glen Innes producers were asked if pasture decline was a problem on their farm, 82 per cent identified the problem (Lees and Reeve, 1994). In the same survey 51 per cent of Glen Innes producers identified pasture quality decline as a problem on their farm. Problems cited relating to pasture quality decline included weeds (64 per cent), poor species persistence including legumes (58 per cent), lower pasture production (55 per cent) and less perennial legumes in pasture (41 per cent). Scott *et al.* (2000) studied several of these pasture sustainability issues for the Northern Tablelands and highlighted their potential impact on subsequent soil and nutrient losses.

In relation to soil quality problems, the NSW Department of Land and Water Conservation (2003) suggest that there are numerous small, scattered pockets of dryland salinity in the Northern Tablelands. These are mainly to the west of the Great Dividing Range, and in terms

of Figure 1, these areas lie towards the western boundaries of the Tenterfield, Severn, Guyra, Uralla and Walcha LGAs. Acid soils are a more widespread problem on the Northern Tablelands (NSW Agriculture, 2001). These areas tend to be on the eastern side of the region in the higher rainfall belt, although there is also an extensive area of "strongly acid" soils to the west of Armidale. NSW Agriculture has been managing a research and advisory program called Acid Soil Action to combat this problem.

Generally, various government policies also have an impact upon Northern Tablelands farm businesses, such as farm commodity marketing arrangements particularly the wool Reserve Price Scheme up until its removal in 1990. As well, legislation aimed at land management issues are also of potential significance to the Northern Tablelands farm sector, for example the NSW Native Vegetation Conservation Act 1997.

From time to time, economists are required to provide advice about the expected impacts of new investments in technologies applicable to grazing systems, of government policies such as those mentioned above, or of external events such as drought conditions or a depreciation in the exchange rate. To be able to provide such advice in a credible manner, economic models of the relevant farming system are a useful first step in understanding the nature of the biological and economic constraints facing producers in their decision making.

Such an economic model for the Northern Tablelands livestock farming system is described in the following sections.

3. The Northern Tablelands Farming System

3.1 Sources of Information

To develop the representative farm model, a variety of information sources regarding the farming system in the Northern Tablelands were used. Farm survey data from ABARE for the years 1990/91 to 2000/01 were obtained for the Northern Tablelands and included specialist sheep properties and sheep-beef properties (unpublished ABARE data). The applicability of this data is limited by the small number of properties and the resulting high level of relative standard errors associated with the data means (refer to Appendix 1). In fact the sample of specialist beef properties is not large enough to provide reliable estimates. ABS farm census data from the 1996/97 census were also available.

NSW Agriculture district extension and research staff were also asked to list and describe the major beef and sheep enterprises undertaken in the region. As well, they were asked to provide estimates of production targets that might be reasonably achieved for the various livestock enterprises (for example, calving and lambing rates and growth rates). Information was also drawn from various research and extension publications and from discussions with several district graziers.

3.2 Characteristics of Regional Agricultural Activities

As noted above, sheep and cattle production were the dominant agricultural enterprises in the region. Other minor commodities produced included cereal cropping, hay production, fruit and vegetables, pigs, dairy and honey activities.

The average agricultural establishment on the Northern Tablelands was 921 ha and produced agricultural commodities to the value of $94,887 in 1996/97 (ABS, 1998). In comparison the average farm area of beef-sheep farms sampled in the ABARE farm survey for the 2000/01 in the Northern Tablelands region was 958 ha (standard error: ± 297 ha). Table 2 shows the average farm areas for various LGAs within the Northern Tablelands region. As well the 1996/97 census results show that the majority of commercial farms in the Northern Tablelands operated mixed beef-sheep farms, with the exception of the Tenterfield LGA where fewer sheep enterprises were undertaken compared with other Northern Tablelands LGAs.

As well, agricultural holdings tend to be smaller in the Central Tablelands (Cabonne (Orange) LGA has an average holding size of 527 ha, Evans (Bathurst) LGA 529 ha, and Yass LGA 588 ha). There is also increased diversification in farm activities particularly in the Central Tablelands with horticulture and viticulture having become increasingly important to these farm businesses in the region.

Table 3 shows the main physical attributes of the sheep-beef farms and specialist sheep farms in the region surveyed by ABARE in 2000/01.

Table 2. Variation in farm size by local government area, 1997

Local Government Area	Average area per holding (ha)	Cattle stocking rate (hd/ha)	Sheep stocking rate (hd/ha)	Per cent farms with cattle	Per cent farms with sheep
Dumaresq	1070	0.33	2.12	70	67
Guyra	850	0.35	2.38	70	82
Severn	880	0.34	1.51	72	69
Tenterfield	893	0.29	0.60	75	27
Uralla	899	0.26	2.94	68	83
Walcha	1098	0.41	2.08	80	66

Source: ABS (1998)
Stocking rates estimated as total numbers of cattle and sheep in each LGA as at March 31, divided by the area of each LGA.

Table 3. Physical characteristics of sheep-beef and sheep farms surveyed by ABARE in the Northern Tablelands in 2000/01

Physical characteristics		Sheep-Beef		Sheep	
	unit	mean	± Std. Error	Mean	± Std. Error
Closing area operated	Ha	958	297	611	18
Closing sheep numbers	No.	4549	1083	3114	93
- ewes	No.	2089	503	1206	470
- lambs	No.	1167	368	406	256
- rams	No.	43	19	20	10
- wethers	No.	1251	530	1482	637
Closing beef cattle numbers	No.	250	70	101	20
- bulls	No.	5	1	1	.
- calves	No.	52	26	27	7
- cows	No.	126	27	44	10
- replacement heifers	No.	34	9	6	.
- other	No.	33	18	23	3
Other grain production	Tonnes	29	28	0	.
No. sheep sold	No.	1223	60	1058	719
No. prime lambs sold	No.	40	58	652	763
No. other lambs sold	No.	267	226	21	.
No. beef cattle sold	No.	121	23	20	2
No. of sheep and lambs shorn	No.	4426	1005	3211	225
No. ewes mated	No.	1715	295	983	482
No. of lambs marked	No.	1460	197	888	719
Lambing rate	%	87	12	87	12
Wool produced	kg	16417	5401	12321	1848
Amount of labour used	weeks	146	50	99	2
Number sampled		5		5	

Source: ABARE (unpublished data)

Based on the foregoing discussion, the Northern Tablelands representative farm model is assumed to have an area of 920 hectares, managed by an owner/operator with further part-time assistance from family labour. This farm has a mix of native and improved pasture, and runs a mix of sheep and cattle enterprises. These aspects of the model farm are detailed immediately below. The overheads, assets and liabilities of the farm are detailed in Section 4.

3.3 Description of the Various Beef, Sheep and Pasture Activities

The Northern Tablelands growing season and locality influence the types of beef and sheep enterprises carried out. In the case of beef cattle production, British breed cattle predominate with some European breeds used for cross-breeding. Traditional enterprises have included store weaner breeding resulting in autumn weaner sales both to local, north-western slopes, southern NSW, Queensland and Victorian producers who finish the stock (Llewellyn and Davies, 2001). Recently, the development of large feedlots in northern NSW and southern Queensland have provided the opportunity for Northern Tablelands producers to retain stock to grow to reach the regional feeder steer market. The supermarket, European Union and grass-fed Japanese bullock markets have grown in importance (Llewellyn and Davies, 2001), while some specialisation by producers as 'backgrounders' of cattle for feedlots is also occurring.

Northern Tablelands sheep activities include a wide variety of enterprises with Merino wool particularly fine wool (18-19 micron) and prime lamb production dominating. Super-fine wool production and first-cross ewe production are also carried out on the Northern Tablelands.

Introduced perennial pasture species, native pasture species and forage crops are utilised on Northern Tablelands farms. Assumptions regarding pasture types, establishment and maintenance practices and their performance were derived from a variety of sources including discussions with several district graziers, NSW Agriculture extension and research agronomists and publications, in particular Lowien, Duncan, Collett and McDonald (1997) and NSW Agriculture (1996). These assumptions are detailed later.

3.3.1 NorthernTablelands Beef Activities Included as Options in the Farm Model

Specialist local trade – occurring in the higher rainfall districts of the region where cows are joined to calve in July and early August to produce vealers at approximately 9 months of age and 180 kg (d.w). These are heavier and better finished than weaners. Replacement cross-bred heifers are purchased in-calf (see Appendix B for more detail on these enterprise options).

Inland Weaners – cows are joined to calve in late July and August, and heifers are joined to calve at 2 years of age. Steers and heifers are sold at 9 months weighing approximately 240-250kg (lw.) for growing and finishing in other regions or locally.

Young Cattle 15-20 months (moderate growth) – cows are joined to calve in August and September to producing yearlings, and heifers are joined to calve at 2 years of age. These are sold at about 18 months of age weighing approximately 260 kg (d.w). Target markets for these cattle include the supermarket and wholesale trades.

Heavy Feeder Steers (Young Cattle 0-2 teeth) – cows are joined to calve in August and September, and heifers are joined to calve at 2 years of age. Heifers are sold as weaners at around nine months of age, while steers are sold at approximately 18 months of age at 440-450 kg (lw.) suitable for entry into feedlots.

3.3.2 Northern Tablelands Sheep Activities Included as Options in the Farm Model

Self Replacing Merino Ewes – a self-replacing 19 micron ewe flock is joined to lamb in late August and September. Wether hoggets and excess ewe hoggets are sold at 18 months of age. Ewes are culled for age at $5^1/_2$ years of age.

Prime Lamb Production – First cross ewes (Merino x Border Leicester) are joined to a short wool terminal sire (eg., Poll Dorset) to produce second cross lambs for sale at approximately 6 months of age. Lambing occurs in late August to early October. Ewes are purchased at 18 months of age and joined to lamb at 2 years. Ewes are culled for age at $5^1/_2$ years of age.

Merino Wethers – 19 micron wethers are purchased as hoggets and culled for age at $5^1/_2$ years of age. In the model an average live weight for wethers is assumed to be 45 kg. They are assumed to be shorn in November.

Pre-lamb shearing of ewes on the Northern Tablelands is still generally practised within 4 to 8 weeks of lambing, while shearing of wethers may occur at other times of the year. For the purpose of the representative farm, shearing of ewes is assumed to occur prior to lambing and wethers are assumed shorn in October. Ewes have traditionally been shorn prior to lambing as a means of reducing casting in pregnant ewes and to improve lamb suckling (Miller, 1991) as well as to reduce the incidence of breaks in the middle of the fibre. An alternative view on the appropriate time to shear in summer rainfall dominant regions such as the Northern Tablelands is to shear in summer to reduce the incidence of fly strike and seed burden in the fleece (Bell, 1991; Bob Marchant, NSW Agriculture, *pers com*). However discussions with district extension personnel and graziers indicated that the late winter shearing of ewes remains the predominate practice in the region.

3.3.3 Northern Tablelands Pasture Activities Included in the Farm Model

Native pasture – Native pastures including Red grass and Microlaena pastures with some clovers present based on soils of naturally moderate fertility. Maintenance fertilizer applications are assumed to be applied at half the recommended rate. Assumed to occur on 440 ha or 48 percent of the model farm area (920 ha).

Introduced pasture – Fescue/Phalaris grass dominated pastures with at least 20 per cent of base dry matter present as white or sub clover. These pastures are based upon soils of moderate to good fertility with annual applications of maintenance fertiliser. Assumed to cover 450 ha or 49 per cent of the total area.

Forage Oats – Sown in February on moderate to good fertility soils with recommended fertiliser rates. Oats is assumed to be sown on 30 ha of the farm or 3 per cent of the farm area.

3.4 Enterprise Budgets for the Cattle, Sheep and Pasture Activities Included as Options in the Farm Model

Enterprise budgets were developed for each of the possible cattle, sheep and pasture activities included as options in the farm model. These are all reported in Appendix B. In preparing these budgets, the prices used were based on data over an extended period of time but expressed in 2001 dollar terms. Thus, these budgets could be termed budgets for a "representative year".

The reason for adopting this approach is because the returns from the various enterprises are extremely variable from year to year. Thus, the optimal farm plans would also vary from one year to the next based upon a profit-maximising response to these large commodity price changes. However, sheep and cattle producers are relatively constrained in their ability to change their enterprise mix in the short and medium terms. Breeding enterprises in particular require an extended period of time to introduce or expand as a consequence of biological constraints. Typically such enterprises are expanded by holding onto young females above the number required to simply maintain the current breeding flock or herd size. This limits the ability of producers to move into or out of a breeding enterprise in the short and medium terms.

Thus, a farmer's decision to invest in particular animal enterprises is necessarily based on their experience over the longer term with regard to an enterprises' profitability, physical and environmental constraints of a particular farm. As well, the farm manager's personal preferences, skills, goals and attitude to risk, are also important.

Therefore commodity prices in any single year are not necessarily the relevant factors in determining the optimal enterprise mix on farms such as those on the Northern Tablelands. Rather it is more likely that as far as price drives farmer enterprise choice, such producer expectations are based upon a number of years of commodity price observation.

Therefore, producer price expectations were assumed to be formed over a period of several years. Specifically, the historical prices for beef and sheep sales were derived from AMLC (AMLC, 1997) and MLA (MLA, various issues) statistics for NSW for the various classes of livestock product over the period 1995 to 2001. Similarly the wool prices used were the average annual clean price for the relevant microns (19 and 28 microns) from Wool International and Australian Wool Exchange over the period 1995/96 to 2001/02 (ABARE, 2003). Prices for replacement stock such as bulls, wether hoggets and first-cross ewes were obtained from sampling sale reports and classified advertisements from *The Land* newspaper (various issues) and from NSW Agriculture beef and sheep budgets over the period 1994 to 2001. All prices are expressed in 2001 dollar terms. The resulting average prices for the major farm outputs for Northern Tablelands region are provided in Table 5.

The representative year whole-farm budgets used 2001 farm costs. These farm input prices were obtained from a variety of sources as detailed in Table 6, while Appendix B details the enterprise gross margins including the costs used. Other price scenarios were examined and these are detailed in Section 4.

Table 4. Commodity price assumptions used in deriving the representative year whole-farm budget

	Type	Price
Cattle Enterprises		
Vealers	steers	306 c/kg dw.
	heifers	296 c/kg dw.
Weaners	steers	167 c/kg lw.
	heifers	157 c/kg lw.
Young cattle	steers 20 m.o. 250 kg dw.	283 c/kg dw.
	heifers 18 m.o. 200 kg dw.	273 c/kg dw.
Heavy feeder steers (0-2 teeth)	steers 18 m.o. 450 kg lw.	170 c/kg lw.
	heifers sold as weaners	157 c/kg lw.
cfa stock	cows	256 c/kg dw.
	bulls	266 c/kg dw.
Sheep Enterprises		
Wool	19 micron wool	1 117 c/kg clean
	28 micron wool	566 c/kg clean
Merino	wether hoggets	$39.00/hd
	ewe hoggets	$42.33/hd
1st cross ewes	2nd cross lambs	100 c/kg lw. ($48.00/hd)
cfa stock	ewes, wethers, rams	50 c/kg lw.

Table 5. Sources of input prices for the farm budgets

Data Type	Source
Pasture input costs	Richardson's Hardware and Agriculture Pty Ltd, Armidale
	The Land Farm Costs Guide (Rural Press Group, 2001a)
Beef input costs	NSW Agriculture Beef Budgets (Llewellyn and Davies, 2001)
	Cooperating district graziers
Sheep input Costs	Richardson's Hardware and Agriculture Pty Ltd, Armidale
	Cooperating district graziers
	The Land Farm Costs Guide (Rural Press Group 2001a)
	NSW Agriculture Sheep Budgets (Webster, 1998)
Livestock purchase prices	*The Land* sale reports for Northern Tablelands (Rural Press Group, 2001b)
	District extension officers and cooperating district graziers

3.5 The Northern Tablelands Whole-Farm Linear Program

The Northern Tablelands farming system described above is quite complex. There are a number of possible sheep and cattle enterprises that compete for different types of pasture and for other farm resources. In such circumstances, it is useful to also model the farming system in a linear programming framework. Linear programming allows the joint evaluation of concurrent farm activities, while considering the costs and returns of all enterprises and any resource adjustments imposed by adoption of the technology. In this farming system, the whole-farm focus incorporates various aspects of the pasture base, resource constraints and sheep and cattle interactions. Such a characterisation is particularly useful when the task is to evaluate the potential benefits of a new technology that may be appropriate for this farming system.

Therefore, a Northern Tablelands linear programming (NTLP) model is constructed to represent a typical beef-sheep farm on the Northern Tablelands of New South Wales. It is derived from the Department of Natural Resources and Environment's whole-farm LP for various pastoral regions of Victoria as well as from previous LP models including Farquharson (1991). The NTLP model uses the same approach as in MIDAS (Kingwell and Pannell, 1987), in which the farm system is based upon a single year in equilibrium for which various beef and sheep enterprises and management strategies are selected to maximise the farm's total gross margin. Calendar months are used as the time unit for farm activities.

The grazing enterprises included as options are those which are common in the Northern Tablelands grazing system as identified by regional agricultural advisors and researchers and some local graziers. The management practices are based upon "best management practices" as described by NSW Agriculture officers, however management targets may be altered in the model, such as herd of flock reproductive performance, animal growth rates and pasture growth rates. Similarly, management strategies such as timing of calving or lambing can also be adjusted.

The basic NTLP matrix includes some 166 activities and 112 constraints. Three sheep activities and four cattle activities are available for selection, as outlined above. In the matrix a large proportion of the activities are related to feed transfers between months and fodder conservation actions. The supplementary feeding of livestock also necessitates significant detail. Pasture production and supplementary feeding assumptions included in the LP are provided in Appendices B and C. Following the method used to outline the MIDAS model (Kingwell and Pannell, 1987), Table 6 provides an overview of the general structure of the NTLP matrix and the proportion of activities and constraints allotted to various components of the LP.

Further details of the Northern Tablelands LP model are provided in the companion Economic Research Report (Alford, Griffith and Cacho, 2003).

Table 6. Outline of the structure of the Northern Tablelands linear program matrix

		Pasture types (3)	Choose Sheep enterprises (6)*	Choose Cattle enterprises (8)*	Casual Labour Requirement (12)	Pasture feed consumed or transferred (72)	Hay/Silage activities - make/ buy/sell (6)	Feed out fodder (24)	Buy/feed grain (12)	Sell animal products (23)	Sign	RHS term
Land area (1)	Ha	1									=	Area
Pasture type areas (3)	Ha	1									<=	Area
Fodder constraints (4)							1				<=	Area
Fodder pools Hay/grain (2)	MJ						-a, +a	+a			<=	0
Threshold enterprise levels (7)			1,-a	1,-a								
Pasture production (36)	MJ	-a				+a, -a					<=	0
Feed Pool (12)	MJ		+a	+a		-a		-a	-a		<=	0
Max. Dry Matter Intake (12)	T DM		+a	+a		-1		-1	-1		>=	0
Labour constraints (12)	Hrs		+a	+a	-1						<=	Max permanent labour
Animal Outputs (23)	Kg or Head		-a	-a						1	=	0

Numbers in parentheses refer to numbers of rows or columns in matrix.
"a" and "1" refers to the coefficients in matrix. Sign refers to type of constraint either equality or inequality in matrix.
* includes binary integers to incorporate minimum enterprise sizes (500 breeding units or wethers for sheep enterprises and 100 breeding cows for cattle enterprises).
Outline follows Kingwell (1987).

4. The Northern Tablelands Representative Farm Model

In this section the objective is to describe a representative farm model of a livestock property on the Northern Tablelands of New South Wales. As noted above, the Northern Tablelands representative farm model is assumed to have an area of 920 hectares, managed by an owner/operator with further part-time assistance from family labour. This farm has a mix of native and improved pasture, and runs a mix of sheep and cattle enterprises. In this section the enterprise mix is described as well as the overhead costs, the annual operating budget and the statement of assets and liabilities of the farm.

4.1 The Representative Farm Model

The wide range of sheep and cattle enterprises from which producers on the Northern Tablelands can choose has already been described. In developing the representative farm model, one of the many possible enterprise mixes was chosen as being typical of the area. In making this choice, guidance was received from the published ABS and ABARE statistics, from the views of local graziers and NSW Agriculture extension officers, and from simulations of a profit-maximising farm plan generated by the NTLP model.

4.1.1 The Representative Farm Plan

The optimal farm plan for the representative year to maximise farm total gross margin using long run commodity price averages was determined by the NTLP model to include three enterprises. These were 1 108 first-cross ewes, 1 732 Merino wethers and a beef herd of 127 cows producing 18 month old steers at 448kg liveweight and excess heifers sold as 9 month old weaners. See Alford *et al.* (2003) for details. This farm plan was taken back to the local advisory and research staff and they all agreed that such an enterprise mix was broadly representative of the Northern Tablelands grazing system. Thus, it was adopted as the representative farm plan.

Compared with the 1996/97 ABS data quoted above, the model under-predicts the size of the wool enterprise and over-predicts the size of the lamb enterprise, with the cattle enterprise almost exactly right. These differences reflect the problems mentioned previously of comparing the economic structure of the farming system in a particular year versus that in a more "representative" year.

4.1.2 The Whole-Farm Operating Budget

The whole–farm budget for the representative farm for the Northern Tablelands includes a statement of assets and liabilities and an annual operating budget. The operating budget includes the cash income and costs associated with each of the farm enterprises as well as the fixed costs incurred for running the farm over the year to derive the farm cash income. An allowance for depreciation (based on 10 per cent of the value of the farm's plant and equipment) along with interest costs are deducted from farm cash income to determine farm operating surplus. Family labour may also be accounted for by subtracting an allowance from the farm cash income (Makeham and Malcolm, 1993). However, in this report no family labour allowance has been subtracted and the resulting farm operating surplus represents a return on owner-operated labour, management and farm assets. Labour requirements in excess

of owner-operated labour availability are purchased at a casual labour rate. Labour budgets for various enterprises are detailed in Alford, Cacho and Griffith (2003).

Pasture costs have not been apportioned to the specific animal enterprises and therefore appear as separate negative gross margins. Similarly, supplementary feeding costs and fodder conservation activities determined by the LP (based upon monthly ME requirements of the animals) were not attributed to a specific animal enterprise but are listed as a separate negative gross margin.

Assumptions regarding the typical overhead costs and debt levels were formed from examination of ABARE survey data for the Northern Tablelands. Average values were determined from the 1990/91 to 2000/01 survey data expressed in 2000/01 dollar terms. These were compared with data from farm business management workshops run during 2000 and 2001 by one of the regional extension officers, to confirm that the average values determined fell within the ranges obtained from these workshops (Marchant, *pers com*). An examination of the relative standard errors estimated by ABARE indicates the variability in the cost overheads that exists between farm businesses.

For this farm plan, the representative year annual operating budget (Table 7) shows a total gross margin for the farm of $86, 191 and total overhead costs for the year of $24, 720. This results in a farm cash income of $61, 471 and a farm operating surplus of $37, 471 after depreciation and interest costs. Note that no allowance for operator and family labour has been made in this case.

The farm operating surplus achieved on this model farm as a percentage of the owner's equity is 2.7 per cent in the representative year. This represents a return on operator and family labour, management and equity. Low returns to equity are typical of Australian broadacre agriculture, and more particularly of specialist livestock producers (Riley, Gleeson, Martin and Delforce, 2001).

4.1.3 Assets and Liabilities of the Representative Farm

The statement of assets and liabilities is based upon estimates of the various capital items including land, livestock and plant and machinery and farm structures determined from the sources previously described. They would require careful re-estimation if applied to any particular farm.

The representative year statement of assets and liabilities (Table 8) shows total assets of the farm to be $1, 498, 060 and liabilities of $100, 000 which equates to an equity level of 93.3 per cent. ABARE survey data suggest that Northern Tablelands pastoral farms typically have high levels of equity, with an average level of equity over the 11 years 1990/1 to 2000/1 of 90 per cent, from those farms surveyed.

Table 7. Whole-farm budgets for representative sheep-beef farm for Northern Tablelands: representative year annual operating budget (2001 dollars)

			Representative Year*	
Annual Operating Budget				
920 ha Total farm				
Enterprise Gross Margins				
Prime Lamb Production	1 108	ewes	$43.71	$48,430
Merino wethers (19 micron)	1 732	wethers	$19.65	$34,034
Young cattle (heavy feeder steers)	127	cows	$419.26	$53,246
Perennial pasture	450	ha	-$67.78	-$30,501
Annual pasture	30	ha	-$161.98	-$4,859
Native pasture	440	ha	-$25.40	-$11,176
Suppl. feed and fodder conservation				-$2,983
Total Farm Gross Margin:				$86,191
Overhead Costs				
Casual wages (36 hrs @ $20 /hr)				$ 720
Rates				$4,300
Registration				$1,500
Insurance (vehicle, building)				$1,500
R&M				$9,000
Other fuel costs				$3,700
Other (elect, phone, etc)				$4,000
Total Overhead Costs:				$24,720
Farm Cash Income				$61,471
Operating Costs				
Depreciation				$15,000
Interest				$9,000
Operator and family labour				$0
Farm Operating Surplus				$37,471
Business Return on Operator's Labour, Management and Equity				2.7 %

* Expressed in 2001 dollars

Table 8. Whole-farm budgets for representative sheep-beef farm for Northern Tablelands: representative year statement of assets and liabilities (2001 dollars)

				Representative year*		
Statement of Assets & Liabilities						
Assets						
Land		920 hectares @	$1200	per ha		$1,104,000
Livestock						
Sheep -	1108	First cross ewes @	$45	per ewe	$49,860	
	22	Rams @	$160	per ram	$3,520	
	1732	Merino wethers @	$40	per wether	$69,280	
	Total value of sheep					$122,660
Cattle -	127	Cows @	$600	per cow	$76,200	
	30	Heifer yearlings @	$400	per heifer	$12,000	
	52	Steer yearlings @	$500	per steer	$26,000	
	4	Bulls @	$1,800	per bull	$7,200	
	Total value of cattle					$121,400
Plant & Equipment						
		Machinery (Average value)				
				Tractor	$35,000	
				Implements	$25,000	
				Vehicles (car, ute, truck)	$50,000	
				Other (motorbikes, wool press, tools etc.)	$40,000	
	Total value of plant and equipment					$150,000
Total Assets						$1,498,060
Liabilities						
		Overdraft (limit $50,000)			$10,000	
		Term Loans			$80,000	
		Other loans			$10,000	
Total Liabilities						$100,000
Equity (Assets - Liabilities)						$1,398,060
Equity percentage (Equity / Total Assets)						93.3 %

* Expressed in 2001 dollars

4.2 Sensitivity Analysis

In this section, a number of other scenarios are examined. These include the effect of changes in price assumptions underlying the representative year whole-farm budget, for the specified set of enterprises; the relative improvement in enterprise gross margin required for a non-specified enterprise to be selected into the representative year optimal farm plan; and the effect of changes in price assumptions for different base years.

4.2.1 Profit Drivers of the Representative Farm

Examining the effect of changes in price assumptions underlying the representative year whole-farm budget provides an opportunity to examine some of the profit drivers of the farm model described in this report. The sensitivity analysis was carried out, post-optimally, by determining the effect on farm operating surplus if there were a 10 per cent favourable shift in relevant commodity prices for the enterprises listed in Table 7. That is, given the relative inflexibility in the short term of farm enterprises, how is the representative year farm plan (enterprise mix remains fixed) affected by changes in commodity prices.

Given the broadly similar investment in wool, prime lamb and beef production in the optimal farm plan for the representative year, a 10 per cent increase in either the price of sheep, wool or beef results in increases in farm operating surplus for the representative farm of similar magnitudes (Table 9). A 10 per cent increase in sheep sale prices or wool price results in the farm operating surplus increasing by 18.2 per cent and 19.7 per cent respectively, while a 10 per cent increase in beef prices results in a 15.9 per cent increase in farm operating surplus. In the case of farm costs a 10 per cent increase in fertilizer costs causes a 10.2 per cent decrease in farm operating surplus.

Table 9. Profit drivers of the representative farm

Assumption	Per Cent Change in Farm Operating Surplus
10 per cent increase in sheep slaughter price	18.2
10 per cent increase wool price	19.7
10 per cent increase in cattle price	15.9
10 per cent increase in fertilizer costs	-10.2

4.2.2 Sensitivity of the Representative Farm Plan to Price Assumptions

The optimal farm plan for the representative farm determined from the LP is sensitive to relatively small changes in input or output prices and production parameters. For example, for the representative year, small improvements in a number of the individual enterprise gross margins relative to the enterprises that are selected in the representative model would result in them displacing the currently selected enterprises. This is illustrated by the results of a sensitivity analysis using the LP model (Table 10) to determine the relative improvement in enterprise gross margin required for that activity to be selected into the representative year optimal farm plan, given the prescribed minimum enterprise size thresholds. With the exception of the beef weaner enterprise, the other available livestock enterprises require less than a 5 per cent improvement in the respective gross margins to be included in an optimal farm plan.

The relatively similar profitability levels between most of the sheep and beef enterprise options would be anticipated. The enterprises were all identified by local graziers and advisory staff as being common on the Northern Tablelands. If one or two enterprises were significantly more profitable over a number of years then it would be anticipated that the majority of Northern Tablelands producers would have concentrated their farm investment in those specific enterprises. Further, the relatively small differences in enterprise profitability when viewed in a whole-farm context also reflect the similar resource requirements that each of the enterprises have, making them readily substitutable.

Table 10. Relative improvement in enterprise gross margins required to be selected in the optimal farm plan for the representative year

Enterprise	$ Improvement in GM per breeding unit	Per cent Improvement in Enterprise GM
Self Replacing Merinos	1.61	3.0
Specialist Local Trade	10.67	3.5
Weaners	60.31	19.3
Young Cattle (18-20 month)	18.30	4.1

It should also be noted that a limitation of the LP is that being a model it is necessarily a simplification of the real world and does not capture all interactions that occur within the whole farm. A set of farm enterprises may be selected by an individual farmer to meet goals other than profitability alone, such as personal preference, labour requirements and management knowledge. As well the model may not capture the vast number of interactions such as the benefits arising from the complementary grazing effect of beef and sheep enterprises; the reduction in risk; and farmer preferences in breeding their own Merino wethers or replacement cows.

4.2.3 Whole-Farm Budget for the Northern Tablelands Representative Farm: 2002 Year

As a contrast to the optimal plan obtained for the "representative" year, the LP was re-run using the actual 2002 prices for commodities as published in NSW Agriculture beef and sheep gross margins (NSW Agriculture, 2003), as summarised in Table 11. Since farm costs in the representative year budgets are expressed in 2001 dollar terms, for 2002 these costs were inflated by 2.5 per cent which is the increase in prices paid by farmers between 2000/01 and 2001/02 (ABARE, 2003). The optimal farm plan based upon 2002 commodity prices is shown in Table 12 and includes a Prime Lamb producing enterprise of 1,558 first-cross ewes and a flock of 3,595 Merino wethers. Interestingly, no cattle enterprises are included in the optimal plan for the representative farm for this particular data set.

The 2002 annual operating budget for the representative farm is given in Table 12. Based on 2002 market prices, this farm enterprise mix achieved a total gross margin of $165,736. After overhead costs, depreciation and interest costs there was a farm operating surplus of $111,818. Based on equity totalling $1,372,870, this operating surplus represents a business return on operator labour, management and equity of 8.1 per cent.

The 2002 statement of assets and liabilities for the representative farm is provided in Table 13, the same as that used in the representative year.

As previously discussed this optimal plan is based entirely on the objective of maximising the representative farm's total gross margin and does not account for the farmer's goals, preference and attitude towards risk.

Table 11. Commodity prices used in 2002 budget

	Type	Price
Cattle Enterprises		
Vealers	steers	280 c/kg dw.
	heifers	270 c/kg dw.
Weaners	steers	125 c/kg lw.
	heifers	110 c/kg lw.
Young cattle	steers 20 m.o. 250 kg dw.	270 c/kg dw.
	heifers 18 m.o. 200 kg dw.	260 c/kg dw.
Heavy feeder steers (0-2 teeth)	steers 18 m.o. 450 kg lw.	145 c/kg lw.
	heifers sold as weaners	110 c/kg lw.
cfa stock	cows	250 c/kg dw.
	bulls	275 c/kg dw.
Sheep Enterprises		
Wool	19 micron wool	1 060 c/kg clean
	28 micron wool	858 c/kg clean
Merino	wether hoggets	$55.00/hd
	ewe hoggets	$60.00/hd
1st cross ewes	2nd cross lambs	153 c/kg lw. ($73.2/hd)
cfa stock	ewes, wethers, rams	112 c/kg lw.

4.2.4 Whole-Farm Budgets for the Northern Tablelands Representative Farm: 2003 Year

The sensitivity of the farm model to future commodity price scenarios was examined by incorporating ABARE forecast commodity price changes for 2003 over 2002. For beef this was (+2.1 per cent), for lamb (+8.3 per cent), for mutton (-22.0 per cent) and for wool (+4.6 per cent) (T. Gleeson, ABARE, *pers comm*). Farm costs were again inflated by 2.5 per cent over the 2002 costs, assuming the same rate of farm cost inflation as determined over the period 2000/01 to 2001/02 (ABARE, 2003).

As a result of these commodity price forecasts and the assumed increase in farm costs the optimal farm plan is the same as the enterprise mix determined for the 2002 year, with 1,558 first-cross ewes and 3,595 Merino wethers (see Table 14). The resulting total farm gross margin is $164,475 and a farm operating surplus of $109,438. Assuming the same values as used in the 2002 Assets and Liabilities (Table 13) the business return on operator's labour, management and equity is 8.0 per cent.

Table 12. Whole-farm budgets for representative sheep-beef farm for Northern Tablelands: 2002 annual operating budget

				For the year Jan-Dec 2002
Annual Operating Budget				
920 ha Total farm				
Enterprise Gross Margins				
Prime Lamb Production	1 558	ewes	$84.33	$131,386
Merino wethers (19 micron)	3 595	wethers	$23.70	$85,202
Perennial pasture	450	ha	-$69.47	-$31,262
Annual pasture	30	ha	-$166.02	-$4,981
Native pasture	440	ha	-$26.03	-$11,453
Suppl. feed and fodder conservation				-$3,156
Total Farm Gross Margin:				$165,736
Overhead Costs				
Casual wages (241 hrs @ $20.50 /hr)				$4,941
Rates				$4,408
Registration				$1,538
Insurance (vehicle, building)				$1,538
R&M				$9,225
Other fuel costs				$3,793
Other (elect, phone, etc)				$4,100
Total Overhead Costs:				$29,543
Farm Cash Income				$136,193
Operating Costs				
Depreciation				$15,375
Interest				$9,000
Operator and family labour				$0
Farm Operating Surplus				$111,818
Business Return on Operator's Labour, Management and Equity				8.1 %

Table 13. Whole-farm budgets for representative sheep-beef farm for Northern Tablelands: 2002 statement of assets and liabilities

				For the year Jan-Dec 2002		
Statement of Assets & Liabilities						
Assets						
Land		920 hectares @	$1200	per ha		$1,104,000
Livestock						
Sheep -	1,558	First cross ewes @	$45	per ewe	$70,110	
	31	Rams @	$160	per ram	$4,960	
	3,595	Merino wethers @	$40	per wether	$143,800	
	Total value of sheep					$218,870
Plant & Equipment						
		Machinery (Average value)				
			Tractor		$35,000	
			Implements		$25,000	
			Vehicles (car, ute, truck)		$50,000	
			Other (motorbikes, wool press, tools etc.)		$40,000	
	Total value of plant and equipment					$150,000
Total Assets						$1,472,870
Liabilities						
		Overdraft (limit $50,000)			$10,000	
		Term Loans			$80,000	
		Other loans			$10,000	
Total Liabilities						$100,000
Equity (Assets - Liabilities)						$1,372,870
Equity percentage (Equity / Total Assets)						93.2 %

Table 14. Whole-farm budgets for representative sheep-beef farm for Northern Tablelands: 2003 annual operating budget

				For the year Jan-Dec 2003
Annual Operating Budget				
920 ha Total farm				
Enterprise Gross Margins				
Prime Lamb Production	1 558	ewes	$87.92	$136,979
Merino wethers (19 micron)	3 595	wethers	$22.14	$79,593
Perennial pasture	450	ha	-$71.17	-$32,027
Annual pasture	30	ha	-$170.07	-$5,102
Native pasture	440	ha	-$26.67	-$11,735
Supplementary feed and fodder conservation				-$3,233
Total Farm Gross Margin:				$164,475
Overhead Costs				
Casual wages (241 hrs @ $21.00 /hr)				$5,061
Rates				$4,518
Registration				$1,576
Insurance (vehicle, building)				$1,576
R&M				$9,456
Other fuel costs				$3,888
Other (elect, phone, etc)				$4,203
Total Overhead Costs:				$30,278
Farm Cash Income				$134,197
Operating Costs				
Depreciation				$15,759
Interest				$9,000
Operator and family labour				$0
Farm Operating Surplus				$109,438
Business Return on Operator's Labour, Management and Equity				8.0 %

5. Economic Evaluation of New Technologies at the Farm Level – Example Application of the Northern Tablelands Whole-Farm Model

5.1 Introduction

Declining terms of trade for Australian farmers require farm managers to continually increase productivity through the application of new production technologies on the farm. Farm-level evaluation of a new technology using LP has the ability to jointly evaluate concurrent farm activities, considering the costs and returns of all enterprises and the resource adjustment imposed by adoption of the technology (Griffith *et al.*, 1995).

The following case study applies the whole-farm budgets developed in this report and the Northern Tablelands LP to estimate the likely economic benefits of a hypothetical pasture technology that could be applied to Northern Tablelands farming systems.

5.2 Case Study– Improvement in Winter Pasture Growth

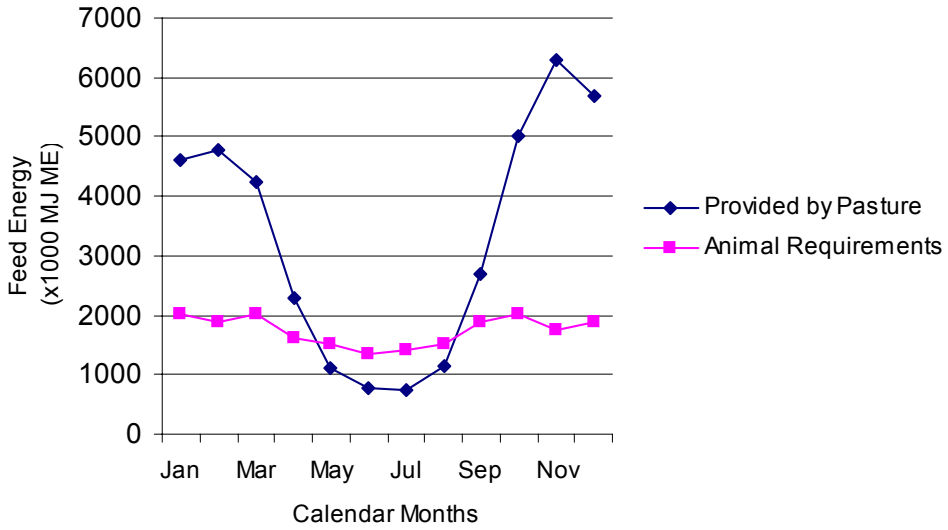
The representative farm model along with the associated LP can account for the opportunity cost of feed supply within a year since pasture growth is based upon calendar months. Therefore it is a suitable basis for *ex ante* estimation of new technologies aimed at improving pasture base productivity.

Within the last two decades various reviews of research priorities for Australia's pasture base have been undertaken (for example, Wheeler *et al.* (1987) and Kemp (1994)). A production limitation recognised in the high rainfall regions of the New South Wales tablelands is the relatively low growth rates of introduced pastures species through the winter period.

Recently, Ayres *et al.* (2001) quantified the limitations of the feed year for the Northern Tablelands with respect to grazing cattle. Specifically they identified two major limitations to production from pasture - the winter-early spring feed gap that is a consequence of the cold winter; and limits on pasture quality in summer-autumn that is as a result of the poorer nutritive value of the secondary regrowth pasture. Figure 5 shows the relationship between animal energy requirements throughout the year and the energy supplied by a typical pasture mix in the Northern Tablelands, as estimated by the Northern Tablelands LP. Researchers have highlighted the potential to target pasture species and cultivar selection to address this winter feed limitation. Examples include Lazenby and Lovett (1975) with tall fescue; Robinson and Archer (1988) with *Poa seiberana*, amongst others; and Ayres *et al.* (2000) with tall fescue (*Festuca arundinacea*) and phalaris (*Phalaris aquatica*).

Donnelly, Freer and Moore (1994) used GRAZPLAN to undertake an evaluation of pasture breeding objectives by examining the impact of improving winter pasture growth on the gross margin of a Merino wether enterprise. They estimate that selection of a more active winter cultivar could increase daily growth rate between May and September by at least 25 per cent. Application of a whole-farm LP might also provide additional insights into such a problem, given the known interactions between sheep and cattle requirements, pasture productivity and other farm constraints.

Figure 5. Comparison of animal feed requirements and pasture feed produced on the representative farm



Two scenarios relating to improved winter pasture growth were run using the Northern Tablelands representative whole-farm model. They are:

1. a 10 per cent increase in winter pasture growth (May to September) from using different cultivars in the perennial pasture. This pasture is assumed to cover 49 per cent of farm area, and pasture seed costs are assumed to increase by 30 per cent, and

2. a 15 per cent increase in growth of the same pasture over the same time period (with pasture seed costs increased by 50 per cent).

A more conservative improvement in winter pasture growth of 10 or 15 per cent was used in these scenarios compared with the Donnelly *et al.* (1994) assumption of 25 per cent, while it was assumed that pasture growth from this improved perennial pasture for the rest of the year remains unchanged.

From this analysis it is found that a 10 per cent increase in winter pasture growth on the introduced pasture area of 450 ha (out of a total 920 ha) would result in a 4.9 per cent increase in farm Total Gross Margin. Similarly, a 15 per cent increase in winter growth results in a 7.1 per cent increase in TGM (Table 15). This corresponds to an increase in Farm Cash Income of 6.9 per cent and 9.9 per cent for the 10 per cent and 15 per cent winter pasture growth scenarios respectively. These improvements in the profitability of the representative farm were achieved by increasing the investment in prime lamb and young cattle enterprises and decreasing the investment in Merino wethers. Wether numbers on this representative farm are predicted to fall from 1,732 (base case) to 1,672 (10 per cent winter pasture increase) and to 1,653 (15 per cent winter pasture increase), respectively. This indicates that the prime lamb and young cattle enterprises, under the current assumptions of the model, better utilise the resources available given an increase in winter pasture growth.

Table 15. Summary of farm-level benefits from improvements in the winter growth potential of introduced pasture species to the representative farm

	Base	10 per cent increase in winter growth	15 per cent increase in winter growth
Total Gross Margin[1] ($)	85,471	89,689	91,551
(per cent improvement over base)		(4.9 per cent)	(7.1 per cent)
Enterprises: Prime lambs (ewes)	1 108	1 147	1 153
Merino wethers	1 732	1 672	1 653
Young cattle (cows)	127	137	143
Feed related costs ($ per dse)	7.81	7.63	7.57
(per cent reduction in feed costs)		(2.3 per cent)	(3.1 per cent)
Additional increase in annual ME provided by the pasture		1.7 per cent	2.5 per cent

[1]TGM includes casual labour costs

Further analysis of these results would include an investigation of the sensitivity of these results to key price and management assumptions used in the LP model. Some of these issues are examined in the companion Economic Research Report (Alford *et al*., 2003).

Finally, the pasture enterprise budgets (Appendix B) underlying the LP model account for the annual maintenance cost of the pasture and an annualised cost of establishing the pasture, so the results reported in Table 15 compare the values of three types of pasture, *after establishment*. A more complete analysis would include a cash flow budget and the implications for TGM while the pasture development was being done. Also, there may be some additional capital required to achieve the optimal stocking levels of prime lambs and cattle, above that retained from the partial liquidation of the wether flock, and these costs would need to be accounted for in the development budget. These investment costs could also be modelled in the multi-period version of NTLP, as described in Alford *et al*. (2003).

6. Summary and Conclusions

The Northern Tablelands region of New South Wales is defined to include the Walcha, Uralla, Armidale-Dumaresq, Guyra, Severn, Glen Innes and Tenterfield local government areas. This region covers an area of approximately 3.12 million hectares including 2.11 million hectares occupied by agricultural establishments (ABS, 1998). From the latest available ABS agricultural census data, there were 2295 establishments carrying out agricultural activities in the Northern Tablelands region, producing agricultural commodities to the value of $217.8 million in 1996/97. Sheep and cattle production were the dominant agricultural enterprises, contributing 86 per cent of this total value including wool (41.7 per cent), beef cattle slaughterings (36.1 per cent) and sheep and lamb slaughterings (8.4 per cent).

Given this pattern, major issues for Northern Tablelands agriculture relate to the economic and environmental sustainability of the beef and sheep grazing system. Economic models of the relevant farming system are a useful first step in understanding the nature of the biological and economic constraints facing producers in their decision making in relation to these issues. Such models are also useful in relation to more general concerns such as the expected impacts of new investments in technologies applicable to grazing systems, or of external events such as drought conditions or a depreciation in the exchange rate. Such an economic model for the Northern Tablelands livestock farming system is described in this report.

Because of the mixed farming nature of the enterprises commonly run, a whole-farm perspective is taken. The whole–farm budget for a representative farm for the Northern Tablelands includes a statement of assets and liabilities and an annual operating budget. The statement of assets and liabilities is based upon estimates of the various capital items including land, livestock and plant and machinery and farm structures. The annual operating budget includes the cash income and costs associated with each of the farm enterprises as well as the fixed costs incurred for running the farm over the year to derive the Farm Cash Income. Allowances for depreciation and interest costs are deducted from farm cash income to determine farm operating surplus. No family labour allowance is subtracted, so the resulting farm operating surplus represents a return on owner-operated labour, management and farm assets. Pasture costs have not been apportioned to the specific animal enterprises and therefore appear as separate negative gross margins. Similarly, supplementary feeding costs and fodder conservation activities are listed as a separate negative gross margin.

A representative whole-farm model of the Northern Tablelands livestock farming system was developed based on ABS and ABARE data on the relevant industries, from simulations with a linear programming model, and from discussions with local graziers and extension officers. The model farm is based on average prices and costs over an extended period of time. The farm comprises 920 ha of which about half is native pasture and about half is introduced pasture. This farm runs a flock of 1,108 first-cross ewes, a flock of 1,732 Merino wethers and a herd of 127 cows producing 18 month old steers suitable for the heavy feeder steer market.

Compared with the 1996/97 ABS data quoted earlier, the model farm has a smaller wool enterprise and a larger lamb enterprise, with the cattle enterprise almost exactly right. These differences reflect the problems mentioned previously of comparing the economic structure of the farming system in a particular year versus that in a more "representative" year.

For this farm plan, the annual operating budget shows a total gross margin of $86,191 and total overhead costs for the year of $24,720. This results in a farm cash income of $61,471 and a farm operating surplus of $37,471 after depreciation and interest costs. The statement of assets and liabilities shows total assets of the farm to be $1,498,060 and liabilities of $100,000 which equates to an equity level of 93.3 per cent. The farm operating surplus achieved on this model farm as a percentage of the owner's equity is 2.7 per cent. This represents a return on operator and family labour, management and equity. One result therefore is that low returns to equity are typical of Northern Tablelands livestock farming systems, just as they are of most of Australian broadacre agriculture.

Other scenarios examined included whole-farm budgets based on 2002 actual market prices and on 2003 expected prices. Given the relatively high prices for sheep relative to cattle in these years, the representative farm would be more profitable running just sheep - 1,558 first-cross ewes and 3,595 Merino wethers. Such an enterprise mix would achieve a farm total gross margin of $165,736. After overhead costs, depreciation and interest costs there would be a farm operating surplus of $111,818. Based on equity of $1,472,870, this surplus would represent a business return on operator labour, management and equity of 8.1 per cent.

However, while the Northern Tablelands representative farm model would suggest that greater profits could be achieved from changing enterprises as commodity prices change, in practice various biological lags, infrastructure, financial and management constraints prevent regular changes in farm enterprises. In fact, diversification amongst a variety of farm enterprises between various sheep and cattle enterprises as evidenced in the Northern Tablelands is one management response to this commodity price variability. Producers' attitudes to risk, and the fact that most establishments maintain both cattle and sheep infrastructures, means that such establishments continue to run a mix of cattle and sheep enterprises. However, if enterprise gross margins change by large amounts, or if there is a major change in the quantity or quality of resources available to the producer, then the enterprise mix does change in a substantial way (see the related discussion in Alford, Griffith and Cacho 2003).

A proposed technology examined with the model was a new pasture variety that gave improved growth in winter. It was shown that a 10 per cent increase in winter pasture growth on the introduced pasture area of 450 ha (out of a total 920 ha) would result in a 5.0 per cent increase in farm total gross margin. This corresponds to an increase in farm cash income of 6.9 per cent. These improvements in the profitability of the representative farm were achieved by increasing the investment in prime lamb and cow enterprises and decreasing the investment in Merino wethers. This indicates that the prime lamb enterprise and the young cattle enterprise, under the current assumptions of the model, better utilise the new resource available (an increase in winter growth in introduced pasture). However a more complete analysis using a pasture development budget would be required to confirm whether this potential increase in farm income could be achieved in practice.

The development of the whole-farm model described in this Report has had a profitability focus to date. Ongoing research is aimed at expanding this focus to include natural resource management issues, such as the well-known decline in pasture productivity, hydrological impacts on regional river catchments and the emerging problems of dryland salinity and soil acidity.

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Appendices

Appendix A: ABARE Survey Data 2000/01

2000/01	Unit	Northern Tablelands Sheep-Beef	Relative standard error
PHYSICAL ESTIMATES			
Farm area	ha	958	(31)
Wheat area harvested	ha	0	
Sheep flock June 30	no	4549	(24)
- ewes	no	2089	(24)
- lambs	no	1167	(32)
- rams	no	43	(46)
- wethers	no	1251	(42)
Cattle herd June 30	no	250	(28)
- bulls	no	5	(30)
- calves	no	52	(50)
- cows	no	126	(22)
- replacement heifers	no	34	(28)
- other	no	33	(56)
Area sown to cereals	ha	0	
Area sown to pulses	ha	0	
Area sown to oilseeds	ha	0	
Area sown to other crops	ha	1	(85)
Wheat production	t	0	
Other grain production	t	29	(97)
Sheep sold	no	1223	(5)
Prime lambs sold	no	40	(144)
Other lambs sold	no	267	(85)
Beef cattle sold	no	121	(19)
Sheep and lambs shorn	no	4426	(23)
Ewes mated	no	1715	(17)
Lambs marked	no	1460	(14)
Lambing rate	%	87	(14)
Wool produced	kg	16417	(33)
Amount of labour used	weeks	146	(35)

Appendix A (continued)

2000/01	Unit	Northern Tablelands Sheep-Beef	Relative standard error
CASH RECEIPTS			
Sheep receipts excluding prime lambs	$	29564	(18)
prime lambs	$	1691	(144)
Beef cattle sales	$	59244	(25)
Other livestock	$	0	.
Wool	$	189662	(35)
Wheat	$	0	.
Barley	$	0	.
Sorghum	$	0	.
Pulses	$	0	.
Oilseeds	$	0	.
Other crop receipts	$	668	(85)
Off farm share farming	$	0	.
off farm contracts	$	0	.
Other cash receipts	$	2432	(53)
Total cash receipts	$	283260	(27)
CASH COSTS			
Sheep purchases	$	6247	(39)
Beef cattle purchases	$	11869	(61)
Wages of hired labour	$	7043	(52)
Shearing and crutching	$	8491	(35)
Fertiliser	$	6427	(34)
Fodder	$	5061	(40)
Crop and pasture chemicals	$	713	(97)
Fuel, oil and grease	$	7397	(23)
Repairs and maintenance	$	10903	(17)
Other materials	$	11191	(37)
Administration	$	4824	(26)
Contracts	$	3207	(56)
Rates	$	4058	(53)
Freight	$	2588	(21)
Handling and marketing	$	31068	(21)
other services	$	9844	(40)
Interest paid	$	15236	(35)
Rent	$	300	(54)
On farm share farming payments	$	0	.
Other costs	$	868	(39)
Total cash costs	$	147335	(19)
GM costs	$	*86904*	
GM	$	*110130*	

Appendix A (continued)

2000/01	Unit	Northern Tablelands Sheep-Beef	Relative standard error
FARM PERFORMANCE			
Farm cash income	$	144432	(19)
- Plus build up in trading stock	$	-8885	(133)
- Less depreciation	$	18982	(24)
- Less operator and family labour costs	$	54867	(30)
Farm business profit	$	61698	(49)
Farm business profit at full equity	$	64814	(48)
- Plus capital appreciation	$	103340	(19)
Profit at full equity including capital appreciation	$	168153	(26)
Opening value of capital	$	1666673	(18)
Closing value of capital	$	1585024	(17)
Farm equity at 30 June	$	1631961	(17)
Farm equity ratio	%	93	(1)
Off farm income	$	54867	(30)
Rate of return excluding capital appreciation	%	3.5	(36)
Closing debt at 30 June	$	26955	(107)

Source: ABARE (unpublished data).

Appendix B: Representative Farm Enterprise Budgets for the Representative Year (2001 dollar values)

Pasture Enterprise Budgets

Enterprise: **Perennial Pasture**
Enterprise Unit: **hectare**

Representative Year - 2001 dollar values

ESTABLISHMENT COSTS	Rate	Unit		Cost	Unit	TOTAL
Chisel 0.7hrs/ha/chisel (x2)	1.4	hrs/ha	@	16.95	per hour	23.73
Scarifier (x2)	0.84	hrs/ha	@	15.1	per hour	12.68
Sowing - combine	0.5	hrs/ha	@	23.37	per hour	11.69
Seed						
Demeter Fescue	5	kg/ha	@	5	\kg	25
Australian Phalaris	2.5	kg/ha	@	9	\kg	22.5
Perennial ryegrass (Impact)	1.5	kg/ha	@	5.5	\kg	8.25
White Clover (Haifa)+ innoc, lime	1	kg/ha	@	4.5	\kg	4.5
Fertiliser						
Starter	125	kg/ha	@	520	per tonne	65
Herbicides						
2,4DB	2.1	L/Ha	@	13.5	per litre	28.35
TOTAL ESTABLISHMENT COSTS						**$ 201.70**
VARIABLE COSTS	Rate	Unit		Cost	Unit	TOTAL
Lifespan of Perennial Pasture				**15**	years	
ESTABLISHING COSTS PER YEAR						13.45
Maintenance Fertiliser						
Years 2-4 SuperP (spread)	375	kg/ha	@	326	per tonne	122.25
Years 5-15 SuperP (spread)	125	kg/ha	@	326	per tonne	40.75
			Average annual maintenance fertiliser			54.33
TOTAL ANNUALISED COSTS						**$ 67.78 /ha**

Enterprise: **Native- Pasture**
Enterprise Unit: **hectare**

ESTABLISHMENT COSTS	Rate	Unit		Cost	Unit	TOTAL
Seed						
White Clover (Haifa)+ innoc, lime	1	kg/ha	@	4.5	\kg	4.5
Subclover (Junee)+ innoc, lime	4	kg/ha	@	4.7	\kg	18.8
Fertiliser						
SuperP (spread)	125	kg/ha	@	326	per tonne	40.75
Herbicides						
2,4DB	2.1	L/Ha	@	13.5	per litre	28.35
Herbicide application	0.2	hrs/ha	@	16.7	per ha	3.34
TOTAL ESTABLISHMENT COSTS						**$ 95.74**

VARIABLE COSTS	Rate	Unit		Cost	Unit	TOTAL
Lifespan of Perennial Pasture				**15**	years	
ESTABLISHING COSTS PER YEAR						6.38
Years 2-15 SuperP (spread)	62.5	kg/ha	@	326 per tonne	20.375	
Average annual maintenance fertiliser						19.02
TOTAL ANNUALISED COSTS						**$ 25.40/ha**

Enterprise: **Forage Oats**
Enterprise Unit: **hectare**

ESTABLISHMENT COSTS	Rate	Unit		Cost	Unit	TOTAL
Chisel 0.7hrs/ha/chisel (x2)	1.4	hrs/ha	@	16.95	per hour	23.73
Offset disc	0.6	hrs/ha	@	15.1	per hour	9.06
Sowing - combine	0.5	hrs/ha	@	23.37	per hour	11.69
Seed						
Oats (Bass)	70	kg/ha	@	0.75	\kg	52.5
Fertiliser						
Starter	125	kg/ha	@	520	per tonne	65
TOTAL ANNUAL COSTS						**$ 161.98**

Beef Cattle Enterprise Budgets

Enterprise: **Specialist local trade (vealers)**

Enterprise Unit: **100 cows (cross-bred)**

Representative Year - 2001 dollar values

Herd parameters:

Conception rate (cows)	90 %
Conception rate (heifers)	100% (bought PTIC*)
Weaning rate	82 %
Adult mortality	2 %
Yearling mortality	3 %
Calf mortality	5 %
Bull requirement	3 %
Bull cull rate	33 %
Age at First Calving	2 years
Cow cull age	10 years

Income:

41.4	Steer vealers	174 kg dw. \hd	@ 306 ¢/kg dw.	22 043.02
41.4	Heifer vealers	155 kg dw. \hd	@ 296 ¢/kg dw.	18 994.32
15.1	Cull cows	250 kg dw. \hd	@ 256 ¢/kg dw.	9 664.00
0.9	Cull bulls	450 kg dw. \hd	@ 266 ¢/kg dw.	1 077.30
			Total Income	**51 778.64**

Variable Costs:

Animal health -	vaccination, drenching and vet costs					
	Cows	99.7	@	2.73	\hd	272.18
	Bulls	2.7	@	64.23	\hd	173.42
	Vealers	85.7	@	0.46	\hd	39.42
Ear tags	Heifers	17.7	@	2	\hd	35.4
Selling Costs						
Cartage	Sales/ Purchases	117.4	@	7	\hd	821.80
Commission	Sales Revenue	51 779	@	4%		2 071.16
Yard dues	No. of head	16	@	3.60	\hd	57.60
MLA levy	No. of head	98.9	@	3.50	\hd	346.15
Tail tags	No. of head	98.9	@	0.11	\hd	10.88
Freight to abattoir	kg dw.	13 574	@	0.05	\kg dw	678.71
Replacements						
	Cross-bred heifers	17.7	@	775.00	\hd	13 717.50
	Bull	0.9	@	3 250.00	\hd	2 925.00
			Total Costs			**21 149.22**
			Gross margin			**30 629.42**
			Gross margin per cow			**306.29**

***** PTIC (pregnancy tested in calf)
Since the LP is based upon single breeding units, decimal places are included in the gross margin to determine costs and income per breeding unit.

Additional assumptions

Average cow liveweight: 510 kg

Cow age structure:

Age (years)	Number
2	18
3	16
4	14
5	13
6	12
7	10
8	9
9	8
Total joined	**100**
cfa cows	8

- Apart from the culling of non-pregnant cows additional culling of cows in the 2 and 3 year age cohorts is assumed due to poor type or performance.
- PTIC cross-bred heifers are purchased as replacements.
- DSE rating as determined by the model is 15.3 (based upon a 50 kg Merino wether).

Enterprise: **Weaner production (stores)**

Enterprise Unit: **100 cows (self-replacing cow herd)**

Representative Year - 2001 dollar values

Herd parameters:

Conception rate (cows)	88 %
Conception rate (heifers)	82 %
Weaning rate	84 %
Adult mortality	2 %
Yearling mortality	3 %
Calf mortality	5 %
Bull requirement	3 %
Bull cull rate	33 %
Age at first calving	2 years
Cow cull age	10 years

Income:

40.7	Steer weaners	269 kg lw. \hd	@ 167 ¢/kg lw.	18 283.66
15.5	Heifer weaners	235 kg lw. \hd	@ 157 ¢/kg lw.	5 718.73
4.3	Cull heifers	211 kg dw. \hd	@ 256 ¢/kg dw.	2 322.69
17.7	Cull cows	228 kg dw. \hd	@ 256 ¢/kg dw.	10 331.14
1.0	Cull bulls	450 kg dw. \hd	@ 266 ¢/kg dw.	1 197.00
			Total Income	**37 853.22**

Variable Costs:

Animal health -	vaccination, drenching and vet costs					
	Cows	100	@	2.73	\hd	273.00
	Heifers	25.2	@	5.73	\hd	144.40
	Bulls	3	@	64.23	\hd	192.69
	Store weaners	84.2	@	0.46	\hd	38.73
Ear tags	Heifers	25.2	@	2	\hd	50.40
Selling Costs						
Cartage	Sales/ Purchases	80.3	@	7	\hd	562.10
Commission	Sales Revenue	$37 853	@	4%		1 514.13
Yard dues	No. of head	79.3	@	3.60	\hd	285.48
MLA levy	No. of head	79.3	@	3.50	\hd	277.55
Tail tags	No. of head	79.3	@	0.11	\hd	8.72
Replacements						
	Bull	1	@	3 250.00	\hd	3 250.00
			Total Costs			**6 597.20**
			Gross margin			**31 256.02**
			Gross margin per cow			**312.56**

Since the LP is based upon single breeding units, decimal places are included in the gross margin to determine costs and income per breeding unit.

Average cow liveweight: 456 kg

Cow age structure:

Age (years)	Number
2	21
3	17
4	14
5	12
6	11
7	10
8	8
9	7
Total joined	**100**
cfa cows	7

- Apart from the culling of non-pregnant cows additional culling of cows in the 2 and 3 year age cohorts is assumed due to poor type or performance.
- DSE rating as determined by the model is 17.6 (based upon a 50 kg Merino wether).

Enterprise: **Young cattle 18-20 months (moderate growth)**

Enterprise Unit: **100 cows (self-replacing cow herd)**

Representative Year - 2001 dollar values

Herd parameters:

Conception rate (cows)	88 %
Conception rate (heifers)	82 %
Weaning rate	84 %
Adult mortality	2 %
Yearling mortality	3 %
Calf mortality	5 %
Bull requirement	3 %
Bull cull rate	33 %
Age at first calving	2 years
Cow cull age	10 years

Income:

40.5	Steers	252 kg dw. \hd	@ 283 ¢/kg dw.	28 882.98
13.9	Heifers	218 kg dw. \hd	@ 273 ¢/kg dw.	8 272.45
3.8	Cull heifers	212 kg dw. \hd	@ 256 ¢/kg dw.	2 062.34
21.0	Cull cows	228 kg dw. \hd	@ 256 ¢/kg dw.	12 257.28
1	Cull bulls	450 kg dw. \hd	@ 266 ¢/kg dw.	1 197.00
			Total Income	**52 672.05**

Variable Costs:

Animal health -	vaccination, drenching and vet costs					
	Cows	100	@	2.73	\hd	273.00
	Heifers	41.3	@	5.73	\hd	236.65
	Steers	41.3	@	5.73	\hd	236.65
	Bulls	3	@	64.23	\hd	192.69
	Store weaners	86.7	@	0.46	\hd	39.88
Ear tags	Heifers	26.7	@	2	\hd	53.40
Selling Costs						
Cartage	Sales/ Purchases	81.2	@	7	\hd	568.40
Commission	Sales Revenue	$52 672	@	4%		2 106.88
Yard dues	No. of head	80.2	@	3.60	\hd	288.72
MLA levy	No. of head	80.2	@	3.50	\hd	280.70
Tail tags	No. of head	80.2	@	0.11	\hd	8.82
Replacements						
	Bull	1	@	3 250.00	\hd	3 250.00
			Total Costs			**7 535.79**
			Gross margin			**45 136.26**
			Gross margin per cow			**451.36**

Since the LP is based upon single breeding units, decimal places are included in the gross margin to determine costs and income per breeding unit.

Average cow liveweight: 456 kg

Cow age structure:

Age (years)	Number
2	22
3	18
4	14
5	12
6	11
7	9
8	8
9	6
Total joined	**100**
cfa cows	6

- Apart from the culling of non-pregnant cows additional culling of cows in the 2 and 3 year age cohorts is assumed due to poor type or performance.
- DSE rating as determined by model is 21.2 (based upon a 50 kg Merino wether).

Enterprise: **Young cattle (0-2 teeth) – Heavy feeder steers.**

Enterprise Unit: **100 cows (self-replacing cow herd)**

Representative Year - 2001 dollar values

Herd parameters:

Conception rate (cows)	88 %
Conception rate (heifers)	82 %
Weaning rate	84 %
Adult mortality	2 %
Yearling mortality	3 %
Calf mortality	5 %
Bull requirement	3 %
Bull cull rate	33 %
Age at first calving	2 years
Cow cull age	10 years

Income:

40.6	Steers	448 kg lw. \hd	@ 170 ¢/kg lw.	30 920.96
16.5	Heifers weaners	205 kg lw. \hd	@ 165 ¢/kg lw.	5 581.13
3.0	Cull heifers	213 kg dw. \hd	@ 256 ¢/kg dw.	1 635.84
18.0	Cull cows	228 kg dw. \hd	@ 256 ¢/kg dw.	10 506.24
1.0	Cull bulls	450 kg dw. \hd	@ 266 ¢/kg dw.	1 197.00
			Total Income	**49 841.17**

Variable Costs:

Animal health -	vaccination, drenching and vet costs					
	Cows	100	@	2.73	\hd	273.00
	Heifers	43.4	@	5.73	\hd	248.68
	Steers	43.4	@	5.73	\hd	248.68
	Bulls	3	@	64.23	\hd	192.69
	Store weaners	86.7	@	0.46	\hd	39.88
Ear tags	Heifers	23	@	2	\hd	46.00
Selling Costs						
Cartage	Sales/ Purchases	79	@	7	\hd	553.00
Commission	Sales Revenue	$49 841	@	4%		1 993.64
Yard dues	No. of head	79	@	3.60	\hd	284.40
MLA levy	No. of head	79	@	3.50	\hd	276.50
Tail tags	No. of head	79	@	0.11	\hd	8.69
Replacements						
	Bull	1	@	3 750.00	\hd	3 750.00
			Total Costs			**7 915.16**
			Gross margin			**41 926.01**
			Gross margin per cow			**419.26**

Since the LP is based upon single breeding units, decimal places are included in the gross margin to determine costs and income per breeding unit.

Average cow liveweight: 456 kg

Cow age structure:

Age (years)	Number
2	20
3	17
4	15
5	13
6	11
7	9
8	8
9	7
Total joined	**100**
cfa cows	7

- Apart from the culling of non-pregnant cows additional culling of cows in the 2 and 3 year age cohorts is assumed due to poor type or performance.
- DSE rating as determined by model is 18.8 (based upon a 50 kg Merino wether).

Sheep Enterprise Budgets

Enterprise: **Self-replacing Merino ewes (19 micron)**

Enterprise Unit: **1000 ewes**

Representative Year - 2001 dollar values

Flock parameters:

Weaning rate	82 %
Weaning age	3 months
Adult mortality	3.5 %
Hogget mortality	3 %
Lamb mortality	5 %
Ram requirement	2 %
Ram cull rate	25 %
Ewe cull age	5.5 years

Income:

Wool sales

		kg/hd (greasy)	Yield (%)	Pcs/bls factor	Clean price ($/kg)	Total
1 005.3	Ewes	4.30	0.72	0.9	11.17	31 289.05
394.3	Ewe hoggets	3.40	0.69	0.9	11.17	9 299.30
394.3	Wether hoggets	3.50	0.69	0.9	11.17	9 572.81
20	Rams	5.85	0.70	0.9	11.17	823.34

Stock sales

388.4	Wether hoggets	39.00 \hd		15 147.60
121.9	Ewe hoggets	42.33 \hd		5 160.03
232.7	Cull ewes	46 kg lw. \hd	@ 50 ¢/kg lw.	5 352.10
5	Cull rams	74 kg lw. \hd	@ 50 ¢/kg lw.	185.00
			Total Income	**76 829.23**

Variable Costs:

Shearing	Ewes, hoggets	1 793.9	@	3.52	\hd	6 314.53
	Rams	20	@	5.02	\hd	100.40
Crutching	Ewes, hoggets	1 825	@	0.56	\hd	1 022.00
	Rams	20	@	1.12	\hd	22.40
Animal health						
Drenching	Adults/hoggets (broadspect.)	1 783.9	x2@	0.19	\hd	677.88
	Lambs (broadspect.)	811.1	x3@	0.13	\hd	316.33
	Adults/hoggets (narrowspect.)	1783.9	x3@	0.21	\hd	1 123.86
	Lambs (narrowspect.)	811.1	x3@	0.14	\hd	340.66
Vaccination	Adults/hoggets	1783.9	@	0.34	\hd	606.53
	Lambs	811.1	x2@	0.34	\hd	551.55
Dipping	Adults/hoggets	1 783.9	@	0.32	\hd	570.85
Jetting	Adults/hoggets	1 783.9	@	0.21	\hd	374.62
	weaners	811.1	@	0.11	\hd	89.22
Mulesing, marking	Lambs	811.1	@	0.90	\hd	729.99
Wool tax	Wool revenue	$ 50 985	@	2%		1 019.70
Commission	Wool revenue	$ 50 985	@	1.3%		662.81
Wool warehousing, testing		25.4	@	23.39	\bale	594.11

Wool cartage		25.4	@	12.50	\bale	317.50
Wool packs		25.4	@	9.50	\bale	241.30
Stock Cartage	Sales/ Purchases	748	@	1.50	\hd	1 122.00
Commission/yard dues	Stock sales revenue	$25 845	@	4.5%		1 163.03
MLA Levy		$25 845	@	2%		516.90
Replacements						
	Rams	5	@	800	\hd	4 000.00
				Total Costs		**22 478.17**
				Gross margin		**54 351.06**
				Gross margin per ewe		**54.35**

Since the LP is based upon single breeding units, decimal places are included in the gross margin to determine costs and income per breeding unit.

Average ewe liveweight: 45 kg

Ewe age structure:

Age (years)	Number
2	264
3	254
4	245
5	237
Total joined	**1000**
cfa ewes	233

- It is assumed that ewes are shorn pre-lambing.
- Hoggets not retained are sold at 18 months of age after one shearing.
- DSE rating as determined by model is 2.2 (based upon a 50 kg Merino wether).

Enterprise: **Prime Lamb production (second-cross lambs)**

Enterprise Unit: **1000 first-cross ewes**

Representative Year - 2001 dollar values

Flock parameters:

Weaning rate	108 %
Weaning age	3 months
Adult mortality	3.5 %
Hogget mortality	3 %
Lamb mortality	5 %
Ram requirement	2 %
Ram cull rate	25 %
Ewe cull age	5.5 years

Income:

Wool sales

		kg/hd (greasy)	Yield (%)	Pcs/bls factor	Clean price ($/kg)	Total
1 006	Ewes	4.6	0.68	0.9	5.66	16 385.85
20	Rams	3.8	0.72	0.9	5.66	284.94

Stock sales

1062.1	Prime lambs	48 kg lw.	\hd	@ 100 ¢/kg lw.	50 980.80
232.7	Cull ewes	57 kg lw.	\hd	@ 50 ¢/kg lw.	6 631.95
5	Cull rams	82 kg lw.	\hd	@ 50 ¢/kg lw.	205.00
				Total Income	**74 488.54**

Variable Costs:

Shearing	Ewes, hoggets	1 006	@	3.52	\hd	3 541.12
	Rams	20	@	5.02	\hd	100.40
Crutching	Ewes, hoggets	1 000	@	0.56	\hd	560.00
	Rams	20	@	1.12	\hd	22.40
Animal health						
Drenching	Adults/hoggets (broadspect.)	1 005.4	x2@	0.19	\hd	382.05
	Lambs (broadspect.)	1071	@	0.13	\hd	139.23
	Adults/hoggets (narrowspect.)	1 005.4	x3@	0.21	\hd	633.40
	Lambs (narrowspect.)	1071	@	0.14	\hd	149.94
Vaccination	Adults/hoggets	1 005.4	@	0.34	\hd	341.84
	Lambs	1 071	@	0.34	\hd	364.14
Dipping	Adults/hoggets	1 005.4	@	0.32	\hd	321.73
Jetting	Adults/hoggets	1 005.4	@	0.21	\hd	211.13
Marking	Lambs	811	@	0.90	\hd	729.90
Wool tax	Wool revenue	$ 16 668	@	2%		333.36
Commission	Wool revenue	$ 16 668	@	1.3%		216.68
Wool warehousing, testing		16.4	@	23.39	\bale	383.60
Wool cartage		16.4	@	12.50	\bale	205.00
Wool packs		16.4	@	9.50	\bale	155.80
Stock Cartage	Sales/ Purchases	1 299.7	@	1.50	\hd	1 949.55
Commission/ yard dues	Stock sales revenue	$57 818	@	4.5%		2 601.80
MLA Levy		$57 818	@	2%		1 156.36

Replacements	Replacement ewes	263.5	@	55	\hd	14 492.50
	Rams	5	@	450	\hd	2 250.00
				Total Costs		**30 776.26**
				Gross margin		**43 712.28**
				Gross margin per ewe		**43.71**

Since the LP is based upon single breeding units, decimal places are included in the gross margin to determine costs and income per breeding unit.

Average ewe liveweight: 56 kg

Ewe age structure:

Age (years)	Number
2	264
3	254
4	245
5	237
Total joined	**1000**
cfa ewes	233

- It is assumed that ewes are shorn pre-lambing.
- DSE rating as determined by model is 2.1 (based upon a 50 kg Merino wether).

Enterprise: **Merino wethers (19 micron)**

Enterprise Unit: **1000 wethers**

Representative Year - 2001 dollar values

Flock parameters:

Adult mortality	2 %
Wether cull age	5.5 years

Income:

Wool sales

	kg/hd (greasy)	Yield (%)	Pcs/bls factor	Clean price ($/kg)	Total
983 Wethers	4.75	0.70	0.90	11.17	32 857.98

Stock sales

237 Cull wethers	45 kg lw.	\hd	@ 50 ¢/kg lw.	5 332.50

Total Income **38 190.48**

Variable Costs:

Shearing	Wethers	983	@	3.52	\hd	3 460.16
Crutching	Wethers	1 000	@	0.59	\hd	590.00
Animal health						
Drenching	Wethers (broadspect.)	1 000	x2@	0.19	\hd	380.00
	Wethers (narrowspect.)	1 000	x3@	0.21	\hd	630.00
Vaccination	Wethers	1 000	@	0.34	\hd	340.00
Dipping	Wethers	1 000	@	0.32	\hd	320.00
Jetting	Wethers	1 000	@	0.21	\hd	210.00
Wool tax	Wool revenue	$ 32 858	@	2%		657.16
Commission	Wool revenue	$ 32 858	@	1.3%		427.15
Wool warehousing, testing		16.7	@	23.39	\bale	390.61
Wool cartage		16.7	@	12.50	\bale	208.75
Wool packs		16.7	@	9.50	\bale	158.65
Stock Cartage	Sales/ Purchases	237	@	1.50	\hd	355.50
Commission/yard dues	Stock sales revenue	$5 333	@	4.5%		239.99
MLA Levy		$5 333	@	2%		106.66
Replacements						
	Wether hoggets	258	@	39	\hd	10 062.00

Total Costs **18 536.63**

Gross margin **19 653.85**

Gross margin per wether **19.65**

Since the LP is based upon single breeding units, decimal places are included in the gross margin to determine costs and income per breeding unit.

Average wether liveweight: 45 kg

Wether age structure:

Age (years)	Number
1.5	258
2.5	253
3.5	247
4.5	242
Total	**1000**
5.5 cfa wethers	237

- Hoggets transferred into flock at 17 months.
- Wethers are shorn in November.
- DSE rating as determined by model is 0.9 (based upon a 50 kg Merino wether).

Supplementary Feeding Enterprise Budgets

Enterprise: **Supplementary feeding**

Representative Year - 2001 dollar values

Fodder conservation		
	Unit	Cost ($)
Mowing and raking	ha	40.00
Conditioning	ha	10.00
Bailing and cartage	tonne	30.00
Silage wrapping	tonne	40.00
Feed out cost (hay/silage)	tonne	10.00
Purchased supplements		
Purchased hay – landed	tonne (85%DM, 8 MJ ME/kg)	140.00
Purchased grain - landed	tonne (88% DM, 12 MJ ME/kg)	150.00

- Other supplementary feed assumptions include that the utilisation rate of hay, silage and grain fed to stock is 85% and the dry matter percentage of silage is 45% with an average energy content of 9 ME MJ/kg.
- The model has several constraints including:
    - a maximum of 10 tonnes (DM basis) of feed grain can be purchased in the year,
    - a maximum of 10 tonnes (DM basis) of hay can be purchased in the year, and
    - fodder conservation cannot exceed 10 hectares on the perennial pasture area and 20 hectares of the forage oats area.

Appendix C: Pasture Production Assumptions

Pasture Production (t DM/ha)

	Perennial	Native	Forage Oats
January	1.28	0.99	0
February	1.42	1.00	0
March	1.38	0.81	0.50
April	0.90	0.32	0.85
May	0.45	0.13	0.56
June	0.32	0.10	0.55
July	0.30	0.10	0.56
August	0.42	0.20	0.85
September	0.81	0.48	1.40
October	1.30	0.87	1.57
November	1.60	1.06	0.70
December	1.55	1.03	0

Pasture Quality (MJ ME/kg)

	Perennial	Native	Forage Oats
January	10.0	8.0	0.0
February	9.5	8.0	0.0
March	9.0	8.0	0.0
April	8.0	8.0	9.0
May	8.0	8.0	9.0
June	7.5	7.5	8.0
July	7.5	7.5	8.0
August	7.5	7.5	8.0
September	9.0	8.0	9.0
October	10.0	10.0	8.0
November	10.7	10.0	8.0
December	10.5	9.0	0.0

Pasture carry-over assumptions

	DM as % Previous Month	ME as % Previous month
January	0.9	0.67
February	0.9	0.72
March	0.9	0.71
April	0.9	0.75
May	0.9	0.73
June	0.9	0.73
July	0.9	0.65
August	0.9	0.60
September	0.9	0.67
October	0.9	0.75
November	0.9	0.75
December	0.9	0.70

It is assumed in the model that a maximum of 50% of pasture grown is available to livestock. In practise this means that in the lowest pasture growth month/s of the year the maximum amount of pasture utilised will be 50% while in other months pasture utilisation will be less than this amount.

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