Scoping the benefits of saving labour in sheep enterprises in Australia

Farming Systems Analysis Service
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1. Executive Summary

The long term decline in the rural population in most regions has reduced the ability of farmers to attract and retain farm labour. This has had ramifications for sheep farmers as sheep production is relatively labour intensive. Furthermore rate of improvement in the productivity of labour in the sheep industry has been low compared to the cropping enterprise.

There is a large variation between producer's cost of production within and between regions. This is a result of variation in production per hectare and adoption rates of more efficient management practices such as work amalgamation and sheep handling systems that allow more efficient undertaking of routine tasks such as drenching, dipping, jetting and crutching. Genetic improvement to develop 'easy-care' sheep that are more resistant to disease require less intervention when lambing and are more resilient and require less supplementary feeding during period when there is a shortage of paddock feed can also reduce labour costs and make sheep production more appealing. However, there is limited information available on the break-down of labour use in sheep production systems, the relative importance of different approaches to labour saving and affect of labour saving on enterprise profitability and optimal farm strategy.

Such information is likely to be useful to farmers to help them assess potential gains in productivity and also in the development of research priorities.

Detailed assessments of the impact of improvement in labour productivity have not been done for mixed farming systems in southern Australia partly because of the complexity of the problem and also the complexity of the production system. Changes to one part of the production system at a particular point in time may have flow on effects to other parts of the system in a later time period.

MIDAS (Model of an Integrated Dryland Agricultural System) provides means by which the impact of changes to the farming systems can be estimated, whilst accounting for the interactions between enterprises, in terms of the change in optimal farm strategy and whole farm profit. MIDAS has been developed for 13 regions within the mixed farming/sheep production zones of southern Australia. Over the past 30 years MIDAS has been applied to a broad range of sheep production problems confronting farmers

The aims of this project are:

1. To identify the importance of saving labour in the sheep enterprise and identify critical periods of the year in which saving labour has the highest value (i.e. a relative economic value for labour in different months).

2. To identify the relative importance of specific management and genetic interventions to improve labour efficiency and its impacts on profitability.

Method of analysis

The analysis in this report was undertaken using MIDAS. MIDAS is a whole-farm bio-economic model that is representative of a typical farm is a specific region. It describes the

production relationships in mixed farm and sheep production systems. It is designed to determine which management strategies for a typical farm that maximise farm profit. As an optimising model it is able to select the best farm strategy for a given set of assumptions from a large range of options..

Four versions of MIDAS, representing four regions of southern Australia were adapted to take explicit account of the demands for labour in the sheep and crop enterprises over the course of a calendar year. The four regions included: Great Southern of WA (GSWA), Central Wheatbelt of WA or the Cereal Sheep Zone (CSZ), southern Victoria (SWVic) and southern NSW (SNSW).

A multi-factorial analysis was completed to examine the effect on profit of improvements in the efficiency of labour allocated to sheep husbandry for two lambing times in each of the four regions. The benefit of improved efficiency was determined for each of a range of husbandry tasks as well as the benefit of improving efficiency of all tasks simultaneously.

In addition to reducing the time taken to complete individual husbandry tasks the benefits of implementing each of five management changes/innovations was also explored. These are:

- Running larger mobs of sheep,
- Employing contractors to complete certain tasks,
- Adoption of lick feeders,
- Breeding of "Easy care" sheep,
- Adoption of shedding sheep.

These were assessed for four scenarios that differed in the availability of labour as an input to production.

Conclusion

Labour shortages on farm have a large impact on farm profitability. Demand for labour in the sheep enterprise is very seasonal so this demand is best met by hiring casual labour. However casual labour is not always available and some would prefer to hire casual staff. Therefore technology or strategies that reduce the labour required in the seasonal peaks will likely increase farm profit.

Owner labour is not able to fully compensate for low labour availability because there are insufficient owner hours available during the times of peak demand. Whilst increasing the number of hours worked can improve profit, additional labour needs to purchased and/or labour efficiency improve to realise the full benefits of overcoming the constraints on labour.

A number of strategies and technologies could be adopted to reduce labour input. Improving efficiency of completing single tasks leads to small or no increases in profit. Freeing up labour in itself is not sufficient to increase farm profit because the spare labour created by the efficiency needs to be able to contribute meaningfully to other tasks that will increase production. The usually requires labour input to be reduced in a number of periods

Reducing labour input for most general tasks in the GSWA and SWVic leads to large profit increases. Sheep monitoring and grain feeding led to the biggest increase in profit across all

regions. Reducing labour input for pasture monitoring was also of high value in GSWA and SWVic. Efficiencies in mustering and administration were of high value in most scenarios examined.

Easycare sheep and lick feeders were shown to be high value strategies primarily because they led to reductions in the requirement for labour across many period of the year. Employing contractors to undertake husbandry tasks like dipping and jetting were of lower benefit because they free up labour in only a small number of periods.

MIDAS proved to be a very effective tool for analysis of labour in sheep production systems of southern Australia.

Implications of Research Findings for Industry

1. Farm profitability can be improved dramatically if labour can be hired to supplement the owner operator. However, sheep producers find it difficult to hire labour because there is no pool of willing workers. A potential area for research is to improve sheep handling methods so that workers are more willing to be involved in sheep operations.
2. For a strategy to be profitable across a number of environments and times of lambing it must reduce the requirement for labour for a number of periods of the year. Reducing the labour demand in short windows is not as valuable because labour shortages in other periods will limit the extent to which sheep numbers can be increased.
3. The returns from saving labour are much greater in the sheep dominant higher rainfall regions and therefore the net benefit to the industry will be strongly influenced by these regions. The benefits of improving labour efficiency in lower rainfall regions are likely to be lower.
4. Quantifying the tradeoffs between production and reducing labour input would help farmers make more informed decisions regarding prioritising jobs on farm. If the tradeoffs that relate to timeliness of jobs could be quantified then on-farms jobs could be better prioritised.
5. Increasing the efficiency of monitoring sheep and pastures has a high value. Some effort has been expended in the area of remote monitoring of pastures, however, to date there has been limited uptake by producers. The lack of adoption may be due to the focus on technology that provides farmers with data on pasture growth rate. An inference drawn from the results of this study is that information that provides a warning that the animals or pastures need closer monitoring, would be of more benefit.
6. Increasing the efficiency of mustering also has a high payoff for most regions and particularly for the regions with high sheep numbers. This indicates that investment in laneways to allow easy movement of sheep may be profitable.
7. Increasing mob size is valuable in all regions. One method of achieving this is through rotation grazing. Rotation grazing has been evaluated in trials but the requirement for labour has not been formally assessed.
8. Improving the efficiency of all the husbandry operations together has a high payoff for the regions that are livestock dominant. A possible mechanism for achieving this is through improved sheep handling facilities. This improvement dovetails with point 1 regarding making sheep related jobs more acceptable and less physically demanding.
9. One of the limitations of this analysis was a lack of data regarding the amount of time producers spend on different jobs. In order to carry out detailed benefit-cost analysis on potential labour saving projects this baseline information would be required. It may be possible to collect this data on-farm if farmers were provided a datalogger and trained in

its use. Provided the period of time being logged was kept short farmers are likely to be willing participants.

10. EasyCare sheep and non-wool (or shedding) breeds of sheep both showed as likely to be profitable for the owner operator who is unable or unwilling to hire labour. These two genetic approaches to saving labour are likely to be competing for adoption with the same producers and therefore improving the information available on the productivity of the genotypes and the amount of labour saved would allow more informed decision making.
11. Use of contractors will not lead to large increases in profitability unless the range of jobs that they perform is increased. If farmers become more sophisticated with the management of labour then there is likely to be a market niche for contractors who provide a wide range of services to industry.

2. Contents

1. Executive Summary 2
Method of analysis 2
Conclusion 3
Implications of Research Findings for Industry 4
2. Contents 6
3. Background 7
4. Project Aims 7
5. Description of MIDAS 8
Model Components 8
Soil Classes 9
Crop production 9
Annual pasture production 9
Lucerne production 10
Stubbles 10
Sheep production 10
Finance 11
Application of MIDAS 11
6. Method of analysis 11
Model Development 11
Running the model 11
Assumptions of the analysis 13
Standard Farms 16
7. Results & Discussion 17
Effect of labour constraints on farm profit 17
Effect of labour constraints on pasture area and livestock enterprise 17
Demand for labour in production 20
Labour efficiency of husbandry tasks 26
Labour efficiency for general tasks 29
Specific Labour Saving Packages 29
Change in distribution of labour demand 31
8. Conclusions 36
Implications of Research Findings for Industry 36
9. References 38
10. Appendix 1 39

3. Background

The demographic structure of Australian sheep farmers has changed dramatically over the last 25 years. The decline in population means that most farms experience problems in attracting and retaining farm labour and these labour restrictions have contributed in part to more crop dominant agriculture due to its relatively lower labour requirement compared to sheep production. Improvements in labour efficiency in cropping has been supported through the introduction of more crop options such as lupins and canola, and better varieties such as wheat varieties with different flowering times that suit more environments, introduction of new herbicides and new machinery technology such as direct drill and GPS-based controlled traffic systems. By contrast, sheep technology has remained relatively stagnant since the quantum changes in productivity that resulted through technologies such as fencing, mechanical shearing, mechanisation, 'sub and super' and exotic perennial pastures. One study undertaken for the Central Wheatbelt region of WA showed that the profitability and production intensity of sheep production could be limited by constraints on the supply of labour to the agricultural sector (Doole *et al*, 2009).

Huge variation still exists between producers in costs of production, resulting from increased production per hectare and adoption of more efficient management practices such as work amalgamation and sheep handling systems that allow more efficient undertaking of routine tasks such as drenching, dipping, jetting and crutching. Genetic improvement to develop 'easy-care' sheep that are more resistant to disease, require less intervention when lambing and are more resilient and require less supplementary feeding during period when there is a shortage of paddock feed can also reduce labour costs and make sheep production more appealing. However, there is limited information available on the break-down of labour use in sheep production systems and the relative importance of different management and genetic approaches to labour saving and the profitability of different enterprise types and the whole farm.

If the major structural issues primarily related to labour scarcity and scale of the sheep enterprise can be overcome there is potential for substantial gains in productivity especially given more favourable outlooks for sheep meat and wool prices as well as allowing for expansion of sheep numbers either through scale or new entrants. Identifying the 'critical control points', in terms of time of year and type of labour required, together with knowledge of current management, sheep genotype and production levels will provide MLA with insights to an investment program for further research, development and extension work to improve labour efficiency and profitability.

4. Project Aims

The key aims of this project are:

1. To identify the importance of saving labour in the sheep enterprise and identify critical periods of the year in which saving labour has the highest value (i.e. a relative economic value for labour in different months).

2. To identify the relative importance of specific management and genetic interventions to improve labour efficiency and its impacts on profitability.

5. Description of MIDAS

MIDAS (Model of a Integrated Dryland Agricultural System) is a whole farm model bio-economic model that describes mixed crop and livestock farming enterprises in a number of regions in southern Australia. Relationships for a large range of a production options are described as well and the interactions between these options. The model is built within an optimization framework which enables model users to quickly identify the set of activities that meets a desired objective. In the case of MIDAS the objective function is whole farm profit.

MIDAS is a representative farm model, calibrated to describe a farming system that is typical of those within a geographic region that is defined by climate and soil type.

Model Components

The model comprises a number different components of the farming system. These are:

(i) Crop/ pasture rotations
Cropping history (or rotation) is represented by up to 60 different activities for each of up to eight land management units described in the model.

(ii) Machinery
Represented by a single activity that describes the availability of machinery to sow crops and pasture during four periods after the break of the season. This constrains the area of crop that can be sown and the reductions in crop yield that occur as a result of delayed sowing.

(iii) Time of sowing penalties
On average, maximum crop yield is achieved when crops are sown within a narrow window after the break of season. Crop sown outside this window have reduced yields. This sub-matix describes the relationship between yield reduction and areas of crop sown, based on the availability of machinery.

(iv) Grain, wool and livestock selling
Selling activities in the model link the physical output of the model with the cashflow and objective function.

(v) Pasture production
The season is divided into 10 periods of varying length depending on the growth rate of pasture. There are 5 periods of growth and 5 periods of senescence and pasture decline.

(vi) Livestock production
A large number of livestock classes are described. These differ in the demand for energy and the levels of production.

(vii) Supplementary feeding
Alternative sources of supplementary feed are available to ensure adequate supply of energy over the summer drought.

(viii) Stubble grazing
Crop residues provide an additional source of feed for livestock during the summer drought. The quality and quantity of stubble available for grazing deteriorates with time and with grazing.

(ix) Finance
Income and expenditure associated with each activity are described in the cashflow

section of the model. Overheads and depreciation are subtracted from the net cashflow to calculate farm profit.

The model is described in more detail below.

Soil Classes

Up to eight land management units (LMU) are described in each version of the model an aggregation of soil types that have the same production levels for a given level of inputs and management. It is implied that all soils within an LMU have similar chemical and physical characteristics. Therefore the proportion of excess water that runs off into water courses and recharges the water table will be the same within each LMU.

Crop production

Different crop and pasture sequences (or rotations) are represented as single activities These are associated with specific crop yields, pasture growth and inputs levels that depend on the sequence. Pulse crops reduce the carryover of cereal diseases and fix soil nitrogen, for example. This affects potential cereal yield and optimum nitrogen rate. The number of continuous years of crop affects the ability of pastures to regenerate naturally and thus the number of livestock that can be grazed profitability is affected. Detailed information on the crop and sequences and production levels is provided in O'Connell *et al.* (2000).

Nine crop and pasture types are included in these activities. These are:

i. Wheat
ii. Barley
iii. Canola
iv. Lupins
v. Field peas
vi. Faba beans
vii. Chick peas
viii. Annual pastures (mixed sward)
ix. Perennial pasture; including lucerne, perennial grass, chicory

Annual pasture production

An annual pasture is a mixed sward of grasses and legumes. The quality and quantity of feed is the average of the sward for each period. Periods 1 to 5 represent the growing season. Each period varies in length according to growth rate and pasture quality (digestibility). Pasture is assumed to germinate in Period 1.

Germination is dependent on soil class and crop/pasture sequence. Growth rate in subsequent periods is a function of feed on offer (kg of dry matter per ha), and is approximated by linear segments. Feed on offer (FOO) is a function of FOO at the beginning of period, the amount of pasture grazed by livestock during the period and the rate of physical deterioration and trampling by livestock (Bathgate & Blennerhasset, 2000).
Pasture quality and quantity decline rapidly after senescence (Periods 6–10). This is represented by individual grazing activities for each period. Conservation constraints prevent

over grazing. Further detail on the representation of pasture production can be found in O'Connell *et al.* (2000).

Lucerne production

Lucerne is modelled differently to annual pasture. Annual pastures can be managed flexibly to optimise the supply of feed to livestock that have changing demands. Paddocks can be subject to a high grazing pressure when demand for energy is high, at the expense of future pasture growth. Alternatively annual pasture may be deferred to improve growth rate and future feed availability. The method of modelling annual pasture provides this flexibility.

Lucerne, on the other hand, requires a rigid management regime. Prolonged high grazing pressures will damage individual plants leading to a reduction in plant density. This will compromise the productivity of the lucerne stand. On the other hand prolonged deferment of pastures will lead to a decline in the quality of the feed (Stockdale & King, 1985). Lucerne is typically grazed for a period and then the livestock are excluded to encourage re-growth. In this model, the implied grazing regime is 2 weeks of grazing followed by a 6 week period of grazing rest. Sheep are removed from the lucerne stand once the feed on offer is reduced to a certain level. While this reduces flexibility of grazing management, previous studies have shown that the profitability of lucerne depends on its ability to provide good quality feed during this period (eg Bathgate & Pannell, 2002).

This rigid grazing regime enables lucerne to be modelled more simply. As the feed on offer at the end of each grazing period is known, the growth rate for the next period can be estimated prior to solving the model and can be used to determine the total feed available for that grazing period.

Stubbles

Crop residues can be a source of high quality feed for livestock after harvest. Sheep preferentially graze the high quality components of the stubble so the quality of stubble declines as it is grazed. There are three stubble grazing activities for each crop representing this decline. Transfer activities ensure the higher quality components are grazed prior to lower quality components. This prevents the model allocating the low quality pasture first and deferring the high quality portion of the stubble to late summer/autumn where the marginal value of feed is highest. Conservation constraints limit the total amount of dry matter available for grazing.

Sheep production

A self-replacing merino flock is described in the model. Three different enterprises can be represented. They include a wool only enterprise, a wool and merino prime lamb enterprise, or a cross-bred prime lamb enterprise. Forty six classes of sheep are described. They differ in age, times of sale and gender. Ewes are culled after five or six years. Death rates, annual wool growth and hauter are a function of the liveweight of each sheep class. Liveweight of ewes also affects lambing rates. Liveweights of animals are a function of the availability and quality of feed.

The relationships used to estimate production of livestock are shown in Young (1995).

Finance

Cash payments for inputs and cash received are described as a bi-monthly cashflow. Provision has been made to enable an overdraft. Interest is paid on bimonthly deficits and earned on surpluses. The objective function is equal to the net cashflow at the end of the year, less depreciation of machinery and infrastructure, less the opportunity cost of non-land assets.

Application of MIDAS

Different versions of MIDAS have been applied to broad range of pasture, livestock and crop research questions over the past 30 years and is ideally suited to help identify the potential impact of new or untested innovations/technologies on farm profit and optimal farm strategy. Recent applications include: assessing the role of perennial pasture species and assessments of the impact of farm production on the condition of natural resources. A list of regions for which a version of MIDAS has been developed is contained in the Appendx.

6. Method of analysis

Model Development

The relationship between labour supply and production levels of different enterprises in mixed farming systems was first considered in MIDAS by Doole et al (2009). BankWest data was used to model the statistical relationship between labour and production for crop and sheep enterprises. However this approach was oversimplified and lacked the detail necessary to estimate the impact of labour saving technologies for different component of the production system. This method was improved by Rose (2010), where the role of labour in different parts of the crop and livestock production systems were made explicit.

This study refined the approach adopted by Rose (2010) and added some crucial elements to the relationships between labour and farm production. The integration of these production relationships in to the model structure of MIDAS was also improved through the development of a labour module. This improved the ease with which labour constraints can be integrated into other versions of MIDAS.

The versions of MIDAS that now include the labour module are:

1. Central Wheatbelt model
2. Southern New South Wales
3. Great Southern of WA
4. South west Victoria

Running the model

A multi-factorial analysis was completed to examine the effect on profit of improvements in the efficiency of labour allocated to sheep husbandry for two lambing times in each of the four regions. The benefit of improved efficiency was determined for each of a range of husbandry tasks as well as the benefit of improving efficiency of all tasks simultaneously.

In addition to reducing the time taken to complete individual husbandry tasks the benefits of implementing each of five management changes/innovations was also explored. These are:

- Running larger mobs of sheep,
- Employing contractors to complete certain tasks,
- Adoption of lick feeders,
- Breeding of "Easy care" sheep,
- Adoption of shedding sheep.

Each change above has different demands for labour through the year, and therefore will have differing impact on the optimal production mix and hence differing effect on farm profit. Running larger mobs of sheep has the advantage of reducing the time required to monitor and muster sheep. Contractors were assumed to reduce the requirement for farm labour to undertake drenching, vaccinating, jetting and dipping. Lick feeders were assumed to reduce the time taken for grain feeding, by reducing the frequency of feeding to once per fortnight, from twice per week.
Easy care sheep were assumed to reduce requirement for drenching and jetting and monitoring. Underlying these assumptions is that easy care sheep are more resistant to internal parasites and less prone to fly strike. Shedding sheep on the other had eliminate the need for crutching and shearing as well as jetting and dipping. However there is also a reduction in wool income as wool is shed in the paddock and not retrieved.

Key results for the factorial analysis and analysis of management/innovation were summarised for each region and used to determine the impact of improving labour efficiency on farm profit between four regions of southern Australia. These are shown in the Results section of this report.

The analysis of labour in farm production systems using MIDAS was carried out in two steps:

1. Identification of the benefit of reducing the time required for each individual job carried out on sheep properties.
2. Evaluation of specific technologies for saving labour.
   The technologies evaluated are
   i) Easy Care sheep. Assumed to require less monitoring (-50%), can be run in larger mobs (+50%), require less drenching & jetting (-50%) and are20% cheaper to shear & crutch.
   ii) Running sheep in larger mobs (+50%), as may be the case with rotational grazing
   iii) Lick feeders which reduce (to 25%) the amount of time required for supplementary feeding
   iv) Non-wool (or shedding) breeds of sheep that don't require shearing, crutching, jetting or dipping.
   v) Use of contractors for major sheep husbandry jobs (drenching, vaccinating, jetting & dipping)

In each case the labour saving possible and any tradeoff with production for each technology hasn't been quantified on farms so the modelling has been based on estimates of likely saving.

Assumptions of the analysis

Table 6.1: Hours worked by each labour unit

	Usual		Seeding	
	Week days	Weekend days	Week days	Weekend days
Owner labour	10	4	12	6
Permanent labour	8	-	9	-
Casual labour	8	-	8	-

Table 6.2: Proportion of owner labour required for supervisions

Labour type	Periods 1-5, 10-18	Periods 6-9 (Seeding)
Permanent	7%	2%
Casual	25%	15%

Table 6.3: Time required for mustering and monitoring sheep flocks

		Mustering	**Flock monitoring**	
		Time required per mob	Times per week	Hours per Mob
Lambs	Merino	1.5	5	0.50
	Merino sold 5 months	1.5	5	0.50
	Merino prime lamb	1.5	5	0.50
	Cross bred-Sucker	1.5	5	0.50
	Cross bred-CO	1.5	5	0.50
Lambs	Post weaning	1.2	1	1.00
Ewes		1.0	1	0.75
Wethers		1.0	1	0.50
Hoggets		1.0	1	0.75

Table 6.4: Time required for grain feeding

Filling sheep feeder		
Capacity of auger	1000	Bushel/hr
Time required to fill sheep feeder	0.10	hr/load
	6.0	mins
	0.0010	hr/bushell
Transport between paddocks	0.20	hr/paddock
	12.0	mins/paddock
Frequency of feeding	2.0	/week

Table 6.5: Time required for fertiliser spreading

	Width of Spreader (metres)	Speed (km/hr)	Field Efficiency (%)	Rate of application (hr/ha)	Helper time % of tractor hrs (%)
Super Phosphate	20	20	30	0.08	10%
Urea	15	20	30	0.11	10%

Table 6.6: Pasture cover curve for annual pasture

Pasture period	Feed on offer S1 (kg / ha)	S2 (kg / ha)	S3 (kg / ha)	S4 (kg / ha)
P1	428	450	450	450
P2	858	913	913	913
P3	2,201	2,289	2,448	2,448
P4	3,185	3,342	3,788	3,788
P5	3,895	4,106	4,781	4,781

Table 6.7: Number of sheep per hour for each husbandry activity

	Drench	Jetting	Dip/Backline	Feed lot	Weaning	Marking	Weighing	Classing	Drafting	Shearing	Crutching
Lambs	300	400	400	1,000	200	500				333	800
Lambs sold 5 months	300	400	400	1,000	200	500	300			333	800
Carryover XB lambs	300	400	400	1,000	200	500	300			333	800
Sucker XB lambs	300	400	400	1,000	200	500	300			333	800
Hoggets - ewe	280	300	300					300		333	800
Hoggets - wether	280	300	300					300		333	800
Ewes	280	300	300						500	333	800
Wethers	280	300	300							333	800

Standard Farms

Table 6.8. Standard results for MIDAS in each of the study regions with unlimited labour available for hiring.

	Southern NSW	Cereal Sheep Zone	Great Southern	Hamilton
Profit	$269,000	$71,900	$293,700	$484,000
Area (ha)	1000	2000	1000	1000
Pasture area (%)	54	41	100	100
Stocking rate (DSE/ha)	11	5.2	13.5	23.7
Flock structure (% ewes)		76		

Southern NSW: May lambing Self replacing merino ewe flock with proportion of ewes mated to a terminal sire. Pastures based on mixed annuals or lucerne with mixed annuals.
Cereal Sheep zone: May lambing merino ewe flock with all ewes mated merinos. Pastures based annuals only
Great Southern: July lambing Self replacing merino ewe flock with proportion of ewes mated to a terminal sire. Pastures based annuals only
Hamilton: September lambing Self replacing merino ewe flock with proportion of ewes mated to a terminal sire. Pastures based on a combination of lucerne, perennial ryegrass and summer active fescue depending on location in the landscape.

7. Results & Discussion

Effect of labour constraints on farm profit

Constraints on the supply of farm labour had a significant impact on both the level of farm profit and the optimal mix of enterprises in both the mixed crop/livestock farms and the livestock only farms (Table 7.1 (a-d)). This result was consistent for the two times of lambing tested for each of the four regions.

Profit increased significantly as the supply of labour increased. The difference in farm profit between an owner operated farm compared with a farm with unlimited labour was around $70,000 in southern NSW (SNSW). This difference is much greater for Hamilton (SWVic) and the Great Southern of WA (GSWA) where the difference in profitability was around $300,000 and $200,000 respectively.

The difference in profit between unlimited labour and unlimited labour with no cost was $10,000 for the CSZ and SNSW, whilst the difference was $80,000 for SWVIC. These differences are a measure of the potential effect of labour saving technology on profit where a farmer is able to employ as much labour as required. The majority of the increase is profit results from saving in the cost of labour.

The difference in profit between owner labour only and unlimited labour with no cost is a measure of the potential gains of labour saving technology and is the gain that could be achieved if the farmer could carry out all operations themselves without the need to hire labour. The gains consist of the increase in profit resulting from running higher stock numbers and the reduction in cost of hired labour.

Effect of labour constraints on pasture area and livestock enterprise

The optimal pasture area increased in GSM and SNSW as the constraint of labour input on production was removed. In SNSW the area of pasture was more than double with no labour restrictions, whilst in GSM pasture area increased by between 10-50% depending on the time of lambing. In contrast for the cereal sheep zone the optimal pasture area was significantly lower with the removal of labour restrictions. This increase in crop area with the removal is an important adjustment to capitalise on removing the constraint on labour (Figure 7.1). This indicates that labour shortage in the cereal sheep zone is impacting on the profitability of the crop enterprise and would be contributing to the move toward farms with 100% crop in the CSZ, however, this isn't the case in the other regions.

Table 7.1: Farm profit, optimal DSE numbers and percentage area of pasture for four labour scenarios in each region.

(a) Southern NSW

	May lambing			August Lambing		
Labour supply	Profit ('000)	Past. %	DSE	Profit ('000)	Past. %	DSE
Owner labour only	197	23	1,500	191	24	1,688
Owner + casual	206	20	1,500	205	18	1,539
Unlimited labour	269	46	5,200	268	48	6,605
Unlimited labour – no cost	279	49	5,600	279	48	6,815

(b) Cereal Sheep Zone WA

	May lambing			July Lambing		
Labour supply	Profit ('000)	Past. %	DSE	Profit ('000)	Past. %	DSE
Owner labour only	41	61%	4,945	65	57%	4,445
Owner + casual	56	50%	4,790	77	43%	4,440
Unlimited labour	72	41%	4,240	93	46%	5,015
Unlimited labour – no cost	81	37%	4,230	103	45%	5,705

(c) Great Southern Model

	May Lambing			July Lambing		
Labour supply	Profit ('000)	Past. %	DSE	Profit ('000)	Past. %	DSE
Owner labour only	69	69%	4,375	69	73%	4,725
Owner + permanent	132	69%	8,185	140	74%	9,130
Unlimited labour	242	78%	10,350	294	100%	13,525
Unlimited labour – no cost	274	80%	10,770	316	100%	14,715

(d) Hamilton

	September Lambing			November Lambing		
Labour supply	Profit ('000)	Past. %	DSE	Profit ('000)	Past. %	DSE
Owner labour only	217	100%	12,135	24	100%	6,595
Owner + permanent	338	100%	18,545	46	100%	12,000
Unlimited labour	484	100%	23,720	129	100%	18,875
Unlimited labour – no cost	561	100%	23,740	167	100%	19,010

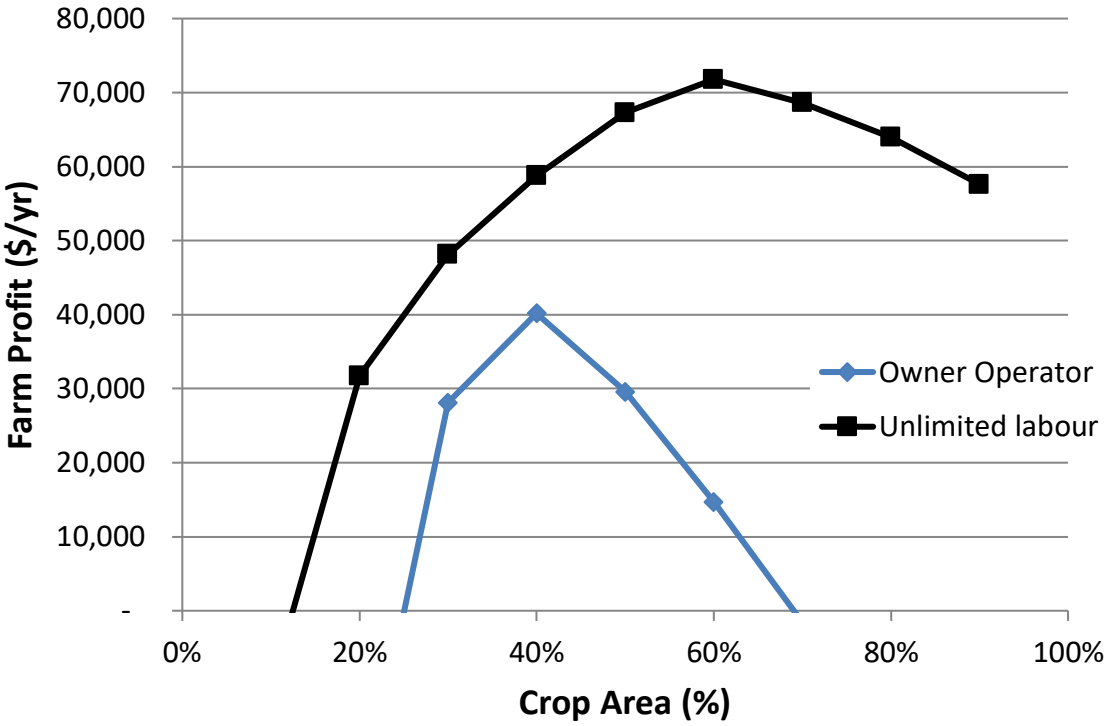


Figure 7.1: Importance of altering crop area in response of varying labour availability in the Cereal Sheep zone.

For all regions stocking rate was increased with the greater supply of labour. The number of DSEs was more than doubled in three regions between the restrictive owner operator scenario and the unlimited labour supply scenario. In the CSZ the number of livestock only increased by 20%.

Employing a casual labourer at specific times when there is a labour shortage (such as seeding and harvest) or one full time permanent does not fully overcome the labour constraints on livestock production. This is highlighted by a comparison of the difference in profit between the owner only scenarios and the casual/permanent labour option and the difference between the casual/permanent and unlimited option. This comparison shows that employing a casual or permanent employee provides less than half of the potential profit increase and much less than half of the potential increase in livestock numbers.

The results from all four regions show that limitations on the supply of labour have a dramatic effect on farm profit and the optimal livestock numbers. This suggests there is potential to significantly increase farm profit by reducing labour input per unit of production.

The labour demand profiles show that for most regions the demand for labour is very seasonal and is not matched to the steady supply that is achieved with owner operator labour or a hired permanent labourer. If farmers are unable or unwilling to hire casual labour then they are unable to match supply to the seasonal labour demand. Therefore technology or strategies that reduce the labour required in the seasonal peaks will allow producers to increase profitability by better achieving the potential of their farming system.

Even in the CSZ, where the results show that labour constraints are limiting crop production to a greater extent than livestock production, livestock production is higher when restrictions on the available supply of labour are removed. This is shown by the higher number of DSEs run with unlimited labour and the much higher stocking rate. Indeed stocking rates are much higher for all regions when the labour supply is not restricted.

Demand for labour in production

Figures 7.2 (a-d) show the demand for labour in sheep production (hrs/1000DSE/week) for the four regions examined in this study. The hours of labour required for production has been standardised across the regions to remove the effects of sheep number and length of labour periods, which differ between models.

The CSZ has the highest peak demand and this occurs in periods 6 and 7 which are at the break of season, this is reflecting the large requirement for supplementary feeding at the break of the season for an autumn lambing flock. Hamilton has the most even spread of labour requirement across the season. The peak in labour demand in each region corresponds with the periods in which most supplementary feeding is undertaken. Differences in the peak demand for labour between regions occur because of differences in the time of lambing and the consequent times of sale of lambs.

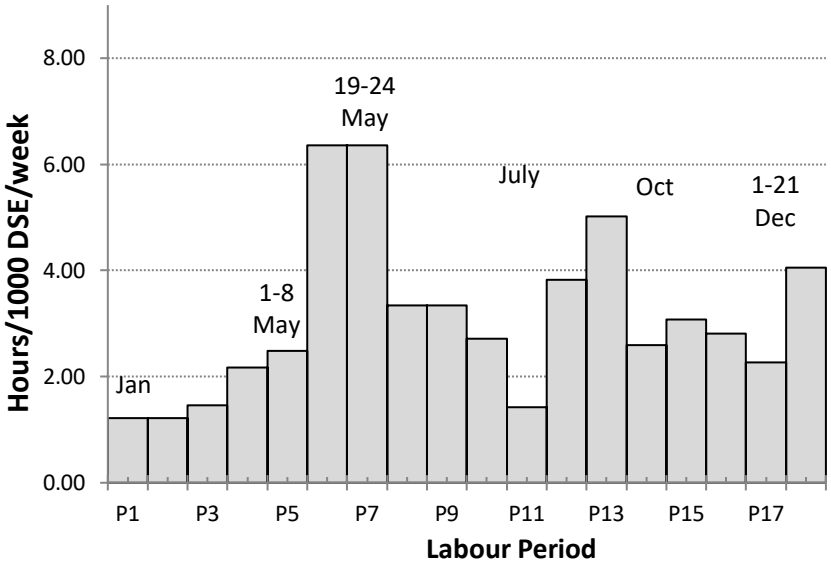
The results indicate that there may be potential gains in productivity through targeting efficiencies in effort required to feed supplementary grain to livestock. The labour demand for CSZ also indicates a potential conflict for labour demand with the cropping enterprise.

Figures 7.3 to 7.6 show the distribution of labour demand for the sheep enterprise over the year and how it changes with landuse, flock type, grazing intensity & time of lambing. Tables A1.2 (a-d) in the Appendix show the detailed labour use for crop and sheep as well as the unused labour in each period, for the four regions.

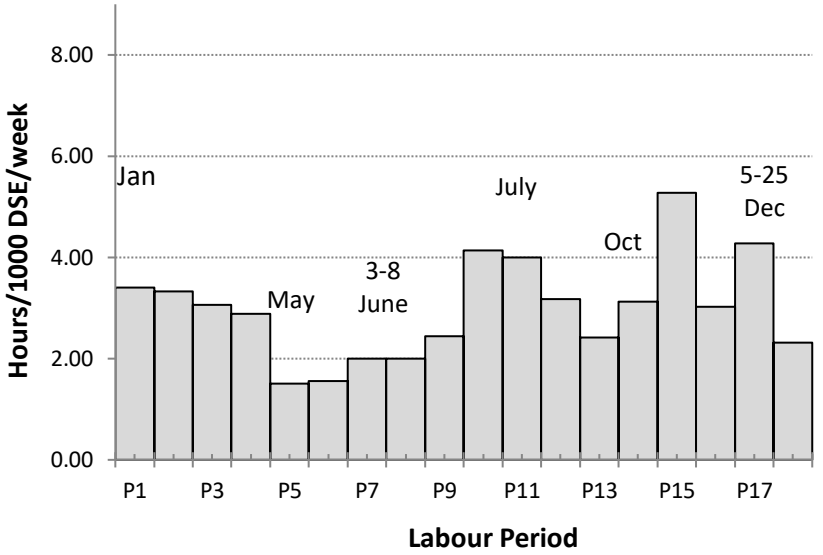
Figure 7.3 indicates that the potential conflict in demand with cropping can be alleviated to some extent by adjusting lambing time in the CSZ. Figure 7.6 also shows that labour demand for the sheep enterprise can be shifted to later in the season (after the season break) because this reduces the requirement for supplementary feeding at the break of the season. However, both figures indicates a potential conflict later in the season at harvest time.

Changing the type of flock from a wool focused flock to a meat focussed flock has a relatively small impact on the distribution of labour demand (Figure 7.4) although the total demand for labour in SWVic is higher for a self replacing meat focussed flock than a merino only flock mainly associated with extra supplementary feeding and feedlotting of lambs.

The results from Figure 7.5 show that the amount of labour used in the sheep enterprise in the Great Southern region of WA increases significantly as stocking intensity is increased, this is associated with the extra supplementary feeding and the extra monitoring required with the higher stocking rate. This highlights a challenge for researchers and research funders in improving the profitability of sheep enterprises through improving labour efficiency. That is, the potential increase in profit shown in Tables 7.2 (a-d) can only be achieved by increasing stocking intensity and that in itself leads to increases in requirement for labour. In addition, improvements in either availability or efficiency are required in most periods. Therefore changes to the production system that alter the labour required in only a few periods are unlikely to result in substantial gains in profit.



(a)



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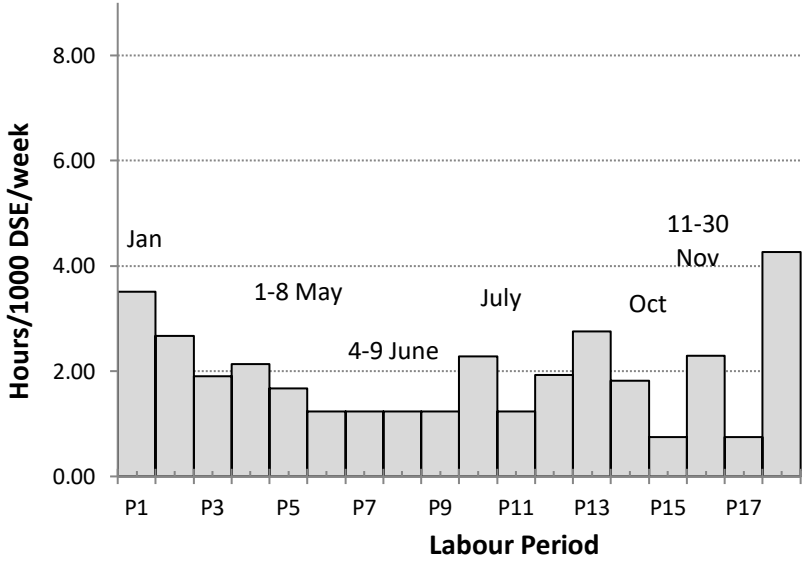

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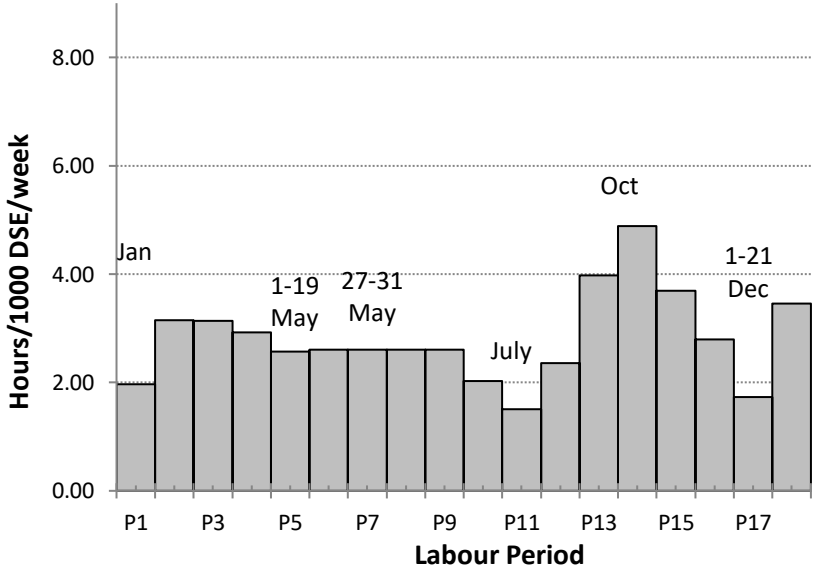


(d)

Figure 7.2: Demand for labour in the sheep enterprise in each period: (a) Cereal Sheep Zone (b) SW Victoria (c) Great Southern & (d) southern NSW

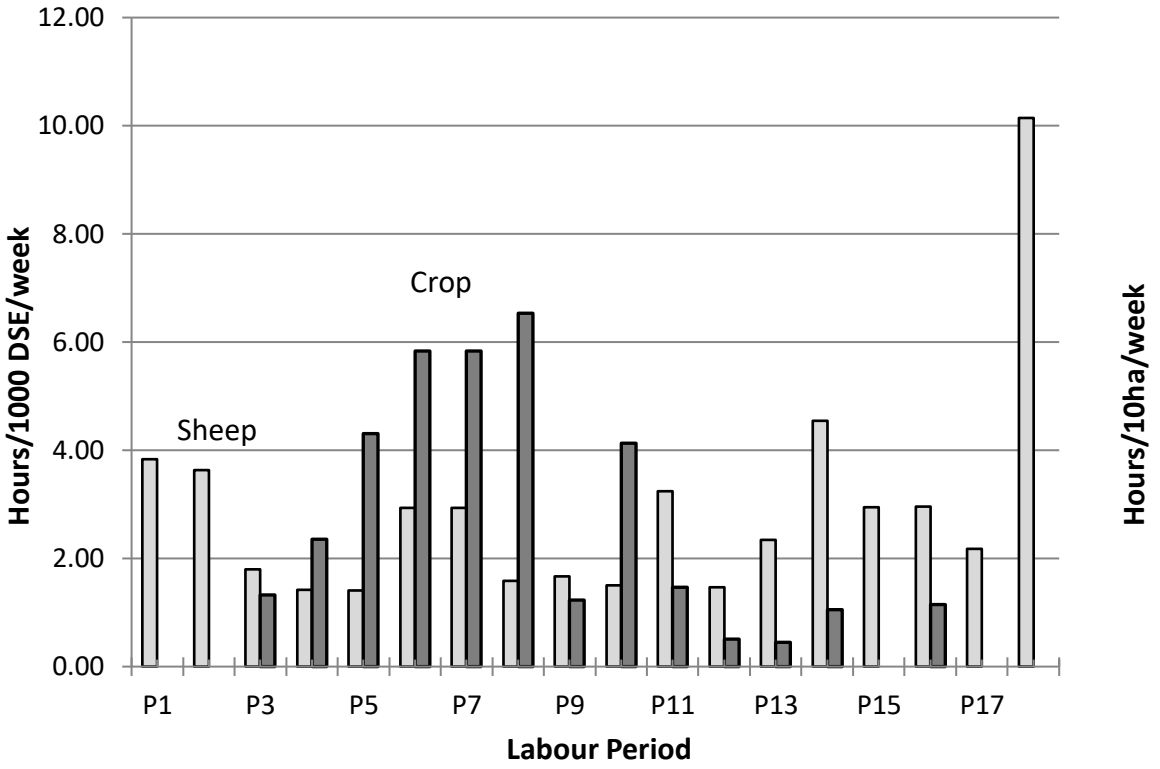


Figure 7.3: Labour demand through the year for the sheep enterprise compared with the crop enterprise.

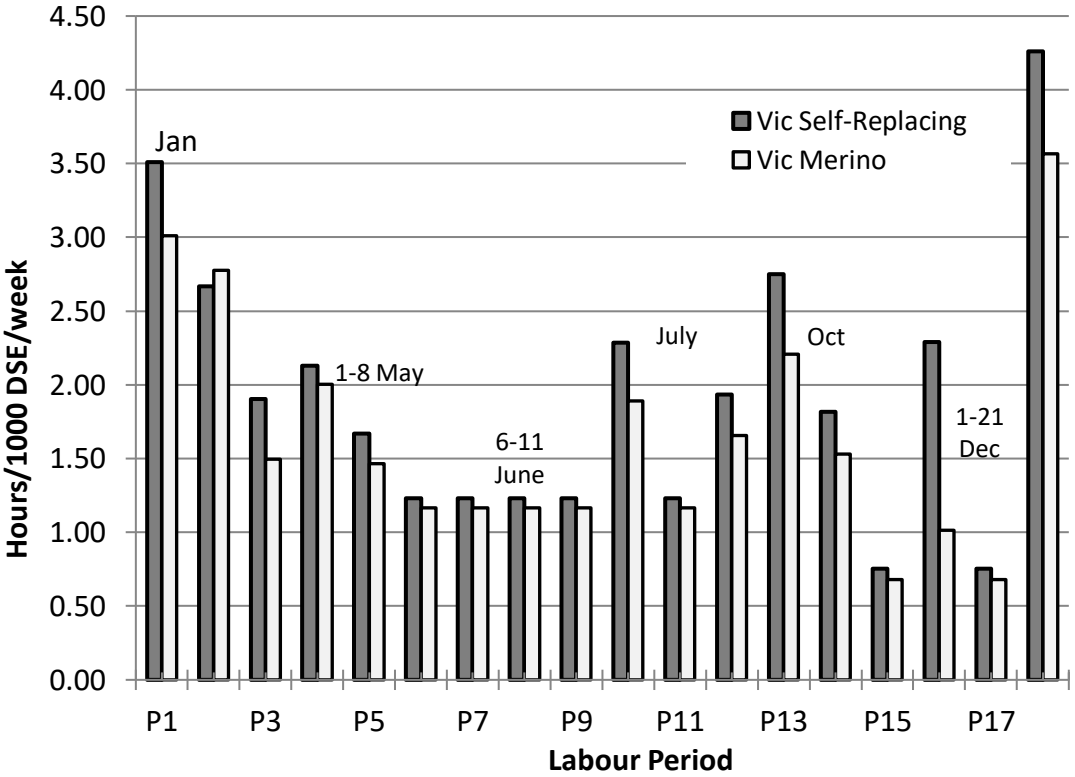


Figure 7.4: Labour demand through the year for the sheep enterprise with a comparison of a Merino Wool flock and a self replacing flock in which surplus ewes are mated to a terminal sire.

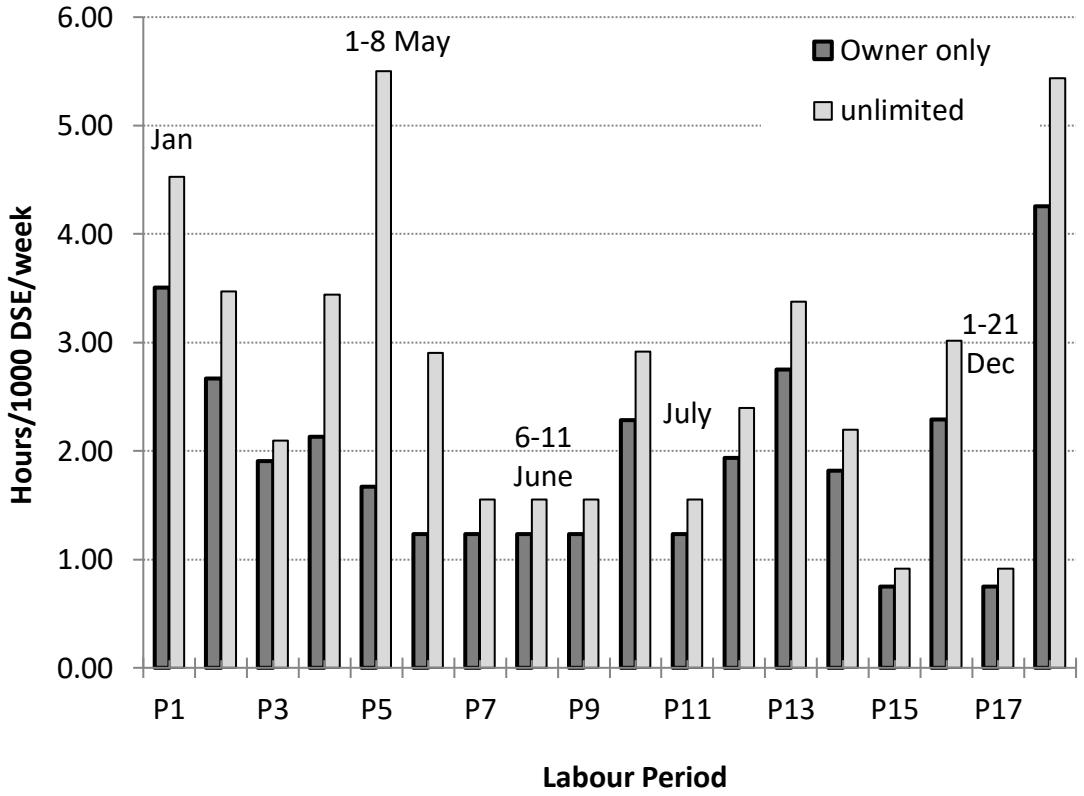


Figure 7.5: Labour demand through the year for the sheep enterprise comparing a low grazing intensity system (Owner only) with a higher intensity grazing system (Unimited).

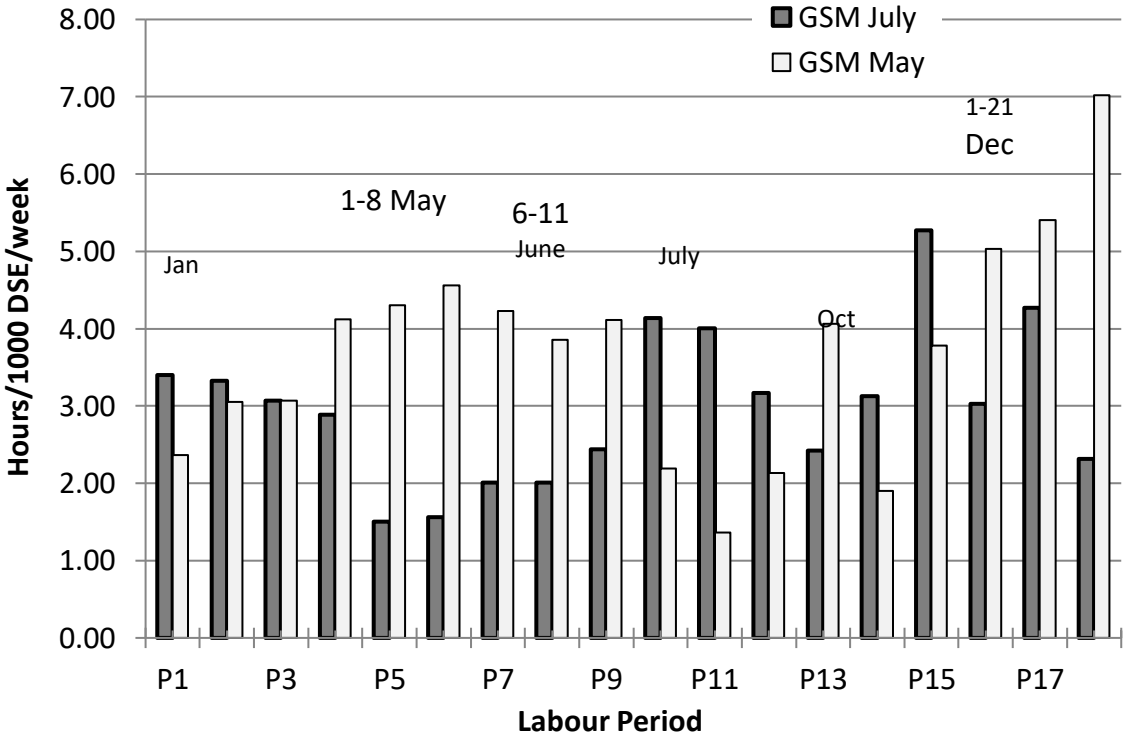


Figure 7.6: Labour demand through the year for the sheep enterprise comparing May & July lambing.

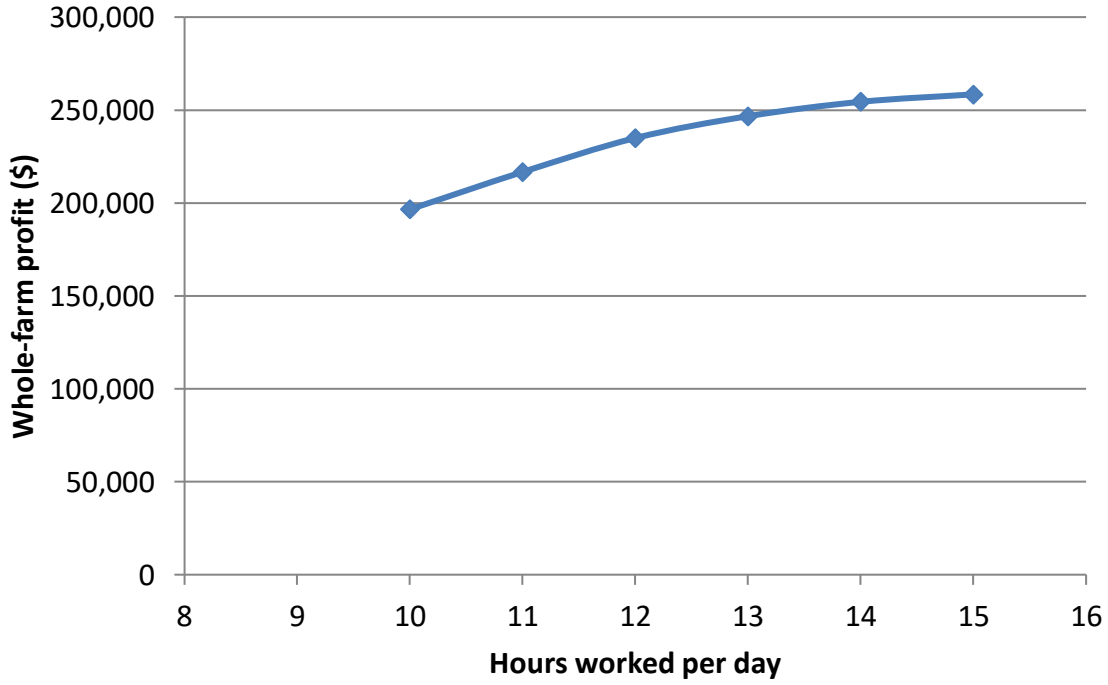
Increasing owner operator labour

Increasing the hours worked by the owner operator only realises a small proportion of the total potential benefits of reducing labour constraints (Figures 7.7 a-d). In the SNSW region,in which it is assumed that the farmer works 10 hours per day and 8 hours during the weekend, farm profit is $197,000. Farm profit increased by around $17,000 for every additional one hour per day worked, up to 13 hours per day. Additional time worked above 13 hours per day resulted in a much smaller increase in profit, which peaked at just over $250,000. This is around $20,000 less than the profit achieved when there are no constraints on the hiring of labour. This demonstrates that increasing the supply of labour through increasing hours of work by the owner operator cannot alone address the labour constraint faced by many farm businesses.

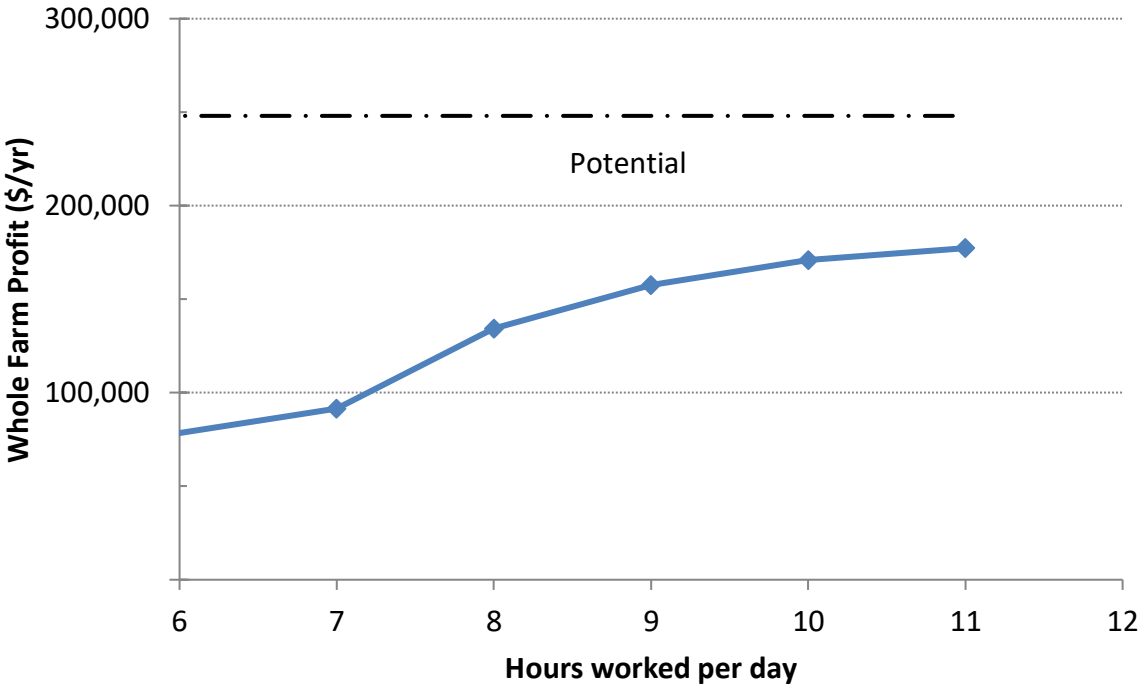
This is consistent with result from other regions, the main difference is that the gap between the profit from working additional hours and the unlimited labour scenarios is much greater in CSZ, GSWA and SWVic.

Owner labour is unable to fully compensate for low labour availability because there are insufficient owner hours available during the times of peak demand.

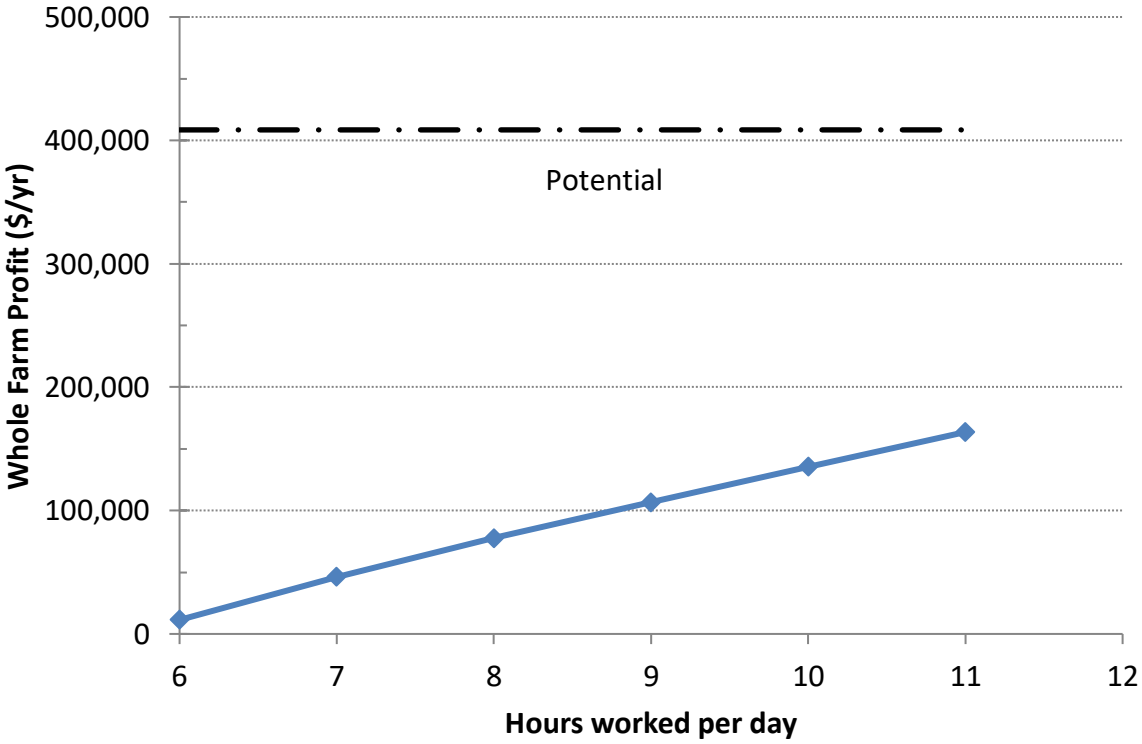
(a) Southern NSW



(b) Cereal Sheep Zone



(c) Great Southern



(d) Hamilton

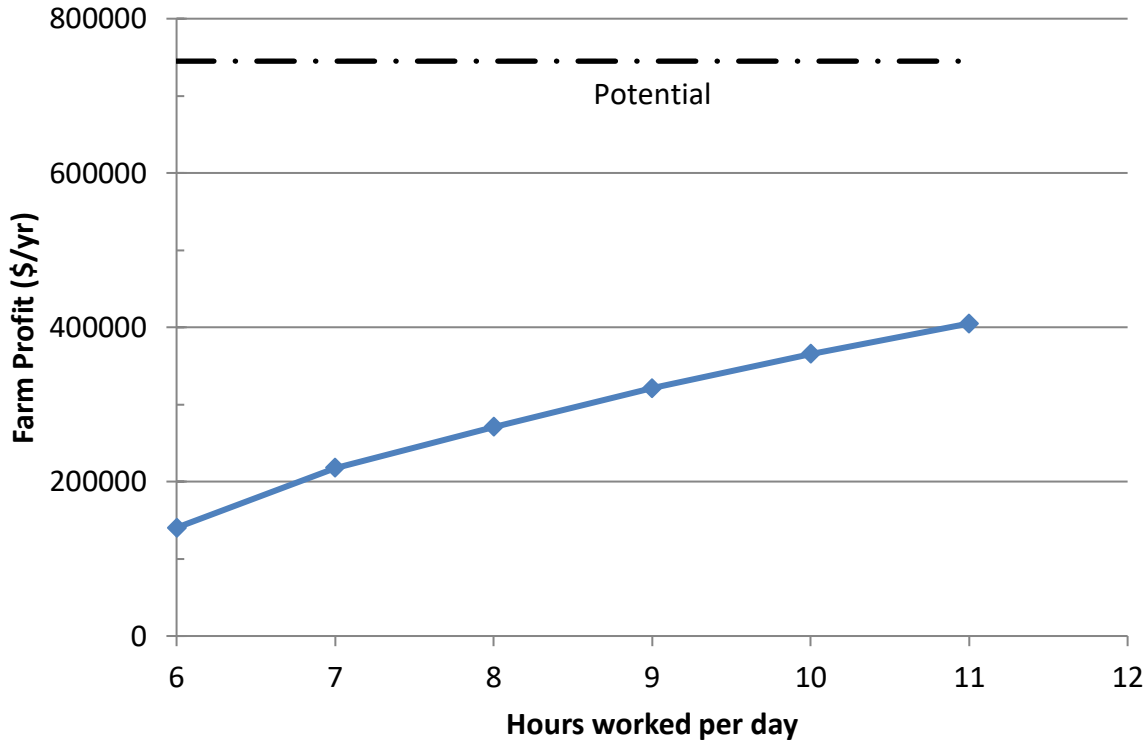


Figure 7.7: Relationship between whole-farm profit and input of owner labour in the absence of hired labour.

Labour efficiency of husbandry tasks

Table 7.2 shows the effect of improving efficiency of individual husbandry tasks on farm profit. In general improving efficiency of most individual husbandry tasks in most regions has little or no impact on farm profit. Drenching in all regions except SNSW, dipping for GSWA and SWVic, drafting and weaning in SWVic and shearing in GSWA are the exceptions, at some times of lambing. Differences between regions occur because different distributions of labour demand affect the extent to which efficiencies free up sufficient labour at times that it may be utilised to increase production (and hence profit). That is, freeing up labour in itself is not sufficient to increase farm profit unless the spare labour created by the efficiency can contribute meaningfully to other tasks that will increase production.

An important consideration when assessing potential value of increasing efficiency is the cost of implementing strategies or technologies that might reduce labour input. This analysis provides the total level of benefits from reducing the requirement for labour and provides the upper limit on what farmers could spend to achieve the specified labour savings.

The ability to generalise in regard to directions for research to improve labour efficiency on individual husbandry tasks is limited because of varying results across regions and scenarios.

Table 7.2: The increase in farm profit that can be achieved from improving the efficiency of labour utilised in husbandry jobs. The increase in efficiency reflected a reduction in the time required to complete each job of 50% of the standard assumptions.

Husbandry	SNSW		CSZ		GSM		Hamilton	
	May	August	May	July	July	May	Sept	Nov
Owner Only								
Drenching	652	0	0	9063	7936	5328	8262	0
Jetting	0	0	0	3400	14	12	2784	0
Dipping	0	0	0	0	5648	1262	0	0
K.FLTime	0	0	0	0	0	0	158	367
Weaning	0	0	0	0	0	0	3583	0
Marking	0	0	193	0	0	0	0	0
Weighing	0	0	0	0	0	0	0	2797
Classing	0	227	0	0	2115	0	1106	0
Drafting	0	580	0	1984	0	0	9437	0
Shearing	651	0	0	0	3538	0	0	0
Crutching	0	104	0	0	0	0	0	0
No Labour limitation								
Drenching	0	1	0	345	1636	1150	3695	909
Jetting	0	0	0	167	598	308	1036	0
Dipping	0	94	0	0	436	135	911	548
K.FLTime	0	94	0	0	86	0	395	369
Weaning	0	0	0	0	94	0	1286	967
Marking	0	83	90	0	0	0	545	0
Weighing	0	0	0	0	134	0	821	730
Classing	0	62	0	0	114	0	238	0
Drafting	123	62	0	100	276	0	1052	0
Shearing	0	62	0	0	960	0	1848	1132
Crutching	94	62	0	0	94	311	417	0

Table 7.3: The increase in farm profit that can be achieved from improving the efficiency of labour utilised for general jobs. The increase in efficiency reflected a reduction in the time required to complete each job of 50% of the standard assumptions.

	Owner Only							
Management tasks	SNSW		CSZ		GSM		Hamilton	
	May	August	May	July	July	May	Sept	Nov
Husbandry	0	3,754	194	12,669	18,033	6,479	18,167	3,299
Administration	0	1,613	1,520	6,840	27,223	24,395	22,144	12,208
Learning Crop skills	4,819	807	1,841	1,774	6,954	6,292	-	-
Learning past. Skills	2,077	1,518	1,227	1,183	1,159	1,049	3,390	2,035
Mustering	1,038	8,048	237	9,362	7,858	3,779	18,167	-
Sheep monitoring	1,498	7,087	6,442	9,139	13,735	13,733	39,490	6,814
Feed wheat	6,495	2,563	2,554	2,042	-	-	-	-
Feed barley	5,974	-	1,144	167	23,345	29,872	-	-
Feed oats	5,550	1,152	-	-	17,464	25,417	-	-
Feed lupins	0	3,276	1,368	-	31,810	40,833	-	16,344
Pasture monitoring	3,350	0	1,416	1,608	12,013	9,996	31,794	7,670
Sheep maintenance	2,887	3,754	0	0	-	-	-	-
	No labour limitation							
Husbandry	218	414	90	345	4,091	1,907	11,603	4,655
Administration	471	62	201	638	1,852	2,686	3,019	1,634
Learning Crop skills	233	62	115	223	436	547	-	-
Learning past. Skills	117	62	77	154	76	91	454	228
Mustering	428	62	108	453	1,980	1,218	11,923	3,180
Sheep monitoring	1,192	62	600	925	5,543	6,650	20,011	3,556
Feed wheat	650	62	480	422	-	-	-	-
Feed barley	844	62	515	898	-	-	-	-
Feed oats	0	62	-	-	-	12,229	12,362	-
Feed lupins	0	62	377	381	10,064	2,734	-	12,614
Pasture monitoring	747	62	183	363	3,933	4,793	9,688	3,640
Sheep maintenance	0	62	0	0	94	0	1,629	0

Labour efficiency for general tasks

Table 7.3 shows the results for tasks that involve changes in labour input in a number of periods, rather than one or two periods as occurs for the husbandry tasks shown in Table 7.2 husbandry. Reducing labour input for most general tasks in the GSWA and SWVic leads to large profit increases. Sheep monitoring and grain feeding led to the biggest increase in profit across all regions. Reducing labour input to pasture monitoring was also of high value in GSWA and SWVic. Efficiencies in mustering and administration were of high value in most scenarios examined.

One important issue not explored in this analysis was the extent to which there are trade-offs with changes to labour input. For example reducing time to monitor sheep or pasture may have unintended impacts. Less time in the paddock may reduce farmers knowledge about the general state of the production system, and consequently less effective decisions about farm strategy. However there is currently only limited data on the potential trade-offs.

Specific Labour Saving Packages

Table 7.4 and 7.5 show the potential increases in profit that would result from a package of changes to the livestock enterprise. The results show using contractors for some tasks improves profit significantly in the GSWA but not in SWVic. In GSWA the jobs for which contractors are available occur through periods of the year in which the owner is fully occupied and therefore utilising contractors can increase profit, however, the increase is only 10% of the total gains that could be made if casual labour could be readily employed. To expand the benefits from using contractors would require expanding the range of jobs that they perform.

There are large benefits to EasyCare sheep in all scenarios and regions. The large profit increase from EasyCare sheep is a result of a combination of reduced labour input, reduced shearing and crutching costs (-20%) and increased mob size. There is the possibility of production trade-offs resulting from different genetic production potential of EasyCare sheep. The result indicate that a reduction in fleece value of 10-15% would offset the benefits of EasyCare sheep for the producer with unlimited labour however, this increases to 25-30% for the owner operator who is unwilling or unable to hire labour.

Lick feeders provide significant benefits also by reducing frequency of carting grain to the paddock. The benefits of both lick feeders and Easycare sheep are highest for the higher rainfall regions. The benefits to the CSZ are higher than those for SNSW which is in line with total sheep numbers, also in the CSZ there is a much larger area of crop and there is more competition for labour around the season break. Freeing up labour at this time not only advantages the livestock enterprise but provides a potential for improvements in labour use in the cropping enterprise the cropping enterprise.

Table 7.4: Increase in profitability from adopting labour saving packages in the Great Southern of WA and south west Victoria.

Innovation	GSWA				SWVic			
	July		May		Sept		Nov	
	OO	Unlimited	OO	Unlimited	OO	Unlimited	OO	Unlimited
EasyCare	37,617	28,489	34,024	31,180	111,208	78,601	40,074	36,885
Lick Feeders	46,529	13,709	70,722	21,667	1	18,586	18,265	18,931
Large Mobs	18,809	6,488	16,660	7,729	81,337	38,939	30,799	17,199
NonWool	-35,245	-200,586	-69,134	-241,620				
Use Contactors	20,589	985	10,877	-304	-752	-14,442	-6,482	-11,349

Table 7.5: Increase in profitability from adopting labour saving packages in southern NSW and the Cereal Sheep zone of WA.

	SNSW				CSZ			
	August		May		July		May	
	OO	Unlimited	OO	Unlimited	OO	Unlimited	OO	Unlimited
EasyCare	16,165	13,777	14,095	11,318	21,914	13,985	27,050	11,809
Lick Feeders	4,330	1,483	9,699	1,363	5,143	5,384	13,651	6,626
Large Mobs	10,357	2,336	8,662	1,485			6,443	600

The results show that adopting shedding sheep has a negative impact on farm profit if reproductive rate is the same for the non-wool sheep as the merino. Previous analysis (Young unpub) has shown that non-wool sheep require a 40-50% increase in reproductive rate to have a similar profitability to merinos. This previous analysis was done with unlimited labour, combining the two sets of results indicates that for producers who are unable or unwilling to hire labour, reproductive rate would only need to be between 10 & 15% higher for the non-wool sheep to be equally profitable. This level of extra production appears to be realistically achievable.

Change in distribution of labour demand

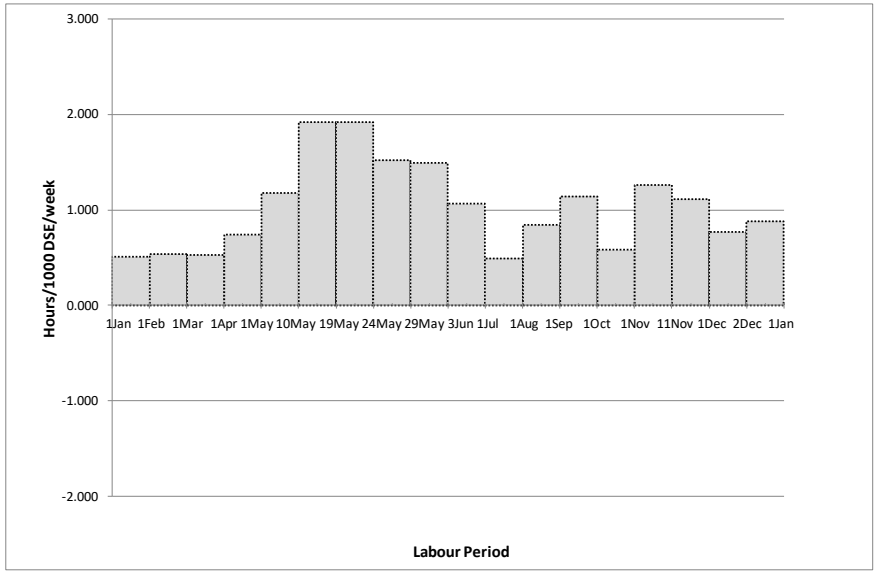
Figure 7.8 (a-d) show the change in the demand for labour in each region when running larger mobs of sheep. Two key features are evident. Firstly there is a fairly even reduction in labour requirement across the year, particularly for GSWA and SWVic. Secondly, the reduction in labour requirement per 1000 DSE/week is fairly small. Interestingly, the regions where the benefits are highest have the lowest reduction in labour requirement per 1000 DSE. However the total reduction in labour is highest by virtue of the greater number of DSE runs on farms in these two regions.

The reduction in labour in Figure 7.9 (a-d) shows the affect of introducing lick feeders into paddocks. The benefits in each region correspond closely to the relative changes in labour requirement over the year. SWVic has the lowest benefit for an owner operated farm (September lambing), mainly because the need for supplementary feeding is low because of the inclusion of summer active perennials in the farm system. Figure 7.9c shows that the reduction in labour occurs in only two periods and the total labour saved is less than 1 hour per week for every 1000 DSE. GSWA on the other hand has the largest reduction in labour and lick feeders result in the highest benefit of all of the regions. They are also of benefit in the CSZ but the benefits are much smaller. This is mainly because the reduction in labour requirement in the first half of the year is balanced by the need to employ more labour in the second half of the year.

The distribution of the reduction in labour requirement for EasyCare sheep is similar to that for running large mobs of sheep. However the absolute reduction in labour requirement was higher for EasyCare sheep, thus the benefits of adoption are much higher than for runner large mobs of sheep.

The impact of using contractors for drenching, dipping, vaccinating and jetting on the distribution of the requirement for labour is shown in Figure 7.11(a&b). In most periods the impact on the requirement for labour is minimal, however, in the periods that include the summer drenching there is a reduction in labour requirement.

Adoption of non-wool sheep reduces the labour requirement for sheep particularly over the early spring & summer months (Figure 7.11 c) which coincide with fly control strategies and shearing. However, there is an increase in late spring which coincides with the finishing and sale of the lamb progeny.



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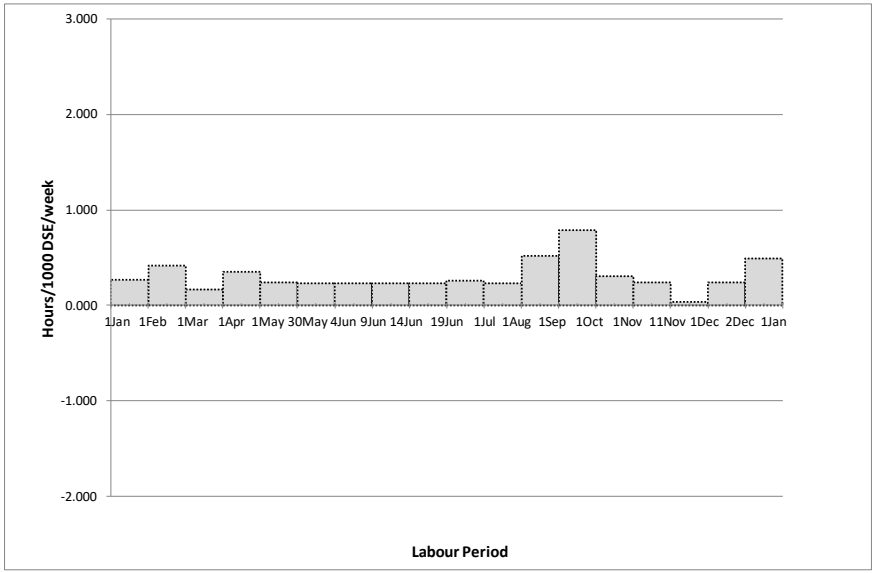

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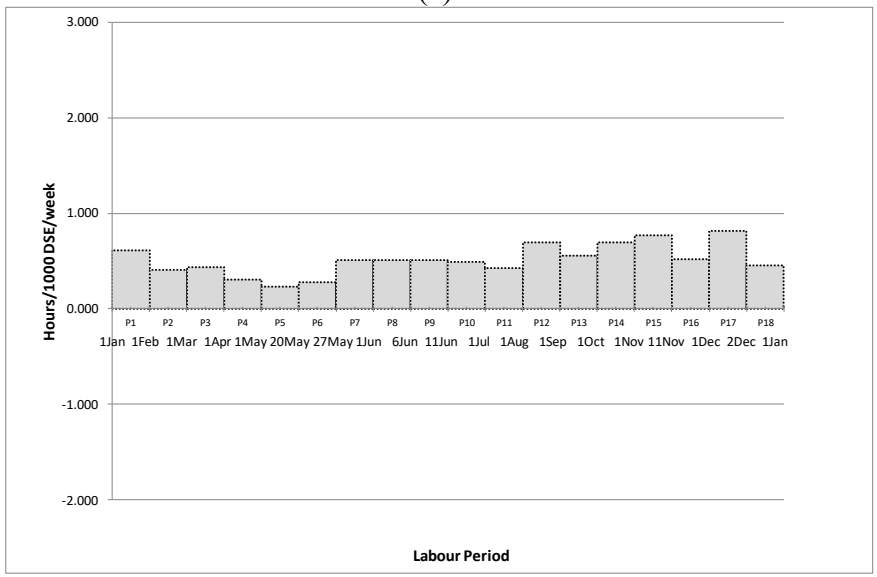

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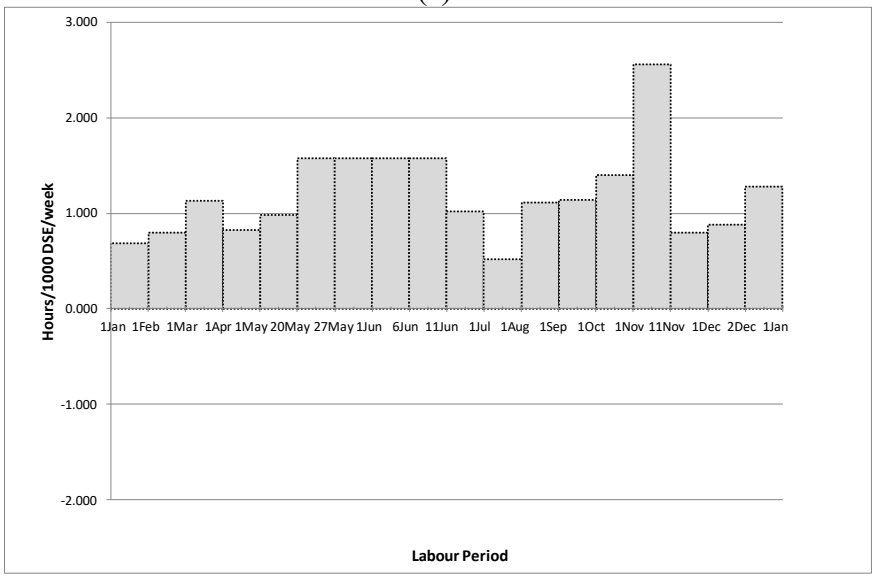


(d)

Figure 7.8: Change in labour requirement for the sheep enterprise when sheep are managed in larger mobs. (a) Cereal Sheep zone, (b) Great Southern, (c) SW Victoria, (d) southern NSW.

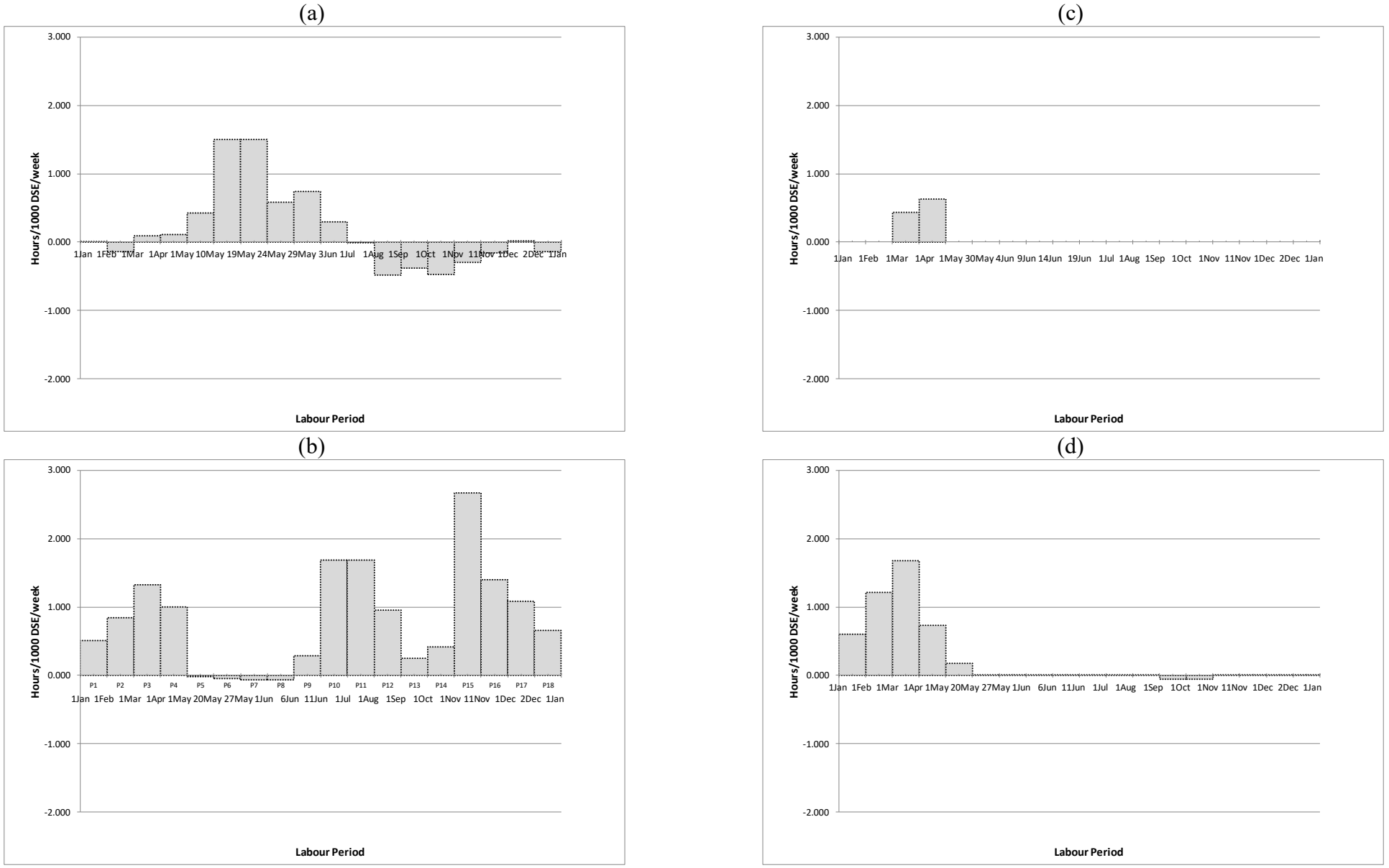


Figure 7.9: Change in labour requirement for the sheep enterprise when supplement is fed using lick feeders. (a) Cereal Sheep zone, (b) Great Southern, (c) SW Victoria, (d) southern NSW.

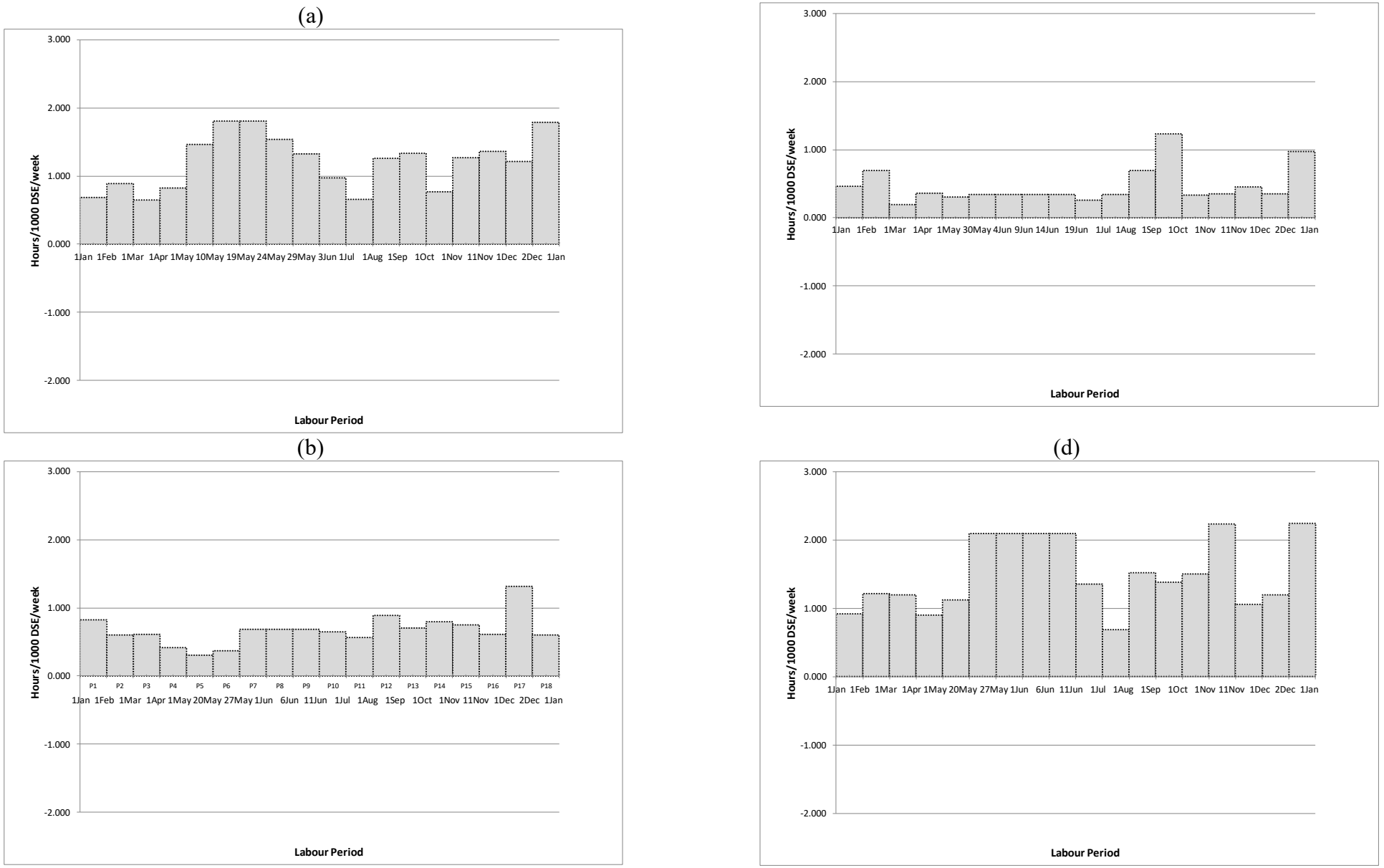
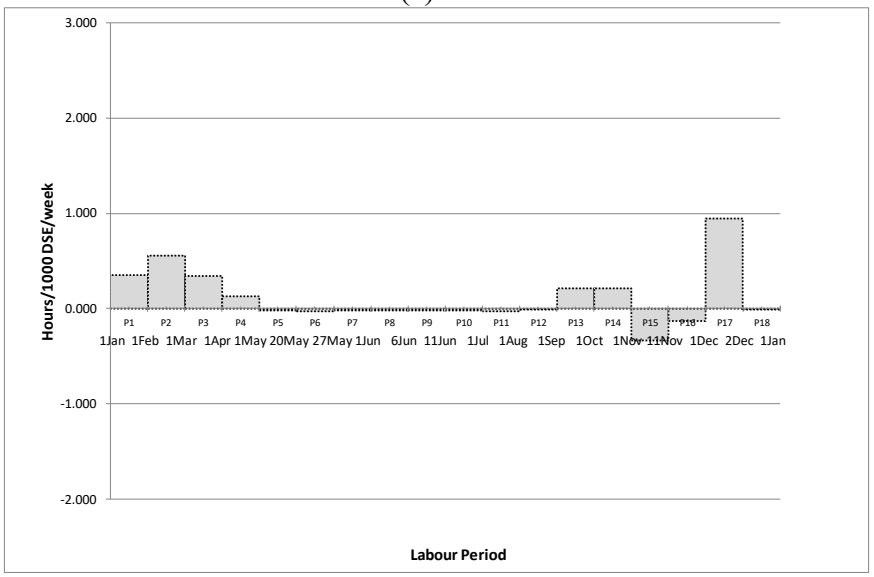
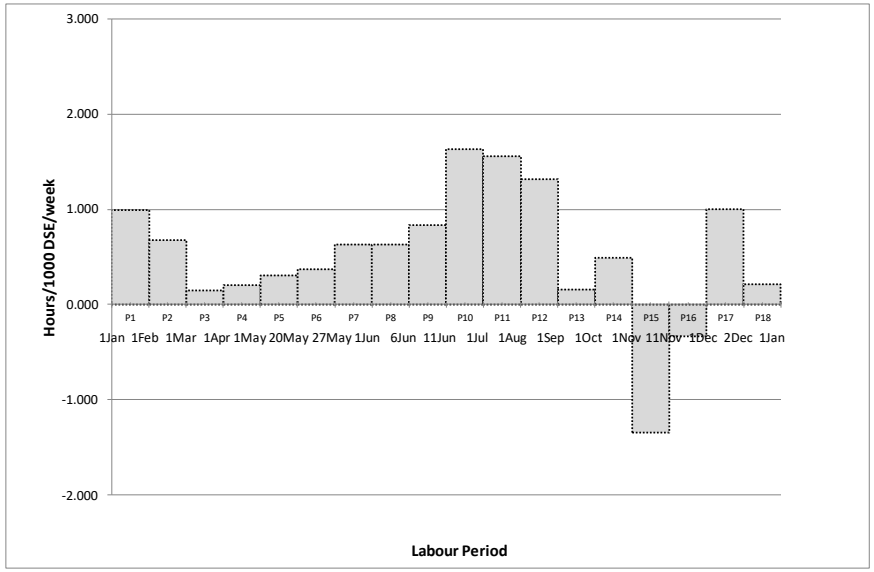


Figure 7.10: Change in labour requirement for the sheep enterprise from running 'Easy Care' sheep. (a) Cereal Sheep zone, (b) Great Southern, (c) SW Victoria, (d) southern NSW.

(a)





(b)

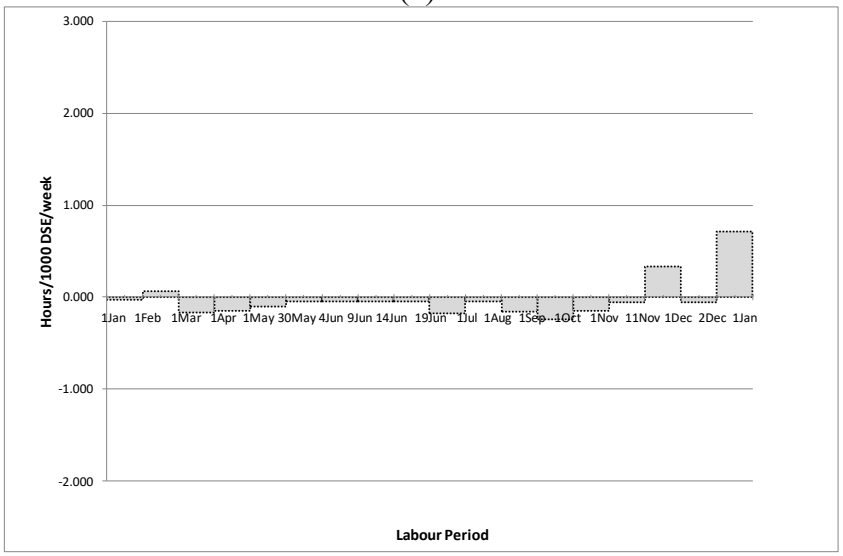


Figure 7.11: Change in labour requirement for the sheep enterprise from using contractors to perform drenching, vaccinating, jetting & dipping (a) Great Southern, (b) SW Victoria and from running non-wool sheep (c) Great Southern.

8. Conclusions

Labour shortages on farm have a large impact on farm profitability. Demand for labour in the sheep enterprise is very seasonal so this demand is best met by hiring casual labour. However casual labour is not always available and some would prefer to hire casual staff. Therefore technology or strategies that reduce the labour required in the seasonal peaks will likely increase farm profit.

Owner labour is not able to fully compensate for low labour availability because there are insufficient owner hours available during the times of peak demand. Whilst increasing the number of hours worked can improve profit, additional labour needs to purchased and/or labour efficiency improve to realise the full benefits of overcoming the constraints on labour.

A number of strategies and technologies could be adopted to reduce labour input. Improving efficiency of completing single tasks leads to small or no increases in profit. Freeing up labour in itself is not sufficient to increase farm profit because the spare labour created by the efficiency needs to be able to contribute meaningfully to other tasks that will increase production. The usually requires labour input to be reduced in a number of periods

Reducing labour input for most general tasks in the GSWA and SWVic leads to large profit increases. Sheep monitoring and grain feeding led to the biggest increase in profit across all regions. Reducing labour input for pasture monitoring was also of high value in GSWA and SWVic. Efficiencies in mustering and administration were of high value in most scenarios examined.

EasyCare sheep and lick feeders were shown to be high value strategies primarily because they led to reductions in the requirement for labour across many period of the year. Employing contractors to undertake husbandry tasks like dipping and jetting were of lower benefit because they free up labour in only a small number of periods.

MIDAS proved to be a very effective tool for analysis of labour in sheep production systems of southern Australia.

Implications of Research Findings for Industry

There are some general findings from this analysis that have implications for the industry and are researchable issues.

1. Farm profitability could be improved dramatically if labour could be hired to supplement the owner operator. The requirement for labour in sheep production is very seasonal, however it is difficult to hire casual labour during these periods because there is no pool of willing workers. A potential area of research is to improve sheep handling methods to encourage workers to be involved in sheep operations, rather than their current preference for cropping jobs that are machinery oriented.
2. For a strategy to be profitable across a number of environments and times of lambing it must reduce the requirement for labour for a number of periods of the year. Reducing the labour demand in short windows is not as valuable because labour shortages in other periods will limit the extent to which sheep numbers can be increased.

3. The returns from saving labour are much greater in the sheep dominant higher rainfall regions. Therefore R&D into labour efficiency should be focussed on the needs of these producers in order to maximise the net benefit to industry. It is likely that targeting the needs (to improve labour efficiency) of the high rainfall zone farmers will also lead to benefits in other regions.
4. Quantifying the tradeoffs between production and saving labour would help farmers better prioritise jobs on farm. It is likely that some farmers intuitively understand this already and they are the farmers that are able to manage large sheep flocks profitably, whereas others are less likely to maintain per head production when they increase stock numbers. If the tradeoffs that relate to timeliness of jobs could be quantified then on-farms jobs could be better prioritised.
5. Increasing the efficiency of monitoring sheep and pastures has a high value. Some effort has been expended in the area of remote monitoring of pastures, however, to date there has been limited uptake by producers. The insight gained from this project indicates that the lack of adoption may be due to the focus on technology that provides farmers with data on pasture growth rate. However, information that provides a warning that the animals or pastures need closer monitoring, may be of more value. This would allow the farmers to physically monitor their paddocks and stock less often thus reducing labour input at particular times of the year.
6. Increasing the efficiency of mustering also has a high payoff for most regions and particularly for the regions with high sheep numbers. This indicates that producers may be better off by investing in laneways to allow easy movement of sheep because this is likely to be profitable.
7. Increasing mob size increases farm profit in all regions. One method of managing larger mobs is rotation grazing. Rotation grazing has been evaluated in trials however, the requirement for labour has not been formally assessed. Collecting on-farm data on this would add an extra dimension to the decision about adoption of rotational grazing.
8. Improving the efficiency of all the husbandry operations has a high payoff for the regions that are livestock dominant. A possible mechanism for achieving this is through improved sheep handling facilities. This improvement dovetails with point 1 regarding making sheep related jobs more acceptable and less physically demanding.
9. One of the limitations encountered in carrying out this analysis was a lack of data on the amount of time producers spend on different jobs. In order to carry out detailed benefit-cost analysis on potential labour saving projects this baseline information would be required. It might be possible to collect this data on-farm if farmers were provided a datalogger and trained in its use. Provided the period of time being logged was kept short farmers are likely to be willing participants.
10. EasyCare sheep and non-wool (or shedding) breeds of sheep both showed as likely to be profitable for the owner operator who is unable or unwilling to hire labour. These two genetic approaches to saving labour are likely to be competing for adoption with the same producers and therefore improving the information available on the productivity of the genotypes and the amount of labour saved would allow more informed decision making.
11. Use of contractors will not lead to large increases in profitability unless the range of jobs that they perform is increased. If farmers become more sophisticated with the management of labour then there is likely to be a market niche for contractors who provide a wide range of services to industry.

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10. Appendix 1

Table A1.1: Time required for grain feeding in each labour period scaled for feeding rate per head

Southern NSW

	Period	Rate of emptying			Expected feed rate		Mob size	MJ fed/Mob	Time req'd	
		kg/sec Lupins	Bush/hr	hr/Bu	g/hd/d	MJ/hd/d		per feed	hr/MJ	MJ/hr
January	L1	1.800	240.0	0.004	100	1.211	500	2119	0.00009	10,596
February	L2	1.800	240.0	0.004	100	1.211	500	2119	0.00009	10,596
March	L3	1.800	240.0	0.004	150	1.817	500	3179	0.00006	15,894
April	L4	3.600	480.0	0.002	200	2.422	500	4239	0.00005	21,193
May	L5	3.600	480.0	0.002	200	2.422	500	4239	0.00005	21,193
Seeding period A	L6	3.600	480.0	0.002	200	2.422	500	4239	0.00005	21,193
Seeding period B	L7	3.600	480.0	0.002	200	2.422	500	4239	0.00005	21,193
Seeding period C	L8	1.800	240.0	0.004	150	1.817	500	3179	0.00006	15,894
Seeding period D	L9	1.800	240.0	0.004	100	1.211	500	2119	0.00009	10,596
June	L10	1.800	240.0	0.004	100	1.211	500	2119	0.00009	10,596
July	L11	1.800	240.0	0.004	100	1.211	500	2119	0.00009	10,596
August	L12	1.800	240.0	0.004	30	0.363	500	636	0.00031	3,179
September	L13	1.800	240.0	0.004	30	0.363	500	636	0.00031	3,179
October	L14	1.800	240.0	0.004	30	0.363	500	636	0.00031	3,179
Harvest legumes	L15	1.800	240.0	0.004	30	0.363	500	636	0.00031	3,179
Harvest cereal	L16	1.800	240.0	0.004	30	0.363	500	636	0.00031	3,179
Harvest late	L17	1.800	240.0	0.004	30	0.363	500	636	0.00031	3,179
December	L18	1.800	240.0	0.004	50	0.606	500	1060	0.00019	5,298

Table A1.2: Labour input for crop and livestock enterprises by labour period.

(a) sNSW

	Hire labour			Owner only		
Labour Period	Crop	Sheep	Unused	Crop	Sheep	Unused
L1	19	69	*68*	16	34	*106*
L2	6	98	*136*	0	48	*192*
L3	103	89	*0*	91	46	*0*
L4	110	72	*69*	129	42	*79*
L5	78	60	*8*	67	30	*49*
L6	117	23	*0*	59	11	*0*
L7	34	16	*0*	42	8	*0*
L8	0	16	*34*	42	8	*0*
L9	163	16	*0*	42	8	*0*
L10	17	48	*109*	18	22	*135*
L11	53	51	*164*	53	23	*193*
L12	18	101	*160*	18	50	*211*
L13	0	104	*156*	0	64	*196*
L14	97	149	*13*	76	86	*97*
L15	3	15	*72*	0	8	*82*
L16	12	29	*139*	16	16	*148*
L17	0	29	*151*	0	16	*164*
L18	0	48	*42*	0	24	*66*

(b) Cereal Sheep Zone

	Hire labour			Owner only		
Labour Period	Crop	Sheep	Unused	Crop	Sheep	Unused
L1	0	29	*98*	0	26	*101*
L2	0	41	*151*	0	37	*155*
L3	60	35	*2*	50	31	*16*
L4	116	52	*19*	98	45	*44*
L5	136	23	*0*	38	17	*0*
L6	145	62	*0*	43	38	*0*
L7	0	35	*10*	24	21	*0*
L8	0	45	*0*	32	13	*0*
L9	0	58	*0*	31	14	*0*
L10	138	158	*0*	144	58	*0*
L11	136	34	*45*	45	30	*141*
L12	40	83	*102*	17	72	*136*
L13	33	116	*59*	15	96	*97*
L14	40	62	*103*	40	46	*120*
L15	13	24	*54*	12	19	*59*
L16	0	44	*136*	17	37	*126*
L17	19	35	*126*	0	31	*149*
L18	0	32	*39*	0	29	*42*

(c) GSM July Lambing

	Hire labour			Owner only		
Labour Period	Crop	Sheep	Unused	Crop	Sheep	Unused
L1	0	71	*164*	0	148	*173*
L2	14	63	*0*	13	135	*0*
L3	40	64	*0*	40	133	*91*
L4	66	59	*66*	66	124	*156*
L5	12	7	*31*	12	16	*60*
L6	157	22	*10*	155	49	*145*
L7	0	7	*38*	0	15	*68*
L8	0	7	*38*	0	15	*68*
L9	0	8	*37*	0	16	*67*
L10	7	50	*63*	8	83	*122*
L11	39	84	*93*	37	138	*200*
L12	24	66	*137*	25	118	*246*
L13	3	49	*158*	3	81	*282*
L14	20	65	*123*	20	113	*235*
L15	20	85	*111*	20	162	*217*
L16	70	20	*0*	101	38	*28*
L17	110	58	*0*	210	111	*0*
L18	41	11	*0*	67	21	*0*

(d) GSM May Lambing

	Hire labour			Owner only		
Labour Period	Crop	Sheep	Unused	Crop	Sheep	Unused
L1	0	50	*186*	0	114	*206*
L2	19	58	*0*	19	128	*0*
L3	40	64	*0*	40	161	*63*
L4	66	83	*41*	66	188	*92*
L5	16	20	*15*	16	45	*26*
L6	124	65	*0*	162	144	*42*
L7	4	14	*26*	0	32	*51*
L8	0	13	*32*	0	30	*53*
L9	0	14	*31*	0	32	*51*
L10	5	27	*88*	5	58	*150*
L11	34	28	*152*	34	63	*278*
L12	13	45	*170*	13	96	*279*
L13	3	82	*125*	3	155	*208*
L14	20	40	*148*	20	63	*286*
L15	20	61	*135*	20	130	*249*
L16	3	34	*53*	3	78	*85*
L17	95	73	*0*	152	169	*0*
L18	19	33	*0*	13	75	*0*

(e) Hamilton September

	Hire labour			Owner only		
Labour Period	Crop	Sheep	Unused	Crop	Sheep	Unused
L1	19	69	*68*	0	173	*223*
L2	6	98	*136*	0	123	*122*
L3	103	89	*0*	92	122	*168*
L4	110	72	*69*	0	106	*161*
L5	78	60	*8*	37	80	*137*
L6	117	23	*0*	0	8	*75*
L7	34	16	*0*	0	8	*75*
L8	0	16	*34*	0	8	*75*
L9	163	16	*0*	0	8	*75*
L10	17	48	*109*	0	46	*95*
L11	53	51	*164*	14	52	*309*
L12	18	101	*160*	3	95	*293*
L13	0	104	*156*	3	130	*181*
L14	97	149	*13*	0	86	*249*
L15	3	15	*72*	0	11	*155*
L16	12	29	*139*	0	87	*242*
L17	0	29	*151*	0	2	*14*
L18	0	48	*42*	0	218	*158*

(f) Hamilton Nov

	Hire labour			Owner only		
Labour Period	Crop	Sheep	Unused	Crop	Sheep	Unused
L1		143	*93*		107	*128*
L2		167	*0*		136	*2*
L3		190	*31*		159	*62*
L4		185	*0*		140	*10*
L5		181	*0*		142	*0*
L6		14	*31*		10	*35*
L7		21	*24*		18	*27*
L8		7	*38*		5	*40*
L9		7	*38*		5	*40*
L10		17	*62*		13	*66*
L11		59	*156*		48	*167*
L12		56	*175*		46	*186*
L13		50	*110*		43	*116*
L14		60	*151*		52	*159*
L15		30	*60*		24	*66*
L16		72	*104*		57	*119*
L17		3	*6*		2	*7*
L18		164	*57*		129	*93*

Figure A1.3 Versions of MIDAS in different regions of southern Australia

	Model Name	Nearest Town.
1	Eastern Wheatbelt	Merredin, WA
2	Central Wheatbelt	Cunderdin, WA
3	Great Southern	Kojonup, WA
4	South Coast	Jerremungup, WA
5	Upper South East	Keith, SA
6	South West Victoria	Hamilton, Vic
7	South West Victoia	Inverleigh, Vic
8	North Central	Vic
9	Southern NSW (450mm)	Wagga Wagga, NSW
10	Southern NSW (650mm)	Tacutta, NSW
11	Central Tablelands	Orange, NSW
12	Central West Slopes	Yeoval, NSW
13	Central West Plains	Condobolin