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47

Economic Analysis of Feral Goats Control within the NSW Rangeland

ECONOMIC RESEARCH REPORT NO. 47 (DECEMBER 2011)

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Economic Research Report No. 47

November 2011



**Trade &
Investment**



**Catchment Management
Authority
Western**

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ABSTRACT

This report presents an economic analysis of feral goat control within NSW rangelands. The economic analysis used the conventional Cash Flow Analysis method to estimate the Net Present Value (NPV) and Benefit Cost Ratio (BCR) of the stream of costs and benefits combinations of feral goat management strategies and domestic stocking rates on representative farms in the region. We found that the NPVs of feral goat management strategies vary between -\$383,577 and \$855, 836 and BCR between 0.34 and 3.77 in 20 years time frame. We also found that results are positively and strongly correlated to feral goat price than feral goat population. We conclude the types of feral goats management strategies adopted by producers have different implications for agricultural production and public policies on natural resources management.

Key words: Feral goats, management, costs and benefits, Pastoral Zone, NSW

JEL Classification Code : Q110, Q120

ISSN 1442-9764

ISBN 978 1 74256 248 3

Published by

NSW Department of Trade and Investment, Regional Infrastructure and Services

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Citation

Khairo, S.A., Hacker, R.B., Atkinson, T.L., Turnbull, G.L. (2011), *Economic Analysis of Feral Goats Control Within the NSW Rangeland*, Report Prepared for Western Catchment Management Authority, Economic Research Report No.47, NSW Department of Trade and Investment, Regional Infrastructure and Services, Trangie, November.

Table of Contents

List of Tables.....	iii
Appendices	iii
Acknowledgements.....	iv
Acronyms and Abbreviations Used in this Report.....	iv
Executive Summary	1
Introduction	3
Overall methodology	3
Developing the representative farm models.....	5
Existing representative farm models.....	5
Consultation with producers	5
Representative farm models.....	6
Revised management options and major assumptions	13
Results and Discussion	15
Average benefits and costs	15
Benefit-cost analysis.....	17
Sensitivity analysis	19
Required improvements in land condition for economic TGP fencing	19
Environmental benefits of feral goat management	21
Conclusions	21
References	23

List of Tables

Table 1. Details of focus groups convened to update representative whole farm models and define the economic and management characteristics of alternative feral goat management strategies.	5
Table 2. Representative whole farm model for the Bourke District.....	8
Table 3. Representative whole farm model for the Cobar District.....	10
Table 4. Representative whole farm model for the Broken Hill District	12
Table 5. Average annual benefits and costs of feral goat control options for the Bourke district (\$)...	16
Table 6. Average annual benefits and costs of feral goat control options for the Cobar district (\$).....	16
Table 7. Average annual benefits and costs of feral goat control options for the Broken Hill district (\$)	17
Table 8. Benefits and costs of feral goat control options in the Bourke District.....	18
Table 9. Benefits and costs of feral goat control options in the Cobar District.....	18
Table 10. Benefits and costs of feral goat control options in the Broken Hill District	18
Table 11. Regression coefficients for sensitivity analysis.....	19
Table 12. Additional carrying capacity required within the fenced area, as a % of the carrying capacity of the representative farm, required for the TGP boundary fencing scenario to break even. .	20
Table 13. Additional carrying capacity, as a % of the carrying capacity of the representative farm, required within the fenced area or over the whole property for TGP scenarios to equal the NPV of the best feral goat management scenario.	20

Appendices

Appendix 1. Summary of the information collected for updating the representative farm model for Bourke, Cobar and Broken Hill Districts	24
Appendix 2. Summary of information collected for the analysis of feral goat management option.....	29
Appendix 3. Merino ewes enterprise gross margins – 21 Micron (Bourke District).....	48
Appendix 4. Merino ewe enterprise gross margins - 21 Micron (Cobar District).	49
Appendix 5. Merino ewe enterprise gross margins – 21.5 Micron (Broken Hill District)	50
Appendix 6. Feed wheat enterprise gross margin	51
Appendix 7. Summary of economic assumptions used in the analysis.....	52

Acknowledgements

The authors thank the WCMA for funding the project and staff members Paul Theakston and Anthony Azevedo for organising the focus groups and helping in the consultation process. We also acknowledge the considerable contributions of producers in the consultation groups, including Lachlan and Joanna Gall, Susan Howard, Ken Turner, Richard Neilson, Jim Strachan, Peter Yench, Rob Hansen, Ashley McMurtrie, Robert Neate, Bob Sinclair and Andrew Mosely for sharing their experience and knowledge on the physical and financial characteristics of pastoral systems and providing information on feral goats management operations in Cobar, Bourke and Broken Hill. We thank Dr. Yohannes Alemseged and Dr. Thomas Nordblom with NSW DPI for reviewing and providing comments on this research report.

Acronyms and Abbreviations Used in this Report

BCA	Benefit Cost Analysis
BCR	Benefit Cost Ratio
DPI	Department of Primary Industries
DSE	Dry Sheep Equivalent
FW	Far West
GM	Gross Margin
MD	Murray Darling
NPV	Net Present Value
OC	Opportunity Cost
PVB	Present Value of Benefits
PVC	Present Value of Costs
TGP	Total Grazing Pressure
TS	Terminal Sire
UD	Upper Darling
WCMA	Western Catchment Management Authority

Executive Summary

Representative whole farm models and benefit-cost analysis methods were used to evaluate a range of feral goat management scenarios for the Bourke, Cobar and Broken Hill Districts. Models were derived from existing representative whole farm models which were updated through focus group discussions with landholders in the three districts. Models were formulated to allow the additional costs and benefits of feral goat management scenarios to be represented as partial budgets relative to the representative farm which excluded feral goat enterprises. Alternative scenarios were evaluated in terms of Net Present Value (NPV) and Benefit–Cost Ratio (BCR) over 20 years time frame and each was assessed for sensitivity to feral goat price and population density.

The scenarios evaluated were:

1. No harvesting of feral goats.
2. Opportunistic harvesting at the current level (as defined by focus group participants);
3. Opportunistic harvesting with additional capital investment to maximise capture and turnoff;
4. ‘Value adding’ to captured goats by use of a goat paddock to grow out small animals, without reduction in domestic livestock;
5. As for 3 above but with a corresponding reduction in domestic livestock;
6. Exclusion of feral goats by Total Grazing Pressure (TGP) fencing of as much of the property boundary as possible;
7. Use of the ‘goat paddock’ established under 3 and 4 above for livestock grazing;
8. Exclusion of feral goats by TGP fencing from an individual paddock with higher livestock production potential than the ‘goat paddock’ established for 3,4 and 6 above;

The analysis concluded that:

- Opportunistic harvesting of feral goats is profitable for landholders in all districts and its profitability could be improved by additional capital investment aimed at maximising feral goat turnoff. Financial incentives for this investment would not be justified since it can be supported by the additional income generated.
- Establishment of a goat paddock, with or without reduction in domestic livestock, is highly attractive in terms of both NPV and BCR and is well able to support the capital costs involved. In all districts establishment of a goat paddock with a corresponding reduction in domestic livestock returns the highest NPV.
- Boundary fencing of properties with TGP fencing, to the extent permitted by local topography, returns negative NPV and BCR less than 1 in all districts if livestock increases are only equivalent to the feral goats removed. However, the additional increases in carrying capacity (within the fenced area) required to break even, or to return a NPV equal to the best feral goat harvesting scenario, are probably within the range achievable by improved grazing management practices.

- Investment in a goat-proof paddock for livestock grazing is best directed to better quality land, with potential for improvement in carrying capacity, rather than to land more suited to a goat paddock. Such investment is economically justifiable, but returns a lower NPV than the best feral goat harvesting scenario unless associated with increases in carrying capacity beyond the substitution of sheep for feral goats within the fenced area. If these increases can be achieved across the whole property then only modest improvements, within the range likely to be achievable by grazing management practices are required. However, if improvements are limited to the fenced area itself then the change required is unlikely to be achievable, except in the Broken Hill district, and this option will remain less attractive than investment in opportunistic harvesting or value adding to harvested feral goats.
- NPV of all control scenarios is more sensitive to goat price than to goat population density so that resource condition issues related to goat density are unlikely to be the primary driver of producers' decisions related to feral goat harvesting or the regulation of feral goat populations.
- Any cessation of feral goat harvesting due to low prices or other impediments, is likely to be seriously disadvantageous for the profitability of livestock enterprises, and probably also for natural resource condition as pastoralists seek to maintain incomes in the absence of an alternative income stream.
- Feral goats represent a conundrum for natural resource management since there are strong economic incentives to retain rather than remove them and there is no stable incentive to reduce their numbers in the interest of either economic returns or resource condition. However, since (probably) achievable improvements in carrying capacity can result in favourable returns from TGP fencing, any attempt to improve natural resource outcomes by public investment may be best directed at encouraging improved grazing management (e.g. through incentives for ground cover) rather than infrastructure for feral goat harvest which is already profitable for landholders.
- The relative economic benefits of the options for feral goat management evaluated in this study are consistent across all districts. Any policy developed on the basis of these analyses should therefore have general application.

Introduction

The aim of this project, as outlined in the Scope of Work contained in the project brief, was to define the economic incentive for feral goat control by producing static economic models for a range of businesses in the Cobar, Bourke and Broken Hill districts. These businesses were to include:

- a. A harvesting operation where feral goats are harvested on an opportunistic basis along with running domestic livestock;*
- b. An enterprise that has total grazing pressure controlled – no feral goats and limited native herbivores.*
- c. An enterprise which runs domestic livestock along with one paddock fenced for goats to grow out the under-weight feral goats caught.*

For enterprises (a) and (c) the competitive interaction of livestock and feral goats was to be represented at different densities of feral goats, and the outcome of the various business types was to be described in terms of standard economic indicators.

In this report, evaluation of the feral goat management options outlined above, and some variations developed over the course of the project, has been based on the use of static (i.e. the basic structure does not change over time), representative whole farm models and conventional benefit-cost analysis procedures.

A representative farm is one that comprises a set of resources and management constraints that is 'typical' for a farming system in a particular district. It is not an average farm but the physical and financial resources described would be recognisable by most local producers as not greatly different to their own business. Such models allow the impact of new technologies or alternative enterprises on farm profitability to be evaluated from a whole farm perspective. However, they do not allow examination of the evolution of alternative business structures over time, or the simulation of biophysical processes to assess impacts on the natural resource base.

The evaluation of alternative enterprises involving capital expenditures over time requires the application of conventional benefit-cost analysis. This allows comparison, ranking or prioritisation of options for which benefits and costs are differentially distributed over time.

Neither representative whole farm models nor benefit-cost analyses may be a good match for all businesses in a district. Careful examination of the assumptions involved is required to assess the extent to which conclusions drawn should be accepted in individual cases.

Overall methodology

The overall methodology of this study has involved the following steps:

1. Development of a representative whole farm model for each district, excluding enterprises based on feral goat management;
2. Development of a partial budget for each of the feral goat management options by determination of the benefits and costs of each relative to the representative model;
3. Development of a 20 year cash flow projection for each option based on the benefits and costs identified in (2) above;
4. Calculation of the present value of benefits and costs, Net Present Value (NPV) and benefit to cost ratio (BCR) over the 20 year planning horizon;

5. Sensitivity analysis to establish the sensitivity of NPV to changes in key variables.

The present value of benefits (PVB) and the present value of costs (PVC) for each scenario were calculated using the standard discounting method shown in equations 1 and 2.

$$(1) \quad PVB = \sum_{t=1}^T \frac{B_t}{(1+r)^t}$$

$$(2) \quad PVC = \sum_{t=1}^T \frac{C_t}{(1+r)^t}$$

where B and C are the dollar values of the benefit and the cost in year t, r is the discount rate and T is the number of years beginning from 2010.

NPV was calculated using the conventional benefit-cost method shown in equation 3.

$$NPV = \sum_{t=1}^T \frac{B_t}{(1+r)^t} - \sum_{t=1}^T \frac{C_t}{(1+r)^t} \quad (3)$$

Equation 3 indicates that NPV can also be derived as:

$$NPV = PVB - PVC \quad (4)$$

If NPV is positive then investment in that particular control strategy is justified. By this criterion the strategy with the highest NPV will be the best.

Benefit cost ratio (BCR) is the ratio of PVB to PVC and is a measure of the cost effectiveness and relative net gain of a particular strategy (Sinden and Thampapillani, 1995). If BCR exceeds 1 the option provides net gain and investment in it can be justified. As with NPV, the option with the highest BCR can be considered the best.

Sensitivity analysis was conducted using the @RISK software package which defined the linear regression relationship between NPV and the value other key variables, particularly goat price and goat population, as these were varied around their means in the form of a normal distribution. Sensitivity of NPV to change in the variable is defined by the value of the linear regression coefficient. The nature of the relationship (direct or inverse) is indicated by the sign of the coefficient.

The competitive interaction between livestock and feral goats at different feral goat densities could not be evaluated explicitly due to the lack of data available to quantify the livestock production and pasture responses. Instead, the benefits of reduced feral goat numbers were represented by an equivalent increase in the livestock population while maintaining the per head production levels defined in the representative models. For all management options sensitivity to goat population was examined as part of the sensitivity analysis described above.

Developing the representative farm models

Existing representative farm models

Khairo *et al.* (2008) developed representative whole farm models for the statistical sub-divisions of UD (includes the Shires of Brewarrina, Bourke and Cobar), MD (includes the Shires of Wentworth and Balranald) and FW (includes Central Darling Shire, Broken Hill and the Unincorporated Area). These models were based on livestock and cropping enterprises only and did not explicitly include the benefits and costs of feral goat harvesting. In the present study representative models for the Bourke and Cobar districts were produced by updating the UD model while the FW model was updated to represent the Broken Hill district

Consultation with producers

Small focus group discussions with local producers (Table 1) were used to update the existing whole farm models to provide the representative models for Bourke, Cobar and Broken Hill used in the present study. These groups also defined the economic and management characteristics of the various feral goat management strategies originally proposed, assuming these were implemented using 'best practice' methods. The focus groups included project staff and representatives of the Western CMA. They were facilitated by Rangeland Livestock Officers of from? Industry & Investment NSW.

Table 1. Details of focus groups convened to update representative whole farm models and define the economic and management characteristics of alternative feral goat management strategies.

Location	Date	Number of producers
Bourke	10 August 2010	2
Cobar	11 August 2010	6
Broken Hill	24 August 2010	5

For the purposes of the focus group discussions goat management strategies were described as

- Opportunistic harvest (equivalent to option a in the Scope of Work)
- 'Value added' goats (equivalent to option c), and
- High level control of total grazing pressure (equivalent to option b),

representing a logical sequence of management intensification.

All focus group discussions were structured in the same way to elicit the required information. The first part of each meeting was devoted to updating the representative farm model by checking the current specifications of

- Property size, land use and current value
- Livestock numbers and values
- Current market value of fixed assets
- Business liabilities
- Enterprise gross margins
- Overhead costs.

Subsequent discussion compiled the following information for each of the three management options.

Management practices

- Best practice control strategies
- Time and frequency of control
- Density/number of goats
 - Influence of season
 - Influence of domestic stocking rate
 - Effect of goat harvesting on livestock stocking rate and production of other enterprises.
- Number of feral goats harvested
- Percentage of feral goats sold
- Percentage of feral goats released
- Percentage of feral goats retained
- Size and location of goat paddock
- Percentage of land suitable for TGP fencing¹
- Exchange rate of sheep for feral goats (in terms of relative forage consumption)
- Risks associated with the control strategy
- Environmental outcomes of feral goat management.

Enterprise costs

- New capital investment required
- Modification of existing structures
- Number of years before replacement
- On-going maintenance and repair costs
- Operating costs (e.g. labour, transport, vehicle and selling costs)

Enterprise revenue

- Goat prices
- Number of feral goats sold
- Opportunities to influence price received.

Details of the information collected in these workshops, as recorded on butcher's paper and in the notes of project staff, are summarised in Appendix 1.

Representative farm models

In developing the representative models for the present study a number of conventions were adopted to facilitate examination of the benefits and costs of feral goat management by a partial budgeting process:

1. feral goat enterprises were excluded from the representative model for each district;
2. capital equipment required only for the various feral goat management options was included in the partial budget for each option;
3. capital equipment that may be used for goats but is also required for sheep or cattle was included in the representative model.

¹ Fencing designed to control total grazing pressure (TGP) by restricting the movement of feral goats and kangaroos

The representative whole farm models for the Bourke, Cobar and Broken Hill districts, comprising a statement of assets and liabilities and the annual operating budget, are given in Tables 2, 3 and 4, respectively. The enterprise gross margins for sheep and cropping enterprises in the annual operating budgets are given in Appendices 2, 3, 4, and 5. Gross margin for the cattle enterprise was obtained from NSW Department of Industry and Investment (2010).

The representative farm for the Bourke district has about \$1.5 million of capital assets with equity of 85%. The business comprises 24,000 ha of land used for pastoral enterprises involving sheep and cattle. The land asset (albeit leasehold) represents 63% of the total capital, followed by livestock (23%) and plant & equipment (14%). The farm makes an annual profit of \$90,000, representing 7% business return on equity.

The representative farm in the Cobar district has about \$1.3 million of capital assets with equity of 85%. The property occupies 20,000 ha used principally for pastoral purposes (95%) but with five percent of the land used for opportunistic cropping of feed wheat, barely and oats grown on short fallow rotation with a minimum of cultivation and chemical input (Appendix 5). About 68% of the total capital value resides in the land, 19% in the livestock and the remaining 13% in plant and equipment. The farm makes an annual profit of \$50,200 or 4.5% business return on equity.

In the Broken Hill district the representative farm has about \$3.2 million of capital assets with equity of 85%. The property is 50,000 ha in area and is used principally for a self replacing Merino enterprise producing both wool and meat. Land contributes 70% of the total capital asset with livestock and plant & equipment accounting for 13% and 17% respectively. The business makes an annual profit of \$155,200 or 4.5% business return on equity.

Table 2. Representative whole farm model for the Bourke District

Statement of assets and liabilities							June 2010
Assets							
Land		24,000	hectares@ \$40 per hectare			\$960,000	
	Land use	Area (ha)	Proportion				
	Pastoral	24,000	100%				
	Cropping	0	0%				
	Conservation	0	0%				
	Unused	0	0%				
	Total value of land					\$960,000	
Livestock		Number	Class				
Sheep (Merino)		3,000	Ewes	\$56	per ewe	\$168,900	
		0	Wethers	\$80	per wether	\$0	
		600	Lambs	\$90	per lamb	\$54,000	
		70	Rams	\$91	per ram	\$6,381	
	Total value of sheep					\$229,281	
Cattle		100	Cows	\$633	per cow	\$63,300.00	
		20	Heifers	\$595	per heifer	\$11,900.00	
		25	Steers	\$804	per steer	\$20,100.00	
		4	Bulls	\$1,148	per bull	\$4,592.00	
	Total value of cattle					\$99,892.00	
Total value of sheep and cattle						\$329,173.2	
Plant and Equipment							
	Machinery (Average value)						
	Grader					\$20,000.00	
	Tractor					\$20,000.00	
	Loader					\$20,000.00	
	Workshop equip.					\$30,000.00	
						\$110,000.0	
	Vehicles (car, ute, truck, motor bike)					0	
	Livestock plant (portable yards, trailer)					\$20,000.00	
	Other (office equip.)					\$3,000.00	
	Total value of plant and equipment					\$223,000.0	
Cash						0	
						\$0.00	
Total Assets						\$1,512,173	
Liabilities							
Total liabilities						226,825.98	
Equity (Assets - Liabilities)						\$1,285,347	
Owner equity percentage (Equity/ total assets)*100						85	

Table 2 (continued)

Annual operating budget					
	24,000	ha	total farm area		
Enterprise gross margins (GM)			GM		
	3,000	Ewes (merino)	\$47	per ewe	\$139,713
	100	Cows	\$454	per cow	\$45,400
					\$185,113
Total farm gross margin					
Overhead costs					
Casual wages				\$8,000	
Rates				\$5,000	
Registration				\$1,500	
Insurance (vehicle, building)				\$3,500	
Other R&M (fencing, tools, pumps, etc)				\$10,000	
Fuel costs				\$15,000	
Services (accounting, consultant, banks, etc)				\$2,000	
Others (elect., phone, internet, etc)				\$5,100	
Total overhead costs					\$50,100
Farm operating surplus					\$135,013
Operating costs					
Depreciation @ 10% of value of plant and equipment				\$22,300	
Interest @ 10% of liabilities				\$22,683	
Operator and family labour				\$0	
Total operating costs					\$44,983
Farm business profit					\$90,031
Business return on equity (%)					7.00

Table 3. Representative whole farm model for the Cobar District

Statement of assets and liabilities						(June 2010)
Assets						
Land		20,000	hectares@ \$45 per hectare			\$900,000
	Land use	Area (ha)	Proportion			
		19,000	95%			
	Pastoral					
		810	4%			
	Cropping					
		0	0%			
	Conservation					
		0	0%			
	Unused					
	Total value of land					\$900,000
Livestock		Number	Class			
Sheep (Merino)		3,000	Ewe	\$56	per ewe	\$168,900
		900	Lambs	\$90	per lamb	\$81,000
		70	Rams	\$91	per ram	\$6,381
	Total value of sheep					\$256,281
Cattle						
		0	Cows	\$633	per cow	\$0.00
		0	Heifers	\$595	per heifer	\$0.00
		0	Steers	\$804	per steer	\$0.00
		0	Bulls	\$1,148	per bull	\$0.00
	Total value of cattle					\$0.00
	Total value of sheep and cattle					\$256,281
Plant and Equipment						
	Machinery (Average value)					
	Tractors					\$20,000
	Implements (headers, field bins, silos)					\$30,000
	Vehicles (car, ute, truck, motor bike, trailer)					\$72,000
	Others (office equip., wool press, compressors, welding gear, etc)					\$40,000
	Total value of plant and equipment					\$162,000
Cash						\$0
Total assets						\$1,318,281
Liabilities						
Total liabilities						\$197,742
Equity (Assets - Liabilities)						\$1,120,539
Equity percentage (Equity/ total assets)						85

Table 3. (continued)

Annual operating budget					
Enterprises gross margins (GM)	20000	ha total farm area			
		Rotation (Feed Wheat, Barley, Oats)	GM		
	81	ha	\$45	per hectare	\$3,670
	3000	Ewes (Merino)	\$48	per ewe	\$143,997
	0	Cows	\$454	per cow	\$0
Total farm gross margin					147,668
Overhead costs					
Casual wages				\$3,000	
Permanent labour				\$0	
Rates				\$5,000	
Registration				\$2,500	
Insurance (vehicle, building)				\$6,000	
Other R&M (fencing, tools, pumps, etc)				\$20,000	
Other fuel costs				\$10,000	
Services (accounting, consultant, banks)				\$3,000	
Others (elect., phone)				\$12,000	
Total overhead costs					\$61,500
Farm operating surplus					86,168
Operating costs					
Depreciation @ 10% of value of plant and equipment				\$16,200	
Interest @ 10% of liabilities				\$19,774	
Operator and family labour				\$0	
Total operating costs					\$35,974
Farm business profit					\$50,194
Business return on equity (%)					4.48

Table 4. Representative whole farm model for the Broken Hill District

Statement of assets and liabilities						June 2010
Assets						
Land		50,000	hectares@	\$45	per ha	\$2,250,000
	Land use	Area (ha)	Proportion			
	Pastoral	49,000	98%			
	Cropping	0	0%			
	Conservation	1,000	2%			
	Total value of land					\$2,250,000
Livestock		Number	Class			
Sheep (Merino)		5,000	Ewes	\$56	per ewe	\$281,500
		125	Rams	\$91	per ram	\$11,395
	Total value of sheep					\$292,895
Cattle		200	Cows	\$633	per cow	\$126,600
	Total value of cattle					\$126,600
	Total value of sheep and cattle					\$419,495
Plant and Equipment						
	Machinery (Average value)					
	Tractors & Graders					\$150,000
	Plant (sheep and cattle)					\$25,000
	Vehicles (car, ute, truck, motor bike, aircraft)					\$310,000
	Tools (bore equip, welder, pumps, etc)					\$50,000
	Other (auger, wool press, compressors, etc)					\$25,000
	Total value of plant and equipment					\$560,000.00
Cash						\$0
Total assets						\$3,229,495
Liabilities						
Total liabilities						\$484,424
Equity (Assets - Liabilities)						\$2,745,071
Equity percentage (Equity/ total assets)						85

Table 4. (Continued)

Annual operating budget					
	50,000	ha total farm area			
Enterprise gross margins (GM)			GM		
	5000	Ewes (Merino)	\$46	per ewe	\$230,271
	0	Ewes (TS)	\$0	per ewe	\$0
	200	Cows	\$454	per cow	\$90,800
Total farm gross margin					\$321,071
Overhead Costs					
Casual wages				\$3,000	
Permanent labour				\$0	
Rates				\$8,500	
Registration				\$1,000	
Insurance (vehicle, building)				\$2,000	
Other R&M (fencing, tools, pumps, etc)				\$35,000	
Fuel and lubricants costs				\$25,000	
Services (accounting, consultant, banks)				\$9,000	
Others (elect., phone)				\$4,000	
Total overhead costs					\$87,500
Farm operating surplus					\$233,571
Operating costs					
Depreciation @ 10% of value of plant and equipment				\$56,000	
Interest @ 10% of liabilities				\$22,360	
Operator and family labour				\$0	
Total operating costs					\$78,360
Farm business profit					\$155,211
Business return on equity (%)					5.65

Revised management options and major assumptions

Focus group discussions resulted in some adjustment to the three basic management options originally proposed in the Scope of Work. The management options finally modelled, and their major assumptions, are outlined below. More details of the general assumptions used are given in Appendix 5.

The opportunistic harvesting option was modelled with two scenarios:

1. 'current' level, as described by the focus groups and
2. 'maximum possible harvest', involving additional capital investment to maximise the opportunistic capture and turnoff of feral goats.

Key assumptions were that:

- Livestock production parameters, for both scenarios, are the same as for the representative farm;
- Stocking rate of domestic livestock does not increase under scenario 2.

The 'value added' option, logically the next step in feral goat control, was also modelled with two scenarios:

1. use of a goat paddock, with TGP fencing, to grow out small animals without reducing domestic livestock
2. use of a goat paddock to grow out small animals with a corresponding reduction in domestic livestock.

Key assumptions were that:

- If sheep number? is not reduced the goat paddock is used partially for sheep grazing and turnoff of grown-out goats from the paddock is typical of the representative farm;
- If sheep number is reduced (by the sheep carrying capacity of the fenced area) the goat paddock is not used for sheep grazing and turnoff of grown-out goats is increased by the dry sheep equivalence of the sheep removed;
- Livestock production parameters of the representative farm are constant for both scenarios;
- No provision was allowed for internal subdivision of the goat paddock to facilitate improved grazing management.

Focus group discussion identified the potential to achieve increases in the price received for feral goats by mustering all goats into a goat paddock and turning off larger lines of heavier animals. This scenario has not been specifically evaluated but the sensitivity of NPV to changes in the price received is investigated further in the sensitivity analysis below.

The 'TGP control' option was modelled with three scenarios:

1. Boundary fencing of as much of the property as possible;
2. Use of the goat paddock envisaged under the 'value added' option to run livestock rather than goats and
3. Fencing of an individual paddock with higher livestock production potential than the goat paddock of scenario 2 above.

Scenario 3 was introduced to acknowledge the fact that goat paddocks are usually established on poorer quality or degraded land whereas establishment of a TGP fenced paddock for livestock grazing is likely to be most profitable on land of higher quality and/or with the potential to achieve an increase in carrying capacity (beyond the equivalent exchange of goats for sheep) as a result of feral goat removal.

For scenario 1 the proportion of the property that could be fenced differed among the three districts, depending on the extent to which focus group participants considered that TGP (or any) fencing was a practical proposition given 'typical' local topography. The proportions were:

- 100% of the property for the Bourke district;
- 80% of the property for the Cobar district;
- 60% of the property for the Broken Hill district.

Key assumptions for scenario 1 were that:

- Within the fenced area livestock carrying capacity increased at the rate of 0.4 sheep DSE for each goat removed;
- Livestock production parameters were the same as for the representative farm;
- At Cobar, opportunistic harvesting over the unfenced area (20% of the property) produced 40% of the feral goats harvested under the opportunistic strategy;
- At Broken Hill, opportunistic harvesting over the unfenced area (40% of the property) produced 60% of the feral goats harvested under the opportunistic strategy.

Key assumptions for TGP control scenarios 2 and 3 – use of a goat-proof paddock for livestock grazing – were that

- Within the paddock livestock carrying capacity increased at the rate of 0.4 sheep DSE for each goat removed;
- In the paddock with high livestock production potential an additional increase in carrying capacity was achieved equivalent to the increase required, within the fenced area, to allow the boundary fencing option (TGP scenario 1) to break even (i.e. achieve a NPV of 0 over the 20 year planning horizon);
- The fenced paddock represented 5% of the property at Bourke and 10% at Cobar and Broken Hill (as determined from focus group discussions);
- Livestock production parameters were the same as for the representative farm;
- The feral goat population available for opportunistic harvesting on the remainder of the property was reduced by erection of the TGP paddock. For scenario 2, the population was reduced in proportion to the area of the property occupied by the paddock. For scenario 3 the reduction was half the proportional area of the paddock, recognising that a lower goat population could be expected on better quality land;
- No provision was allowed for internal subdivision of the goat paddock to facilitate improved grazing management.

In addition to these variants of the original proposals a further ‘do nothing’ option was added in an attempt to address concerns expressed by some focus group participants regarding the potential impact on livestock enterprises of severely reduced harvest pressure resulting from reduced feral goat prices or other disincentives (e.g. mandatory NLIS tagging).

Key assumptions of this option were that:

- When harvesting ceases the feral goat population would increase initially at 42% per annum (Mahood, 1985, cited by Parks *et al.*, 1996) up to the population of the representative farm, and thereafter at 12% per annum (the average rate of increase reported by workshop participants within a goat paddock);
- Livestock numbers would be reduced as feral goat numbers increased to maintain a constant population in terms of DSEs, and therefore the condition of the land resource.

Results and Discussion

Average benefits and costs

The average benefits and costs (over 20 years) for alternative goat management options are summarised in Tables 5, 6 and 7 for the Bourke, Cobar and Broken Hill districts, respectively. Costs include capital, overhead and variable components, opportunity costs (OC) due to sheep or goat income foregone, and sheep purchases. Benefits are derived from cost savings and sales of feral goats and sheep.

The highest average net benefit, in all districts, is derived from the ‘value added with reduced livestock’ option because this allows increased turnoff of feral goats (since no livestock are grazed in the goat paddock) and generates additional income in the short term from sale of sheep removed from the goat paddock.

The TGP control scenario 1 – boundary fencing of as much of the property as possible - has the highest capital cost, high goat opportunity cost, and results in negative average net benefit in all districts. However, at Broken Hill the average net benefit is only slightly negative because with only 60% of the property fenced the goat opportunity cost is minimised.

Use of the ‘goat paddock’ for grazing by livestock results in a small negative average net benefit at Bourke and small positive average net benefits elsewhere. In contrast, fencing of an equal area of good country, capable of achieving a modest increase in carrying capacity beyond the exchange of goats for sheep, provides positive net benefits in all districts due both to increased sheep income and reduced goat opportunity cost compared to use of a ‘goat paddock’ exclusively for livestock. However, the benefit is still considerably less than the best of the goat management scenarios.

For all districts the do-nothing option has a high goat opportunity cost and average negative net benefit.

Table 5. Average annual benefits and costs of feral goat control options for the Bourke district (\$)

Benefits and Costs	Do nothing	Opportunistic harvest		Value added goats		Livestock with TGP control		
		Current	Max. harvest	Constant livestock	Reduced livestock	5% Goat country	5% Good country	100% of property
Benefits								
Cost savings	16,908	100	100	0	0	0	0	0
Goat income	0	42,749	47,853	64,449	64,579	26,020	27,643	20,800
Sheep income	0	0	0	0	10,400	5,960	10,589	31,047
Total benefits	16,908	42,849	47,953	64,449	74,979	31,980	38,769	51,847
Costs								
Capital	0	2,370	2,878	7,956	7,956	7,956	7,956	20,637
Overhead	0	2,900	2,900	3,429	3,429	3,429	3,392	470
Variable	0	11,634	11,634	10,379	10,379	10,379	10,378	3,383
OC (goats)	42,649	0	0	0	0	14,040	1,560	42,680
OC(sheep)	11,384	0	0	0	620	0	0	0
Sheep purchase.	0	0	0	0	0	1,465	3,848	4627
Total costs	54,033	16,904	17,412	21,764	22,384	35,804	23,286	71,797
Net benefits	-37,125	25,945	30,541	42,685	52,595	-3,824	14,207	-19,950

Table 6. Average annual benefits and costs of feral goat control options for the Cobar district (\$)

Benefits and Costs	Do nothing	Opportunistic harvest		Value added goats		Livestock with TGP control		
		Current	Max. harvest	Constant livestock	Reduced livestock	10% Goat country	10% Good country	80% of property
Benefits								
Cost saving	26,256	0	0	0	0	0	0	0
Goat income	0	54,659	61,270	111,400	117,700	54,659	37,215	44,764
Sheep income	0	0	0	0	18,027	13,730	15,142	22,694
Total benefits	26,256	54,659	61,270	111,400	135,727	68,389	52,357	67,458
Costs								
Capital	0	4,885	7,459	10,440	10,440	10,439	10,439	13,376
Overhead	0	2,900	2,900	3,429	3,429	3,429	3,429	3,429
Variable	0	18,471	18,470	15,608	15,608	15,608	15,608	530
OC (goats)	54,559	0	0	0	0	34,320	1,650	31,200
OC (sheep)	21,125	0	0	0	942	0	0	0
Sheep purchase.	0	0	0	0	0	97	1,485	31,560
Total costs	75,684	26,256	28,829	29,477	30,419	63,889	31,154	87,456
Net benefits	-49,428	28,403	32,441	81,923	105,308	4,500	21,204	-19,998

Table 7. Average annual benefits and costs of feral goat control options for the Broken Hill district (\$)

Benefits and Costs	Do nothing	Opportunistic harvest		Value added goats		Livestock with TGP control		
		Current	Max. harvest	Constant livestock	Reduced livestock	10% Goat country	10% Good country	60% of property
Benefits								
Cost saving	24,133	0	0	0	0	0	0	0
Goat income	0	54,650	60,290	84,700	88,724	54,752	43,676	23,077
Sheep income	0	0	0	0	10,400	6,500	27,262	17,566
Total benefits	24,133	54,650	60,290	84,700	99,124	61,250	71,079	40,643
Costs								
Capital	0	2,750	3,400	13,670	13,670	13,670	13,668	26,600
Overhead	0	2,900	2,900	3,430	3,430	3,430	3,376	0
Variable	0	18,480	18,480	14,070	14,070	14,070	14,069	2,310
OC (goats)	54,850	0	0	0	0	21,580	1,237	13,080
OC (sheep)	7,178	0	0	0	1,610	0	0	0
Sheep purchase.	0	0	0	0	0	1,110	3,848	600
Total costs	62,028	24,130	24,780	31,170	32,780	53,860	36,198	42,590
Net benefits	-37,895	30,520	35,510	53,530	66,344	7,390	34,881	-1,965

Benefit-cost analysis

Benefits and costs for alternative feral goat management options at Bourke, Cobar and Broken Hill are given in Tables 8, 9 and 10, respectively.

Judged by the NPV criterion the ‘value added with reduced livestock’ scenario is the most attractive for producers in all districts but it is only marginally superior to ‘value added with constant livestock’. Both are substantially superior to either of the opportunistic harvest scenarios which, in turn, are superior to use of the ‘goat paddock’ for livestock grazing only. However, the NPV for TGP fencing of a paddock in good country is comparable, or even superior at Broken Hill, to the opportunistic harvest scenarios though still substantially lower than the ‘value added’ scenarios. The result at Broken Hill reflects the larger size of the representative farm and therefore the greater increase in the livestock population and sheep income produced from the fenced paddock. The do-nothing and boundary fencing scenarios for all districts are unlikely to be desirable because they return negative NPV.

The ranking of scenarios on the BCR criterion is broadly similar to that described above for NPV although some minor differences are apparent.

Table 8. Benefits and costs of feral goat control options in the Bourke District

Evaluation Criteria	Do nothing	Opportunistic harvest		Value added goats		Livestock with TGP control		
		Current	Max. harvest	Constant livestock	Reduced livestock	5% Goat country	5% Good country	100% of property
PVB	127,331	407,346	462,477	614,017	639,459	425,094	384,086	331,100
PVC	376,359	163,910	170,358	217,660	229,645	308,231	175,767	714,678
NPV	-249,029	243,436	292,119	396,357	409,815	116,863	208,319	-383,577
BCR	0.34	2.49	2.71	2.82	2.78	1.38	2.19	0.46
Desirability	x	√	√	√	√	√	√	x
Ranking (NPV)	7	4	3	2	1	6	5	8

Table 9. Benefits and costs of feral goat control options in the Cobar District

Evaluation Criteria	Do nothing	Opportunistic harvest		Value added goats		Livestock with TGP control		
		Current	Max. harvest	Constant livestock	Reduced livestock	10% Goat country	10% Good country	80% of property
PVB	198,822	519,716	589,848	1,126,919	1,172,435	607,246	555,907	412,489
PVC	511,095	255,538	282,801	299,174	316,599	548,620	312,400	525,752
NPV	-312,273	264,177	307,047	827,745	855,836	58,626	243,506	-113,263
BCR	0.39	2.03	2.09	3.77	3.70	1.10	1.78	0.78
Desirability (NPV)	x	√	√	√	√	√	√	x
Ranking (NPV)	8	4	3	2	1	6	5	7

Table 10. Benefits and costs of feral goat control options in the Broken Hill District

Evaluation Criteria	Do nothing	Opportunistic harvest		Value added goats		Livestock with TGP control		
		Current	Max. harvest	Constant livestock	Reduced livestock	10% Goat country	10% Good country	60% of property
PVB	281,144	520,597	580,311	847,732	879,006	692,575	710,541	353,488
PVC	443,082	233,004	239,905	318,424	343,574	555,392	327,171	368,247
NPV	-161,939	287,593	340,406	529,307	535,432	137,183	383,370	-14,759
BCR	0.63	2.23	2.42	2.66	2.56	1.25	2.17	0.96
Desirability (NPV)	x	√	√	√	√	√	√	x
Ranking (NPV)	8	5	4	2	1	6	3	7

Sensitivity analysis

The net benefits from the alternative feral goat management scenarios are affected by goat and sheep prices, the number of feral goats captured, and capital and other costs involved with managing feral goats operations. In focus group discussions participants identified feral goat prices and population as the two most important variables affecting their decisions to initiate harvesting operations.

Regression coefficients from the @RISK analysis (Table 11) indicate that all scenarios are more sensitive (positively or negatively) to goat price than to the goat population on the property as a whole, NVP changing by 0.87-0.99% for every 1% change in price but by only 0.10-0.36% for every 1% change in population. The negative values for the whole property TGP control scenario indicate that fencing the whole or a large segment of the property incurs a high opportunity cost in goat income foregone which increases with both goat price and population. Similar opportunity costs are incurred by the do nothing scenario, which also incurs the opportunity cost of sheep income foregone since the total animal population, in terms of DSE, is held constant.

Table 11. Regression coefficients for sensitivity analysis

District	Variables	Do nothing	Opportunistic harvest		Value added goats		Livestock with TGP control		
			Current	Max. harvest	Constant livestock	Reduced livestock	Goat country paddock	Good country paddock	Whole property*
Bourke	Goat price	-0.90	0.93	0.93	0.93	0.93	0.92	0.92	-0.87
	Goat pop.	-0.34	0.29	0.28	0.28	0.29	0.22	0.34	-0.32
Cobar	Goat price	-0.92	0.95	0.95	0.94	0.94	0.99	0.72	-0.94
	Goat pop.	-0.36	0.29	0.29	0.32	0.32	0.10	0.26	-0.19
Broken Hill	Goat price	-0.93	0.94	0.93	0.93	0.93	0.99	0.92	-0.97
	Goat pop.	-0.30	0.28	0.29	0.32	0.32	0.25	0.29	-0.29

* Proportion of whole property fenced – Bourke 100%, Cobar 80%, Broken Hill 60%

Required improvements in land condition for economic TGP fencing

None of the TGP scenarios for livestock grazing described above resulted in a NPV or BCR equal to or better than the ‘value added with reduced livestock’ scenario for feral goats. Nevertheless, in all districts TGP fencing of a single paddock for livestock grazing, either in good country or goat country, returns a positive NPV and BCR greater than 1 (Tables 8, 9 and 10) so the investment could be justified even if the return is lower than would be achieved by investment in a goat paddock to grow out captured feral goats. Fencing of good quality country is always the better option, because it is assumed to achieve an improvement in resource condition and the opportunity cost of foregone goat income is reduced.

However, TGP boundary fencing of as much of the property as feasible returns negative NPV and BCR less than 1 in all districts (Tables 8, 9 and 10). In this case an increase in livestock carrying capacity within the fenced area, additional to the substitution of sheep for feral goats assumed in the models, is required to allow this option to break even although the increases required are relatively small (Table 12). Differences between the districts reflect the extent of boundary fencing feasible and thus the opportunity cost of feral goat income foregone. At Broken Hill, where only 60% of the property can be fenced and the unfenced area allows 60%

of the normal level of opportunistic goat harvesting to be maintained, the required increase is almost negligible. In contrast, a considerably higher increase is required at Bourke where the whole property can be fenced and all feral goat income is foregone. The situation at Cobar, where 80% of the property can be fenced, is intermediate.

Table 12. Additional carrying capacity required within the fenced area, as a % of the carrying capacity of the representative farm, required for the TGP boundary fencing scenario to break even.

District	% of property boundary fenced	Carrying capacity of representative farm (DSE/ha)	Additional carrying capacity required (% of rep. farm)
Bourke	100	0.20	10
Cobar	80	0.25	4
Broken Hill	60	0.25	0.2

Further increases in carrying capacity would be required to allow any of the TGP fencing scenarios to return a NPV equal to the best feral goat management scenario ('value added' with reduced livestock). The required increases (Table 13) may be sought either within the fenced area itself or more broadly over the whole property. These increases will need to be achieved by the application of improved grazing management practices (e.g. some form of non-continuous grazing) in addition to the removal of feral goats but the cost of infrastructure that may be required to allow implementation of these practices has not been considered in determining the carrying capacity increases required.

Furthermore, if land is already overstocked in the presence of feral goats, so that no increase in livestock carrying capacity can be expected simply from their removal, the increases shown in Tables 12 and 13 will underestimate the improvements required.

Table 13. Additional carrying capacity, as a % of the carrying capacity of the representative farm, required within the fenced area or over the whole property for TGP scenarios to equal the NPV of the best feral goat management scenario.

District	Carrying capacity of representative farm (DSE/ha)	Additional increases in carrying capacity required to equal best feral goat scenario (% of representative farm)					
		Within the fenced area			Over the whole property		
		Goat country paddock	Good country paddock	Whole property*	Goat country paddock	Good country paddock	Whole property*
Bourke	0.20	290	124	43	14	6	43
Cobar	0.25	640	220	63	59	20	51
Broken Hill	0.25	102	21	14	10	2	8

* Proportion of whole property fenced – Bourke 100%, Cobar 80%, Broken Hill 60%

Determination of the extent to which improved grazing management may be able to increase the carrying capacity of semi-arid rangelands within the Western Catchment is beyond the scope of this project. However, Bryant *et al.* (1989) and White *et al.* (1991), summarising early experience with short duration grazing in semi-arid rangelands in the US, indicated that stocking rates compatible with maintenance of range condition could be 10-20 % higher under this system compared with continuous grazing. In Zimbabwe, Gammon (1984) suggested that increases in stocking rate should not exceed 30%, under average rainfall conditions, compared with less intensive systems. McCosker (2000) claimed an average 2.1 fold increase across surveyed properties practising time control (cell) grazing in the USA, RSA, Zimbabwe and Namibia over 5-25 years. Anecdotal evidence in the Western Catchment (P. Theakston, pers. comm.) suggests that a doubling of carrying capacity over several years might be feasible with exclusion of feral goats and the introduction of rotational grazing. Certainly, differences of this magnitude in the estimated carrying capacity of areas in poor versus good range condition would not be exceptional so that opportunities for substantial improvement in carrying capacity with improved management of grazing and TGP should be expected.

From this brief discussion it is clear that the increases in carrying capacity required to make TGP boundary fencing either a break even proposition (Table 12) or economically comparable with the best feral goat management option (Table 13) are either quite modest or probably achievable given the increases that could be expected from the combination of TGP control and improved grazing management.

However, when TGP fencing is confined to a single paddock used for livestock grazing, that investment will only be competitive with value adding to harvested feral goats if improvements in carrying capacity can be realised over the whole property, through the combination of goat exclusion in the fenced area, opportunistic harvest in the unfenced area and improved grazing management overall. Under these circumstances the required improvements in carrying capacity might be feasible. Otherwise, with the possible exception of the Broken Hill district, the improvements required within the fenced paddock alone would not be achievable.

Environmental benefits of feral goat management

Focus group participants identified a number of environmental benefits they considered resulted from feral goat management. These included reduced total grazing pressure, higher level of ground cover, reduced soil degradation, increased biomass, and biodiversity conservation. No valuation of these benefits has been included in the analyses described above.

Conclusions

The essential features of this analysis and their implications for future approaches to feral goat management are:

- Opportunistic harvesting of feral goats is profitable for landholders in all districts. In terms of NPV, the current level of opportunistic harvest could be improved by additional capital investment aimed at maximising feral goat turnoff. However, financial incentives for this investment would not be justified since it can be supported by the additional income generated. Any incentive aimed at stimulating this higher level of turnoff would be better related to desirable outcomes such as ground cover rather than infrastructure.

- Establishment of a goat paddock, with or without reduction in domestic livestock, is highly attractive in terms of both NPV and BCR and is well able to support the capital costs involved. In all districts establishment of a goat paddock with a corresponding reduction in domestic livestock returns the highest NPV. There would appear to be no justification for public subsidisation of this form of investment.
- Boundary fencing of properties with TGP fencing, to the extent permitted by local topography, returns negative NPV and BCR less than 1 in all districts if livestock increases are only equivalent to the feral goats removed. However, the additional increases in carrying capacity required to break even, or to return a NPV equal to the best feral goat harvesting scenario, are probably within the range achievable by improved grazing management practices (although the cost of additional infrastructure for grazing management has not been considered in determining the increases required).
- Investment in a goat-proof paddock for livestock grazing is best directed to better quality land rather than land more suited to a goat paddock. Such investment provides positive NPV and BCR in all districts, and is economically justifiable, but returns a lower NPV than the best of the feral goat harvesting scenarios unless associated with increases in carrying capacity beyond the substitution of sheep for feral goats within the fenced area. If such increases can be achieved across the whole property then only modest improvements, within the range likely achievable by grazing management techniques, are required. However, if improvements are limited to the fenced area then the change required is unlikely to be achievable except perhaps in the Broken Hill district, and this option will remain less attractive than investment in value adding to harvested feral goats.
- NPV of all control scenarios is more sensitive to goat price than to goat population density so that resource condition issues related to goat density are unlikely to be the primary driver of producers' decisions related to feral goat harvesting or the regulation of feral goat populations.
- Any cessation of feral goat harvesting due to low prices or other impediments, is likely to be seriously disadvantageous for the profitability of livestock enterprises, and probably also for natural resource condition as pastoralists seek to maintain incomes in the absence of an alternative income stream.
- Overall, there are strong economic incentives to retain and exploit feral goats in the Western Division rather than remove them. Since price rather than population density is likely to be the major driver of harvesting they represent a conundrum for natural resource management since there is no stable incentive to reduce their numbers in the interest of either economic returns or resource condition. Since (probably) achievable improvements in carrying capacity can result in favourable returns from TGP fencing, any attempt to improve natural resource outcomes by public investment may be best directed at encouraging improved grazing management (e.g. through incentives for ground cover) rather than infrastructure for feral goat harvest since such investment is already profitable for landholders.
- The relative economic benefits of the options for feral goat management evaluated in this study are consistent across all districts. Any policy developed on the basis of these analyses should therefore have general application.

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Appendix 1. Summary of the information collected for updating the representative farm model for Bourke, Cobar and Broken Hill Districts

Assets and Liabilities	Bourke	Cobar	Broken Hill	Comments
Property size and value	40,000 ha west of Bourke 10,000 ha east of Bourke 24,000 ha reasonably representative \$1400/cow area; \$15/acre (\$37.05/ha) for rep. property; \$40/ha reasonable; land values have appreciated in recent years beyond the production potential. Land use – 100% pastoral	40–50,000 acres (16–20,000 ha) \$18–20/acre (\$45–50/ per ha) Land use: fundamentally pastoral but cropping on 10% of the land south of Cobar; 2,000 acres (810 ha) more typical of cropped area (about 4% of typical property); only crop about 200 ac (81 ha) in any year	Size: 50,000 ha business holding, one business may have >1 lease Value: \$20 acre or \$50 ha. Land use: pastoral 98%; Conservation 2% (to recognise that growing number of landholders have conservation agreements; 4/18 at recent meeting have such agreements)	Property sizes vary depending on location; and increase westward. Property values have increased but income has declined. No unused, conservation, and cropping land in most cases. Properties are predominantly used for pastoral purposes.
Livestock numbers and composition	No change required to overall livestock numbers in the representative model but: Wethers no longer kept except on country unsuitable for ewes; otherwise all wethers turned off as lambs. Many properties no longer running cattle but this may change with change of seasons	No alteration in sheep numbers required in the representative farm model; no cattle enterprise; prices of ewes, wethers and rams all estimated at \$80. (Prices will be inserted from current I&I gross margins)	5000 ewes 125 rams 200 cows Value of ewes = \$80–\$100; there is significant price variation.	The land is basically used for self-replacing Merino and cattle enterprises but has turned to prime lamb production. Income from wethers is lower than lambs. Dual purpose sheep like Dohne are also being introduced

Assets and Liabilities	Bourke	Cobar	Broken Hill	Comments
Plant and equipment	2 Utes (\$50 k) Family vehicle (\$60–\$65 k new; \$30–\$40 k second hand) 3 Bikes (\$18–20 k) Tractor, loader & grader (\$20 k each) (total value of farm vehicles ~ \$200 k) Tools – compressor, generators, welding gear, power tools (\$30 k) Set portable yards (\$15 k) Multi-purpose trailer (\$3k–\$4 k) Office equip. – computer \$2–\$2.5 k; fax \$400.	2 motor bikes; 2 utes (one old and one newer); 1 grader, loader or dozer, 1 quad bike. Set portable yards, scales, wool press Tools – compressor, welder, generator, hydraulic, post driver (\$30 k). Cropping plant: 2 tractors, implements; augers, header, field bins, silos. Office equip. – Computer, fax (\$5 k). Total – \$150 k–\$160 k (Note: Need to include 50% of cost of multi-purpose trailer in the base model.)	Farm vehicles 2 x utes – \$50k 2 x motor bikes – \$10k 1 quad bike – \$10k Tractor/grader/loader – 150,000 Truck: \$40 k Total farm vehicles: \$260 k Aircraft: \$50,000 Sheep plant – \$20 k (e.g. portable yards, scales, jetting race) Cattle plant – \$ 5 k (e.g. crush, scales) Office – \$2.5 k (computer, fax) Tools – \$50 k (bore equipment, welders, generators, pumps etc.) Other = \$25 k (e.g. spare fencing equipment, poly pipe, fittings etc)	The size and type of plant and equipment vary depending on the enterprises being conducted and the size of the operation.
Liabilities	About 85% equity for business still surviving.	85% equity would be reasonable; further information from Rural Financial councillors.	Assume 85% equity, as for other districts.	

Assets and Liabilities	Bourke	Cobar	Broken Hill	Comments
Production parameters	Ewes: Body weight: 55 kg DSE Rating: 1.5 Stocking rate: 0.25 DSE/ha Lambing: 70–80% Weaning: 1.5–2% loss from lambing Ha @Weaning age: 10mths Ram %: 1.5–2.0% Mortality (adults): 5% Ewe hogget culling: often not happening due to low sheep numbers Wool cut: 6 kg Micron: 21 Yield: 60% (inc. pcs, bls etc) Age at first joining: 1.5–2 yrs Productive life: Keeping as long as possible at present due to drought; some up to 8 y.o. % joined to terminals: A few producers joining up to 30% of ewes to terminal sires (but not typical of the district) Wethers: Body wt: 60 kg DSE rating: 1.1 Mortality (Adults): 5% Wool cut: 7 kg (3kg weaners) Micron: 21.5 Yield: 60% Age at sale: 4 years (if holding), 10–12 mths as lambs Cattle: Stocking rate: 0.25 DSE/ha No further discussion	Ewes: Live weight: 55: Weaning: 70% Mortality: Lambing to weaning 5% Ewe hogget culling not common practice. Micron 21 Yield 64% Age at first joining: 1.5 yrs Productive life 7 yrs % joined to terminal sires: 20–25% but not typical (cyclical) Wethers: Body weight: 60 kg Mortality (adults): 5% Wool cut: 6.5 kg Micron 21. Sold at: 2–3 years; sold or 60 kg live weight	Ewes: Live weight: 60 kg (increase DSE rating for this district above 1.7 in base model); Stocking rate: 15 acres/ewe (0.28 DSE/ha @ 1 ewe= 1.7 DSE) Marking%: 80 Weaning %: 77 (80% lambs marked, 4% mortality marking ton weaning) Ram %: 2% Mustering not included, Dorpers and most meat sheep would scan but not merino sheep. Ewe hogget culling = 20%; wool cut = 6–7 kg; mortality = 4%; lambs = 3kg/lambs; micron = 21.5; wool yield = 63%; age @ first joining = 1.5; Joined to terminal sires if there is any = 20% of ewes; 8/10 graziers use terminal sire over CFA ewes; SAAM, Dorset, border leister black/white Suffolk , terminal are being introduced. Lambs: body weight = 40 kg; wool cut 3 kg/ lamb short before sale; micron = 19; yield = 65%; sold at age = 12; sold at wt = 40 kg Cows: DSE same as sheep, weaning% = 75, heifers retained = 90%; Bull 2%; steers sold \$ 300 (12 months)	Culling in some instances is not happening due to the need to build up numbers. Due to drought, producers now retain ewes for much longer than in the past – up to 8 years in some cases. Some join ewes to terminal sires – up to 30%.

Assets and Liabilities	Bourke	Cobar	Broken Hill	Comments
Variable costs	Sheep: Shearing: \$5.40–5.80/hd (\$6.00 average for district); x2 for rams. Crutching: \$1/hd Cartage: \$20/bale Wool packs \$13 ea Overall wool expenses: \$90/bale Mustering: – \$4 k/year including wages, planes, etc (producer 1) – \$10 k/yr or \$1/hd/yr (producer 2) Scanning: minimal Drenching: 3 yrs in 10 Vaccination: lambs only (typically about 50%) Replacement rams: \$400 ea Cartage, sale sheep: \$6–7/hd to Dubbo; many now sold by electronic auction – \$1/hd listing price. Commission Wool sales 6% Sheep sales 5%. Cattle: Bull replacements: x2 representative model Commission on sales: 5%	Sheep: Shearing: Ewes \$6– \$6.25/hd Rams \$12–\$12.50/hd Crutching: \$1/hd Cartage: \$12/bale Shearing supplies: \$10/bale (500 ewes cost about \$1500 in wool costs including shearing supplies; about \$3/ewe) Marking and mulesing: \$1.60 per hd Mustering: 20 days @ \$200/day (bit high) Live sheep cartage: \$ 4–\$6/hd (to Dubbo; depending on size of truck); Auction Plus becoming more common; Commission Wool sales 6% Sheep sales 5%. Cropping: 2000 acres (810 ha) of cultivation country; 200 ac (81 ha) sown in cropping phase Yield: 4–6 bags/acre (approx 0.8–1.2 tonnes/ha) Crop rotation: wheat barley, oats; plant 3 years in 4; 50% of plantings produce grain; otherwise cut for hay or graze so get something off every year. Harvesting: \$20/ha Crop management: 1 pass (direct drilling), low fertiliser rates, minimum herbicide use.	Sheep: Shearing: Ewe/wether \$6.50 Rams \$10 Crutching: \$3 Cartage \$14/bale to Adelaide; Shearing supplies \$10/bale No change on marking, mustering, dipping, jetting (spray on), no scanning (except for meat sheep), no drenching, vaccination only for lambs Other costs: trisolfen at lamb marking (for pain relief) Rams: \$750/hd Cartage – sale sheep \$4.50/hd Wool tax 2% Commission Wool sales 6% Sheep sales 5%. Cattle: Replacement bulls = \$2000 Selling costs: NLIS (tag & management) \$5 Transport \$50.00/hd Levy \$5.50/hd Yard charges \$5.00/hd Commission 5%	

Assets and Liabilities	Bourke	Cobar	Broken Hill	Comments
Overhead costs	Rates: \$5000 (includes Shire, LHPA, Western Lands Lease rental without subsidy, wild dog rates) Insurance: \$1.5–\$1.6 k rego (2 vehicles); \$6 k other insurance (reduce 40% for home & contents) Electricity: \$4.5 k (half for business) Phone: \$4.5 k (half for business) Administration: \$50/mth Internet Services: \$2 k pa (accounting, consultancies, bank fees)	Labour: \$2 k–3 k Rates: \$4.5 k/yr (with part payment of WLL. rent at present) (assume \$5 k without WLL subsidy) R & M: \$20 k Electricity: \$12 k (includes phone, power + internet) Services: \$3 k	Labour: \$2500; Rates = 8500; Rego \$1000; insurance \$2,000; maintenance, \$35,000; fuel and oil = \$25,000, electricity; \$4,000 And admin \$4500; services= 5,000	
Interest rates Depreciation:	About 9–10% \$25,000 pa	About 9–10%	About 9–10%	

Appendix 2. Summary of information collected for the analysis of feral goat management options

1. Opportunistic harvesting					
	Bourke	Cobar	Broken Hill	Comments	
Control objective	Cash flow (Price currently 90c/kg live weight, back from \$1/kg); \$30– \$35/hd; \$40 k–\$50 k per year. Assist with property and grazing management; willing to leave other jobs if can pick up 100–150 goats.	Cash flow; (flexibility of income) TPG control – reducing competition with sheep.	Easy money and reduce TGP	The primary objective of goat control is additional income generated from goat harvesting. Control of TGP or property management is secondary. Goats are seen as a resource, not as pests. No need to exclude them from property.	
Control strategy	Most properties have traps on water and/or containment yards (especially containment yards); 6 containment yards and 4 trap yards typical; generally about 1/3 of waters trapped but use one more regularly than others and should be placed where goats are common.	Fencing waters with trap gates, including exclusion of water points; opportunistic mustering.	1. Trapping – easier in summer, about 2/3 of goat numbers are trapped in summer 2. Mustering – about 2/3 of people muster because they don't have traps.	Most producers have traps on watering points and/or containment yards but majority use containment yards.	
Trigger for start of control strategy	Good price, wind direction favourable for moving goats on to property from other areas; availability of water and feed favours goat movement onto property; hot weather for trapping.	Price/cash flow; seasonal conditions (warm weather required to trap on waters; feed availability also determines availability of goats); goat population; consignment lots (making a load)	Number of goats present; pressure goats are placing on water and pasture; price.		

	Bourke	Cobar	Broken Hill	Comments
Trigger to stop control strategy	Price drops, depot not taking goats; busy with other work.	Price drops, population of goats.	Reduction in numbers available, goats not present in large mobs, seasonal conditions (less likely to muster in cooler weather)	
Length of control	Sporadic and opportunistic	Sporadic and opportunistic	Mostly sporadic and opportunistic	
Frequency and time	Once or twice/week, usually combined with water runs; All year round but usually capture more in summer.	Population dependant; as above, warm weather.	Some may have annual muster, others muster on sight; depends on property (whether goats are always present or moving through). Often 3–6 months between musters but varies from once a year to once a week; some people disturb goats as little as possible so as not to scare them away.	Summer harvest dominates the region.
Population	Average approx. 1920 goats on a 24,000 ha property (assuming reasonable goat country, not open flood plain; about 1/2–1/3 of property is believed to run goats.); population is static given conditions are right (e.g. water, wind, etc)	3000–4000 (total including kids); 1.3 goats per 10 acres (not typical perhaps lower) (NB this equals 6500 goats on typical property – too high)	Varies greatly between flats and hills; maybe only 50 resident on a flat property up to 5000 on a hilly property – 1500 for a ‘typical’ property	Goats don’t like running with sheep. Goat population is high if sheep not present

	Bourke	Cobar	Broken Hill	Comments
Feral goats harvested	960/yr (50% of estimated population).	1800–2000/yr. (50% of estimated population) Assuming a combination of country.	Varies greatly between flats and hills; may sell 300 per annum on a flat property and up to 5000 per annum on a hilly property. About 1670 feral goats harvested (111% of year-in-year-out population) and about 1000 per annum sold are reasonable for a typical property.	At Broken Hill, unlike the other districts, the total number of feral goats harvested is 111% of the total feral goat population carried on the representative property. 60% of the feral goats harvested are sold and the remaining 40% released.
Effect of seasonal conditions and domestic stocking rates on goat population.	Goat number is not very sensitive to seasonal conditions; water availability influences goat number more than seasonal conditions; with high domestic stocking rate goat number seems to decrease but not greatly; goats prefer paddocks with no sheep.	Similar to Bourke. No of goats does not change much with seasonal conditions; more goats with low domestic stocking rate but not a big effect. If stock conservatively and have feed will have migration of goats onto property if seasonal conditions decline.	Population does not change much with seasonal conditions but more goats with low domestic stocking rate (as for other workshops) With low domestic stocking rate: Population of about 2500 goats under good or bad seasonal conditions – can muster/trap 1500 under poor seasonal conditions as they move into open country; can muster 750 under good seasonal conditions as harder to trap or muster with high feed availability. With high domestic stocking rate: Population of about 1000 under good or poor seasonal conditions; can muster/trap 1000 if seasonal conditions are poor and 500 if seasonal conditions are good. Goats prefer paddocks without sheep.	Effect of seasonal conditions and domestic stocking rate on goat number is not sufficient to justify including these variables in the budget analysis. Goats prefer not to graze with sheep – tend to avoid areas or paddocks where sheep are stocked.

	Bourke	Cobar	Broken Hill	Comments
Time for goat numbers to build up again	Numbers remain fairly static if wind and water conditions are right.	Approximately 2–3 months, up to about 6 months; varies with season and temperature	Influenced by seasonal conditions and wind direction etc; can be rapid; 3–6 months average to rebuild numbers. Distribution of sheep can be influenced by anticipated movement of goats out of ranges onto flat country which is trapped (i.e. destock when goats are expected to move out of the ranges).	Mustering on adjacent National Parks can prompt movement of goats out of ranges.
Changes to the productivity of other enterprises.	Nil. Production figures in the base model assume a background of feral goat grazing and opportunistic harvesting.	Nil	Nil Sheep: Body weight and wool cut would be slightly lower if not harvesting goats. Cattle: as for sheep	Nil impact on base model production parameters. The assumption in Cobar and Bourke is that the sheep paddocks are conservatively stocked and properly managed with rotational grazing. Base model production figures left unchanged because the model assumes some level of feral goat control.

	Bourke	Cobar	Broken Hill	Comments
Advantages of goat control	Saving from damage to fences, reduced pressure on watering points, etc	Reduce TGP	Reduce TGP	
% Sold and released	Typically 100% sold; some individuals may release goats less than 24 kg live weight (may be up to 20% of goats captured).	Overweight goats only, 50% but dependant on season, percentage can fluctuate (40–60%); release 50% but (in practice) put some into goat paddock. Sold if >20 kg live weight.	60% sold (1000 head) and 40% released; animals <23 kg live wt are released. Some people only sell billies and release nannies but others sell everything to get them off the property.	Mix of strategies: one group sells all while another group sells part of the total goats captured.
Investment required to maximise goat off take	Extra 6–10 containment yards on 24,000 ha property; results in nil change in average number of goats on property but harvest increased by about 20%.	If all waters trapped and some strategic fencing would increase the number of goats harvested by 10%.	Generally adding more infrastructure will see diminishing returns in terms of goats turned off; traps etc are already in the most favourable locations. Additional 1–2 traps would increase goats sold by 10–20% (may increase number captured by up to 50%).	
Risks	Goats not run through sheep yards/sheds – so no fibre contamination. OH&S risks associated with goat handling.	Price not considered a risk as wanting to control the population.	Fibre contamination – most people now having separate infrastructure for handling goats. OH&S – especially for mustering; trapping is less risky.	Producers are earning a large income from the sale of feral goats, with insignificant expenses. Currently, they are price takers but they harvest goats as long as the price covers their direct expenses.

	Bourke	Cobar	Broken Hill	Comments
Environmental outcome	Reduced TPG as a result of harvesting, big impact on ground cover; impacts of goats on INS e.g. hopbush; damage to other vegetation may outweigh benefits of impact on INS.	Increased biomass; unable to maintain condition of country without harvesting goats; conserve water supply.	Control of TGP particularly of 'favoured' areas; control of some INS – may lead to increased ground cover.	
New capital investment	6 containment yards (approx 10m x 10m): 1 day to build (owner labour); \$400 each – includes mesh (1100 mm) forcing yard, hinge joint wings (50 m total), 2 gates, loading ramp; bungle to force into loading ramp; half coil 1100 mm mesh, steel posts, trees utilised where possible instead of posts. Traps – \$2 k–\$4 k to build (assuming owner labour)	Ideally would have 12–15 waters fenced and trapped; \$3,500–\$5,000 per trap. Typical property has 50% of waters trapped and 2–6 containment yards. Some containment yards may have permanent wings only, for use with portable panels. Trap yards are made of hinge joint, 50 x 50 m, 5 m post spacing, 4 gates; top barb; bottom barb; have forcing yard, race, two drafting yards (sale and keep), no loading ramp – use with portable ramp; need 'open' ramp and race so goats don't catch horns. \$3 k for materials. Containment yards and traps have same design and cost.	2 or 3 waters trapped (out of 20; target areas preferred by goats) Trap yards: At ground tank: 600m mesh; 200 star droppers; 2 spear gates, 2 gates, ramp (supplement with 20 portable panels) At trough: 50 x 50 m Reduce mesh and posts by 1/3 Same number of gates 2 sets basic yards for mustering goats (containment yards) Mesh – several 30 m rolls Gates HJ wing (30m; optional) Round traps are becoming more popular, less pressure on corners and so less damage.	Can use for sheep on rare occasions e.g. stragglers. Note large difference in price of containment yards between Bourke and Cobar.
Repairs and maintenance of new capital	Minimal e.g. twitching with wire; maybe \$100/yr for traps and \$100/yr for containment yards.	Minimal if done properly \$100/yr.	Nil	

	Bourke	Cobar	Broken Hill	Comments
Productive life of new capital	20 years	20 years if maintained properly.	15 years	
Modifications to existing infrastructure	Add holding yard to trapped waters – 25 ha, hinge joint with 3 plain wires, 10–15 m post spacing (10m post spacing required for CMA funding)	Nil	Nil	
Plant and equipment	Multi purpose trailer– high maintenance when used for goat harvesting (e.g. bearings, flat tyres); dogs; motor bikes (20% of usage of station bikes is for goats)	Trailer – \$4 k, 50% usage for goats; \$5 k potable panels	Trailer with crate – sometimes specifically for goats, sometimes shared with other enterprises. (Note: 4 sets of community owned portable yards available for use)	Cost varies significantly.
Variable costs	For one load per week – motorbike (100 km), ute plus trailer (60–70 km); additional cost of transport to depot (ute and trailer –150 km round trip) For larger numbers (>80 head) depot will pick up and pay reduced price. Total cost approx. \$3/goat (tyres, bearings, fuel etc)	Vehicle & trailer: \$1000/yr (inc. R&M) Wages \$200/day x 20 days/year Motor bike: 11,000 km in 2.5 years (approximately 2000 km/yr for goats only) Vehicle: 800 km/muster, 4 musters/yr Salt (for trapping on water points): 40 blocks per year @\$14 Cartage: \$3.00–3.50/km for body truck; B–Double \$3.40 per km, up to \$5–6/km. Overall \$308 per load with several hundred per load.	Fuel and oil – 10% of the total fuel and oil cost R&M: 10% of the total R&M Dogs (4): \$1/dog/day (feed and vet costs) Freight: \$1/hd Price: \$30/goat that is average wt 35kg@90c	Goat buyers/depots have significantly improved over the years – running as a better business.

	Bourke	Cobar	Broken Hill	Comments
Options to influence price	Nil – basically price takers; don't put together big enough lines to influence price.	Shop around for best price – can be up to 10 c/kg difference, more room to move on price with bigger numbers; reputation as supplies of good quality goats also helps with price; \$5–10/hd better off to send big numbers to works (rather than small numbers to depot).	Drafting on weight may allow influence on price. Selling to depots means taking the price on offer unless can put big numbers together.	Bourke: Establishment of a network of goat depots in recent years has significantly assisted producers to control goats.
2. Value added option – establishment of a goat paddock to grow out underweight feral goats				
	Bourke	Cobar	Broken Hill	Comments
Control objective	Value add by growing out NCV's in goat paddock; grow out NCVs for 6–8 months to reach 24 kg live weight; don't lose NCV's by migration.	Taking pressure off outside areas; getting consignment lot together, more bargaining power for price, abattoirs may offer premium for a truck load at short notice. Additional objective for some landholders: Maximise goat income by mustering ALL goats into goat paddock and drafting off heavier sale lines (average live wt 26kg, even lighter saleable goats are retained to gain weight).	Grow out the under weight animals; put together larger and more uniform mobs to obtain better price/hd by sale to works rather than depot, and more cost effective freight; can be a price maker rather than price taker; allows time to talk to different buyers. Control of grazing pressure – goats restricted to one paddock in rougher country. Control of INS and other weeds (Noogoota burr)	Able to retain underweights caught and not risk losing them via migration.
Control strategy	The same as opportunistic – mustering and trapping – but with NCVs retained	Same as option one; combining harvesting goats with paddock confinement; fenced goats attract goats from outside (ranges and feeder properties; ramps into goat paddocks to allow jump ins)	As for opportunistic but with addition of goat paddock	Save time by moving shorter distances; goats attract more goats; keeping on top of numbers at all times.

	Bourke	Cobar	Broken Hill	Comments
Trigger for start of control strategy	As for opportunistic	Can pick up smaller groups of goats	As for opportunistic	
Trigger to stop control strategy	As for opportunistic	When have a truckload or feed supply in goat paddock limited	As for opportunistic	
Length of control	As for opportunistic	As for opportunistic	As for opportunistic	
Frequency and timing	As for opportunistic	More frequently than for opportunistic harvest and longer period of year.	As for opportunistic	
Population	As for opportunistic	As for opportunistic	As for opportunistic	
Feral goats harvested	As for opportunistic	As for opportunistic	1500 stated at workshop (essentially the same as the 1670 estimated number harvested under opportunistic)	Broken Hill: If neighbours cooperated and built goat paddocks could achieve a significant reduction on a regional basis.
Effect of seasonal conditions and domestic stocking rates on population.	As for opportunistic	As for opportunistic	As for opportunistic	
Time for goat numbers to build up again	As for opportunistic	As for opportunistic	As for opportunistic	

	Bourke	Cobar	Broken Hill	Comments
Changes to the productivity of other enterprises.	As for opportunistic	As for opportunistic; Turnoff of additional goats under this strategy compared to opportunistic will allow small increase in number of sheep carried (no goats released); If goat paddock is multi-purpose may increase sheep numbers further; depends on how long paddock is used for holding goats.	As for opportunistic	
Advantages of goat control	As for opportunistic	As for opportunistic	As for opportunistic	
% Sold and released	Animals over 24 kg live wt sold (generally 80% of animals mustered); others kept.	50% sold; 50% retained, 0% released. Note: Natural increase and jump-ins increase number in paddock by 5–10% per annum.	60% for large mobs; (for smaller mobs all go to goat paddock and sold later). 40% retained and marketable within 12 months.	
Risks (outside goat paddock)	As for opportunistic	As for opportunistic	As for opportunistic	
Environmental outcome (outside goat paddock)	As for opportunistic	Keeping on top of numbers all the time.	Reduction in grazing pressure is greater than for opportunistic harvest as NCV's are not released.	

	Bourke	Cobar	Broken Hill	Comments
Paddock size, country type and impact on domestic livestock numbers	1200 ha (5% of total area); up to 4450 ha. (18.5% of total area). Locate on harder country (mulga preferred due to long term feed supply, more sustainable in long run and low sheep productivity); location also influenced by convenience, accessibility and existing infrastructure. Reduction in domestic stock number not proportional to size of paddock due to location on less productive country.	4000–5000 acres (approx. 1820 ha), size of paddock important for welfare of animals. Locate goat paddock close to area of property where goats are harvested; should not be worst paddock – must grow adequate feed for goats (browse important). Keep in mind main enterprise and possibility of multi – purpose use in future. Goat paddock can be used to grow feed for any purpose – not just goats – and may ultimately be used for sheep. Income from goats can pay for fencing upgrade on paddock that will ultimately be used for sheep (so must be in productive country); can make more money from Dorpers than goats so need to remove goats.	5000 ha; 10% of representative property. Location depends on the country – rougher, scrubby paddocks preferred but must be flat enough to fence and maintain fences. Country has low grazing value so relatively low impact on domestic stock numbers – 10% of country in goat paddock reduces domestic stocking rate by only 5%.	Land type is influenced by choice, convenience, accessibility, infrastructure, mulga, long term feed supply, more sustainable for the long term. Goat paddock utilised for sheep as well. Time for build up does not change – same as for opportunistic harvest.
Best practice management of goat paddock	Stocking rate no higher than equivalent sheep stocking rate; don't underestimate time required to grow out NCVs; need to take out the same number of goats as are put in even if some are not finished; if stocking rates are not reasonable paddock will be flogged out and can't finish the animals.	Well fenced and watered Good roads for truck access Good yards, draft and loading ramp Take action if paddock being overgrazed Rotational use of goat paddocks – need at least 2 internal subdivisions for rotational grazing, 4 would be preferable; internal fencing can be cheaper than boundary fence. Look at ground cover and standing feed to make stocking rate decisions. Paddock is a holding paddock NOT breeding paddock or sacrifice paddock and is not to be flogged out.	Needs to be subdivided for rotational grazing and resting and also segregation of goat lines; need at least 2 paddocks either by subdivision or adding another paddock. Management of goat mob composition e.g. larger billies can pull scrub down for small goats. Good handling facilities including trap yards at water required to allow for rapid action if season turns and need to remove goats quickly. Manage stocking rate on a similar DSE basis to sheep (i.e. maintain DSE's equivalent to sheep stocking).	

	Bourke	Cobar	Broken Hill	Comments
Production parameters for goat paddock	Body wt (into pdk): 24 kg DSE rating: 25 kg dry nanny equivalent to 0.4 x 45 kg dry ewe (A. Munn, pers. comm.) Stocking rate: equivalent to sheep Mortality: 15% (?) Growth rate: Variable (lower than sheep) Time in paddock: often longer than anticipated Body weight (out of pdk): >24 kg Rate of increase: Small natural increase, small number of jump-ins.	Body wt (into paddock): 15 kg, Socking rate: Ideal is high stocking for short periods and long resting periods Mortality: 1% Growth rate: 1 kg/month; up to 4 kg/month in good season Body wt (out of paddock): 22–24 kg Natural increase and jump-ins: 5–10% per annum.	Body wt (into paddock): 15 kg (small); 27 kg mixed goats DSE rating: refer to A Munn's work at Fowlers Gap; 2:1 goat: sheep. Stocking rate: 1 DSE:15 ac (1DSE:6 ha) Mortality rate: Small 1%, others 0% Growth rate: Small – 2 kg/month (ordinary season); mixed – very low when mixed goats in paddock. Av. time in paddock: small – 9 mths (to reach 30 kg live wt); mixed – until achieve a commercial lot. Body wt. (out of paddock): 30 kg (for small animals placed in paddock) Rate of increase: Small – very few kids (10%) Jump ins – variable but very few All – assume 50% nannies in paddock, 100% kidding over 9 months; so if place 1000 mixed goats in paddock, get 1500 out in 9 months.	Possible changes in management are: All goats mustered from the property contained in goat pdk then drafted off by weight for sale. Keep lighter goats on for longer despite being at lower end of saleable weight range. Assess ground cover and standing feed in order to make stocking rate decisions. Goat paddock is a holding paddock, not a breeding or sacrifice paddock.
Risks (of goat paddock)	Risk of establishment of goat paddock is minimised by ability to use paddock for other enterprises; risk of overgrazing if not properly managed.	Price fall; potential to over graze, goat number can increase because of jump ins and so must monitor. if no feed in goat paddock goats can attempt to get out.	Overgrazing – may become a sacrifice paddock. Eating turpentine (and other) seedlings and degrading the vegetation. OH&S – drafting.	Question raised – would 2 x 1500 acre paddocks be better than 1 x 3000 acre paddock?

	Bourke	Cobar	Broken Hill	Comments
Environmental outcome (of goat paddock)	Scrub control.	Capacity to keep on top of goat numbers all the time. Ability to rest the paddock Beneficial browsing of the understory (INS control)	If managed properly should reduce scrub and increase ground cover but can be overgrazed. Goats will break down large turpentines and eat dry leaves later; apparently remove turpentine seedlings. If unpalatable shrubs increase may not be able to return paddock to sheep grazing.	
New capital investment	In some cases can upgrade existing infrastructure, in others start from scratch (but still related to existing infrastructure) For new infrastructure: 7 line hinge joint with top belly and bottom plain, and top barb (CMA specs – min. 10m post spacing) Water – poly tank, trough. Yards (\$2 k–\$3 k).	Cleaning costs (dozer): 1½ hrs /km; \$175/km Hinge joint 8/90/30 – \$2000 km (material) Posts: 110 /km at \$5.00 ea Plain wire: 2½ rolls (belly + bottom) per km High tensile bard wire 2 x 500 m rolls per km @\$85/roll Strainers: 100 x 100 mm RHS galvanised @ \$28–\$30. Stays: \$20 each Incidentals: \$35–40/km (staples, etc) Gates: 4 If starting from scratch with new paddock – fencing about \$4.5 k per km erected	Goat paddock fencing: Hinge joints ‘(Stocktite’) 7/90/30, no plain wires, top barb; 10m post spacing (maybe a spacer in between); 750 m strains, normal end assemblies, gates, 2 waters. Fence lines must be well cleared.	No break down of the various costs associated with new capital investments was provided for Broken Hill. Assumed to be about \$3600/km erected for all districts.
Repairs and maintenance of new capital	Repair roo holes etc; more R&M required with electric fencing due to more clearing, fence runs etc.	\$100/km/yr;	Minimal if well prepared. Ongoing clearing of fence lines required.	
Productive life of new capital	20 years.	20–25 years	25 years	

	Bourke	Cobar	Broken Hill	Comments
Modifications to existing infrastructure	Electric offsets – every 15 m (1 per post)	May modify existing paddock to produce goat paddock.	Nil	
Plant and equipment	Drafting set up, loading ramp	No additional plant & equipment required	Trap yard, loading ramp, draft and good yards	
Variable costs	Mustering: minimal cost, one person to muster, once every 3 or so months and drench?	As before.	5 days/1000 saleable goats @ \$250/day; 10 days per year total; checking fences, water etc.; \$5–7/hd transport direct to works. Price: Captured – 90 c/kg live wt at 35 kg. Paddock goats direct to works – \$2.60/kg dressed	
Options to influence price	No distinction in price between captured and grown-out goats; weight gain only influence on price.	Opportunity to put truck load together at short notice, opportunity to grow animals to heavier weight (not just NCVs);	Larger lots of uniform goats. Allows better price and reduction in freight cost per head.	Influence on price is possible if bigger lots of uniform goats are presented.

3. Control of TGP					
	Bourke	Cobar	Broken Hill	Comments	
What is possible	Achieve 95–100% exclusion in the right country; complete control is impossible. Group commented they are happy for goats to be present as long as able to control number.	Could fence 80% of property with hinge joint with 90% control within this area; other 20% of property supports goats and is NOT used for livestock. Complete control is impossible	Control not possible without adequate fences. Strong concern that if goats are removed they will be replaced by kangaroos.		
Control objective	High level control of total grazing pressure (given)	High level control of total grazing pressure (given)	High level control of total grazing pressure (given)		
Control strategy	Exclusion fencing is the only way to keep goats out. Mustering could be involved.	Fencing (boundary); Could fence off areas prone to goats and keep separate; combination TGP boundary plus internal fences plus trap yards at water could possibly achieve 95% control particularly in warmer months; hinge joint around most accessible areas of the property.	Two options: 1. Boundary fence with hinge joint and trap all waters; this would give complete goat control and control of kangaroos, emus; not practical due to rough country, creek crossings etc. 2. Boundary fence the better country (60%) and trap all waters; harvest feral goats off the remaining 40%; approx 100 km fences total; add 30% to cost of fencing and traps to eliminate roos.	Alternatives: complete boundary fence to exclude goats and kangaroos or fence only the good country to get the benefits of continued feral goat harvest and reduced weedy weeds.	
Trigger for start of control strategy	Needs several weeks to clear out paddock (plane, dogs etc.) Begin control if seeing goats in exclusion area	Zero tolerance	Zero tolerance		
Trigger to stop control strategy	No more goats	Zero tolerance	Zero tolerance		
Length of control	Several weeks	Zero tolerance	Zero tolerance		

	Bourke	Cobar	Broken Hill	Comments
Frequency and timing	One off; or whenever goats seen in paddock.	Zero tolerance	Zero tolerance	
Population	1920, first year only	10% of goat numbers remain inside the fence; outside the fence numbers will be disproportionately high – best goat habitat fenced out. Assume unfenced country can turn off 30% of the opportunistic harvest of goats and runs no livestock.	Assume 40% of goats are on the 60% of property fenced (600 goats); 60% are on the unfenced area (900 goats). For the fenced area – 600 goats in year 1, 280 in year 2 (allowing for natural increase) and 0 in year 3 onwards. For the unfenced area: steady population of 900 goats.	
Feral goats harvested	1920	Inside fenced area: 2800 in year 1 (70% of whole property population, all turned off in year 1); additional 224 goats per annum (80% of the 280 goats assumed to infiltrate the paddock each year). Outside fenced area: 600 goats per annum (assuming 30% of normal population remains on unfenced area, 50% harvest, 100% turnover).	Inside fence: 600 in year 1 (all sold), 280 in year 2 (all sold), 0 in yr 3+ Outside fence: opportunistic harvest rate on steady state population of 900 i.e. 111% mustering rate with 60% sold (equals 600 goats sold per annum)	
Effect of seasonal conditions and domestic stocking rates on population.	Nil	Nil	Nil	
Time for goat numbers to build up again	N/a	N/a	N/a	

	Bourke	Cobar	Broken Hill	Comments
Changes to the productivity of other enterprises.	Additional 1000 DSE of livestock carried (roughly half number of goats excluded). If livestock numbers are not increased, removing goats might increase production of existing ewes but general feeling is that any increase would be small.	If exchanging goats for sheep – exchange rate is 2-3:1 (goats: sheep); production per head does not change. If keep stocking rate constant: Lambing %: 90 Weaning %: 85 Wool cut: +0.5 kg Micron: 21.5 wethers and ewes Productive life ewes: 6 years No changes to cattle or cropping enterprises	If could TGP fence the entire property would increase livestock numbers from 5000 to 7500 ewes, and from 200 cows to 300 cows. In top end scenario might double SR. Increases are achieved due to reduction in goats AND roos. Still conservatively socked and production parameters remain the same. (For budget purposes, assume that 80 of livestock are carried on the fenced area and that livestock are exchanged for goats at the standard rate in this area; livestock numbers do not change outside the fenced area).	Bourke: One participant believes that this is the upper limit. The productivity improvement is not clear with sheep. Broken Hill: Takes about 1-2 years for pasture to recover before additional livestock could be carried.
Advantages of goat control	n/a	n/a	n/a	
% Sold and released	100% sold the first year.	100% sold first year inside fence; outside the fenced area, harvest 50% of population and sell 100% of harvested goats.	Inside fenced area – 60% of population sold in year 1; remainder with natural increase sold in year 2 Outside fenced area – same as opportunistic harvest – 60% sold. (see above)	
Risk	Fence damage especially in water ways in undulating country.	Reduction in supplementary income. Benefit from increase in options for more enterprises (agistment, etc.)	No goat income, risk not spread as well (2 enterprises, sheep and cattle, rather than three). Implications for INS and other browse.	

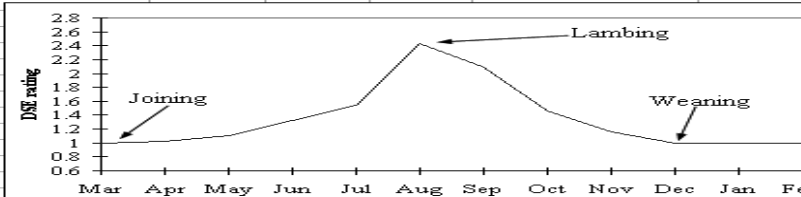
	Bourke	Cobar	Broken Hill	Comments
Environmental outcomes	Better rest for pastures; enhanced regeneration of pastures; improvement in availability of shrubs, browse, etc.	Improved pasture quality and quantity Increased ground cover (towards 40%) Decreased seasonal variability Greatly increased ability to plan and/or budget feed	Reduction in emus; reduction in kangaroos with increased pasture availability; Implications for INS and other browse.	
New capital investment	62 km hinge joint (specs. as for value added option) to enclose 24,000 ha. – total cost \$256 k. (approx \$4 k per km). Other cost estimates for same specs. – \$1800/km (excluding labour) – \$3000/km (including labour); Western CMA estimate for TGP fencing – \$3 k–\$4 k/km Cost varies with quality of materials used.	See specification for TGP fencing. (Assume that no trap yards are built in the fenced area specifically for goats. Trap yards and containment yards in unfenced area as for opportunistic harvest on a pro rata basis)	Same specs as value added fencing and opportunistic traps and yards BUT add 30% to cost of water traps for kangaroo control. Require traps on 12 dams and 25 troughs (with 30% increase in cost to control kangaroos) (Note: originally indicated property had 20 waters so need to use average number of waters and divide between troughs and tanks in ratio 2:1; say 80% within the fenced area)	
Modifications to existing infrastructure	n/a	Nil	Nil	
Repairs and maintenance of new capital	Repair hinge joint in washouts etc – \$600–1000/yr).	Fence maintenance – clearing, washouts etc – 1% capital costs/yr.	5% of the capital cost/yr	
Plant and equipment	n/a	n/a	n/a	
Productive life of new capital	Greater than 20 years	30+ years	30 years	

	Bourke	Cobar	Broken Hill	Comments
Variable costs	Total variable cost will increase if sheep number increases (but not cost per head), no variable costs associated with feral goats after first year.	Cost of goat harvest the same as previous.	Cost of goat harvest and livestock operations per head as previously.	
Options to influence price	Can put together large loads in the first year so can sell directly to works instead of depot.	Nil – back to opportunistic harvest.	Nil – back to opportunistic harvest or all goats turned off to depot at lowest price.	
4. Do nothing option				
Broken Hill: Scenario requested at Broken Hill to look at the impact on sheep enterprise of goat population that is not controlled due to either reduced feral goat price or imposition of regulation e.g. NLIS tagging requirements.		At \$0.60/kg live weight at depot goat turnout drops by 50%; at \$0.40/kg liveweight goat harvest ceases. Goat population dynamics: 150% kidding per year Mortality, 10% pa Assume base population of 1500 (Half does); Does live to 10 years Ewe population is reduced as goat population increases on a DSE basis		

Appendix 3. Merino ewes enterprise gross margins – 21 Micron (Bourke District)

Enterprise:		MERINO EWES - 21 Micron April 2010					
Enterprise size:		1000 Ewes					
INCOME:						Standard Budget (\$)	Your Budget (\$)
Wool (Greasy)		number	class	kg /hd	\$/kg		
Shear		950	ewes	6.00	\$4.65	\$26,511.84	
		20	rams	7.50	\$4.95	\$742.50	
		347	ewe hoggets	3.77	\$5.59	\$7,312.78	
Crutch		1317	adults	0.40	\$2.97	\$1,564.60	
Sheep Sales		number	class	\$ /hd			
		171	CFA ewes	\$56.30		\$9,627.30	
		4	CFA rams	\$91.16		\$364.64	
		365	weth weaners	\$45.00		\$16,425.00	
		126	ewe hoggets	\$90.00		\$11,340.00	
		A. Total Income:				\$73,888.66	
VARIABLE COSTS:							
REPLACEMENTS:		number	class	\$ /hd			
		4	rams	\$900.00		\$3,600.00	
		number	class	cost (\$)	reps		
Shearing		1297	ewes/hoggets	\$6.00	1	\$7,782.00	
		20	rams	\$12.00	1	\$240.00	
Dipping		1317	adults/hoggets	\$1.07	1	\$1,409.19	
Crutching		1297	ewes/hoggets	\$1.00	1	\$1,297.00	
		20	rams	\$1.50	1	\$30.00	
Drenching		1317	adults/hoggets	\$0.17	0.3	\$67.17	
		750	lambs	\$0.18	0.3	\$40.50	
Jetting		1317	adults/hoggets	\$0.19	1	\$250.23	
		365	ewe weaners	\$1.42	1	\$518.30	
Vaccination- 6 in 1		1317	adults/hoggets	\$0.18	0	\$0.00	
		750	lambs	\$0.18	1	\$135.00	
Mules +Mark		750	lambs	\$1.45	1	\$1,087.50	
Supplementary feed -no allowance							
Mustering		1317		\$1.00		\$1,317.00	
Livestock selling cost							
Commission in Sheep sales				5%		\$1,806.59	
Livestock cartage		666	sale sheep	\$5.00		\$3,330.00	
Wool selling costs							
Commission, warehouse, testing charges				6%		\$2,265.42	
Wool tax				2.00%		\$722.63	
Wool - cartage		43	bales	\$20.00		\$860.00	
- packs		43	packs	\$13.00		\$559.00	
		</					

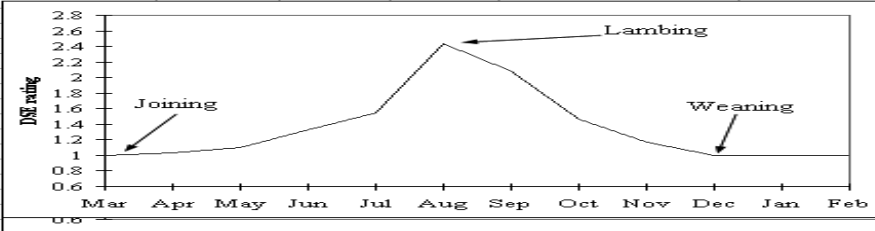
Appendix 4. Merino ewe enterprise gross margins - 21 Micron (Cobar District).

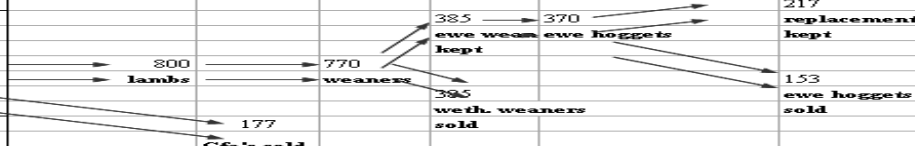
Enterprise:		MERINO EWES - 21 Micron April 2010					
Enterprise size:		1000 Ewes					
INCOME:						Standard Budget (\$)	Your Budget (\$)
Wool							
	number	class	kg /hd	\$/kg			
Shear	950	ewes	6.50	\$4.91		\$30,313.42	
	20	rams	7.50	\$4.95		\$742.50	
	333	ewe hoggets	3.77	\$5.59		\$7,017.74	
Crutch	1303	adults	0.40	\$2.97		\$1,547.96	
Sheep Sales							
	number	class	\$ /hd				
	154	CFA ewes	\$56.30			\$8,670.20	
	4	CFA rams	\$91.16			\$364.64	
	350	weth weaners	\$45.00			\$15,750.00	
	112	ewe hoggets	\$90.00			\$10,080.00	
VARIABLE COSTS:		A. Total Income:					\$74,486.47
REPLACEMENTS:							
	number	class	\$ /hd				
	4	rams	\$900.00			\$3,600.00	
	number	class	cost (\$)	reps			
Shearing	1283	ewes/hoggets	\$6.25	1		\$8,018.75	
	20	rams	\$12.00	1		\$240.00	
Dipping	1303	adults/hoggets	\$0.58	1		\$755.74	
Crutching	1283	ewes/hoggets	\$1.00	1		\$1,283.00	
	20	rams	\$1.50	1		\$30.00	
Drenching	1303	adults/hoggets	\$0.17	0		\$0.00	
	800	lambs	\$0.18	2		\$288.00	
Jetting	1303	adults/hoggets	\$0.19	1		\$247.57	
	350	ewe weaners	\$1.42	1		\$497.00	
Vaccination- 6 in 1	1303	adults/hoggets	\$0.18	0		\$0.00	
	800	lambs	\$0.18	2		\$288.00	
Mules +Mark	800	lambs	\$1.60	1		\$1,280.00	
Scanning	950.00	ewes	\$0.75	0		\$0.00	
Supplementary feed -no allowance							
Mustering	1303	adults/hoggets	\$1.00			\$1,303.00	
Livestock selling costs							
Commission in Sheep sales			5%			\$1,981.08	
Livestock cartage	620	sale sheep	\$5.00			\$3,100.00	
Wool selling costs							
Commission, warehouse, testing charges			5.00%			\$1,743.24	
Wool tax			2.00%			\$792.43	
Wool - cartage	45	bales	\$12.00			\$540.00	
- packs	45	packs	\$11.10			\$499.50	
		B. Total Variable Costs:					\$26,487.32
		GROSS MARGIN (A-B-C)					\$47,999.15
		GROSS MARGIN /EWE					\$48.00
		GROSS MARGIN /DSE					\$32.00
		GROSS MARGIN /HA					\$8.00
1. Sensitivity Table - Effect of wool price and cut on gross margin per DSE							
Wool Cut		Ewe Greasy Wool Price					
		\$/Kg greasy					
Kg/Hd		\$4.05	\$4.46	\$4.91	\$5.36	\$5.86	
5.50 kg	18.13	40.97	43.34	45.70	48.31		
6.00 kg	25.77	43.09	45.67	48.24	51.09		
6.50 kg	51.96	45.21	48.00	50.79	53.88		
7.00 kg	17.69	47.33	50.33	53.34	56.66		
7.50 kg	46.52	49.44	52.66	55.88	59.45		
2. Budget details and comments							
Production details		Feed requirements - ewes and followers up until weaning					
Flock mortality	5%						
Productive life	7 years						
Ewe body weight	60						
DSE rating /ewe	1.50						
Stocking rate/ha	0.25 dse's						
Ram %	2%						
Marking %	80%						
Weaning %	70%						
Weaning age	4 months						
Ewe hogget culling not common							
Age at first joining	1.5 dse's						
Sold at the age	2-3 yrs						
3. Flock Structure							
Age	Number of ewes						
1.5	221						
2.5	210						
3.5	199						
4.5	190						
5.5	180						
6.5	0						
Total	1000						
4. Wool Prices							
	Micron	AWEX Type	Clean price	Yield	Greasy price	Other Specifications	
Merino Ewe							
- Fleece GTM	21	MF5B	\$8.16	64%	\$5.22	1%VMB, 35n/ktex, 90mm	
- Whole clip price	94%	of fleece price			\$4.91	used in budget	

Appendix 5. Merino ewe enterprise gross margins – 21.5 Micron (Broken Hill District)

Enterprise:		MERINO EWES - 21 Micron April 2010					
Enterprise size:		1000 Ewes					
INCOME:							
Wool	number	class	kg /hd	\$/kg		Standard Budget (\$)	Your Budget (\$)
Shear	960	ewes	5.39	\$4.88		\$25,270.53	
	20	rams	7.50	\$4.95		\$742.50	
	370	ewe hoggets	3.77	\$5.59		\$7,797.49	
Crutch	1350	adults	0.40	\$2.97		\$1,603.80	
Sheep Sales	number	class	\$/hd				
	177	CFA ewes	\$56.30			\$9,965.10	
	4	CFA rams	\$91.16			\$364.64	
	385	weth weaners	\$45.00			\$17,325.00	
	153	ewe hoggets	\$90.00			\$13,770.00	
A. Total Income:						\$76,839.06	
VARIABLE COSTS:							
REPLACEMENTS:		number	class	\$/hd			
		4	rams	\$900.00		\$3,600.00	
	number	class	cost (\$)	reps			
Shearing	1330	ewes/hoggets	\$6.50	1		\$8,645.00	
	20	rams	\$10.00	1		\$200.00	
Dipping	1350	adults/hoggets	\$0.58	1		\$783.00	
Crutching	1330	ewes/hoggets	\$3.00	1		\$3,990.00	
	20	rams	\$3.00	1		\$60.00	
Drenching	1350	adults/hoggets	\$0.17	0		\$0.00	
	800	lambs	\$0.18	0		\$0.00	
Jetting	1350	adults/hoggets	\$0.19	1		\$256.50	
	385	ewe weaners	\$1.42	1		\$546.70	
Vaccination- 6 in 1	800	lambs	\$0.18	2		\$288.00	
Mules +Mark	800	lambs	\$1.45	1		\$1,160.00	
Others (Trisulfen)	800	lambs	\$1.45	1		\$1,160.00	
Supplementary feed -no allowance							
Mustering	1350	adults/hoggets	\$1.00			\$1,350.00	
Livestock selling costs							
Livestock cartage	719	sale sheep	\$4.50			\$3,235.50	
Commission in Sheep sales			5%			\$1,770.72	
Wool selling costs							
Commission, warehouse, testing charges			5%			\$2,071.24	
Wool tax			2%			\$708.29	
Wool - cartage	40	bales	\$14.00			\$560.00	
- packs	40	packs	\$10.00			\$400.00	
B. Total Variable Costs:						\$30,784.94	
GROSS MARGIN (A-B-C)						\$46,054.12	
GROSS MARGIN /EWE						\$46.05	
GROSS MARGIN /DSE						\$30.70	
GROSS MARGIN /HA						\$6.14	

1. Sensitivity Table - Effect of wool price and cut on gross margin per DSE						
Wool Cut	Ewe Greasy Wool Price \$/Kg greasy					
Kg/Hd	\$4.02	\$4.43	\$4.88	\$5.34	\$5.84	
4.39 kg	37.73	39.46	41.37	43.27	45.38	
4.89 kg	21.18	41.59	43.71	45.83	32.91	
5.39 kg	28.80	43.72	46.05	48.39	81.72	
5.89 kg	52.76	45.84	48.40	50.95	84.54	
6.39 kg	20.78	47.97	50.74	53.52	87.36	

2. Budget details and comments						
Production details	Feed requirements - ewes and followers up until weaning					
Flock mortality	4%					
Productive life	5 years					
Ewe body weight	60					
DSE rating /ewe	1.50					
Stocking rate/ha	0.2 dse's					
Ram %	2.0%					
Marking %	80%					
Weaning %	77%					
Weaning age	4 months					
Ewe hogget culling per	12.5%					
Age for first joining	2 dse's					

3. Flock Structure						
Age	Number of ewes					
1.5	217					
2.5	208					
3.5	200					
4.5	192					
5.5	184					
6.5	0					
Total	1000					

4. Wool Prices						
Merino Ewe	Micron	AWEX Type	Clean price	Yield	Greasy price	Other Specifications
- Fleece GTM	21	MF5B.	\$8.16	63%	\$5.14	1%VMB, 35n/ktex, 90mm
- Whole clip price	95%	of fleece price			\$4.9	used in budget

Appendix 6. Feed wheat enterprise gross margin

1. GROSS MARGIN BUDGET:					Standard	Your
Feed Wheat					Budget	Budget
INCOME:					\$/Ha	\$/Ha
	1.23	tonnes/ha @	\$150.00	/tonne (on farm)	\$184.50	
			A. TOTAL INCOME \$/ha:		\$184.50	
VARIABLE COSTS:						
			Cultivation.....		\$39.94	
			Sowing.....		\$12.33	
			Fertiliser.....		\$24.40	
			Herbicide.....		\$11.70	
			Insecticide.....		\$0.44	
			Contract-harvesting.....		\$29.63	
			Levies.....		\$0.00	
			Crop Insurance.....		\$0.00	
			Cartage, grading & bagging.....		\$21.33	
			B. TOTAL VARIABLE COSTS \$/ha:		\$139.76	
			C. GROSS MARGIN (A-B) \$/ha:		\$44.74	

Appendix 7. Summary of economic assumptions used in the analysis

Description	Units	Bourke		Cobar		Broken Hill	
		Opp	VA	TTGP	Opp.	VA	TTGP
Feral goats population	hd	1920	1920	1920	4000	1500	1500
Feral goats harvested	hd	960	960	1920	2000	1670	1500
Harvested feral goats over 24kg/hd	no	768	768	0.0	1000	1001	900
Harvested feral goats under 24kg/hd	no	192	192	0.0	1000	668	450
Feral goats retained	no	0.0	480	0.0	0.0	0.0	0.0
Feral goats released	no	0.0	0.0	0.0	1000	668	0.0
Feral goats sold	no	960	1200	1920	1000	1002	900
Goat paddock size	ha	0.0	1200	0.0	0.0	0.0	0.0
Goat proof fence	km	0.0	13.9	62.0	0.0	0.0	69.3
Self mustering traps on waters	no	4.0	4.0	0.0	7.0	3.0	2.0
Containment yards	no	6.0	6.0	0.0	3.0	2.0	2.0
Price of feral goat greater than 24g/hd	\$/hd	32.5	32.5	32.5	33.0	33.0	33.0
Price of goat less than 24 kg/hd	\$/hd	5.0	5.0	5.0	5.0	5.0	5.0
Time lag before domestic stocking increased	years	0.0	0.0	1.0	0.0	0.0	1.0
Life time of the capital assets	year	20	20	20	20	20	20
Goat mortality	%	0.0	2	0.0	0.0	0.0	0.0
Natural rate of increase in goat paddock (inc. Jump ins)	%	0.0	12	0.0	0.0	12	0.0
Investment for maximum goat off-take (Traps)	no	0.0	0.0	0.0	0.0	2.0	0.0
Investment for maximum goat intake (containment yards)	no	8.0	0.0	0.0	0.0	2.0	0.0
Additional income from investment for max goat off-take	%	20	0.0	0.0	0.0	20	0.0
Cost of contract fencing	\$/km	0.0	3600	3600	0.0	0.0	3600
Cost of building self mustering traps on waters (contract rates)	\$/trap	4500	4500	0.0	4250	4250	0.0
Cost of building containment yard (contact rate)	\$/yard	700	700	0.0	3000	3000	0.0
Proportion of land area assigned for exclusion (TGP)	%	0.0	0.0	100	0.0	0.0	60
Proportion of land area assigned for harvesting (TGP)	%	0.0	0.0	0	0.0	0.0	40
DSE rating (goat) relative to sheep DSE	DSE	0.4	0.4	0.4	0.4	0.4	0.4
Inflation rate	%	5.0	5.0	5.0	5.0	5.0	5.0
Discount rate	%	7.0	7.0	7.0	7.0	7.0	7.0
Opp = Opportunistic harvesting; VA = Value added; TTGP = Total TGP control							

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ECONOMIC RESEARCH REPORT NO. 47

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within the NSW Rangeland

December 2011



Department of
Primary Industries