Economics of controlling African Lovegrass (*Eragrostis curvula*) in native pasture in the Far South Coast of NSW

Part Two – the technical report

by

Jim Crosthwaite and Josh Dorrough

May 2014

Contact for further information

Josh Dorrough - josh.dorrough@naturalregen.com.au

Citation (for final report):
Crosthwaite, J. and J. Dorrough (2014) Economics of controlling African Lovegrass (*Eragrostis curvula*) in native pasture in the Far South Coast of NSW. A report commissioned for the Far South Coast Farmers Network, Bega.

This report was commissioned by the South East Local Land Services. It is part of a wider project examining the management of native pastures and unpalatable grass weed invasion, primarily by African lovegrass.

About the authors:

Jim Crosthwaite is an agricultural economist by training who completed his PhD in 2001 on Farm Businesses and Natural Resource Management. From 1988 until 2012 he worked for the Victorian Government. He managed major research projects relating to farm businesses and biodiversity, and drivers of land use change, and managed the Conservation Management Network program for some years. His publications, many co-authored, include *Economic benefits of native grasslands on farms, Future investment in landscape change in southern Australia, Incentives for sustainable wool production*, and *Retaining native vegetation on farms: understanding its private value*.

Josh Dorrough is an ecologist by training. His research has focused on understanding the interactions between native ecosystems and agricultural production. He completed his PhD on the effects of management and exotic plant invasion on Monaro native grasslands in 2001. He worked as research scientist for the Victorian State Government until 2008 and has been a visiting scientist at the CSIRO since 2007. He has over 20 international research publications on the management and restoration of native ecosystems within agricultural landscapes.

Acknowledgements
The cooperation of farmers in the Bega area made the project possible. We particularly thank those who were interviewed at length.

Contractors were also more than willing to provide information during short phone interviews, and one face-to-face interview.

Staff from South East Local Land Services (SELLS), in particular Graham Scott and Andrew Taylor, gave valuable direction and advice. A meeting with members of the Far South Coast Farmers Network during the period of field visits was important for providing guidance.

All specialists, no matter how skilled, have a mentor. Associate Professor Bill Malcolm from The University of Melbourne was kind enough to review the proposed methods and report, and provide critical comment and suggestions where appropriate.

Responsibility for the approach and findings remain with Jim Crosthwaite.

Contents

Definitions

DSE – dry sheep equivalent is used to standardise the annual feed requirements of different classes of stock. "A 50 kg wether maintained at constant weight has a dry sheep equivalent (DSE) rating of 1. Animals requiring more feed have a higher rating and animals requiring less feed have a lower rating. The DSE rating of all classes of stock is based on the annual feed requirements of the animals." (NSW DPI 2005).

Activity gross margin - Gross margin is the income from a livestock activity less the variable costs like health and selling costs and feed supply costs - $25/DSE is commonly achieved in beef and sheep enterprises across eastern Australia, but $20/DSE may be more likely if prices are lower or enterprise production costs are higher. It excludes farm overheads and any variable costs that are not specific to an activity and instead relate generally to the whole farm.

Opportunity cost - the net benefits or sum of money given up by choosing one alternative rather than another (Malcolm *et al*. 2005), usually the next best alternative. As family labour can often be used in other valuable ways, even though it may not be explicitly rewarded with cash wages, the cost of the contribution of family labour to producing farm income value is included also.

Marginal analysis involves looking at what is extra or changed, compared to a base case. The base case can be the current situation, or the future situation if nothing is done. The situation with change minus that without change are compared. The analytical approach involves evaluating changes, not some average performance (Malcolm *et al*. 2005).

Steady state – In this context, steady state refers to a situation where pastures have reached their potential after an investment. Steady state analyses compare the income and costs of the annual performance of different pasture and livestock systems once full annual performance has been reached, achieved as a result of an initial capital investment. The capital investment is not included in a steady state analysis.

Real dollar terms – dollar values in the future that have any expected inflation removed from them

Nominal dollars terms – dollar values in the future that include expected annual inflation

Discount rate – The discount rate is equivalent to the interest rate on a loan or the return the capital invested could earn in another use. It is the rate at which future streams of income or expenditure are discounted to present day values. Real discount rates exclude inflation, and are used in this report. Nominal discount rates include inflation. Discounting is used because we value having money in hand more than in the future. People generally would rather $20,000 now rather than $2,000 in each of the next 10 years. It is more likely that they would want a premium on the $2,000 in each of the later years. In this report, projects are evaluated at a discount rate of 5% and 10%,

NPV – Net present value is the present value of all future receipts (income) less costs, after future benefits and costs have been discounted at the opportunity cost rate of interest. The NPV helps to compare the magnitude of future flows of income and expenditure that are of different size and timings. The NPV is estimated over a fixed time, usually 10 to 15 years into the future. It allows the relative value of alternative investments involving the same capital outlay to be compared.

Annuity – a fixed sum of money paid or received every year. In this report, we calculate the annuity of the lump sum NPV by taking the Net Present Value and working out how much it would be equivalent to if spread evenly over 10 years (at a given interest rate).

Return on capital – the annual profit expressed as a percentage of the initial capital outlaid.

IRR – Internal rate of return is the rate of return on an investment. It is the discount rate that makes NPV zero. The IRR allows comparison of the profitability of investments, unrelated to the magnitude of the investment. However, it is usually not a useful measure when the investment required is very low, or when returns are high (e.g. 30% or more).

Introduction

African Lovegrass (*Eragrostis curvula*, from here on ALG) is widespread in Far South Coast New South Wales, posing major management problems for farmers and significant threats to other environmental values, in particular having a direct threat to lowland grassy woodlands. For many farmers ALG poses a threat, not just to particular paddocks, but to the whole farm business.

In this report we explore the economic consequences of managing ALG in dryland native pastures. These pastures dominate large areas of the Bega Valley, and are prone to invasion by ALG.

This project is part of a larger one "Managing pastures for production, conservation and weed suppression". This is funded through the Australian Government's Caring for our Country program. The initial aim of this project is to "undertake a baseline survey of grassy woodlands on private land in the Springvale area of southern NSW, to identify the extent of African Love Grass and Serrated Tussock invasion and develop management plans with landholders to reduce weed impacts and improve sustainability." African Lovegrass (ALG)was identified as the most significant weed risk in the region. South East Local Land Services (SELLS), the Far South Coast Landcare Association (FSCLA), the Far South Coast Farmers Network and Springvale Landcare are all supporting this project. This wider research is being enabled through collaboration with the Queensland University of Technology and University of Wollongong and the project team is continuing to look at other avenues to improve the community's knowledge in this area.

This economics project will provide a basis for the wider ongoing research into managing productive native pastures and controlling weeds.

Dense stands of ALG are visible from the road in many areas of the Bega Valley. This raises the question of whether there are rational economic reasons for this situation, aside from personal and family reasons. We investigate this by addressing the economics of farmers controlling African Lovegrass or doing nothing about the plant.

The focus of this project is on farms with paddocks of dryland native pastures. Such paddocks are widespread in Far South Coast New South Wales, and arguably have underpinned the production systems for beef and sheep enterprises. Here sown pastures have had variable success except on intensively managed dairy farms that are frequently sown with highly productive pastures that are not expected to have a long life.

The dryland native pastures are characterised by the presence of native grasses such as *Themeda australis* (Kangaroo grass), *Microlaena stipoides* (Weeping grass), and *Poa labillardierri* (Poa tussock) but also contain a range of exotic naturalised grasses such as *Paspalum dilatatum (*Paspalum*)*, *Cenchrus clandestina* (Kikuyu)*, Lolium perenne* (Rye grass), *Sporobolus africanus* (Parramatta grass)and *Dactylis glomeratum* (Cocksfoot). They also support a range of herbaceous non-grass plants including *Glycine* species (native legumes), *Hypochaeris radicata* (cats-ear or flatweed) and naturalised annual grasses and legumes. Some of these pastures meet the definitions of Lowland Grassy Woodland in the South East Corner bioregion which is listed as an endangered ecological community in New South Wales (http://www.environment.nsw.gov.au/determinations/LowlandGrassyWoodlandEndSpListing.htm).

African Love Grass is invading these pastures, with significant impacts on productivity, but also with negative effects on the composition and function of the lowland grassy woodlands. The invasion has been relatively gradual; ALG is known to have been in the region for 70-80 years (Tim Collins, personal communication), though punctuated by periods of rapid increase associated with dry/drought conditions, overgrazing and failure of sown crops and pastures. In many pastures ALG is now dominant, forming continuous large stands.

The effects on livestock productivity from ALG are thought to be significant – the species is of very low palatability, especially when rank, and can form large dense monoculture stands, excluding more palatable species (Firn 2009). However, ALG can also provide feed during drought, which can lead to some benefits in terms of grazing value and savings in terms of reduced need for purchased feed.

There are several questions from a farm business perspective:

- Is it possible and profitable to manage native pastures in such a way to avoid the invasion of African Love grass, or to minimise its impact?
- How can farmers best manage native pastures already or potentially invaded by African Lovegrass if profitability is not necessarily their main goal?
- Can native pastures contribute to the success of the farm business, or at least not significantly adversely affect it - both before and after African Lovegrass has invaded the pastures?
- Once AGL has invaded pastures, is it economic to bring it under control or to utilise it?
- What are the key factors in influencing future profitability of the whole farm where there is a risk of African Love grass taking hold in native pastures, or where it already has taken hold?
- If the economics of maintaining the native component of pastures is negative, will farmers who maintain at least some areas of native pasture (say 25 to 100 ha) be financially worse off and, if so, by how much?
- Is there much variation between farms, whether by enterprise or size, and whether the native pasture is fertilised or not?

The rate of invasion by ALG tends to be lower in less heavily stocked strategically grazed perennial pastures. Droughts are critical times for pastures, when overgrazing can create large areas of bare ground and animal movement can disperse ALG seed. Conservative stocking to maintain perennial pasture cover, especially as seasons become dry, is an important strategy to slow rates of invasion. Such a strategy involves early de-stocking as soil moisture and pasture growth rates decline to maintain a minimum of 1500-2000 kg dm ha^{-1} at all times. This strategy is most applicable in early stages of invasion.

There are a range of options for managing pasture invaded by ALG. Possible options are roller wiping, spot spraying, boom spraying, utilisation (involving slashing and/or fertilising), grazing management, and sowing other species like Kikuyu (*Cenchrus clandestina*). Some options, depending on management, may lead to the loss of some of the native species. Options considered are those that offer some potential for the native species to persist in these pastures. Of the available management options our analyses and discussion focus on roller wiping, utilisation and preventative grazing management.

In this report we focus primarily on the economics of **Roller Wiping** and **Slashing**.

Roller Wiping involves using a ground or hydraulic driven roller towed by a vehicle (4-wheel bike, ATV or light tractor). The rollers are wetted periodically with glyphosate while being towed over the pasture. The method takes advantage of the lower palatability of ALG relative to other pasture species, which results in differences in pasture height. The roller is set at a height that minimises herbicide contact with pastures species other than ALG. The roller/s, held on a towing frame, are pulled at approximately walking speed, though faster speeds are possible in light infestations. Roller wiping is increasingly used for managing ALG in the Bega Valley and is considered applicable for situations where ALG has already invaded and at scattered to dense infestation levels.

Slashing is the primary control method for utilisation that can also include fertiliser application and relatively high density, rotational livestock grazing (with recovery during the growing season of 30-45 days). Depending on total livestock numbers carried on the farm and the number of paddocks, there may or may not be a need for sub-division fencing to enable utilisation to be a practical method. Utilisation of ALG is considered only applicable where ALG has already become a dense infestation.

The economic analyses compare these strategies to doing nothing or '**Do Nothing**'. This provides a contrast to the other strategies and indicates the potential losses avoided by preventing lovegrass invasion or by managing or eliminating ALG by either the methods detailed or by some other method.

The analytical approach taken here is also relevant to sown pastures that have been invaded by ALG, though these will have different stocking rates and costs of management.

The report is structured in the following way.

After outlining **the method** taken in the study, we give some **background to the five farms** that informed the findings and discuss the **whole farm context** for decisions about ALG management.

We then discuss the effect of ALG on **carrying capacity and income** from livestock sales.

This is followed by an assessment of the **costs of undertaking management**, drawing on information from a number of contractors and five case study farms.

Following this, we explore the **economic implications of adopting management strategies under three different starting densities of ALG** The three different starting densities of ALG reflects the broad differences in situations among farms in the Bega Valley. The three situations we consider are:

1. Dense infestations of ALG (some paddocks with >66% cover of ALG and at least 100ha of dense ALG)
2. Scattered to light infestations (no more than 33% cover of ALG across at least 100ha of the farm)
3. Emerging infestation – scattered isolated plants or small patches in only a few paddocks.

Within each of these situations we contrast the alternative options for management and consider the costs and benefits of each option.

We conclude with a discussion of the findings, and as this study is a preliminary one, make recommendations for further analysis.

Methods

The method of data compilation and economic analysis is summarised here. More detail is given in the Appendix.

Design

A project brief was developed in consultation with Graham Scott, Andrew Taylor (South East Local Land Services) and Josh Dorrough (Natural Regeneration Australia). It is available on request.

Collecting information

Farmers to interview were selected carefully following agreed criteria. Josh Dorrough contacted the farmers initially. Jim Crosthwaite did an initial interview by phone with three farmers. Josh Dorrough accompanied Jim Crosthwaite to the interviews at each of the five properties.

Farmer interviews took between 1 and 2 hours and focused on obtaining information on the farm business, livestock carrying capacity, role of ALG in farm management, and detailed examination of the methods of ALG management including the implements used, time involved and the costs and benefits. In particular, the interviews sought to derive information about changes in carrying capacity as a result of implementing control/management methods. The approach taken to this was flexible, and in some cases could be assessed at the whole of farm scale while in others a particular paddock was focused on.

Contractors who do slashing and weed control were also contacted to obtain their rates per hour and other information such as implements used, ground speeds or area covered per hour. One contractor was interviewed in person. Contractor costs provide an approximate guide to likely farmer costs and it is useful to be able to compare them.

Information about carrying capacity of native pastures with different levels of infestation by African Lovegrass was compiled by Josh Dorrough. Information was provided in interviews by farmers and a short survey questionnaire was filled out by five farm advisors. Findings cover native pasture of low fertility (<15ppm colwell Phosphorus) and native pasture previously fertilised (typically 15-25ppm colwell phosphorus).

Estimates of the effect of ALG on farm income relied on the carrying capacity information, as well as estimates of likely changes in carrying capacity obtained through the management and control measures. The benefits of controlling ALG are based on being able to increase stock numbers and/or improve livestock condition. The same results apply when farmers already have a control strategy in place. We are talking then about avoided losses.

NSW DPI information was used as the basis for estimates of gross margins for beef and sheep enterprises and for some machinery costs, as well as providing useful background on weed control.

Analysing the information

Detailed budgets were prepared for slashing and roller wiping on 100 hectares. These show a break-down of costs for two or three farmers, and one contractor. These budgets are shown in the third appendix.

The first type of analysis is to compare two 'steady state' situations at some point in the future:

1. doing nothing about ALG; and
2. undertaking a control measure.

For analyses in which pasture productivity changed over time, the cost and income information are combined in an economic analysis run over 10 years. The net benefits of managing ALG in different ways are captured in two measures – annuity and net present value (see definitions section). One of the spreadsheets is shown in appendix four.

Finally, sensitivity testing was conducted to show the effect of changing the key factors that influence the economic results. These analyses focused in particular on varying the likely costs of the control (in terms of $/ha), gross margins per DSE and underlying assumptions about stocking rates.

Other analyses are also discussed, but not presented in detail, including:

- Measuring the benefits of ALG during drought;
- Lighter stocking to avoid baring paddocks going into a drought; and
- Spot spraying.

The five farms and African Lovegrass

The five farms each have very different farming operations, though they all share the problem of African Lovegrass.

Two of the farms are dairy farms with large intensively managed areas of the farm. Three farms run beef cattle, with two of them also running sheep. Size varies considerably, ranging from 150 hectares to over 700 hectares.

Farms also vary according to:

- Numbers working on the farm, and extent of off-farm work
- Age of operators
- Extent of sown pasture
- Whether animals were finished before sale, and how

All five farmers had made considerable effort to manage African Lovegrass. In each case management strategies had developed over time, with considerable experimentation. Some of the farmers were looking to change strategy, or to adopt one more widely.

There is no one correct strategy for controlling African Lovegrass. It depends on context, including, but not limited to, availability of family labour (or willingness to pay contractors), type of country, feed demands of stock being run, availability of capital, willingness to use chemical herbicides, personal and family goals and attitudes towards risk.

Effect of ALG on carrying capacity and income

African lovegrass affects farm profitability in a number of ways, but the primary affect is from its low palatability and digestibility and the subsequent loss of pasture carrying capacity. Below we describe how ALG impacts on pasture carrying capacity.

Estimates of the effect of ALG on carrying capacity on unfertilised and previously fertilised native pasture in the Bega Valley are shown in the following figure. These estimates of reductions in stock carrying capacity were developed based on *the known performance of uninfested pastures and* estimates by farmers and farm advisors of expected changes in production as a result of infestation by ALG. [1]

Interviews and survey of farmers and advisors suggested that at less than 33% ground cover African lovegrass was expected to have little or no impact on pasture carrying capacity. At low densities grazing pressure on other more palatable species is increased and this effect increased as ALG cover increased.

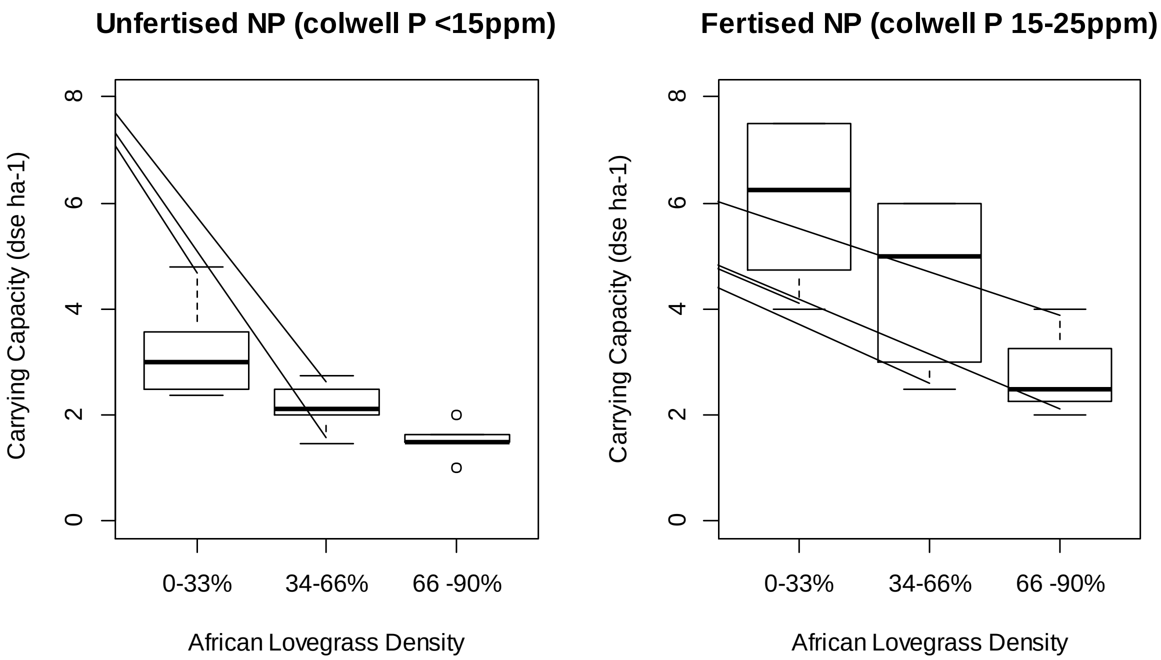

Figure 1. Estimates of the effect of African Lovegrass on pasture carrying capacity in the Bega Valley. Pastures differ in soil fertility (indicated by available phosphorus levels) and the level of infestation by African Lovegrass. In the boxes is shown the range of estimates, within which 50% of all estimates occur (25th to 75th percentile). The black solid line is the median estimate. The dashed lines indicate the spread of 95% of estimates. Estimates are derived from interviews and a survey questionnaire with farmers and farm advisors.

In summary, fertilised pasture (shown on right in Figure 1) is expected to carry between 5 and 7 DSE per hectare before ALG starts to affect productivity, and 2.5-3 DSE per hectare once infestation is dense. On unfertilised native pasture, the respective carrying capacity is expected to be 3 DSE per hectare and 1.5 DSE per hectare. As shown in the figure, there is some variation around this.

[1] Doing nothing to control African Lovegrass is widely agreed by local farmers, agronomists and extension officers to result in a reduction in stocking rate. Animals are very reluctant to eat the mature grass, which has low palatability and low feed value. At low densities, ALG does not affect livestock utilisation – stock find enough feed in the other grasses and forbs, though these species are put under increasing pressure as the density of ALG increases.

Taking the mid-points from Figure 1, carrying capacity on a block of 100 hectares is estimated.

- 600 DSE would be carried if the pasture was fertilised. This is equivalent to 100 dry breeders at 450kg (6.2 DSE each) or 65 growing cattle at 540kg each (9.2 DSE each).[2]
- 300 DSE would be carried if a fertilised native pasture were supporting a dense infestation of African lovegrass, which is equivalent to 50 beasts at 6.2 DSE.
- 300 DSE would be carried in an unfertilised native pasture with none or only a light infestation of ALG.
- 150 DSE (approximately 25 head of 450kg dry cattle at 6.2DSE) would be carried in an unfertilised native pasture with a dense infestation of African lovegrass.

It should be noted that some landholder experience suggests that rank ALG, in an almost monoculture state, could potentially reduce carrying capacity below that estimated here, to less than 1.5DSE ha^{-1} in both fertilised and unfertilised native pastures.

In Table 1, the effect of changes in stocking rate on income can be clearly seen. A change of 2 DSE per hectare is expected to change livestock activity gross margin (GM) by $50 per hectare, or $5,000 on a 100 hectare block.

If the market price that farmers can achieve for their livestock is falling, activity gross margin will be lower. For an activity gross margin per DSE of $20, rather than $25, a 2 DSE per hectare change in stocking rate will change gross margin by $40 per hectare.

Table 1 is set out to show key information at different stocking rates for the 100 hectare block - the total gross margin for the 100 hectare block (column 4), total livestock sales (column 6) and number of cattle sold (column 7).

Table 1. Expected income from extra stock on 100 hectares - at a gross margin of $25. The ratio of GM to sales is assumed to be 1.5

DSE/ha	**GM/DSE $**	**GM/ha $**	**GM/100ha $**	**Sales $**	**Number of cattle sold @$500 ea**
1.5	$25	$37.50	$3,750	$5,625	11
2	$25	$50.00	$5,000	$7,500	15
3	$25	$75.00	$7,500	$11,250	23
4	$25	$100.00	$10,000	$15,000	30
6	$25	$150.00	$15,000	$22,500	45

Control choices – whole farm considerations

Decisions about control of ALG involve more than choice of technique for these and other farms. ALG influences the whole approach to farm management.

Decisions are made by farmers with knowledge of the situation across the farm, in the business, and in the family.[3] This situation would influence decisions at any particular time about whether and how to control African Lovegrass.

[2] It is also equivalent to 462 sheep – either mature 50kg ewes pregnant with a single lamb, or 40kg lambs growing at 100g/day (1.3 DSE).

Apart from its profitability, any strategy needs to be assessed for its effects on farm cash flow (especially after tax and any interest payments), and risk to the business. These are whole farm issues.

This information is relevant, even if individual farmers do not want to pursue the most profitable investment. It helps to know what you might be giving up in pursuit of other goals, and farming families usually have multiple goals. Managing for land protection, biodiversity or amenity may be important goals also. Doing so is easiest for farmers with off-farm income or relatively low income needs.

Slashing increases the need for improved pasture utilisation that may be difficult without sub-divided paddocks and fewer large mobs. Rotating fewer large mobs of stock more often is required, though this may actually decrease labour costs (Jim Moll, farm advisor, personal communication).

Chemical control is more easily done paddock-by-paddock, though it can tie up capital and labour that could be better utilised elsewhere on the farm.

If equipment is purchased, it's per hectare cost is reduced as the size of the area increases.

Do Nothing to control ALG – effect on the farm business as a whole

Here we examine the impact on profitability and cash flow for the whole farm of doing nothing to control ALG.

At the whole farm level, overhead costs like rates, electricity and telephone must be paid irrespective of income level. If ALG reduces income by say 25%, it can have a drastic impact on profitability and cash flow. Table 2, for a hypothetical beef/sheep farm illustrates this effect. In the second column, income effects are shown, when it is reduced by 25 %.

These results do not account for possible changes in some whole farm variable costs as a result of reduced numbers of livestock e.g. animal health, fodder, selling expenses.

Table 2. Expected whole farm profit and return to capital – with and without effect of ALG

	Without ALG impacts	ALG affects income by 25%
	$	$
Assets	$900,000	$900,000

[3] We can envisage the circumstances under which pastures become heavily infested. On a dairy farm, where pastures are intensively managed, ALG could reach a high density if labour was in short supply and family labour was stretched, or weed control contractors were not available. Likelihood on intensively managed areas on a dairy farm is considered low because productivity of these paddocks is closely monitored. On a beef or sheep property, it is more likely. Situations could include:

- Intention to sell the property, combined with a willingness to run down the assets
- A cash shortfall leading to sale of of livestock and reluctance to spend money on ALG control measures
- Illness or other factors leading to shortage of labour to control ALG

Income	$130,000	$97,500
Overheads	$45,000	$45,000
Whole farm variable costs	$24,000	$24,000
Net profit	$61,000	$28,500
Return on capital	6.78%	3.17%

The effect of ALG on the farm business as a whole will vary depending on what proportion of the farm it has infested. If it has affected 80 % of the farm, as on some beef/sheep properties, then 25 % reduction in income below potential may be a reasonable estimate. If the ALG has infested only the less productive areas, for example on an intensively managed dairy farm, then the overall impact will be much less.

Estimating the costs of control

Contractor charges for Slashing and Roller Wiping

Contractor rates were obtained to provide a benchmark for assessing the costs likely to be faced by farmers. Contractor rates include a labour allowance, and the value of the capital tied up in the equipment. The costs on a farm will vary depending on factors such as terrain, availability of labour and equipment used.

Findings about contractor rates are shown in the Table 3 & 4 below. Contractors provided us with information about their charges and their equipment. Supported by information from some of the contractors as well as farmers, we have estimated an approximate speed of travel under different circumstances to estimate area covered per hour, and cost per hectare.

Roller Wiping

Table 3. Roller Wiping - Average contractor charges per hour and hectare based on two different ground speeds

ALG Density	Ground Speed	Hourly rate	Coverage	Charge / ha
Heavy	4 km/hr	$88	1.2ha/hr	$74
Light	7 km/hr	$88	2.1ha/hr	$42

For analysing roller wiping, a rate of $88 per hour ex-GST for a 3 metre wiper is used. This is the average charge rate of the first four contractors in Appendix Two. For light infestations of ALG, this wiper will cover an estimated 2.1 hectares per hour, if travelling at an average speed of 7 kms per hour. Cost is estimated at $42 per hectare, based on $88/hour and 2.1ha/hour (see Table 3). For purposes of analyses and presentation of results we round this figure down to $40/ha. For heavy infestations, cost is estimated at $74 per hectare, with the towing vehicle travelling at 4kms/hour. For purposes of analyses and presentation of results we round this figure down to $70/ha.

The results are later tested to see the effect of changing the cost, as there will be circumstances where actual costs may be more or less than the average contractor rates.

Slashing

For analysing slashing, a rate of $110 per hour ex-GST for a 2.4 metre slasher has been estimated. Although slasher widths vary widely, there is a strong positive correlation between hourly rates charged by contractors and slasher width (Figure 2) and as a result the rate per hectare is similar, regardless of slasher width.

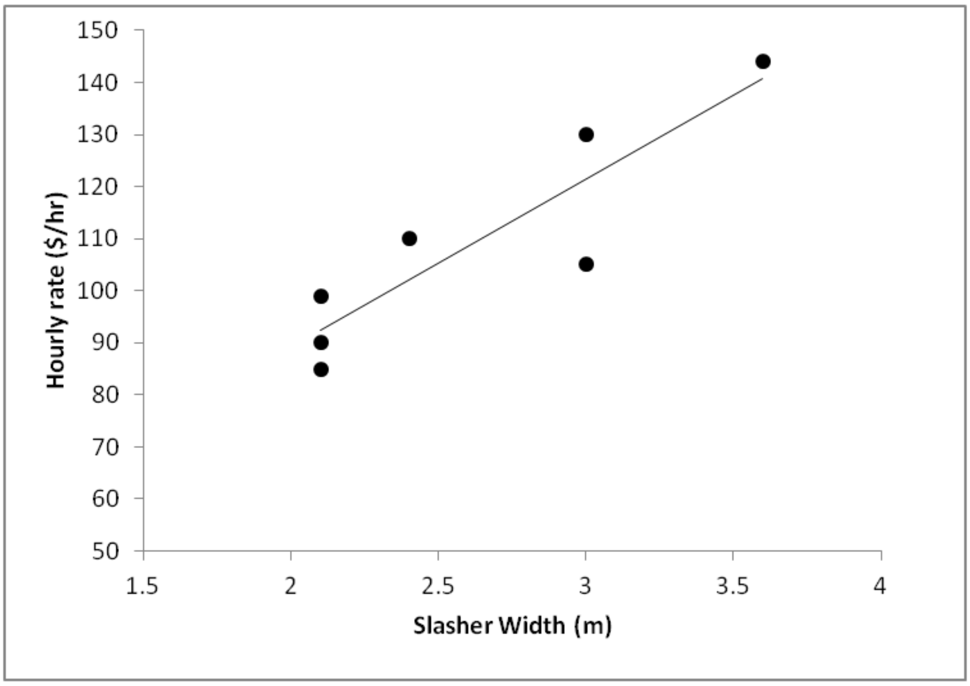

Figure 2. Relationship between hourly rate and slasher width for five contractors (2 contractors had different hourly rates depending on ALG density).

For paddocks that have been recently slashed and grazed (last 18 months), the area covered per hour is estimated at 1.2 hectares, costing $92 per hectare. We assume a 100hp tractor is used, mostly working in 6th gear. Slashing speed is estimated at 5.0 kilometres per hour.

For slashing old rank African Lovegrass, the area covered is estimated at 0.5 hectares per hour, costing $191 per hour. In this situation, a 100hp tractor is under high load and mostly working in 4th gear. Slashing speed is estimated at 2.4 kilometres per hour.

These estimates are based on information from farmers and five slashing contractors (see Appendix Two). The results are later tested to see the effect of changing the price, area covered per hour, implement size, as well as excluding family labour.

Table 4. Slashing - Average contractor charges per hour and hectare based on two different ground speeds.

ALG Density	Ground Speed	Hourly rate	Coverage	Charge / ha
Heavy	2.4 km/hr	$110	0.5/hr	$191
Light	5 km/hr	$110	1.2ha/hr	$92

Farmer costs

In this section, we examine the actual costs on different case study farms. Firstly we address roller wiping. There are similar technologies like wick wiping, for which the results are relevant. Secondly we explore the costs of slashing and utilising ALG.

The availability of family labour is likely to influence how much area is managed, because it requires effort every year. For either slashing or chemical control, there are three options – do it yourself, hire labour or bring in contractors. We have accounted for all three options.

Including a labour cost is helpful, even when that labour is undertaken by a family member. Putting a minimum price on that time (assumed here to be $19/hr) helps inform which activity is most important to do, and which activity can be contracted out or even not done at all.

Roller Wiping

Costs of roller wiping can vary greatly among farms (see Table 5). The variation between farms depends on a range of factors and includes the amount of chemical used, type of roller, towing vehicle, source of labour, density of ALG, area wiped per year, and past experience of each farmer. On all farms, it costs significantly more to control a heavy infestation than a light one – all the direct costs increase as well as family labour cost. Capital costs of owning the equipment are not affected.

The costs shown in Table 5 can be compared to contractor rates in Table 3 (see above).

Farmer costs range from below to above contractor rates. For a farm using a large tractor 100 % of the time for roller wiping, and a double roller with hydraulics, costs appear to exceed contractor rates (but see Table 7 below showing size of area wiped), though efficacy of control needs also to be considered.

Other farmers are able to reduce costs to well below contractor rates with a cheap single roller, and a lighter towing vehicle that is also used for other purposes around the farm (thus spreading the capital cost more widely).

As discussed above, it is useful to include a cost for family labour, however, if it is excluded the costs of roller wiping drop to $15 - $21 per hectare on Farms 2 & 3. Capital costs comprise 21 – 29% of total cost.

Many factors will influence costs on any particular farm. In Table 6 below, the estimated sensitivity of roller wiping costs to changes in key variables is shown. Farm 3 is used as the example. The effect of larger changes, and the effect of changes in combination of factors, can be estimated using this table.

Table 5. Estimated roller wiping costs per hectare when controlling 100 hectares on three farms

	Light infestation			Heavy infestation		
	Farm 1	**Farm 2**	**Farm 3**	**Farm 1**	**Farm 2**	**Farm 3**
Direct costs						
Spray cost	$6.04	$6.04	$8.74	$26.42	$26.42	$38.25
Fuel cost	$2.06	$0.74	$1.49	$3.61	$1.30	$2.60
R&M	$3.33	$1.19	$2.38	$5.83	$2.08	$4.17
Hired labour	$11.18	$0.00	$0.00	$19.56	$0.00	$0.00
Sub-total	**$22.61**	**$7.97**	**$12.61**	**$55.42**	**$29.80**	**$45.02**
Indirect costs						
Family labour cost	$0.00	$9.50	$19.00	$0.00	$16.63	$33.25
Annual Capital cost - roller wiper	$9.03	$5.64	$1.24	$9.03	$5.64	$1.24
Annual Capital cost - vehicle	$24.88	$1.93	$6.94	$24.88	$1.93	$6.94
Sub-total	**$33.90**	**$17.07**	**$27.17**	**$33.90**	**$24.19**	**$41.42**
TOTAL	**$56.51**	**$25.04**	**$39.78**	**$89.33**	**$53.99**	**$86.44**

Notes to table.

1. Vehicle speed is 7kms per hour for light infestation and 4kms per hour for heavy infestation. Speed is influenced by density of ALG, width of roller wiper (usually three metres), and whether using a single or double roller.
2. On Farm 3, roller wiping is done in both directions, unlike the other two farms, which influences R&M and family labour cost.
3. Farm 1 uses a light tractor to tow the roller wiper, farm 2 use a quad bike, and farm 3 use a side-by-side (new cost approx. $20,000). Some farmers regard using a quad bike to tow a roller as dangerous in steeper country, or where rocks and wombat holes may be hidden
4. The roller wiper on Farm 1 is a dual wiper, whereas the others are single wipers. The capital cost of the roller wiper on Farm 3 is very low as it was purchased for under $1,000 – if the labour involved in modifying it were included, the cost would be closer to that on Farm 2.

Table 6. Estimated sensitivity of roller wiping costs to changes in key variables on Farm 3. See text for base case assumptions

	Base case	Drums of mixed chemical per day Increase from 2 to 3	Speed of travel – kms/hr Decrease from 7 to 6	Hectares done per year Decrease from 100 to 75	% use of towing vehicle in wiping Increase from 40% to 80%	ALG density Increase from light to heavy
Direct costs						
Spray cost	$8.74	$13.11	$10.20	$8.74	$8.74	$38.25
Fuel cost	$1.49	$1.49	$1.73	$1.49	$1.49	$2.60
R&M	$2.38	$2.38	$2.78	$2.38	$2.38	$4.17
Hired labour	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Sub-total	**$12.61**	**$16.98**	**$14.71**	**$12.61**	**$12.61**	**$45.02**
Indirect costs						
Family labour cost	$19.00	$19.00	$22.17	$19.00	$19.00	$33.25
Annual Capital cost - roller wiper	$1.24	$1.24	$1.24	$1.65	$1.24	$1.24
Annual Capital cost - vehicle	$6.94	$6.94	$6.94	$9.25	$13.87	$6.94
Sub-total	**$27.17**	**$27.17**	**$30.34**	**$29.90**	**$34.11**	**$41.42**
TOTAL	**$39.78**	**$44.16**	**$45.05**	**$42.51**	**$46.72**	**$86.44**
% increase		**11%**	**13%**	**7%**	**17%**	**117%**

Costs are affected by size of area

The area being wiped is significant for assessing whether purchasing and undertaking roller wiping is worthwhile. Here we look at it in more detail.

The capital cost per hectare will fall as the area controlled increases, as shown in Table 7. This works in reverse – to control ALG on just a small area it can make more sense to engage a contractor.

In considering this, a light infestation is expected to require wiping perhaps every three years. On a 150ha property, this equates to 50ha a year; on a 300ha property to 100ha a year; and on a 600ha property to 200ha a year.

Farm 1 has African Lovegrass on more than 600 hectares. Results in Table 7 suggest that the cost of wiping 200 hectares a year will be just below the cost of bringing in contractors. If only 50 hectares is controlled, then cost is expected to double.

Table 7. Estimated per hectare costs by size of area wiped annually on Farm 1 - light infestation

	Area wiped		
	50 ha	**100 ha**	**200 ha**
Direct costs	$22.61	$22.61	$22.61
Other costs			
Family labour cost	$0.00	$0.00	$0.00
Annual Capital cost - roller wiper	$18.05	$9.03	$4.51
Annual Capital cost - vehicle	$49.75	$24.88	$12.44
Sub-total	**$67.80**	**$33.90**	**$16.95**
Total	**$90.42**	**$56.51**	**$39.56**

Slashing and utilising ALG

Slashing is looked at alone, as well as in conjunction with applying fertiliser and investment in fencing.

Slashing is typically just one part of a strategy to utilise ALG. Other components involve

- Providing stock licks as a supplement
- Grazing more heavily at the right times, which requires sub-division and extra water points
- Fertiliser may be applied to boost growth of ALG in its early stages

Slashing is likely to be considered as a strategy once ALG has heavily infested a pasture, rather than before. Realistically, this means a decision to not eradicate ALG and to no longer maintain a native-dominated pasture.

In this section, we examine the actual costs on two different farms.

In Table 8, variation between farms can be seen. Farm 2 has higher fuel costs, paid labour, as well as higher capital costs. However, this farm slashes well over 100 hectares a year – and in reality its costs per hectare are lower than we have estimated because the capital costs of equipment are spread over a larger area (see Table 9 further below).

Table 8. Estimated slashing costs per hectare when controlling 100 hectares on two farms

	Farm 1 $/ha	Farm 2 $/ha
Direct cost		
Fuel cost	$10.29	$13.00
R&M	$7.50	$7.50
Hired labour	$0.00	$19.56
Sub-total	*$17.79*	*$40.06*
Indirect cost		
Family labour cost	$16.63	$0.00
Annual Capital cost - slasher	$5.68	$11.66
Annual Capital cost - vehicle	$36.21	$47.28
Sub-total	*$58.51*	*$58.94*
TOTAL	**$76.31**	**$99.00**

Costs are affected by size of area

As with roller wiping, the size of the area being slashed is an important influence on costs. The capital cost per hectare will fall as the area controlled increases, as shown in Table 9.

Table 9. Per hectare costs by size of area slashed annually on Farm 2

	Area slashed		
	50 ha	**100 ha**	**200 ha**
Direct costs	$40.06	$40.06	$40.06
Other costs			
Family labour cost	$0.00	$0.00	$0.00
Annual Capital cost – slasher	$23.31	$11.66	$5.83
Annual Capital cost – vehicle	$94.57	$47.28	$23.64
Sub-total	$117.88	$58.94	$29.47
Total	**$157.94**	**$99.00**	**$69.53**

Assumptions for economic analysis

Below we summarise the key assumptions that underpin all of the economic analyses presented below.

General

- The farm has 100ha of area affected by ALG

- The analysis runs over 10 years, except where a steady state approach is used
- Capital costs, except livestock, are salvaged at 20% of their original value
- Any new fences and water points are salvaged at 40% in year 10 as they are expected to have a longer life
- Results are before tax. The tax situation of farmers varies greatly. After tax results would assume a given tax rate, say 15%. We do not do that here.
- The density of infestation is assumed to be either light (<33% cover) or heavy (>66% cover)
- In this report, we're not directly examining the situation in between 33 % and 66 %. The effects of starting with an intermediate density of ALG can be inferred from sensitivity analyses that use different starting stocking rates.

Control frequency and size of area managed each year

- For roller wiping heavy infestations, 100ha is wiped in the first two years and 33 ha per year thereafter.
- For light infestations, 33 ha of roller wiping is done every year, so the whole 100 hectares is done every three years.
- For slashing, 100ha is slashed every year. We later contrast this with slashing every 18 months. Only dense infestations are slashed, though in some cases we compare this to getting in early.

Stocking rates

- See the Table 10 below and also the section above on carrying capacity (Figure 1)
- Before ALG impacts on animal productivity, we assume there is surplus feed elsewhere on the farm to carry the stock at other times of the year, when not on these paddocks.
- After ALG impacts on carrying capacity (ie. above 33% cover) to avoid overgrazing other parts of the farm we assume those livestock must be agisted off-farm to retain current stock numbers. Other options available to the farmer could be to buy additional feed to maintain current stock numbers. Though this alternative is not tested here, agistment cost is a good approximation of a range of short term feed supply alternatives.
- Stock licks and other supplementary feed is not required.

Table 10. Estimated changes in stocking rate applied to each management scenario in the 10 year development budgets. For heavy infestations with no management (ie. "Do Nothing") stocking rates stay at 3 DSE/ha for fertilised and 1.5 DSE/ha for unfertilised, throughout the 10 years. Under Do Nothing with a light infestation the density of ALG is expected to increase over time, leading to a decline in stocking rates. The rate of decline in stocking rate is however unknown, though we estimate a gradual decline over the 10 years until ALG reaches a dense infestation by year 10.

	Year					
	1	**2**	**3**	**4**	**5**	**6 +**
Light Infestation - fertilised native pasture						
Do Nothing	6	6	5.75	5.5	5	4.5 - 3
Roller wiping	6	6	6	6	6	6
Light Infestation - unfertilised native pasture						
Do Nothing	3	2.7	2.5	2.2	1.8	1.5
Roller wiping	3	3	3	3	3	3
Heavy Infestation - fertilised native pasture						
Do Nothing	3	3	3	3	3	3
Roller wiping	3	3	4	5	6	6
Slashing	3	4	5	6	6	6
Heavy Infestation - unfertilised native pasture						
Do Nothing	1.5	1.5	1.5	1.5	1.5	1.5
Roller wiping	1.5	1.5	2	2.75	3	3

Prices and costs associated with livestock

- Stock are valued at $69/DSE
- Extra cattle have to be 'purchased' at $500 a head, but their value is included as salvage value (at full price) at the end of 10 years.
- Agistment cost is $0.50/week/DSE
- Agistment is for 52 weeks a year – in the 'do nothing' situation where stocking rate declines over time

Costs specific to Roller wiping

- Cost of engaging a contractor for roller wiping is $70 for heavy infestations, and $40 per hectare for light infestations. These represent the average rates charged by contractors. We vary these costs to test sensitivity.
- Capital costs are $10,000 for a roller wiper. It is assumed that the farmer owns a towing vehicle (tractor, quad bike or mule) – but this is not always the case.

Costs specific to Slashing

- Cost of engaging a contractor for slashing is $191/ha for paddocks with rank stands, and $92/ha when stands are relatively short.
- For farmers who slash, capital costs are $10,000 for a slasher, and $60,000 for a 100hp tractor.
- Cost of paddock sub-division and water points is $20,000, spread over two years, which is seen as necessary for grazing management to keep the ALG short.
- Fertiliser costs $45/ha and is applied every third year (we treat this as $15/ha per year) at 100kg/ha at $400/tonne delivered with $5.50/ha spreading cost.

Fuel and R&M costs

- Fuel cost after rebate is $1.30
- Repairs and maintenance cost per operating hour is estimated at
  - $6/hour for a light tractor, $2/hour for a quad bike and a side-by-side.
  - $0.50/hour for a single roller wiper, $1.00/hour for a double roller wiper with hydraulics,
  - $3/hour for a 2.4 metre slasher
    A suggested guide to R&M costs of implements is 2% of replacement price per year
    http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0011/302699/Guide-to-machinery-costs-and-contract-rates.pdf

Comparisons in the economic analysis

We need to compare the results of roller wiping and slashing to a base case. Correctly establishing the base case is critical.

For farmers now with large areas of dense rank ALG

Base case
Do Nothing different - pasture productivity has already been greatly reduced.

Alternatives
Roller wipe for two years, then every three but also tested for every 2 years. Landholders can either buy equipment, or get a contractor.

Slash first year at higher cost, then every 12 or 18 months at a lower cost. Landholders can either buy equipment, or get a contractor.

For farmers with light infestations

Base case – Do Nothing different, which is expected to result in a loss of productivity over time as the ALG becomes increasingly thick and rank. We assume the loss begins in Year 3, but in reality it may be later or earlier.

Alternative
Roller wipe every three years, but also tested for every 2 years. Landholders can either buy equipment, or get a contractor.

There are short-term advantages in doing nothing to control African Lovegrass:

a) Avoiding, or putting off, costs of control;

b) Realising the capital value of selling livestock as pasture declines.

Realistically most farmers want to maintain stock numbers.[4] Before the heavy ALG infestation forced an alternative strategy, stock were being moved in and out of these paddocks over the year. After infestation increase above 33% we assume feed has to be brought in, or stock run off-farm. We use the example of agisting the stock in the Do Nothing case – as stocking rate declines, a given number of stock have to be agisted for the whole year to ensure stocking rate does not exceed carrying capacity. The stock agisted are assumed to obtain the same weight gain as those retained on the farm.[5] Total livestock income remains the same, but cost of agistment is now included. If the farmer were to reduce livestock numbers, the quite substantial cash flow received from the forced livestock sales would be included in the 10 year analysis.

Managing light infestations – economic analysis

Now the expected costs and income are looked at together. Here we examine control options for light infestations that are below 33 % ground cover. African Lovegrass is only expected to impact on stocking rates when it is over 33 % of ground cover. It is likely that there are some subtle long-term effects on pasture composition, but we don't account for them in this analysis.

We consider roller wiping and contrast this to doing nothing.

First, we look to the future and compare a pasture that is regularly being roller wiped with one that has fully declined in productivity. This is a 'steady state' analysis.

Secondly, we look at the current situation as it might be now. If the farmer opts to do nothing over 10 years it is assumed that the pasture will gradually decline in productivity as the ALG invades (see assumed rates of decline in Table 10 above). A discounted cash flow analysis is required to deal with the different income and costs.

Farmers have the choice of purchasing or bringing in a contractor. Our initial analysis is based on hiring a contractor.

Roller Wiping – light infestations - steady state

Wiping is required once every three years when there is a light infestation. This means that, each year, one-third of the 100 hectare block is wiped. We compare regular wiping, which enables

[4] Note that short-term returns could be higher from selling off stock as the pasture degrades. Realising these short-term gains, without paying the costs of controlling ALG, is likely to suit some farmers, especially as impacts may take many years to be realised.

[5] Alternative ways of measuring the impact are

- Reduced income from running fewer stock
- Feeding purchased hay, grain and supplements sufficient to maintain stock weight
- Leasing or buying land

"The fair rental value for a lease for livestock production is similar to long-term agistment rates and will generally fall between 5% and 9% of the value of the land."
NSW Department of Primary Industries (2007) Leasing land – calculating a rental, Primefact 338
http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0017/104093/leasing-land-calculating-a-rental.pdf

stocking rates in a previously fertilised native pasture to remain at 6 DSE per hectare (3 DSE per hectare if it is unfertilised), to doing nothing to heavily infested ALG pasture, where stock numbers have been reduced to 3 DSE per hectare (1.5 DSE per hectare if it is unfertilised). We are thus interested in avoided losses.

Costs are taken to be $40 per hectare sprayed (ie. 33 hectares per year hiring a contractor), and income is based on the gross margins at different stocking rates as per Table 1.

In the following tables we present the results for the steady state case – that is when control measures are being undertaken to keep ALG under control, compared to a situation where ALG has taken over.

Table 11. Steady State - Estimated annual net benefits of roller wiping 100 ha of fertilised and unfertilised native pasture by pasture type at a gross margin of $25/ha and with control costs of $40/hectare

	Fertilised native pasture			Unfertilised native pasture		
	No control $	Control $	Net Gain/Loss $	No control $	Control $	Net Gain/Loss $
Net Income from stock	$7,500	$15,000		$3,750	$7,500	
Cost of ALG control	$0	-$1,320		0	-$1,320	
Net Cash Flow before tax	$7,500	$13,680	$6,180	$3,750	$6,180	$2,430

On fertilised native pasture, as shown in Table 11, there are significant gains to be made, or more strictly losses to be avoided, by keeping ALG under control by roller wiping – an estimated $62 per hectare. However, on unfertilised native pasture gains are an estimated $36 per hectare (Table 11).

Variables that might change results here are:

- stocking rate on pastures heavily infested with ALG
- stocking rate after control measures
- gross margin, which is mostly influenced by price of stock sold
- control costs

The results of testing a change in these variables is summarised in the table 12.

If stocking rate for roller wiped pastures increase by 1 DSE per hectare for fertilised native pasture, then net income for Control rises to $17,500 and net cash flow to $16,180. This means that the gain in net cash flow between Control and No Control increases to $8,680. On unfertilised pasture, if stocking rate is 0.5DSE higher, the gain becomes $3,680.

If gross margin per hectare falls to $20 per hectare, rather than $25 per hectare, then the gain in net cash flow between Control and No Control is $3,180 for fertilised native pasture and $930 for unfertilised native pasture.

For every change in control costs of $10 per hectare sprayed, the gain from Control compared to No Control changes by $330 on both pasture types.

The results highlight that small changes in some of our base assumptions, especially for gross margins, can make a substantial difference to the expected benefits or losses in each pasture type.

Table 12. Expected difference in net cash flow between Control and No Control when key variables change by pasture type

		Pasture type	
Variable		Fertilised	Unfertilised
		$ difference	$ difference
BASE CASE	As above (table 10)	$6,180	$2,430
DSE / ha			
Fertilised	7	$8,680	
Unfertilised	3.5		$3,680
Gross margin	$30	$3,180	$930
Control cost/ha	$20	$5,850	$2,100
	$50	$6,180	$2,430

Note: The difference for DSE / ha refers to the maximum potential stocking rate gain from Control compared to No Control. This can result from a change in stocking rate for Control going up or No Control going down, or a combination of both. On unfertilised the marginal change is likely to be smaller.

Roller Wiping – light infestations - discounted cash flow analysis

While the above steady state comparison is useful to indicate the long-term avoided annual losses, to assess the potential economic impacts of investing in control of ALG requires a development budget where ALG densities and hence stocking rates are assumed to change over time.

In the Do Nothing case, stocking rates will gradually decline (Figure 3) and to retain total stock numbers livestock need to be agisted.

Figure 3 below shows the assumed changes in stocking rate for Roller wiping and Do Nothing on fertilised native pasture. The pattern is the same for unfertilised native pasture, but starting from 3 DSE per hectare.

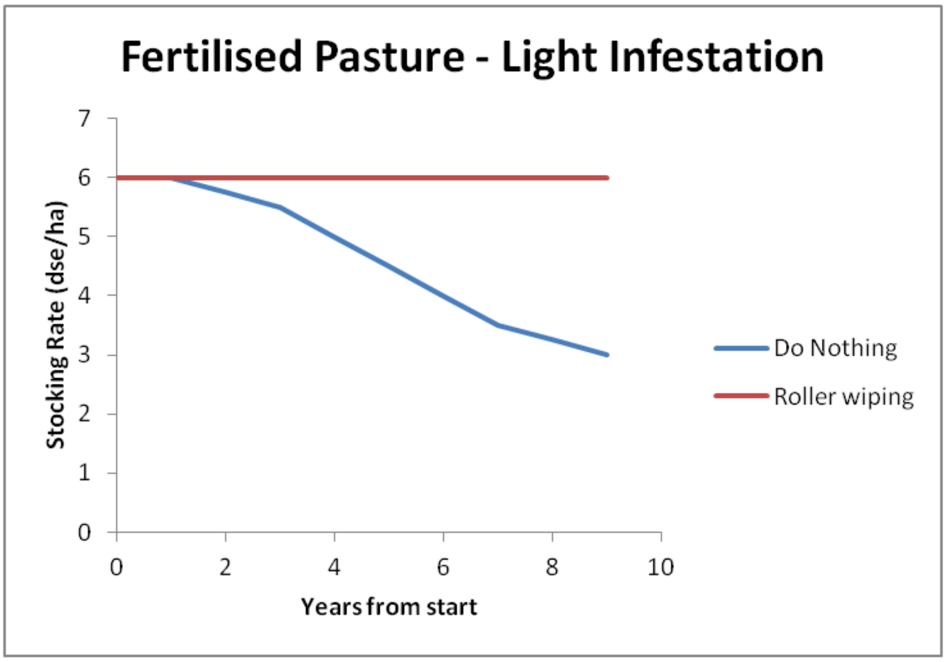

Fig 3. Estimated changes in stocking rates over time for Do Nothing and Roller Wiping on fertilised native pasture with a light infestation

Do Nothing has some important assumptions. We assume that the farmer will want to keep livestock numbers at the same level – this means agisting or feeding stock. We use agistment. Total livestock income remains the same, but cost of agistment is included. If the farmer were to reduce livestock numbers, the income received from those sales would be included in the 10 year analysis.

We use a spreadsheet that runs over 10 years, and convert income and expenses each year back to the base year using a discount, or interest, rate. Results can be expressed in terms of Net Present Value, Internal Rate of Return or as an annuity (see Definitions).

Results are shown in the two tables below for two different gross margins.

Table 13. Fertilised native pasture – expected results for Roller Wiping and Do Nothing – by gross margin

	Gross Margin = $25/DSE			Gross Margin = $20/DSE		
	Do Nothing	Roller Wipe	Difference	Do Nothing	Roller Wipe	Difference
Annuity @ 5%	$11,883	$13,680	$1,797	$8,883	$10,680	$1,797
NPV @5%	$91,755	$105,633	$13,878	$68,590	$82,468	$13,878
NPV @10%	$75,236	$84,058	$8,822	$56,802	$65,624	$8,822

Key assumptions

- For light infestations, 33 ha of roller wiping is done every year, so the whole 100 hectares is done every three years.
- Cost of engaging a contractor for roller wiping is $40 per hectare for light infestations.

Roller Wiping is more profitable than Do Nothing at both gross margins. The annuities suggest that at a gross margin of $25 per hectare, the farmer will be better off each year by an average $17.95 per hectare (or $1,797 on 100 hectares).

Table 14. Unfertilised native pasture – expected results for Roller Wiping and Do Nothing – by gross margin

	Gross Margin = $25/DSE			Gross Margin = $20/DSE		
	Do Nothing	Roller Wipe	Difference	Do Nothing	Roller Wipe	Difference
Annuity @ 5%	$6,513	$6,180	-$333	$5,013	$4,680	-$333
NPV @5%	$50,288	$47,720	-$2,568	$38,705	$36,138	-$2,567
NPV @10%	$40,754	$37,973	-$2,781	$31,537	$28,757	-$2,780

In contrast to the situation on fertilised native pasture, results in columns 3 and 6 show that roller wiping is likely to be less profitable than Do Nothing at both levels of gross margin/DSE in unfertilised native pasture. However, it is more profitable if a higher gross margin/DSE is combined with a higher stocking rate change than we allow – this is shown further below.

The effect of ALG density on stocking rates is a major influence on profitability relative to doing nothing. What if rates of ALG invasion are faster or slower than we have estimated in the base case assumption (see Figure 4 below)? And what if the actual carrying capacity potentially falls below what we estimated? We know relatively little about how quickly stocking rate is likely to change, and the extent to which it changes. So it is important to test the results for stocking rate curves that are higher or lower.

The more rapid decline in stocking rate shown in Figure 4 might be expected if ALG densities increase dramatically in response to drought and overgrazing. This curve might also be what we would expect if the effects of ALG densities on stocking rates are greater than what we estimated from the median values in Figure 1, though the minimum stocking rate would also be lower. A slower rate of invasion might be expected if no drought conditions are experienced over the 10 year period or if ALG has a lesser impact on stocking rates.

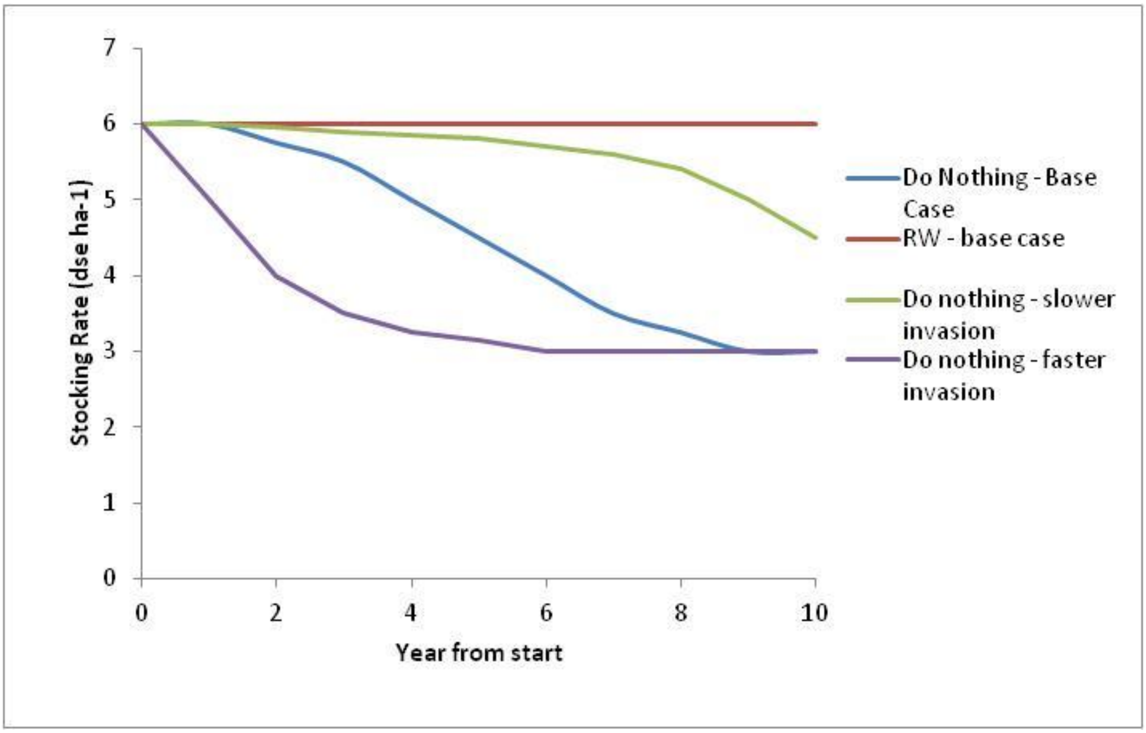

Figure 4. Alternative stocking rate scenarios in a fertilised native pasture starting with a light infestation. Roller wiping (RW) is assumed to maintain current stocking rates, while doing nothing leads to on-going invasion by ALG and subsequent declines in stocking rate.

The results of testing for these different stocking rate curves, resulting from a faster or slower rate of ALG invasion are shown in Figure 5 for a fertilised native pasture with a light infestation. We don't present the results for an unfertilised native pasture.

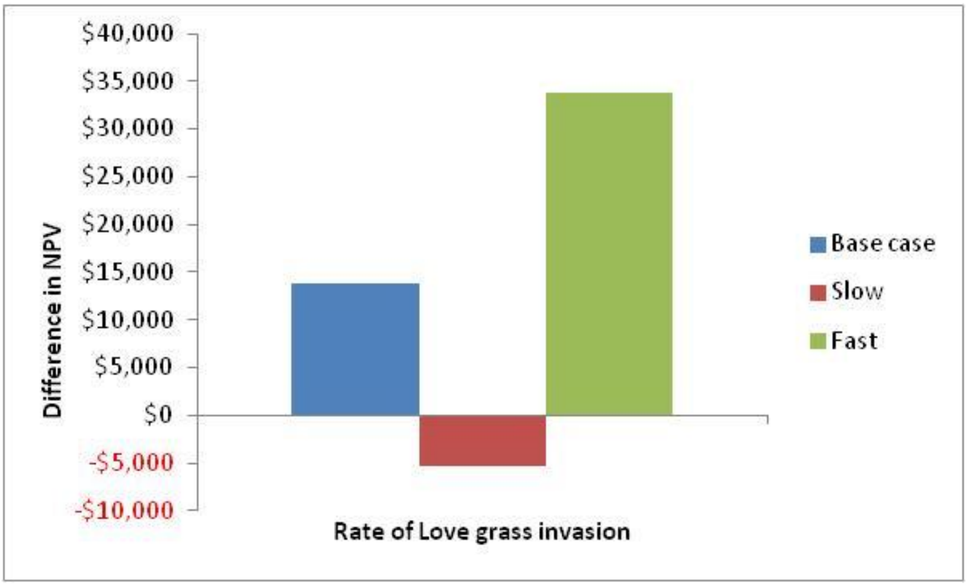

Figure 5. The difference between control (roller wiping) and do nothing NPV (NPV roller wiping minus NPV do nothing) for three different rates of ALG invasion, as per Figure 4. In all cases roller wiping enables a stocking rate of 6 to be maintained. Under do nothing the rate of invasion is either faster, slower or the same as the base case. Rate of return is 5% and gross margin is $25.

Figure 5 shows that if the rate of ALG invasion with no control (ie. do nothing) is much faster than we assume in the base case then roller wiping avoids very large potential losses (ie. active control through roller wiping has a much larger NPV than doing nothing). This might be the case if the effects of lovegrass on potential carrying capacity are much more significant than we have assumed or if rates of invasion occur rapidly. However, in many cases, especially when in early stages of invasion, actual rates of invasion may be much lower than we have estimated. In these cases, although roller wiping will assist in preventing a later infestation, over 10 years such an action may be less profitable, despite avoiding higher costs in the future. Although we do not present results for an unfertilised native pasture, the conclusion remains the same – the faster the likely rates of invasion, the greater the avoided losses.

Managing heavy infestations – economic analysis

Here we examine control options for infestations that are over 66 % ground cover.

African Lovegrass is expected to impact on stocking rates when it is over 33 % of ground cover. Both roller wiping and slashing are investigated as control options. As earlier stated, we're not examining the situation between 33 % and 66 %. Results for these farms will be somewhere in between, and will be shown indirectly as some of our analysis allows for ALG to get worse over time when starting with a light infestation, and for ALG to get better when heavily infested.

As shown above, after heavy ALG infestation we assume stocking rates will halve, from 6 to 3 DSE per hectare on fertilised native pasture and from 3 to 1.5 DSE per hectare on unfertilised native pasture.

Figure 6 below shows expected stocking rate changes for each strategy on fertilised native pasture. For unfertilised native pasture, the figure is similar but starting from a stocking rate of 1.5 DSE per hectare.

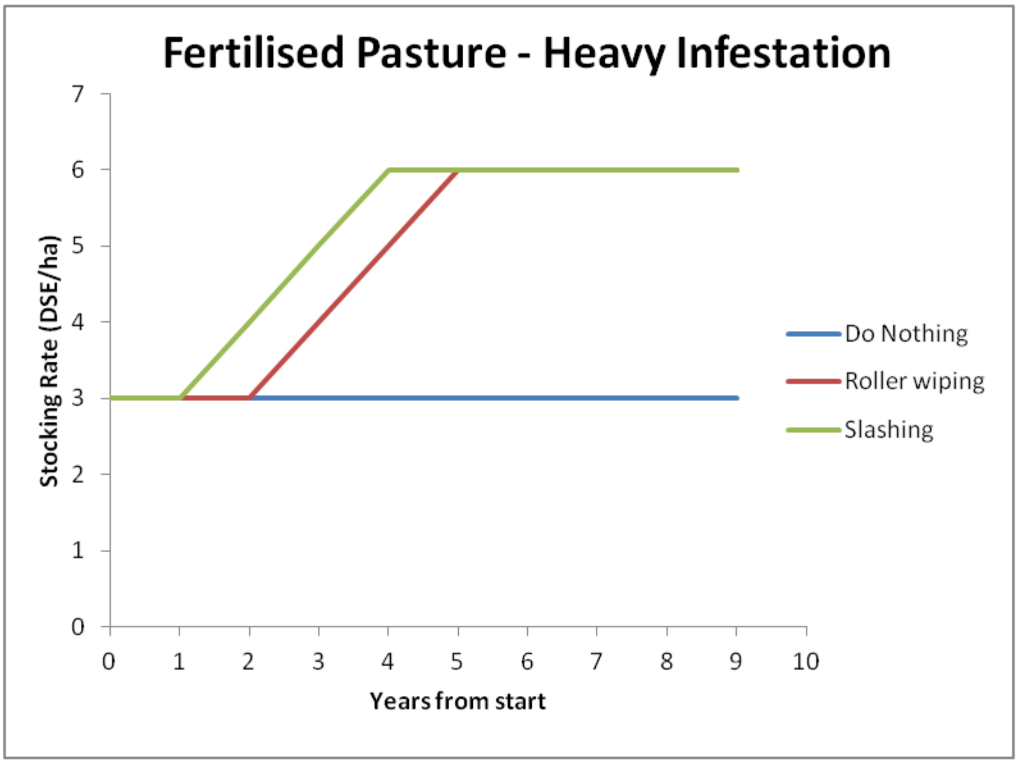

Figure 6. Stocking rate over time for Do Nothing, Roller wiping and Slashing on fertilised native pasture with a heavy infestation

Here we consider roller wiping and slashing as alternatives to doing nothing for managing a heavy infestation.

In all cases farmers have the option of either buying equipment or bringing in a contractor. Initially, we examine the economics when bringing in a contractor.

As it is brought under control, both the stocking rate and the control cost will change.

A steady-state analysis has less value in this circumstance, and so we concentrate on the results of the discounted cash flow analysis.

We use a spreadsheet budget that runs over 10 years, and convert income and expenses each year back to the base year (present value) using a discount, or interest, rate. Results can be expressed in terms of Net Present Value, Internal Rate of Return or as an annuity (see definitions above).

Roller Wiping – heavy infestation – discounted cash flow analysis

We assume the entire 100ha pasture is wiped in the first two years (at a higher cost) and then every 3 years, though we also test for wiping every second year.

Here the cost of roller wiping is assumed to be $70 per hectare for the first two years and $40 per hectare per year after that.

It is also necessary to include the values of livestock that have to be purchased as stocking rates again increase. Each beast is valued at $500.

In the following table (Table 15) we present the results for when roller wiping has allowed stocking rates to be raised (“After heavy infestation”), compared to if nothing had been done. It also shows what would have happened if control started before infestations became dense (“Before heavy infestation”), which is equivalent to the results obtained for roller wiping a light infestation (see previous section).

Table 15. Expected economic benefit of controlling ALG using roller wiping on 100 hectares. Costs are based on use of a contractor. Estimates are derived from a 10 year discounted cash flow analysis with a livestock gross margin = $25

	Fertilised native pasture			Unfertilised native pasture		
	Do nothing $	After heavy infestation $	Before heavy infestation $	Do nothing $	After heavy infestation $	Before heavy infestation $
Annuity @ 5%	7,500	$9,115	$13,680	3,750	$3,272	$6,180
NPV @ 5%	$57,913	$70,387	$105,633	28,957	$25,263	$47,720
NPV @ 10%	$46,084	$49,479	$84,058	23,042	$16,074	$37,973

Looking at the results in Table 15, acting before ALG takes over is the best option in all circumstances.

For fertilised native pasture, the annuity results show that controlling ALG once a heavy infestation has occurred results in only a small annual gain compared to Do Nothing of an estimated $1,615 ($9,115 - $7,500). Beginning a control program early produces an annuity that is an estimated $6,180 ($13,680 - $7,500), or $62 per hectare, higher than Do Nothing.

For unfertilised native pasture, the annuity results show that controlling ALG once a heavy infestation has occurred results in small annual loss of an estimated $478 ($3,272 - $3,750) compared to Do Nothing. Beginning a control program early produces an annuity that is an estimated $2430 ($6180 - $3750), or $24.30 per hectare, higher than Do Nothing.

The NPV figures show a similar result. Calculating NPV at the higher discount rate of 10 % means that cash flows towards the end of the 10 year period are valued much less than earlier ones – hence the figure is much less than that for NPV at 5 %.

Internal rate of return, and return on capital are not appropriate measures because contractors are used instead of a capital outlay on equipment. Stock are purchased as the heavy infestation is brought under control – on fertilised pasture, stock purchases total $21,000 spread over three years from the third year.

Sensitivity testing

What if the maximum achievable stocking rate is higher or lower than the base case? Figure 7 shows some potential alternatives when the rate of increase in stock numbers is approximately the same but the maximum achievable stocking rate differs from the base case. We show the changes in stocking rate for a fertilised native pasture.

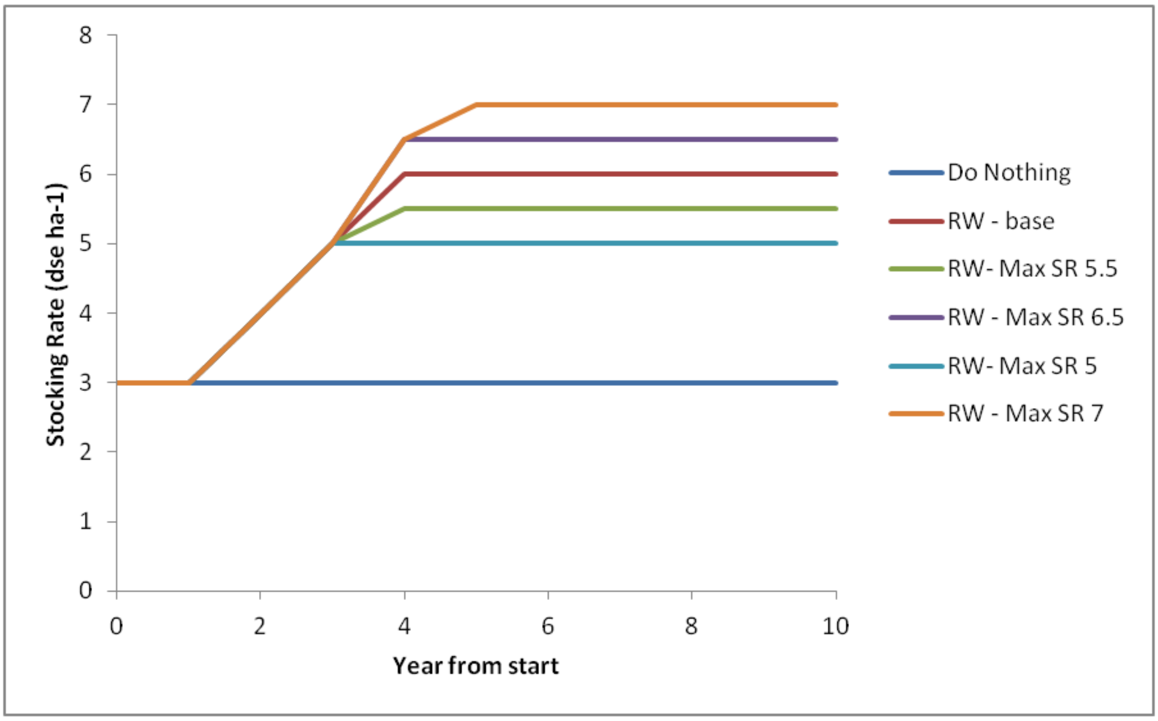

Figure 7. Alternative maximum stocking rates in heavily infested previously fertilised native pastures. The base case has a stocking rate of 6 dse ha-1.

Figure 8 shows how varying the assumptions about the maximum achievable stocking rate affect NPV (@5%) relative to the do nothing case, for both gross margins of $20 and $25/ha. The vertical line in the centre of the graph represents the base case stocking rate.

For a fertilised native pasture with a heavy infestation, at a gross margin of $25 per hectare, even if the potential stocking rate is only 5dse per ha, we estimate that roller wiping will be more profitable than doing nothing. However at a GM of $20/dse, with a decline in the maximum achieved stocking rate of little more than 0.5 dse per ha, roller wiping is estimated to be less profitable than doing nothing. However, at both gross margins, if a higher stocking rate can be achieved then roller wiping would be far more profitable than doing nothing. These results indicate that the likely profitability of roller wiping, over doing nothing, once a heavy infestation is reached is very much dependent on the gross margins/DSE the producer can achieve.

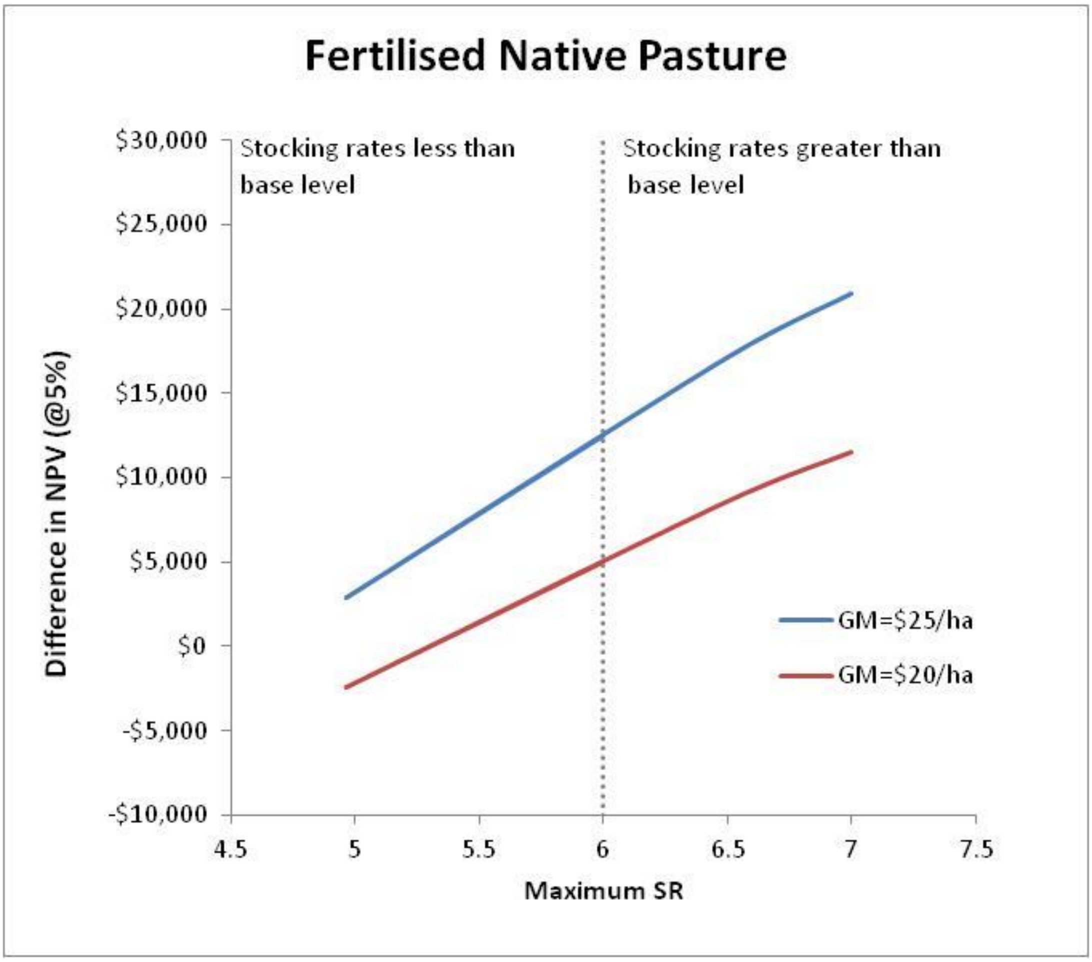

Figure 8. The effect of gross margin per DSE and changes in the base stocking rate assumptions on the difference in NPV compared to doing nothing over 10 years in a fertilised native pasture with a heavy African Lovegrass infestation. SR assumptions underpinning this analysis are presented in Figure 7. At 5% rate of return.

For an unfertilised native pasture, changes in stocking rate assumptions have a very large relative effect on expected differences in NPV, though gross margin is also very important, especially at higher stocking rates. Our results suggest that at a gross margin of $20 even if the maximum achievable stocking rate is 4 dse per ha, then roller wiping is estimated to be less profitable than doing nothing For a GM of $25, we estimate that the maximum stocking rate must be greater than 3.5 dse /ha for roller wiping to be more profitable than doing nothing.

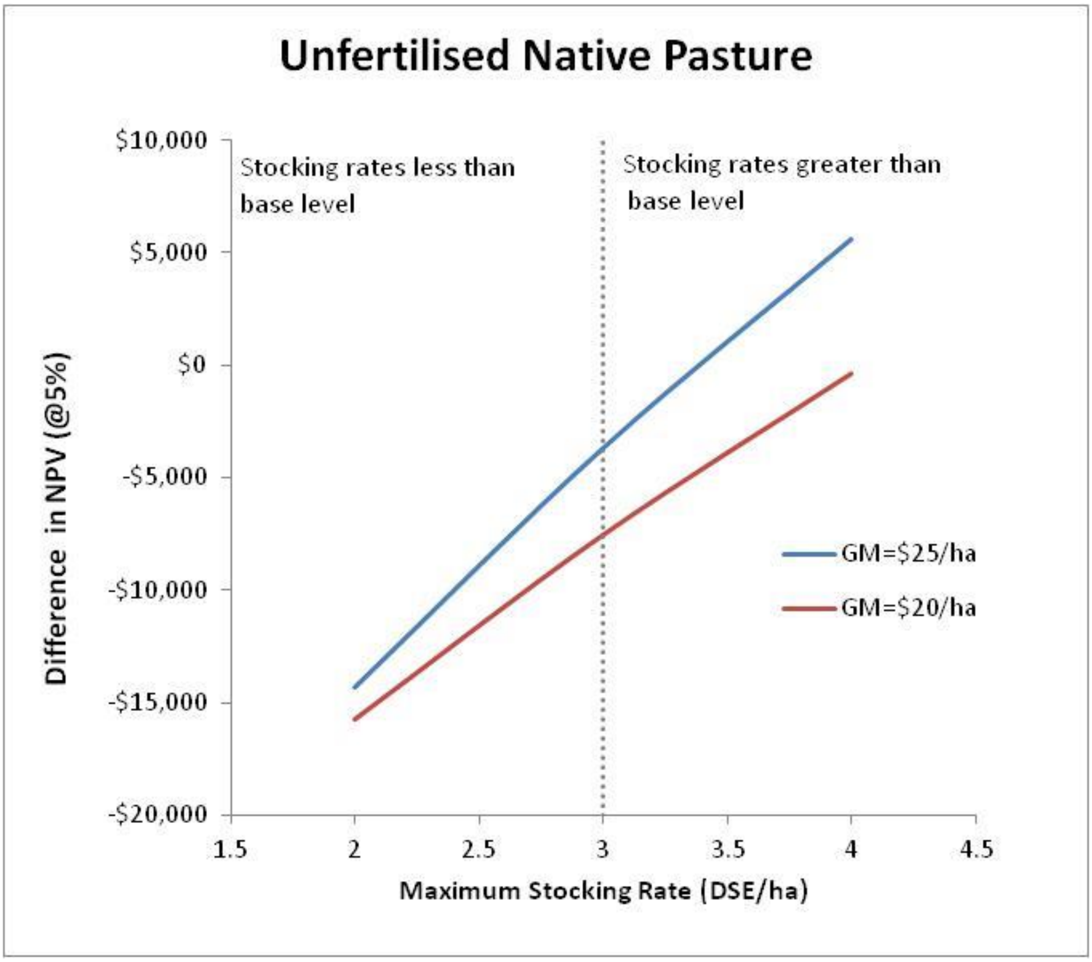

Figure 9. The effect of gross margin per DSE and changes in the base stocking rate assumptions on the difference in NPV compared to doing nothing over 10 years in a unfertilised pasture with a heavy African Lovegrass infestation. Rate of return is 5%

Once ALG is out of hand, results vary depending on the perceived riskiness of control measures – and this is a real risk as many farmers have failed to control ALG with roller wiping. It pays to get it right first time. More risk averse farmers will only be prepared to roller wipe if they get a greater return.

- If risk is regarded as high (discount rate of 10% real), NPV results suggest that Doing Nothing is more profitable than controlling a heavy infestation in many circumstances – on both fertilised and unfertilised native pasture.
- If risk is regarded as low (discount rate of 5% real) NPV results suggest that controlling a heavy infestation is worthwhile on fertilised native pasture, but less so on unfertilised native pasture.

In some cases however, roller wiping fails. The effect can be quite significant. If it fails in the first year, NPV (at 5%) is estimated to decline by $6,000 in a fertilised pasture and $2,000 in an unfertilised native pasture.

We have assumed that after the initial roller wiping of two consecutive years, that roller wiping will only have to be undertaken every third year ie. 33 ha is wiped per year. However, some farmers have suggested roller wiping might be required every second year after the initial period of control. Roller wiping every second year reduces the NPV (@5%) for a fertilised native pasture by $4,000. While this is a significant amount, it is a lesser impact than an early failure.

Buying the roller wiper

We now investigate the economics of buying a roller wiper, instead of hiring a contractor. The roller wiper costs $10,000.

Table 16. Expected economic benefit of controlling ALG on 100 hectares using a purchased roller wiper worth $10,000 - 10 year period – Gross margin = $25

	Fertilised native pasture			Unfertilised native pasture		
	Do nothing $	After heavy infestation $	Before heavy infestation $	Do nothing $	After heavy infestation $	Before heavy infestation $
Annuity @ 5%	$7,500	$8,336	$12,804	$3,750	$2,492	$,5304
NPV @ 5%	$57,913	$64,367	$98,866	$28,957	$19,243	$40,953
NPV @10%	$46,084	$43,073	$76,954	$23,042	$9,669	$30,870
IRR		52%			19%	

Key assumptions

- For roller wiping heavy infestations, 100ha is wiped in the first two years and 33 ha per year thereafter.
- Capital costs are $10,000 for a roller wiper. It is assumed that the farmer owns a towing vehicle (light tractor, quad bike or side-by-side).
- Extra cattle have to be 'purchased' at $500 a head as carrying capacity increases, but their value is included as salvage value (at full price) at the end of 10 years.
- Fuel cost after rebate is $1.30
- Repairs and maintenance cost per operating hour is estimated at $0.50/hour for a single roller wiper, $1.00/hour for a double roller wiper with hydraulics. Towing vehicle costs are not included.

If control starts before the pasture is heavily infested, results show an expected net annual gain of $5,304 ($12,804 - $7,500) for fertilised native pasture. After a heavy infestation, NPV at 5 % for roller wiping is higher than for Do Nothing. As NPV at 10 % is lower than Do Nothing - this suggests caution for risk-averse farmers.

Results are similar for unfertilised native pasture. Acting early is clearly more profitable than delaying action. When a pasture is already infested, there are substantial costs associated with adopting roller wiping even at a 5% rate of return.

If the roller wiper costs $5,000 and not $10,000, the expected results are better but not greatly so - as shown in Table 17. The annuity increases by $400 to $8,873 for a previously fertilised native pasture, though wiping an unfertilised pasture is still estimated to be less profitable than no action at all.

Table 17. Expected economic benefit of controlling ALG on 100 hectares using a purchased roller wiper worth $5,000- 10 year period – Gross margin = $25

	Fertilised native pasture			Unfertilised native pasture		
	Do nothing $	After heavy infestation $	Before heavy infestation $	Do nothing $	After heavy infestation $	Before heavy infestation $
Annuity @ 5%	$7,500	$8,873	$13,341	$3,750	$3,029	$5,841
NPV @ 5%	$57,913	$68,515	$103,014	$28,957	$23,391	$45,101
NPV @10%	$46,084	$47,233	$81,114	$23,042	$13,829	$35,030

Slashing – heavy infestation

Slashing is usually started once ALG is significantly affecting carrying capacity – when it has reached a ground cover of 66 % or more. We examine this situation.

Slashing – steady state analysis

We compare regular slashing to doing nothing to heavily infested ALG pasture, where stock numbers have been reduced.

With control, fertilised and unfertilised native pastures would carry 6 DSE/ha and 3 DSE/ha respectively. Without control, stocking rate has fallen and stays at 3 DSE/ha and 1.5 DSE/ha respectively.

Slashing is undertaken every year, in the initial evaluation. Later we test the effect of doing it every 18 months, which is being achieved locally where livestock are also being managed to keep the ALG short and palatable.

Costs are taken to be $92 per hectare per year based on hiring a contractor, and income is based on the gross margins at different stocking rates as per an earlier section. We later review the effect of farmers buying a slasher to do it themselves. We assume that they already have a tractor available to tow the slasher on the farm but also analyse the outcomes when a 100hp tractor needs to be purchased.

In the following tables we present the results for the steady state case – that is when slashing has allowed stocking rates to be raised, compared to if nothing had been done. In the steady state, all necessary capital expenditure on fencing and water points has occurred.

Table 18. Steady State - Estimated net benefits of slashing 100 ha of fertilised and unfertilised native pasture by pasture type at a gross margin of $25/ha and with control costs of $92/hectare

	Fertilised native pasture			Unfertilised native pasture		
	No control $	Control $	Difference $	No control $	Control $	Difference $
Net Income from stock	$7,500	$15,000		$3,750	$7,500	
Cost of ALG control	$0	$9,200		$0	$9,200	
Net Cash Flow before tax	$7,500	$5,800	-$1,700	$3,750	-$1,700	-$5,450

The results in Table 18 show that slashing fertilised native pasture that is dominated by ALG is expected to be unprofitable compared to doing nothing – a loss of $17 per hectare ($1,700 on 100 hectares). This is based on net income from stock rising from $7,500 ($3 x $25 x 100) to $15,000 ($6 x $25 x 100), and control costs of $9,200 ($92 x 100).

There is expected to be a greater loss of $54 per hectare if slashing unfertilised native pasture – a result that could be reasonably expected given its low carrying capacity and the relatively high costs of slashing. Even at a gross margin of $30 per DSE and a control cost of $70, net cash flow for the fertilised pasture is expected to be -$25 per hectare (not shown in this table).

Slashing unfertilised native pasture is not examined any further. We found that it was not profitable on any realistic assumptions about stocking rate, gross margin, and control cost.

Table 19. Difference in net cash flow between Control and No Control when key variables change for fertilised native pasture

Variable	Detail	$ difference
	As above (table 10)	-$1,700
DSE / ha	Increase by 1	$2,500
Gross margin	$30	-$200
Control cost/ha	$60	$1,500

Note - The difference for DSE / ha refers to the maximum potential stocking rate gain from Control compared to No Control. This can result from a change in stocking rate for Control going up or No Control going down, or a combination of both. On unfertilised the marginal change is likely to be smaller.

We show in Table 19 the change in key variables that might result in a positive net cash flow from hiring a contractor to slash ALG in fertilised native pasture. A reduction in control costs to about $60 per hectare can be justified if slashing is done every 18 months, compared to every 12 months. The difference in net cash flow between Control and No Control jumps to $15 per hectare, compared to -$17 per hectare for every 12 months.[6]

[6] This scenario also arises if labour is excluded from the costings (see earlier section on costs of slashing). However, assume for a moment that the farmer is doing the slashing, this size deduction of labour should only be made if there are no other uses for the family labour which is generally unrealistic. Similarly, control costs can be reduced if the slasher and towing vehicle are valued at much less than in this analysis (see earlier section on slashing costs).

Stocking rate has a significant effect on these results. If slashing can increase stocking rate by one DSE per hectare, compared to No Control, then the expected benefit is a positive $25 per hectare ($2,500 on 100 hectares) in net cash flow compared to doing nothing.

Higher gross margin also affects results, but, on its own, it is not expected to make slashing more acceptable than No Control.

It is important to note that variables may change in a negative direction – compared to the positive direction shown in these tables. If this happened, there would be a greater loss from Control than shown here.

Slashing – discounted cash flow analysis

Here we further investigate slashing of fertilised native pasture to account for the change over time in stocking rate and the higher slashing costs in the first year when ALG is dense.

Slashing unfertilised native pasture is not examined in this section, as previous results strongly suggest it is not economic in any likely circumstances.

Discounted cash flow analysis is required in order to account for the change over time.

We assume slashing is conducted annually. The effect of doing it every 18 months is later tested.

Stocking rate also increases year by year, with increases expected until year 4, after which it remains steady, as shown below:

Year	1	2	3	4+
Stocking Rate	2	3	5	6

Capital costs are $20,000, spread out over years two and three, for fencing and water points. This is to assist in getting greater livestock densities to help prevent the ALG from becoming rank. In some circumstances fencing and water infrastructure may already be sufficient to enable farmers to maintain high livestock densities at critical times, in which case these additional costs can be avoided.

Applying fertiliser is likely to be necessary to favour more palatable species within the ALG sward and also to increase the palatability of the ALG. Here we assume fertiliser costs $10 per hectare each year.

Other assumptions including costs associated with slashing are shown in the Assumptions section of the report.

In Table 20, we compare results from Doing Nothing to slashing in two situations – a) starting after a heavy infestation, and b) before that infestation affects stocking rate. The farmer is assumed to have invested $20,000 over two years in fencing and water points, but nothing in equipment as a contractor is assumed to be undertaking the work.

Table 20. Expected economic benefit of slashing ALG on 100 hectares using a contractor - 10 year investment period - Gross margin = $25

	Do nothing	Start after heavy infestation	Start before heavy infestation
	$	$	$
Annuity @ 5%	$7,500	-$547	$675
NPV @ 5%	$57,913	-$4,220	$5,208
NPV @10%	$46,084	-$12,696	-$3,696

Key assumptions

- Cost of engaging a contractor for slashing is $191/ha for paddocks with rank stands, and $92/ha when stands are relatively short.
- Cost of paddock sub-division and water points is $20,000, spread over two years, which is seen as necessary for grazing management to keep the ALG short.
- Fertiliser costs $45/ha and is applied every third year (we treat this as $15/ha per year) at 100kg/ha at $400/tonne delivered with $5.50/ha spreading cost.
- Fuel cost after rebate is $1.30
- Repairs and maintenance cost per operating hour is estimated at $3/hour for a 2.4 metre slasher

On the given assumptions, slashing is not found to be a profitable strategy. The annuity from doing nothing is $75 per hectare (or $7,500 on 100 hectares). This falls to $6.75 per hectare if slashing is started early so higher first year costs are avoided, and to -$5.47 per hectare if the ALG has become rank, tall and dense .

We now test the assumptions to see what changes, if any, reverse these results. Table 21 and Figure 10 show the results for varying some key assumptions.

Taken on their own, many of the results are now positive, and are even producing a rate of return (IRR) that is well over 10 %.

Table 21. Expected economic benefit of slashing ALG on 100 hectares using a contractor - 10 year investment period - – varying key assumptions.

	Initial assumptions	Gross margin		Frequency	Control cost changes		Stocking rate		Fertiliser Cost	
		$20	$30	Every 18 months	$70 from year 2	$80 from year 2	Gets to 7 in yr4	Gets to 8 in yr4	none	$20/ha
Annuity @ 5%	-547	-3,188	2,095	2,927	1,382	505	884	2,315	453	-1,547
NPV @ 5%	-4,220	-24,618	16,177	22,603	10,672	3,903	6,826	17,872	3,501	-11,942
NPV @ 10%	-12,696	-28,564	3,172	9,148	-1,178	-6,413	-5,617	1,461	-6,551	-18,840
Internal rate of return	3%	-5%	12%	16%	9%	7%	7%	11%	6%	0%

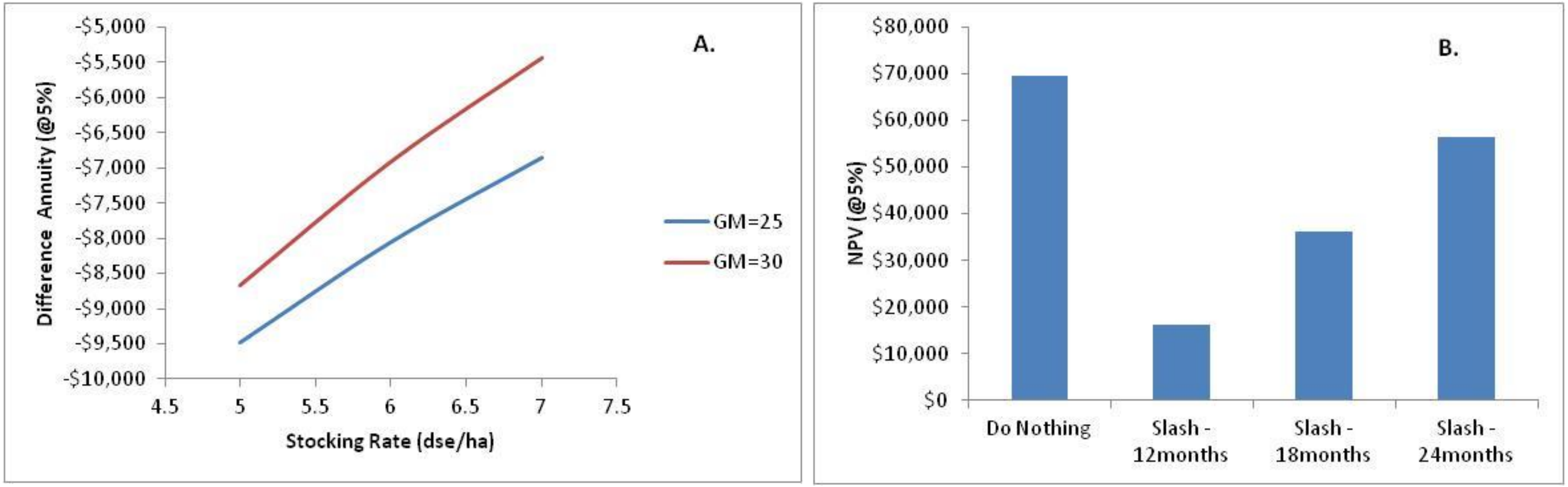

Figure 10. (A) The effect of varying gross margin and potential maximum stocking rate on the difference in annuity between utilisation and doing nothing and (B) the effect of varying slashing frequency on 10 year NPV (@5%) compared to doing nothing at a gross margin of $30.

Another alternative is to use fire to bring about the initial short and more palatable ALG, avoiding the initial higher costs of slashing in the first year. If slashing was subsequently every 18 months, and assuming the fire in year 1 had no associated costs, we estimate the annuity to be $38 per hectare (with a gross margin of $25 and a maximum stocking rate of 6 DSE per hectare).

Adopting slashing is but part of an intensive management strategy for dense lovegrass. When adopted in conjunction with intensive grazing management, in some cases slashing frequency could be lowered to an average of every 18-24 months. Some local producer experience also suggests that when intensively grazed ALG is capable of a carrying capacity of 7 or more DSE per hectare. Under this scenario the profitability of Slashing would be higher and would certainly be expected to exceed that of doing nothing (see Figure 11), especially if the rank lovegrass under a do nothing scenario led to carrying capacities of 2 DSE per hectare or less (see Table 22 below).

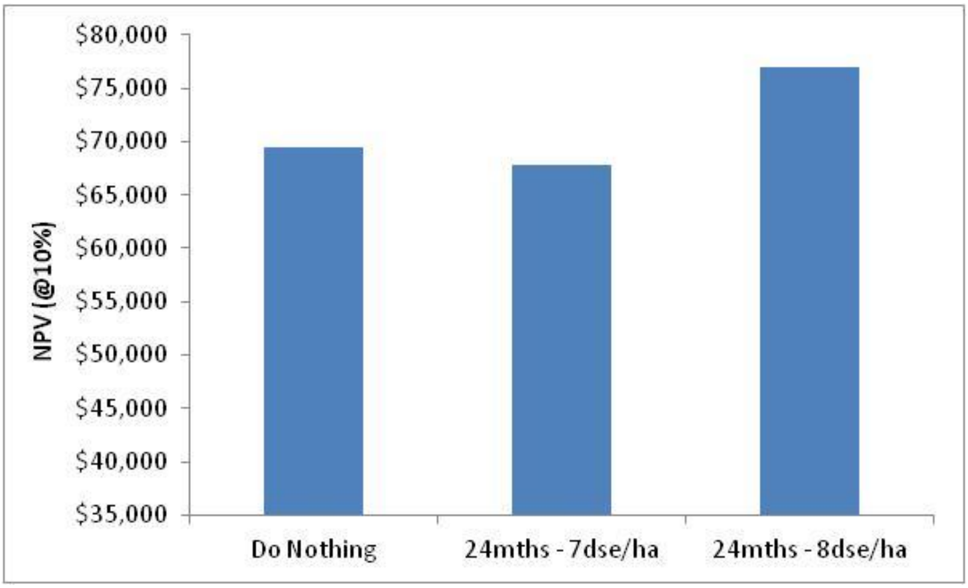

Figure 11. If slashing can be reduced to every 24months and stocking rates raised to over 7 dse per hectare then utilisation can be more profitable than doing nothing. NPV over 10yrs at 5%, gross margin of $30. All other assumptions are the same as the base case.

In some cases ALG can become very thick and rank and our assumptions about the potential stocking rate under the do nothing scenario are potentially overly optimistic. What if the Do Nothing has a lower stocking rate – say only 2 DSE per hectare instead of 3 DSE per hectare? Does this make any difference to the results? Table 22 shows clearly that it does.

Table 22. Expected economic benefit of Doing Nothing on 100 hectares - 10 year investment period - – varying stocking rate under Do Nothing scenario at a gross margin of $25

	Initial assumptions (3 dse/ha) $	1.5dse $	2 dse $	2.5 dse $
Annuity over 10 years @ 5%	$7,500	$3,750	$5,000	$6,250
NPV @ 5%	$57,913	$28,957	$38,609	$48,261
NPV @ 10%	$46,084	$23,042	$30,723	$38,404

We can combine both different starting stocking rates (ie. the stocking rate possible in rank lovegrass with no management) and potential maximum stocking rates to provide some indication of the range of situations when utilisation may be more profitable than doing nothing. In Figure 12 we show how the difference in annuity between doing nothing and utilisation varies based on different stocking rate assumptions. When the do nothing and starting stocking rate are 1 DSE/ha we estimate that if landholders can lift stocking rates above 6 DSE/ha then annuities (@5%) for utilisation will be greater than doing nothing. However, if the starting (do nothing) stocking rates are 3 DSE/ha then utilisation will need to lift stocking rates to 9 DSE/ha or greater.

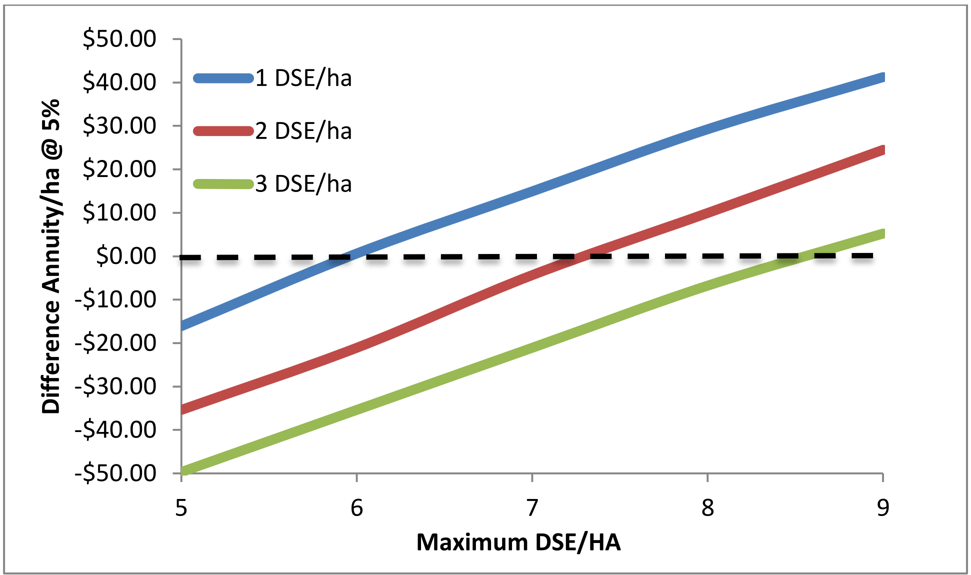

Figure 12. The effect of stocking rate assumptions on the profitability of utilisation. Each line represents a different stocking rate assumption for the do nothing scenario. The maximum DSE/ha is the stocking rate reached after 4-5 years of applying utilisation. Difference in annuities are calculated as utilisation annuity minus do nothing annuity. Positive values indicate that annuities for utilisation are greater than the do nothing case. Gross margin of $25. Other key assumptions are that the frequency of slashing declines from annual to every 18 months by year 3 and to every 24 months by year 7. Estimates exclude capital costs of tractor and slasher and assume a contractor does the slashing.

Avoiding ALG and managing an emerging infestation

There are many areas within the Bega Valley where ALG is present but not yet more than isolated patches or scattered individual plants. In these circumstances control activities focus on preventing further spread and if possible local elimination.

As well as vigilant active control through plant removal (spot spraying, chipping), grazing management is crucial. In particular, grazing planning for short dry periods, that may extend to drought, offers an important way to manage ALG invasion. There are farmers in the Bega Valley who alter stocking in response to feed availability to maintain a minimum competitive pasture density. The keys are to monitor rainfall, availability of feed, and how many days the pasture can carry stock. The strategy involves de-stocking and re-stocking as required – which may suit some farmers, but not others.

Such a strategy as outlined below can be compared to two other alternatives.

Active management with conservative stocking
Stocking at 10% less than other farmers, to maintain a minimum pasture biomass and cover, combined with early destocking in drought to avoid bare ground, and active vigilant control with chipping and spot spraying (0.15-0.2 hrs per hectare per year, depending on current ALG density). Under such actions, there is a low probability of ALG dominance over the medium term.

Roller wipe
Stock normally, and roller wipe every two to three years or vigilant annual spot spraying (more effort required than 1 eg. spot spraying 0.2 – 0.4 hrs per hectare per year). ALG maintained at light infestation, stocking rates maintained, but dependent on maintaining active control.

The analysis of Do Nothing and Roller Wiping in previous sections has provided approximate results for the second and third alternatives.

A steady state analysis can be used to compare Stocking at 10% Less to Roller Wiping. Extra information required about spot spraying costs, and results can be tested for variations in these and in stocking rate. A more thorough analysis requires further information about likely stock prices, selling costs, and frequency of sale.

A discounted cash flow analysis is required to compare Stocking at 10% Less to Do Nothing. This has not yet been undertaken as part of this project.

Table 23 provides a comparison of three strategies for handling drought, and the pros and cons of de-stocking early. It could help frame a further analysis.

Table 23. Comparison of Acting Early and other strategies for managing drought

	Acting early	Acting late – putting pressure on pasture	Acting late – start feeding early
Goal	Maintain pasture mass and cover	Maintain stock numbers	Maintain stock numbers and stock condition
Pasture condition	Maintained	Declines	Declines because sup feed just fills pasture gap, doesn't stop decline
Stock numbers	Matched to carrying capacity of pasture	Over-stock	Supplementary feed to maintain carrying capacity
Feed bought in	None	Could do so	Yes
Timing & trigger	Continuous as pasture availability declines, stock condition less relevant	Stock condition has fallen, getting desperate	Stock condition starts to fall
Restocking	When the drought ends, or when seasonal break comes	When the drought ends	When the drought ends
Probabilities of dry period	Irrelevant, given decision rules	Hoping that weather will break	Hoping that weather will break

Benefits of ALG in drought

ALG has potential to provide feed value in dry and drought conditions. As a result a greater proportion of stock may be held or reduce the need for supplementary feeding i.e. the ***proportional*** impact of drought on stock numbers/carrying capacity is expected to be less. For example for a fertilised native pasture running 6 DSE in a good season the carrying capacity may halve during a dry/drought year. In an ALG invaded pasture running 2-3 DSE/ha, the same drought may result in a lesser impact e.g. reducing stock numbers by only 10-30%. The actual effects are however unknown and would vary depending on management leading up to drought (i.e. typical stocking rate relative to carrying capacity), whether de-stocking started early, severity and length of dry conditions, seasonal timing of dry conditions (with ALG only likely to have benefit in warm season drought).

We have not made an allowance for such effects in this report and further data collection and analyses would be required to estimate this benefit.

Discussion

Method
This project presented several challenges.

The first was obtaining estimates of the effect of ALG on carrying capacity. There is no research showing this impact, so our estimates relied on asking farmers and contacting farm advisors. Likewise for the effects of roller wiping and slashing. They are expected to increase stocking rates if applied to a heavy lovegrass infestation, while roller wiping is expected to maintain stocking rates if Lovegrass density is low. Estimating these effects was challenging as there is no empirical data to support these assumptions. Our estimates instead relied on information provided to us by producers.

The second was obtaining information about the costs of roller wiping and slashing. There are many variations in the equipment used and how it is used. We had to obtain this information from contractors and farmers, and then standardise it.

A third challenge was to identify the base case against which alternatives would be evaluated, and to identify alternatives to include. This was harder than may seem from reviewing this report. Sometimes Do Nothing involved an unchanged stocking rate (for Heavy Infestations) or a decreasing stocking rate (as the extent of infestation grew).

Whole farm context
We began this report by emphasising the whole farm context within which decisions about particular parts of the farm are managed. Paddocks that are infested by ALG are no exception.

Some of the results we have found make more sense when interpreted in this context. In the analysis of options for a paddock of 100 ha of fertilised native pasture infested by ALG, the results suggest that it is less profitable to slash that paddock than to do nothing.

There are clear circumstances in which the farmer may make a rational decision to slash such a paddock. For example, if the paddock is required to feed a particular group of livestock at certain times of the year. There may be a very high marginal value of feed from that paddock at that time, particularly if the need for feed cannot be easily met in other ways or is costly.

Accounting for all costs
The prices charged by contractors are a reasonable approximation of the full cost to a farmer, though of course the contractor will include a profit margin. This is a return to the contractors labour and capital. The cost of farm labour has been included because, with rare exceptions, it has an opportunity cost or some other valuable use on the farm. The cost of equipment has also been included, because it has to be replaced sometime in the future - and most likely sooner if bought second-hand than if bought new.

Roller wiping and slashing as options for controlling ALG
Our results suggest that roller wiping might be a profitable strategy for many producers, but even so results still vary depending on context. In unfertilised native pastures roller wiping is likely to be less profitable than doing nothing, though there are some combinations of assumptions that would make it more profitable.

In contrast slashing is rarely more profitable than doing nothing, but again there might be some combinations of situations that may make slashing a profitable alternative. Slashing will still appeal to a small group of farmers as a way of controlling ALG because of their particular circumstances.

ALG control and the farm business
We now review the questions raised in the Introduction from a farm business perspective:

Is it possible and profitable to manage these pastures in such a way to avoid the invasion of African Love grass, or to minimise its impact?
Yes, as a strategy for keeping ALG in check on fertilised native pastures before it starts to affect productivity, roller wiping is expected to be more profitable than allowing the native pastures to decline over the 10 year period of analysis. This remains true for nearly all the range of the variables we tested – stocking rate and gross margin per hectare being the key ones.

On unfertilised native pastures, roller wiping is expected to be profitable only under limited conditions – for example, when a gross margin per hectare is $25 or higher is combined with stocking rate reaching towards 4 DSE per hectare.

We have not evaluated an avoidance strategy, but suspect that it is also likely to be profitable, even on unfertilised native pasture - particularly when combined with a grazing strategy that is attuned to ground cover.

How can farmers best manage native pastures already or potentially invaded by African Lovegrass if profitability is not necessarily their main goal?
The results of this project show that some investments in roller wiping or slashing native pasture give a positive return, but which are not as profitable as doing nothing to control ALG. If they have other goals relating to the native pasture, it can be rational for them to pursue their preferred control measure instead of doing nothing. The results give an indication of the net income they are likely to forgo by doing so. In some cases, this will be insubstantial – say $5 per hectare, in other cases it could be substantial.
Once AGL has invaded, is it economic to bring it under control or to utilise it?
A heavy infestation increases first year control costs, and several years pass before income from livestock reaches previous levels. However, for fertilised native pasture control through roller wiping is expected to be successful under most of the circumstances that were evaluated.

However, it is not expected to be profitable to control heavy invasions of unfertilised native pasture – but getting in first can be worthwhile as discussed above. Avoiding the invasion in the first place may be profitable, but has not been investigated fully here.

Under limited circumstances, slashing and then utilising the ALG is expected to be profitable on fertilised native pasture that is heavily infested with ALG. Stocking rate, frequency of slashing and cost of control are key factors. Slashing frequency in particular has a large effect and in some circumstances farmers may be able to carefully manage livestock pressure to reduce the frequency of slashing. Where this is possible with existing fence and water infrastructure utilising ALG will be more profitable.

Can native pastures contribute to the success of the farm business, or at least not significantly affect it - both before and after African Lovegrass has invaded?
The results suggest that keeping ALG under control is profitable with fertilised native pasture – it can thus contribute to the farm business. Unfertilised native pasture is expected to contribute much less to the farm business. However, our results suggest that roller wiping these pastures is only a little

less profitable than doing nothing, if it is done early. Secondly, while the unfertilised areas are generally a small proportion of the whole farm, they may provide valuable feed at times when fertilised pastures are less productive eg. during drought.

What are the key factors influencing future profitability of the whole farm where there is a risk of African Loverass taking hold in native pastures, or where it already has established?
Failure to act early stands out as a key factor. Our results show that it pays off. Moreover, control of ALG can consume precious time and resources that could be devoted to other income-earning or leisure activities.

Another key factor is the size of the infested area relative to the whole farm. Control activities can be more easily managed, with the right equipment on a larger farm. There are economies of scale – although no one wants to be controlling weeds on a large scale! Even so, our results do suggest that controlling ALG on small farms will be less profitable, especially if the farmer purchases the necessary equipment – in these cases using a contractor is likely to be the best option. On larger farms, investing in a roller wiper for instance is likely to be viable, while for smaller infestations using a contractor may be a more cost-effective strategy.

If the economics of maintaining the native component of pastures is negative, will farmers who maintain at least some areas of native pasture (say 25 to 100 ha) be financially worse off and if by how much?
If 100 hectares of unfertilised native pasture is infested with ALG, the farmer will be worse off on average each year by the difference in two net cash flows –doing nothing *less* the control action. This is captured in the annuities. Our results from Table 14 show that, using a contractor and at a gross margin of $25, the expected figures are $6,513 and $6,180 respectively. The difference is $333, or $3.33 per hectare.

On fertilised native pasture, the result is expected to be much more favourable, as shown in Table 12.

Is there much variation between farms, whether by enterprise or size, and by whether the native pasture is fertilised or not?
The profitability of control is unlikely to change much between different enterprises. The size of a farm will influence how significant the infested area is to the overall operation. Controlling ALG on a dairy farm that is intensively run and has a large turnover will be much more easily absorbed in the whole farm operation than on a smaller cattle or sheep farm.

Our results demonstrate that the private benefits of controlling ALG is substantially greater in fertilised native pastures and likely to be even greater in sown pastures. This is likely to play out on an individual farm with more productive land prioritised for control.

Recommendations for further research

Further work that could be undertaken includes:
- Investigate alternatives to avoid or prevent an early infestation
- Spot spraying as an alternative in its own right

Relatively small effort would be required to:
- Produce case studies showing the income required to break-even
- Produce a case study showing the value of extra land required to run the stock that can no longer be run on the farm because of ALG

Results from this project can serve as a guide as to which ecological and agronomic research would be most useful to conduct. The starting point might be to ask what new information could be obtained that might change the relative profitability of the different strategies? A better understanding of the rates at which ALG invades, changes in carrying capacity for different levels of ALG infestation and the respective change in carrying capacity obtained through ALG control would be among those key areas worthy of better information.

References

Firn, J., 2009. African lovegrass in Australia: a valuable pasture species or embarrassing invader? *Tropical Grasslands*, 43(2), p.86.

Kidston, J.M., Ferguson, N.J. & Scott, M.C. (2010) Weed control in pastures and lucerne 2010. Industry & Investment NSW. Available online.

Malcolm, B., Makeham, J. and Wright, V. (2005) The farming game : agricultural management and marketing. 2nd Edition. Cambridge, U.K. ; New York : Cambridge University Press. Available online.

Simpson, R.J., Graham, P., Davies, L. and Zurcher, E. (2009). 5 Easy Steps to ensure you are making money from Superphosphate. CSIRO and Industry and Investment NSW. (available online)

NSW DPI (2005) Using DSEs and carrying capacities to compare beef enterprises. Available online.
http://www.dpi.nsw.gov.au/agriculture/farm-business/budgets/livestock/beef/info/dse
see esp. Table 1. Comparative feed requirements of livestock and Table 2. Estimated carrying capacities for pasture types in NSW

Appendices

Appendix 1: The method in detail

Development of research propositions

Two propositions were developed to help guide the study – in particular selection of the case study farms.

Proposition 1 - The best strategy will vary depending on density of ALG.

Proposition 2- Catching ALG early makes a big difference to long-term outcomes – from scattered ALG to low density to high density.

Criteria for selecting case farms

Drawing on the research propositions:

- Low density ALG is represented on at least three farms
- High density ALG is represented on at least three farms

Across all farms, the key ALG control strategies were being used.

We also aimed to include a minimum two dairy farmers, two beef producers, and two sheep/goat producers.

Each farm had to also meet the following criteria:

- The farm is accessible
- The farm has African Lovegrass
- Commercially orientated and runs a relevant enterprise
- Willingness to participate, able to provide relevant information and for confidentialised information being included in this report

Representative areas for evaluating the economics of each control strategy

The selected farms varied enormously in family goals, size, enterprise mix and approach to Lovegrass management. It was necessary that the economic analysis of Lovegrass control portray a much simpler version of reality.

The analysis was conducted by collecting information from all farms, identifying standard elements and then applying three Lovegrass control strategies to a 'representative block' of 100 hectares on three farm types – dairying, beef breeders, and merinos with cross bred lambs.

Results were tested for both low density ALG and high density ALG.

Do nothing	No ALG
	Low density ALG

	High density ALG
Roller wiping	No ALG
	Low density ALG
	High density ALG
Slashing (utilisation)	No ALG
	Low density ALG
	High density ALG

The budgets

A series of budgets have been prepared to support this analysis.

One set of budgets were prepared to identify the cost of each control strategy. These take account of materials used, capital equipment cost, labour, repairs & maintenance. We assume that

Development budgets were then prepared for each strategy. These show costs and returns over 10 years. It was necessary to use such budgets because of the changes over time in stocking rate and in control measures that are undertaken. Results can then be compared across the strategies using annuities, net present value, and where relevant, internal rate of return.

All of these measures 'add up' the net result each year, but adjust it for current interest rates – just like having an bank account that can go into overdraft. Early years might be negative because of capital expenditure, and later years are positive if stocking rates increase and frequency of control reduces.

We use a 5 % interest rate, which would be 8 % after inflation of 3 % per year.

Annuities show the amount that is earned on average each year – the annuity could be also be a loss. *Net present value* shows the lump sum value in current day dollars. *Internal rate of return* is the return on the capital invested.

Snapshots into the future using partial budgets also help to explain the results –they have to be interpreted with care because the returns and costs of each strategy are not constant over time.

A whole farm budget is also presented to show the effect at the whole farm level of reduced income due to heavy ALG infestation.

Sources of information and assumptions

All budgets draw on technical and cost data from contractors, farmers and other sources. Sources of data and technical issues are explained in the relevant section of the report.

Assumptions are outlined in the relevant section of Results.

Appendix 2: Contractor charges – roller wiping and slashing

Range of contractor charges – roller wiping at average speed of 7kms/hour

Contractor	Width	Charge – before GST	Estimated area covered per hour	Estimated charge per hectare	Comment
	Metres	$/hour	Ha/hour	$/ha	
Normal conditions – 7kms/hour					
1	3.2	88	1.96	43.35	Single roller
2	3.0	81	2.1	38.88	Single roller
2	3.0	100	2.1	48.00	Price is for difficult conditions.
3	2.8	85	2.24	39.60	Uses wick wiper with ute
4	6.0	75	4.2	18.00	Width is 6m (3m plus two 1.5m wings) – based in north NSW
Heavy conditions – 4kms/hour					
1	3.2	88	1.12	75.65	Single roller
2	3.0	81	1.2	67.23	Single roller
2	3.0	100	1.2	83	Price is for difficult conditions.
3	2.8	85	1.28	68.64	Wick wiper with ute
4	6.0	75	2.4	31.5	6m total (3m plus two 1.5m wings) – based in north NSW

Contractor charges - slashing at an average speed of 5 kms/hour

Contractor	Width (metres)	Charge/hour – before GST	Estimated area (hectares) covered per hour	Estimated charge/hectare	Comment
Normal conditions					
1	2.1	$85	0.52	$163	7 foot, 100hp tractor. Extra $60 for travel if under 4 hour job
2	2.1	$90	0.52	$173	7 foot slasher, 85hp tractor
3	2.1	$99	0.52	$190	7 foot, 75hp tractor – up to 70 acres
3	2.4	$110	0.6	$183	8 foot, 100hp tractor – over 70 acres
4	3.0	$105	0.75	$140	
5	3.6	$144	0.85	$169	12 foot slasher, 130hp tractor
Heavy conditions					
4	3.0	$130	0.75	$173	
5	1.5	$126	0.38	$332	1.5m slasher, 130hp tractor

Appendix 3: Roller Wiping - example of calculating costs (per hectare)

		Farm 1		Farm 2		Farm 3	
Infestation - heavy, medium, light		light		light		light	
TIME TAKEN							
Speed of vehicle km/hr							
Heavy infestation		4		4		4	
Medium infestation		6		6		6	
Light infestation		8		8		8	
Selected speed	derived	8		8		8	
Width of unit/m		3		3		3	
Area covered/hr going one way		2.4		2.4		2.4	
Single or double roller		Double		Single		Single	
One or two passes		1		1		2	
Area covered/hr	derived	2.4		2.4		1.2	
Hours/ha	derived	0.42		0.42		0.83	
Hours usually worked/day		6		6		6	
Hectares/day	derived	14.40		14.40		7.20	
			Cost/ hectare		**Cost/ hectare**		**Cost/ hectare**
DIRECT COSTS							
Spray							
Spray used		Glyphosat e 450 g/L		Glyphosat e 450 g/L		Glyphosate 450 g/L	
Quantities per drum (litres)							
Glyphosphate		**5**		5		3	
Wetter		**0.3**		0.3		0.3	
Broadcoat spray oil						1	
Water		**20**		20		20	
Prices (per litre)							
Glyphosphate		7.5		7.5		7.5	
Wetter		1.8		1.8		1.8	
Broadcoat spray oil						4.5	
Cost (per mixed drum)							
Glyphosphate	derived	37.5		37.5		22.5	
Wetter	derived	0.54		0.54		0.54	
Broadcoat spray oil	derived	0		0		4.5	
Total cost	derived	**$38.04**		**$38.04**		**$27.54**	

		Farm 1		Farm 2		Farm 3	
Number of mixed drums (25l)/day							
Heavy infestation		**5**		**5**		**5**	
Medium infestation		**3**		**3**		**3**	
Light infestation		**2**		**2**		**2**	
Total SPRAY cost per day		**$76.08**		**$76.08**		**$55.08**	
Hectares per day	derived	**14.40**		**14.40**		**7.20**	
Spray cost per hectare			**$5.28**		**$5.28**		**$7.65**
Equipment							
Method - quad bike or tractor		Light tractor		Quad bike		Kawasaki Side-by-side	
Fuel							
Time taken (hrs)	from above	0.42		0.42		0.83	
Fuel/hour - litres	derived	3.33		1.2		1.2	
Fuel cost/litre		1.3		1.3		1.3	
Fuel cost/hour	derived	$4.33		$1.56		$1.56	
Fuel cost/ha			**$1.81**		**$0.65**		**$1.30**
R&M - roller & vehicle							
Time taken (hrs)	from above	0.42		0.42		0.83	
R&M/hour - roller wiper		$1.00		$0.50		$0.50	
R&M/hour - vehicle		$6.00		$2.00		$2.00	
			$2.92		**$1.04**		**$2.08**
Hired labour							
Yes or no		yes		no		no	
Time taken (hrs)	from above	0.42		0.00		0.00	
Labour cost/hr		$19.25		$19.25		$19.25	
Superannuation @ 9.25%		$1.92		$1.92		$1.92	
Workers Comp @ 12%		$2.31		$2.31		$2.31	
Labour cost/ha	derived		**$9.78**		**$0.00**		**$0.00**
Total direct cost/ha			**$19.79**		**$6.98**		**$11.03**
INDIRECT COSTS							
Family labour							
Yes or no		no		yes		yes	
Time taken (hrs)	from above	0.00		0.42		0.83	
Labour cost/hr		$19.95		$19.95		$19.95	

		Farm 1		Farm 2		Farm 3	
Labour cost/ha			**$0.00**		**$8.31**		**$16.63**
Cost of roller wiper							
Purchase price		$8,000		$5,000		$800	
Expected life at purchase		12		12		8	
Interest rate		5%		5%		5%	
Annualised cost	derived	$903		$564		$124	
Cost per 100 hectares		*$9.03*		*$5.64*		*$1.24*	
Area sprayed as % study area		100%		100%		100%	
… per hectare actually sprayed			**$9.03**		**$5.64**		**$1.24**
Cost of tractor/quad/side-by-side							
Purchase price		$31,000		$10,000		$18,000	
% life used in roller wiping		100%		20%		40%	
Expected life at purchase (years)		20		15		15	
Interest rate		5%		5%		5%	
Annualised cost	derived	$2,488		$193		$694	
Cost per 100 hectares		$24.88		$1.93		$6.94	
Area sprayed as % study area		100%		100%		100%	
… per hectare actually sprayed			**$24.88**		**$1.93**		**$6.94**
Total, incl. family labour & capital cost							
… per hectare			**$53.69**		**$22.86**		**$35.83**
Breakdown … per hectare							
Spray cost			$5.28		$5.28		$7.65
Fuel cost			$1.81		$0.65		$1.30
R&M			$2.92		$1.04		$2.08
Hired labour			$9.78		$0.00		$0.00
Sub-total			**$19.79**		**$6.98**		**$11.03**
Family labour cost/ha			$0.00		$8.31		$16.63
Capital cost - roller wiper/ha			$9.03		$5.64		$1.24
Capital cost - vehicle/ha			$24.88		$1.93		$6.94
Sub-total			**$33.90**		**$15.88**		**$24.80**
TOTAL			**$53.69**		**$22.86**		**$35.83**

Notes:

- How wiping is done varies. Some use a double roller, going one way. Others use a single roller, either doing one pass or going over the paddock twice. This influences area covered per hour.
- All farmers have roughly the same working day as each other, and use roughly the same number of drums of spray per day. One farmer uses significantly less glyphosphate.
- The vehicle pulling the roller is different in each case – which influences fuel use, R&M and annualised capital cost. Two farmers obtained their roller cheaply on the second-hand market. This is allowed for by reducing the expected life of the equipment – having a similar effect as if replacement cost was used.
- One farmer uses hired labour, and the other two rely on family labour.

Appendix 4: Example of a 10 YEAR DEVELOPMENT BUDGET for Roller Wiping - fertilised native pasture – using a contractor

Year	1	2	3	4	5	6	7	8	9	10
Area (ha) under study	100									
Salvage value as % of initial value	20%									
Area of ALG controlled per year	100	100	33	33	33	33	33	33	33	33
Cost of ALG control/ha	70	70	40	40	40	40	40	40	40	40
Fertiliser & spreading $/ha	-	-	-	-	-	-	-	-	-	-
Stocking rate (dse/ha)	**3**	**3**	**4**	**5**	**6**	**6**	**6**	**6**	**6**	**6**
Gross margin/DSE	25	25	25	25	25	25	25	25	25	25
Cash Inflow										
Income from stock	7,500	7,500	10,000	12,500	15,000	15,000	15,000	15,000	15,000	15,000
Salvage value of livestock										20,833
Total cash inflow	7,500	7,500	10,000	12,500	15,000	15,000	15,000	15,000	15,000	35,833
Cash outflow										
Capital costs										
Roller wiper/slasher	-									
Livestock	-	-	6,944	6,944	6,944	-	-	-	-	-
Variable costs										
Total cost ALG control	7,000	7,000	1,320	1,320	1,320	1,320	1,320	1,320	1,320	1,320
Fertiliser & spreading	-	-	-	-	-	-	-	-	-	-
Total costs	7,000	7,000	8,264	8,264	8,264	1,320	1,320	1,320	1,320	1,320
Net Cash Flow before tax	500	500	1,736	4,236	6,736	13,680	13,680	13,680	13,680	34,513

		RESULTS	**TESTING**	**Stocking rate**				**Gross margin**	
			CHANGES	**Down 0.5**	**Down 1**	**Up 0.5**	**Up 1**	**$18**	**$30**
Net Present Value @	**5%**	$70,387		$60,735	$51,083	$80,039	$89,691	$51,286	$89,488
	10%	$49,479		$41,798	$34,117	$57,159	$64,840	$34,741	$64,216
Annuity over 10 years	**5%**	$9,115		$7,865	$6,615	$10,365	$11,615	$6,642	$11,589