



# **Economic Impact of Lantana on the Australian Grazing Industry**

**FINAL REPORT**

**Department of Natural  
Resources & Water**

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# Executive Summary

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## Background and Objectives

Lantana is a significant weed of both agricultural and natural habitats. It is believed to have been introduced in various locations in Australia in the early 1840s and quickly spread beyond domestic cultivation to become established in the wild. Lantana was first declared noxious around 1920, and by the 1950s had spread over more than 1,600 kilometres of Australia's east coast (NSW Government, 2005a and 2005b).

The objective of this report is to gather and assess quantifiable data on the impacts and issues associated with lantana and its subsequent control throughout Australia, specifically in Queensland and New South Wales. The information will be used by Natural Resources and Water (NRW) and the National Lantana Management Group to assess the costs and benefits of lantana on production, natural areas and other public areas.

## Approach and Process

A literature review was undertaken to identify the key areas required to be targeted for information gathering. A targeted survey was then undertaken to identify and quantify the on-farm impacts of lantana to the grazing sector, as well as the qualitative impacts associated with its presence.

The key data identified through the analysis included:

- Current area of infestation and rate of expansion;
- Cost of control by density of infestation;
- Other economic impacts:
  - Stock poisoning;
  - Increased mustering costs;
  - Reduced carrying capacity;
  - Increased maintenance expenditure; and
  - Land value.

## Key Data Inputs

It is estimated that there are approximately 2.2 million hectares of grazing land in Australia where some presence of lantana is currently recorded (based on grid mapping, approximately 1.7 million in Queensland and 0.5 million hectares in NSW). Based on CLIMEX modelling, lantana has the potential to invade up to 34.5 million hectares of grazing land (29.7 million in Queensland and 4.8 million hectares in NSW). Further, there is potential for lantana to increase the density of coverage within already affected areas.

Landholders on average incur a total cost of \$42.78/ha per year<sup>1</sup> where lantana is present. The total cost consists of:

- \$6.40/ha in stock poisoning;
- \$5.50/ha in increased mustering costs;
- \$19.55/ha in reduced carrying capacity; and
- \$11.33/ha in increased maintenance expenditure.

Where control initiatives are undertaken, landholders spend approximately:

- \$44.00 in the treatment area in **light** infestations; and
- \$3.70 over the total area of infested land for light infestations.
  
- \$62.60 in the treatment area in **medium** infestations; and
- \$8.00 over the total area of infested land for medium infestations.

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<sup>1</sup> All data from the survey is on a per hectare per annum basis, unless otherwise specified.

- \$75.10 in the treatment area in **heavy** infestations; and
- \$10.80 over the total area of infested land for heavy infestations.

## Findings

### Cost Impact

The presence of lantana in Australia costs the Australian grazing sector approximately \$104.3 million (2005/06) per annum in terms of lost productivity, and increased management expenses. This is comprised of approximately \$70.8 million in Queensland and \$33.4 million in NSW.

The majority of landholders generally consider the other economic impacts of lantana to be insignificant. However, where occurring and quantified, they equate to significant impacts in lost production and increased maintenance costs. This implies that landholders may be underestimating the magnitude of the impact that lantana has on their land.

Land value is affected once lantana is present regardless of the level and extent of the infestation. There is little variation between the average reduction in land value for the total property area (\$8.54/ha) and the infested areas (\$12.95/ha).

### Control Cost

There is a wide range of landholder expenditure (virtually \$0/ha to greater than \$100/ha) on different control techniques across varying densities of infestation and terrain types. Expenditure on current control initiatives by landholders is estimated to be in the order of \$17.1 million per year (2005/06).

Control techniques employed by landholders appear to reduce the area of medium and light infestations. However, in areas of heavy infestation, control techniques are generally only expected to slow the rate of expansion rather than reduce the area infested. Individual cases of successful control in areas of heavy infestation have been reported.

In some cases it may be highly beneficial to clear lantana for agricultural use. However, on average, there is no financial incentive for landholders to control lantana on their land, because, on average, the benefits from control do not outweigh the cost of control. This is highlighted by the indicative calculation in the following table for the control of a hectare of medium infestation.

**Table E.1. Calculation of Indicative Benefits of Controlling Lantana (Medium Infestation)**

Description	Data
Cost of Lantana (\$/ha) (A)	-\$42.78
Control Cost (\$/ha) (Medium Infestation) (B)	\$62.60
Benefits of Controlling Lantana (\$/ha) (C)	\$42.78
Net Benefit From Control (\$/ha) (D = C – B)	-\$19.82

Note: The benefit of control (C) is equal to the removal of the cost impact of lantana (A).

It is expected that continuing with existing control initiatives will yield a negative net present value (NPV) over 30 years of approximately \$219.7 million. However, whilst on average there is no financial incentive to control lantana, landholders still manage and control lantana infestations in strategic locations. Where landholders are able to successfully control lantana infestations in the lower end of the control cost profile (reported in Section 3.4.3) this would likely lead to production benefits from controlling lantana in both the short and long term.

Aside from production benefits, landholders also control lantana for other intangible benefits, such as preventing environmental degradation, ease of management and property access and to preserve the future productive capacity of their land.

Where the continuation of the biological control program for lantana resulted in the release of successful control agents, it is expected this would result in significant production and non-production based benefits. To examine and test this, a hypothetical example was developed for production impacts. The hypothetical example examined a biological control research program undertaken for a period of approximately 10 years (costing approximately \$300,000 per year<sup>2</sup>) with a five year establishment program that resulted in the successful release of agents that achieved approximately 50% effectiveness (that is, reducing the impact of lantana by 50% at the end of year 15). This scenario was identified to be highly desirable, with the potential to return over \$90 for every dollar invested<sup>3</sup>.

## Economic Impact

The presence of lantana decreases the productivity (or output) of the Australian grazing sector through impacts such as stock poisoning/ health and reduced carrying capacity. This subsequently reduces the contribution of the Australian grazing sector to the Australian economy through direct and flow-on (turnover of goods and services utilised in the agricultural production process) impacts. This loss in productivity is partially offset by investments made by landholders in the control of lantana, which also contributes to economic activity.

The value of lost production from the Australian grazing sector resulting from the presence of lantana is expected to be approximately \$46.2 million annually<sup>4</sup>. This has a total negative impact, direct and flow-on, to the Australian economy of approximately:

- \$82.8 million in gross output;
- \$42.0 million in value added or GDP;
- \$16.1 million in wages and salaries paid; and
- 744 full time equivalent employment positions.

## Social and Environmental Impacts

An assessment of existing literature on lantana suggests various social and environmental impacts, for which there was little quantifiable data available.

In this study landholders perceived that the negative impacts of lantana outweigh the positive impacts. The most significant negative social and environmental impacts identified by landholders are outlined in the following table.

**Table E.2. Qualitative Negative Impacts of Lantana**

Impact	Weighted Average <sup>(a)</sup>
Removes and/or replaces native vegetation	3.6
Reduces the conservation value of your land	3.5
Reduced scenic amenity of your land	3.4
Restriction in the movements of animals/humans	3.4
Harbours feral animals	3.4
Increases management stress	3.3
Restricts property access	3.3
Increases the risk of fire	3.0
Displaces native animals	2.9
Impacts negatively on tourism	2.7

Note: Weighted average across a 0-5 rating scale, with a maximum score of 5.

The following positive impacts were also recorded, however, their average scores indicate they are considered relatively insignificant.

<sup>2</sup> Estimated annual cost of two full time researchers and associated on costs.

<sup>3</sup> Assumes a 10-year research program (at \$300,000/ year), 5-year establishment program (at \$50,000/ year) and 50% agent efficacy.

<sup>4</sup> Net of expenditure on control initiatives

**Table E.3. Qualitative Positive Impacts of Lantana**

Impact	Weighted Average <sup>(a)</sup>
Stabilising soil and preventing erosion	2.5
Aesthetically pleasing	2.3
Improved soil for pasture renovation	2.1

Note: Weighted average across a 0-5 rating scale, with a maximum score of 5.

Whilst the environmental or social impacts of lantana were rated qualitatively, no data was identified to accurately quantify these impacts. A study conducted by AECgroup (2003) examined the value and impact of environmental weeds in Queensland within areas of high conservation value, such as national parks. The study identified an average environmental impact value of \$72.5 million per annum (2003 values) in Queensland. The study identified using contingent valuation (dichotomous choice) by asking households their willingness to pay to protect areas of high conservation significance in Queensland from lantana, which was identified to be approximately \$55/household per year.

## Limitations of the study

The nature and extent of the impacts of lantana in this study were based on available information gathered from the survey and from the review of existing literature. The outcomes could be improved if the following information were also available:

- Reduced size of grid squares: Smaller grid squares utilised in CLIMEX modelling would lead to increased levels of detail and accuracy. Proxies were developed to more accurately estimate the actual areas of infestation in the analysis;
- Improved assumptions surrounding the base assumptions in the CLIMEX modelling: Anecdotal evidence suggests that perhaps some of these should be amended (for example: maximum altitude, temperature assessments);
- Validation of CLIMEX modelling: Where the current area of infestation exceeded the future maximum predicted by CLIMEX modelling the current area was used and assumed to be at maximum distribution;
- Land use by area: Paucity of data relating to the area of land classed as grazing use that is actually productive land verses natural habitat or bushland;
- Rate of expansion of existing infestations by density of infestation: Would assist in the development of detailed growth models examining infestation rates;
- Rate of expansion into new areas and establishment process: Would assist in the development of detailed growth models examining infestation rates; and
- Quantified environmental and social impacts: Would assist in understanding the less tangible impacts associated with lantana in non-production areas.

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# 1. Introduction

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## 1.1 Purpose of Study

The AEC Group Limited (AECgroup) was commissioned by Queensland Department of Natural Resources and Water (NRW) and the National Lantana Management Group to undertake an assessment of the economic impact of *Lantana camara* (lantana) to the Australian grazing sector to provide information for policy development and funding decisions and to identify its social and environmental impacts.

The purpose of the report is to gather and assess quantifiable data on the impacts and issues associated with lantana and its subsequent control throughout Australia, specifically in Queensland and New South Wales. The information will be used by NRW and the National Lantana Management Group to assess the costs and benefits of lantana on production, natural areas and other public areas.

## 1.2 Scope and Objectives

The report aims to:

- Assess the costs and benefits of lantana on the Australian grazing industry.
- Where there is no data, collect new information through landholder and stakeholder surveys with sufficient sample size and then provide statistically significant results.
- Develop scenarios based on available information such as production impacts, control and research costs and maps of lantana distribution.
- Develop a model, which will evaluate current and potential impacts of lantana over a specified period.

## 1.3 Approach and Methodology

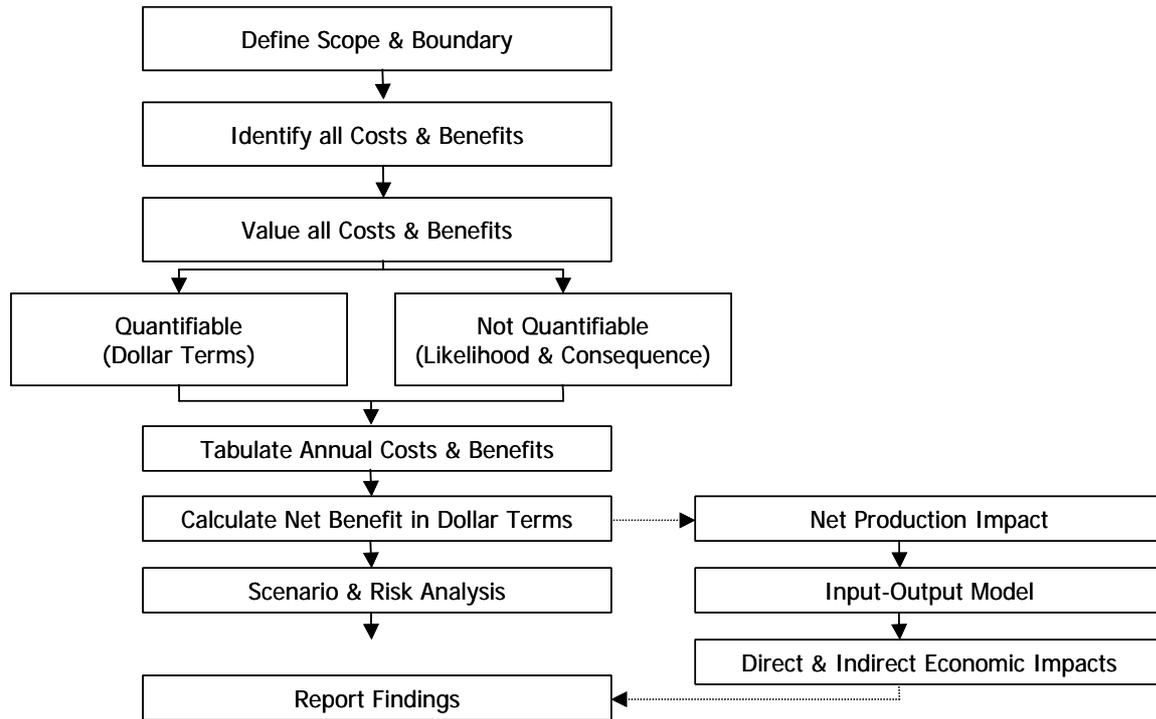
The project reviewed available literature and information to identify the key target areas for information gathering. A targeted survey was then undertaken to identify and quantify the on-farm impacts of lantana to the grazing sector, as well as determine the qualitative social and environmental impacts associated with its presence.

This information was then examined in a cost benefit analysis (CBA) framework to identify the current cost and benefits associated with control initiatives currently being undertaken. An overview of the CBA methodology is outlined in detail in **Appendix A**.

The economic impact of lantana to the Australian economy was quantified using an Input-Output (IO) framework. An overview of the IO methodology, key terms and limitations is included in **Appendix B**.

An outline of the two models, and how they interact, is provided in the following figure, with the IO model component identified by the three boxes connected to the rest of the model by dotted lines.

Figure 1.1. Evaluation Framework



Source: AECgroup

## 1.4 Document Structure

This document examines the existing literature regarding lantana and its impacts and management requirements. Specific impacts by stakeholder group are identified along with the key findings of the landholder survey that assessed the current and potential impact of lantana. These impacts are then combined with existing and future potential distribution patterns to identify the current cost of lantana to the Australian grazing sector as well as the economic impact of these production impacts within the Australian economy.

## 1.5 Acknowledgements

The authors extend special thanks to the members of the steering committee, Tessie Tumaneng-Diete, Andrew Clark and Chris Curteis, for their contribution to the development of the report, Terrence Chen and the PestInfo network for the provision of distribution mapping data, and John Hodgson and Andrew Leys for the review and distribution of the survey instrument.

## 1.6 Disclaimer

Whilst all care and diligence have been exercised in the preparation of this report, the AEC Group Limited does not warrant the accuracy of the information contained within and accepts no liability for any loss or damage that may be suffered as a result of reliance on this information, whether or not there has been any error, omission or negligence on the part of the AEC Group Limited or their employees. Any forecasts or projections used in the analysis can be affected by a number of unforeseen variables, and as such no warranty is given that a particular set of results will in fact be achieved.

## 2. Literature Review

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With lantana considered as a significant weed in over 60 countries worldwide, several research studies have been conducted regarding the effects, distribution and control of lantana both domestically and internationally. This section provides a review of some of the key issues identified in relation to the evaluation of the economic impact of lantana in Australia.

### 2.1 Lantana Background and Overview

#### 2.1.1 Overview of Lantana

*Lantana camara* (lantana) originates from tropical and subtropical America and is now a major weed in over 60 countries. Lantana is recognised as one of the ten worst weeds worldwide. It is a brittle, multi-branched, thicket-forming shrub, normally 2-4 metres tall but capable of scrambling over other vegetation to 15 metres high. It is an aggregate species derived from natural and horticultural hybridisation, and has the ability to cross-pollinate with other weedy and ornamental varieties to form new, more resilient strains (CRC for Australian Weed Management, 2003).

Lantana is believed to have been introduced in various locations in Australia in the early 1800s and quickly spread beyond domestic cultivation to become established in the wild. Lantana was first declared noxious around 1920, and by the 1950s had spread over more than 1,600 kilometres of Australia's east coast (NSW Government, 2005a and 2005b).

#### 2.1.2 Pest Status

Lantana is recognised as a Weed of National Significance (WoNS) due to its invasiveness, potential distribution range and impacts on primary industries, conservation and biodiversity.

In Queensland, all lantana species are declared Class 3 pest plants under the *Land Protection (Pest and Stock Route Management) Act 2002*. Class 3 pest plants are defined as weeds established in Queensland that have or could have adverse economic, environmental or social impacts. Under the Act it is an offence to introduce, release, sell or otherwise supply a Class 3 pest. Lantana species cannot be sold and landholders may be required to control these plants if they live next to an environmentally significant area. In other states of Australia lantana's pest status is as follows:

- *New South Wales*: Declared Class 5 throughout NSW, as well as Class 3 in three local government areas (LGAs) and Class 4 in 54 LGAs primarily along the NSW coast. For Class 5 weeds the requirements in the Noxious Weeds Act 1993 must be complied with. The growth and spread of Class 4 weeds must be controlled according to the measures specified in a management plan published by the local control authority. Class 3 weeds must be fully and continuously suppressed;
- *Northern Territory*: Both Class B and Class C. The growth and spread of Class B noxious weeds is to be controlled while Class C noxious weeds are not to be introduced to the Northern Territory;
- *South Australia*: Class 11+. Class 11+ plants are restricted from sale, but their control is not required;
- *Tasmania*: Declared under the Weed Management Act 1999 (Tas.). Lantana may not be imported into Tasmania, and its sale or other supply is not permitted. Landholders may be required to control lantana on their property;
- *Western Australia*: Declared Class P1 under the Agriculture and Related Resources Act 1976. The movement of Class P1 plants within the State is prohibited, including

contaminated machinery and produce. Since October 2005 the sale of lantana has been banned;

- *Victoria*: Declared as a restricted weed in November 2005, meaning lantana is banned from sale within the State; and
- *Australian Capital Territory*: Declared as Prohibited under the Pest Plants and Animals (Pest Plants) Declaration 2005 (No 1). Prohibited plants are banned from being supplied within the Territory.

### 2.1.3 Growth and Development

Lantana grows in both dry and humid climates in warm regions, mainly on richer soils, from sea level to approximately 1,000 metres and prefers moist conditions. It is frost sensitive, has a low tolerance of soil salinity but tolerates partial shading. Lantana is a perennial shrub that is constantly renewed at the base and is long lived under favourable conditions. Once established, it tends to die only under stressful conditions such as intense or prolonged drought or shading (CRC for Australian Weed Management, 2003).

Lantana seedlings germinate predominantly after the initial summer rains, although seedlings can germinate throughout the year where there is sufficient moisture. Initial seedling growth is slow until the root system becomes established, after which nearby stems intertwine to form dense thickets. Approximately half of the flowers produce seeds, with typically 1-20 seeds per flower head. Mature plants can produce up to 12,000 seeds per annum (CRC for Australian Weed Management, 2003).

Lantana generally flowers the summer following germination and then every summer thereafter from September/October until March/April. Many studies, however, have shown that lantana can flower whenever the soil is moist and the air is warm and humid (Swarbrick *et al.*, 1998). Each flower head consists of 20-40 flowers, with a wide variety of colours, while the fruit has many berries that contain a single seed (NSW Government, 2005a). **Table 2.1** outlines the general growth pattern for lantana.

**Table 2.1. Lantana’s Growth Pattern**

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
<b>Flowering</b>												
<b>Seed Formation</b>												
<b>Seed Drop</b>												
<b>Germination</b>												

General growth pattern
  Additional growth in very wet years

Source: CRC for Australian Weed Management (2003)

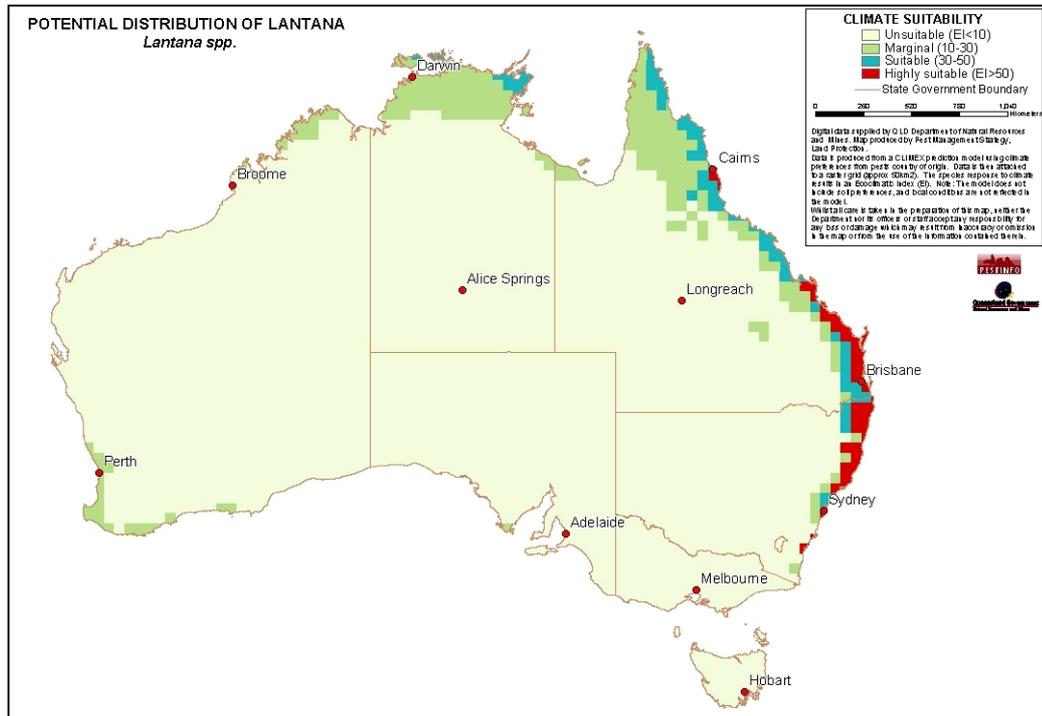
### 2.1.4 Current and Potential Distribution

Following its first introduction in 1841, lantana spread rapidly along the eastern coast of Australia and is now a prominent coastal and sub-coastal weed over 1,600 kilometres from Cairns to Sydney in altitudes between sea level and 600 metres, or exceptionally to 1,000 metres (NSW Government, 2005a and 2005b). Parsons and Cuthbertson (2001) estimated that lantana infests approximately four million hectares of pasture in Australia, primarily along the eastern coast.

Lantana is generally considered to have reached its potential distribution range, but continues to invade new habitats within the range as well as increasing in density (ARMC-ANZ, 2001). Lantana has also spread into drier areas with western infestations known as far west as Surat and Rubyvale in Queensland, with lantana present in at least

one major westward flowing river system (Condamine Balonne catchment), fuelling concern that lantana may spread further inland along riparian corridors in the future. Day *et al.* (2003) provides a detailed assessment and summary of the distribution of the different varieties of lantana in Queensland and elsewhere in Australia.

**Figure 2.1. Potential Distribution of Lantana in Australia**



Note: CLIMEX has been used to estimate the potential distribution of lantana. CLIMEX is a dynamic simulation model that uses climatic parameters to predict the potential distribution of a species (Surtherst *et al.*, 1999). Monthly long-term climatic averages for a variety of locations are used to calculate the potential for a location to support a permanent population of a particular organism.  
Source: Queensland Government (2006b)

Outside of Australia lantana is widely grown as an ornamental shrub in the tropics and sub-tropics, as well as other warm, temperate zones. In the tropics and sub-tropics and temperate zones it has established as a significant weed (Swarbrick *et al.*, 1998).

Lantana can spread quickly over short distances by sending roots into the soil from its stems. Seeds are also distributed in the droppings of fruit-eating birds and mammals, allowing the weed to spread over large distances. Day *et al.* (2003) suggest that lantana is allelopathic, releasing chemicals into the soil to prevent germination and competition from some other plant species; however, this is yet to be scientifically validated. Other discussions imply beneficial impacts by lantana providing a layer of nutrients to the soil to benefit the growth of other plants. The net impact of lantana is not confirmed.

## 2.2 Impacts

### 2.2.1 Benefits

Due to its attractive colouring and low level of maintenance requirement, lantana has been extensively grown as a garden ornamental in Australia, although is now banned from sale in all States and Territories. Lantana, like native species, can provide benefits in the form of food and shelter to a number of native birds, animals and insects, and has also been effectively used to form a temporary buffer along forest edges for bush regeneration projects. The weed is considered to be useful in preventing soil erosion on steep slopes and stream banks, and is able to suppress some weeds considered to have a greater detrimental ecological impact (Queensland Government, 2004).

Lantana infestations can prevent soil compaction and is a source of organic matter for pasture renovation or improvement (Queensland Government, 2004). In India the seeds have been used for stockfeed (Swarbrick *et al.*, 1998), however, there is no record of this having occurred in Australia.

Studies have shown that the mixed essential oils in lantana flowers have the potential to be used for perfumery or beneficial drugs (Ahmad *et al.*, 1962; Peyron *et al.*, 1971), but so far have not been commercialised. Given lantana's allelopathic affects there is also suggestion that extracts could be used as a biocide (Swarbrick *et al.*, 1998). Lantana can also be used to protect food items against various pests (Swarbrick *et al.*, 1998).

## 2.2.2 Costs

Lantana provides a variety of negative economic, social and environmental impacts. The primary negative economic impact of lantana is to the productivity of beef and dairy pastures, although lantana is also considered a serious weed of the plantation timber and orchard industries (Swarbrick *et al.*, 1998). Lantana readily invades uncultivated pastures and out-competes useful native grasses and fodders, resulting in a reduction in carrying capacity and restricted access and movement of animals, humans and vehicles (ARMC-ANZ, 2001). Data from a survey conducted in 1999 of Queensland landholders identified that increased mustering costs due to lantana ranges from between \$1 and \$65 in the beef industry and between \$0 and \$55 in the dairy industry (see **Table 2.2**).

**Table 2.2. Increased Mustering Costs per Hectare by Density of Lantana Infestation, 1999**

	Beef (\$/Ha)			Dairy (\$/Ha)		
	Light	Medium	Heavy	Light	Medium	Heavy
<b>Minimum</b>	\$1.00	\$5.00	\$7.50	\$0.00	\$0.00	\$0.00
<b>Maximum</b>	\$22.00	\$45.00	\$65.00	\$15.00	\$35.00	\$55.00

Source: Queensland Government (1999)

Lantana is unpalatable, and in large doses (approximately 1% of total body weight) is poisonous to stock, particularly cattle. If untreated lantana poisoning can result in a variety of undesirable symptoms including photosensitization, loss of appetite, jaundice, liver and other organ/tissue damage, and even death (Queensland Government, 2003). There is some anecdotal evidence to suggest that children can also be poisoned by eating lantana berries.

Culvenor (1985) estimated that annual losses to pasture based industries in Queensland were approximately \$7.7 million (in 1985 dollar terms), made up of approximately 1,500 stock deaths (\$0.5 million), 4.5% reduced performance (\$2.0 million), 7.3% loss of pasture (\$3.0 million) and \$2.2 million in control costs.

Total control costs by primary industries in Queensland are estimated as greater than \$10 million per year (ARMC-ANZ, 2001). In 2004, the costs of lost production in Australia due to lantana were conservatively estimated as greater than \$22 million per annum as an indexed figure from Culvenor's (1985) value estimate, including the expansion of distribution to NSW (Queensland Government, 2004).

Lantana impacts on transport corridors and utility easements, where it restricts access, visual safety and imposes significant control costs (ARMC-ANZ, 2001). It poses a particular problem for railways in New South Wales where it is considered one of the eight most troublesome weeds. It is also a problem along disturbed power line easements (Swarbrick *et al.*, 1998).

Lantana is a serious invader of plantation forestry, in particular commercial hoop pine plantations in coastal southeast Queensland and coconut plantations in the tropics. Lantana competes with tree seedlings for light so significant costs can be incurred in controlling lantana in the early years of a plantation. Management costs are incurred to gain access to plantations for trimming, measuring, estimating yields and harvesting. The presence of lantana also creates the potential for a fire hazard. Annual control costs in these plantations exceeded \$0.9 million in the late 1970s, but fell to around \$0.5 million by the mid-1980s (Swarbrick *et al.*, 1998) due to a change in policy about continued control. Wells (1984) estimated that lantana control costs account for

approximately 30% of the establishment and 25%-50% of the harvesting cost of these crops.

Lantana is also a serious invader of disturbed natural ecosystems. It infests disturbed rainforest remnants on the north coast of New South Wales, but significant stands of rainforest resist invasion. It is the same in southeast Queensland, although it mainly invades areas of open eucalypt woodland where it forms dense mono-specific thickets, greatly reducing the conservation value and increasing the fire hazard in these areas (Fensham *et al.*, 1994; Humphries and Stanton, 1992). Lantana produces chemicals that can inhibit germination and growth of other plants in natural ecosystems, giving lantana a competitive advantage (Gentle and Duggin, 1998 and 1997; Day *et al.*, 2003), and has also been shown to have an allelopathic effect on citrus rootstocks (Singh and Achhireddy, 1987). Lantana is also postulated to have an adverse affect on the richness of some soil faunal assemblages, including several functional groups of ant species (Cummings, 2004).

There are eleven endangered ecological Communities in NSW that are at risk from lantana (Eastern suburbs banksia scrub; Illawarra subtropical rainforest; Littoral rainforest; Lower Hunter spotted gum - Ironbark forest; Lowland Rainforest on floodplain; Pittwater spotted gum forest; Riverflat eucalypt forest on coastal floodplains; Sub-tropical coastal floodplain forest; Swamp sclerophyll forest on the coastal floodplains; Swamp-oak floodplain forest; and Umina coastal sandplain woodland) (Coutts-Smith & Downey, 2006) and 20 flora species are under threat specifically from lantana. The 2005 NSW Proposed Key Threatening Process also provides a list of additional species that may be influenced by lantana.

In Queensland lantana is present in five threatened plant communities, 165 Reserves, one Ramsar site and poses a potential threat to at least 60 plant and animal species of conservation significance (ARMC-ANZ, 2001). Lantana is also considered a major threat to the Wet Tropics World Heritage Area of northern Queensland, where it invades disturbed rainforest (Humphries and Stanton, 1992). Lantana is an aggressive invader of natural ecosystems in many other countries as well, for example, the Galapagos Islands, many Pacific islands and South Africa (Swarbrick, 1998).

Lantana also provides a haven and alternate host for various pests and pathogens, while exotic birds feed on the fruit. While no scientific research has directly linked lantana to Bell Miner associated Eucalypt dieback (BMAD), literature does suggest that its presence results in increased canopy opening, which is suspected to be a primary cause for increases in psyllid and Bell Miner numbers (Wardell-Johnson *et al.*, 2006).

## 2.3 Management and Control

There are a number of strategies in place for the control of lantana at a local, regional, state and national level. At the national level, the WoNS strategy developed in 2001 sets out plans for the management and control of lantana across Australia. The WoNS strategy is designed to coordinate with state, regional and local weed and pest management strategies in order to confront the problem posed by lantana in an integrated manner. Prior to the introduction of the WoNS strategy lantana control was undertaken by numerous landholders and community groups, but these activities were typically not well coordinated at a regional, state or national level. Funding for many of these groups came from grants provided on an annual basis, making planning difficult and increasing disillusionment when funding was discontinued (ARMC-ANZ, 2001).

A range of control methods has been utilised in the management of lantana throughout Australia and overseas. A mix of these control methods typically gives the best and most economical results. Since lantana is extensively established on the east coast, and prevention of spread is the most cost-effective management tool, the highest priority of lantana control in Australia is to prevent its spread into northern Australia and west of the Great Dividing Range (CRC for Australian Weed Management, 2003).

A national survey completed by 1,021 landholders and land managers in 2003 revealed the following information regarding the average annual costs of controlling lantana.

**Table 2.3. Average Cost of Lantana Control per Hectare of Property Size, 2003**

Property Size	Average Annual Cost/Ha (\$)
<100 ha	\$31.70
101-500 ha	\$21.00
501-1,000 ha	\$8.40
1,001-5,000 ha	\$3.80
5,001-10,000 ha	\$2.90
>10,000 ha	\$0.86

Source: Queensland Government (2004)

### 2.3.1 Manual Control

Manual control methods are highly intensive, but minimise the disturbance to the soil and desirable vegetation, and lower the risk of both erosion and germination of lantana seeds. Manual methods of control include:

- *Hand grubbing*: A mattock, chip hoe or lever is used to remove the whole plant, including its root system;
- *Hand cutting*: Brush hooks or machetes are used to slash lantana plants, enabling access to heavy infestations for carrying out other types of control; and
- *Hand pulling*: Hand pulling seedlings and their roots is often useful as a follow-up treatment and is most effective when the soil is moist.

Manual control methods have the advantage of being able to access areas that machinery and vehicles cannot, and are suitable for small sized infestations (Queensland Government, 2004).

### 2.3.2 Herbicides

Numerous chemicals have been trialled for controlling lantana, with a varying degree of success. In general, the most effective herbicide groups are the phenoxy acid based, benzoic acid based and pyridine based groups (Swarbrick, 1998). There are five main application techniques used (Queensland Government, 2006a, CRC for Australian Weed Management, 2003), which vary in their volume and concentration:

- *Foliar spraying*: The entire plant is sprayed with chemicals. This is usually effective on plants that are less than two metres high;
- *Splatter gun or gas gun*: Large droplets are splattered onto plant foliage at a high herbicide concentration;
- *Basal bark*: Herbicide is applied to the lower bark of the stems. This technique is useful for larger plants;
- *Cut stump*: Herbicide is painted onto the top of a freshly cut stump. This technique is also usually applied on larger plants; and
- *Aerial*: Herbicide is sprayed onto plants using a helicopter boom. This technique is generally only used to control extensive areas in a short time period.

Basal bark and cut stump techniques are time consuming as they require the treatment of each stem of lantana, making them unpractical in large stands of lantana, but useful for controlling lantana in sensitive areas. In many instances the high costs of chemical control can make herbicides an uneconomical management technique for large infestations of lantana.

### 2.3.3 Mechanical Control

Lantana can physically be removed using a number of mechanical techniques, including (Queensland Government, 2006a; CRC for Australian Weed Management, 2003):

- *Stick raking*: A blade (stick rake) is attached to a bulldozer or heavy tractor to cut and remove lantana stumps and roots. This technique can result in considerable soil disturbance, and may leave significant material in the ground. Additionally, without immediate revegetation, lantana can easily reinfest stick raked land;
- *Mechanical grubbing*: An implement is attached to a tractor, backhoe, excavator or bobcat to remove entire lantana plants from the ground;
- *Chain pulling*: Lantana plants are removed by wrapping the plants in a chain attached to a tractor, or between two dozers;
- *Ploughing*: Disc ploughing cuts and turns over stumps and roots. This method is often used as a follow-up treatment in areas that can be cultivated;
- *Dozing*: A dozer's blade is run across the ground to remove rootstock. A significant portion of lantana may be left in the ground depending on maturity; and
- *Slashing*: Slashing smashes the root stock and provides a small kill rate, but increases a window of opportunity if the season is not conducive to follow-up herbicide spraying.

Mechanical control can be suitable for small to large sized infestations. Stick raking, chain-pulling, dozing or slashing are suitable for removing standing biomass, while grubbing is useful against small infestations and along fence lines. A significant impact on lantana can be made in a short space of time. Ploughing is most useful against previously treated infestations or before seeding a competitive pasture.

Mechanical control like all other controls always requires follow-up. The objective is usually removal of extensive plant biomass to allow access for other controls. Left without follow-up it can lead to regrowth of the infestation and seedling germination because of soil disturbance. Not all sites are suitable for mechanical control options, such as steep inclines, gullies, riparian areas or areas of wider ecological significance.

### 2.3.4 Trampling and Grazing

Livestock can be used in the control of lantana through two methods:

- *Trampling*: Cattle can be used to trample thickets of lantana, creating tracks and tunnels that allow access to carry out other control methods; and
- *Grazing*: Livestock can also be allowed to graze on lantana, however this option is not recommended due to the toxic nature of some lantana varieties.

These two methods can not control lantana on their own and should only be used as an aid in management and control. Good pasture management and suitable stocking rates can discourage or prevent the establishment or spread of lantana in pastures (Queensland Government, 2004).

### 2.3.5 Fire

Fire is a relatively inexpensive control option that is well suited to dense infestations, although caution must be exercised due to the risk to people and property. Permits are required and fire-breaks can mitigate the spread of the fire. Fire can be used prior to or post mechanical or herbicide control to improve their efficacy, or as a follow-up control measure. However, as an indiscriminate control method, fire is not generally suitable for lantana control in rainforests (Queensland Government, 2006a) and some care needs to be taken in other vegetation communities or environmentally significant areas. Fire can

also have production impacts through the need to generate a suitable fuel load by locking up paddocks, damage to fences and the loss of production until pastures are re-established.

### 2.3.6 Biological Control

A total of thirty biological control (or biocontrol) agents have been introduced to Australia since 1914, of which seventeen have become established, and four of these are effectively reducing the vigour and competitiveness of lantana in certain areas. Day *et al.* (2003) provide a summary of the distribution of the various biocontrol agents throughout Australia, lantana varieties impacted on, and the climates they prefer. The effectiveness of agents varies depending on their spread, area of the plant they impact and seasonality. Biocontrol has in many cases, at least seasonally, decreased the size of individual plants and reduced their capacity to produce viable seed.

Between 1914 and 1952 the Australian biocontrol program is estimated to have cost approximately \$1.2 million in total. Since 1953, research into biocontrol for lantana is estimated to have cost approximately \$12.4 million, making the overall cost of the lantana biocontrol program \$13.6 million in 2004/05 dollar terms (AEC Group Limited, 2006). Each new species costs approximately 3-5 scientist years in host specificity testing, mass rearing and releases.

## 2.4 Qualitative Economic, Social & Environmental Impacts

### 2.4.1 Benefits

There were no financial benefits identified.

**Table 2.4. Economic, Social and Environmental Benefits of Lantana**

Issue	Description	Stakeholder Impacted		
		P	C	G
<b>Economic</b>				
Sale as ornamental	Sale of lantana as an ornamental provides income to the nursery industry. However, legislation now prohibits the sale of lantana as an ornamental in all States and Territories.	✓		✓
Soil improvement	Source of organic matter to aid pasture renovation and improvement, as a one off benefit.	✓		
Substitute food source	Seeds can be used as a substitute for stockfeed, although this has not been recorded as being undertaken in Australia.	✓		
Perfumery and pharmaceuticals	The mixed essential oils have the potential to be used in perfumery and beneficial drugs.	✓	✓	
Biocides	Allelopathic nature suggests the chemicals it secretes could be extracted for use as a biocide.	✓	✓	
Food storage	Can be used to help protect food items from various pests, although this has not been recorded as being undertaken in Australia.	✓		
<b>Social</b>				
Aesthetics as ornamental	Use as colourful ornamental that requires little maintenance.		✓	
Employment	Control provides employment opportunities. However, this is a diversion of labour away from other, productive tasks.	✓	✓	✓
<b>Environmental</b>				
Substitute habitat	Thickets provide substitute habitat for birds and animals where the natural habitat has been replaced. However, lantana is often the cause of the natural habitat being replaced, which can cause an imbalance of native species.		✓	
Food source	Native birds, animals and insects eat lantana.		✓	

Issue	Description	Stakeholder Impacted		
		P	C	G
Buffer	Can act as a buffer, preventing invasion by grass and other weeds in areas such as disturbed rainforests and agricultural lands. Lantana has successfully been used as a temporary buffer along forest edges during bush regeneration projects.	✓	✓	✓
Reduced erosion	Stabilises soils and prevents erosion, particularly in steep areas and along stream banks.	✓	✓	
Improves soil	Reduced soil compaction and improved soil quality.	✓	✓	

Notes: Stakeholder Codes: P = Private, C = Community, G = Government

## 2.4.2 Costs

**Table 2.5. Economic, Social and Environmental Costs of Lantana**

Issue	Description	Stakeholder Impacted		
		P	C	G
<b>Financial</b>				
Stock health	Poisonous to stock and if ingested can lead to reduced productivity through illness or death.	✓		
Reduced carrying capacity	Crowds out other vegetation, reducing the carrying capacity of productive land.	✓		
Restricted access	Restricts access to areas, increasing management and mustering/harvesting costs to pasture and plantation forestry. Other industries, such as tourism and utilities, can also be affected by reduced access.	✓	✓	✓
Control	By mechanical, chemical, labour, etc.	✓	✓	✓
Veterinary expenses	Treating stock that have become ill by consuming lantana.	✓		
Transport/Utility companies	Impacts on transport corridors, particularly in terms of safety and access and/or necessitating costly control.	✓	✓	✓
<b>Economic</b>				
Fire hazard	Thickets can be a fire hazard, increasing the risks to forestry plantations, native vegetation, pasture, livestock, native animals and buildings.	✓	✓	
Allelopathic	Has been shown to have an allelopathic affect on citrus rootstock, increasing the risk to these crops.	✓		
Threat to ecotourism	Can replace or reduce vegetative areas of significance, reducing the appeal of these areas as a tourism destination.	✓	✓	✓
Reduces conservation value	Invasions in woodland and forests can significantly reduce the conservation value of these areas.		✓	✓
<b>Environmental</b>				
Management stress	Control can be extremely time consuming, especially for large infestations.	✓		✓
Hinders access	Thickets can significantly reduce access to recreational and scenic areas.		✓	
Scenic amenity	Can replace or reduce vegetative areas of scenic significance, reducing the appeal of these areas.		✓	
Reduces biodiversity	Native and other plants are out-competed and replaced, removing the habitat for a number of animals and some soil faunal assemblages and thus reducing the biodiversity of these regions. Several communities of environmental and ecological significance are currently under threat due to lantana invasion.		✓	
Fire hazard	Creates a fire hazard in forest and other woody areas.		✓	✓
Hosts pests and pathogens	Provides a haven and alternate host for a variety of pests and pathogens.	✓	✓	✓

Notes: Stakeholder Codes: P = Private, C = Community, G = Government

## 3. Quantifying Impacts (Survey Results)

### 3.1 Sample Size and Confidence Interval

Survey questionnaires were sent to 502 landholders in QLD and NSW region, with 385 responses received, which equates to a response rate of 76.7%. Of those 385 responses received, 376<sup>5</sup> responses were recorded and analysed, which delivers a confidence interval of approximately +/- 4.9%<sup>6</sup>.

The survey instrument is included as **Appendix C**. A detailed analysis of the survey results is included as **Appendix D**, with the key points identified from the survey analysis summarised below.

### 3.2 Respondent Information

A total of 288 (76.6%) landholder surveys were returned from Queensland while a total of 88 (23.4%) landholder surveys were returned from NSW. The greatest proportion (28.7%) of respondents were aged 50-59 years, followed by 60-69 years (25.5%) and 40-49 years (17.3%).

**Table 3.1. Age Profile of Respondents**

Age	%
No response	10.9%
20 – 29 years	0.3%
30 – 39 years	5.3%
40 – 49 years	17.3%
50 – 59 years	28.7%
60-69 years	25.5%
70+ years	12.0%
<b>Total</b>	<b>100.0%</b>

A high proportion of landholders have had lantana on their land for<sup>7</sup>:

- 20-50 years (31.1%);
- More than 50 years (26.6%); and
- 10-20 years (13.6%).

The majority (57.7%) of respondents indicated that lantana has an impact on the management of their business, while 35.6% did not consider that lantana impacted on their management.

Approximately 49.5% of respondents indicated that lantana impacts on the profit of their business. However, 41.0% did not consider that lantana impacted on business profit, indicating significant differences in opinion, regarding the impact of lantana between respondents.

### 3.3 Infestation (Extent & Density)

On average, respondents estimated that:

- 51.1% of their total land area is not infested;
- 22.6% is lightly infested;
- 15.8% is of medium infestation; and

<sup>5</sup> Nine (9) responses were excluded from the analysis due to landholders indicating that they no longer have lantana on their land. The total number of surveys examined was reduced for some questions as they were only partially completed by respondents.

<sup>6</sup> Calculated on an average of 7,500 landholder population, assuming that between 5,000-10,000 landholders are in QLD and NSW.

<sup>7</sup> However, this could also be representative of the length of land ownership/management.

- 10.5% is heavily infested.

A higher proportion of respondents indicated that over the past five years

- The area of infestation has decreased (46.2%); and
- The density of infestation has increased (39.2%). However, this was only marginally greater than the decrease in density (37.5%).

With the continuation of existing control efforts, landholders expect to reduce the area of infestation over the next five years, with little progress made beyond that time. However, the density of infestation is expected to increase, as indicated by a:

- Slight reduction in the area infested over the next five years, with little change beyond that;
- Reduction in the areas of 'light' infestation;
- Little change in areas of 'medium' infestation; and
- Increase in areas of 'heavy' infestation.

**Implication:**

*With almost 50% of land area infested with lantana to some degree, control techniques employed by landholders appear to reduce the area of medium and light infestations. However, in areas of heavy infestation, control techniques are generally only expected to slow the rate of expansion, not reduce the area infested.*

## 3.4 Control

### 3.4.1 Activities

The most common areas where lantana is controlled are in:

- Production areas (71.8%);
- Non-production areas (58.8%);
- Adjoining Council land (26.6%); and
- Natural Reserve (21.8%).

Of those respondents who control lantana in non-production areas (58.8%):

- The majority (82.8%) do so to maintain the environment;
- 77.8% do so to prevent spread to productive areas;
- 9.0% do so to meet legislative requirements; and
- 24.0% nominated 'other' reasons.

### 3.4.2 Techniques

Of all control techniques utilised by landholders, the most frequently nominated techniques used in productive and/or non-productive areas include:

- Chemical (78.7%);
- Manual Labour (69.9%); and
- Mechanical (54.0%).

When asked the most common technique used for controlling lantana, chemical (34.3%), manual labour (26.1%) and mechanical (54.0%) were recorded as the highest.

### 3.4.3 Costs

Of those respondents that indicated a cost of controlling/maintaining lantana:

- 26.8% indicate that they spend less than \$5 per ha per year on controlling lantana in light infestations;

- 18.6% indicate that they spend less than \$5 per ha per year on controlling lantana in medium infestations; and
- 30.6% indicate that they spend more than \$120 per ha per year on controlling lantana in heavy infestations.

**Table 3.2. Range of Control Costs Experienced by Landholders (2006)**

	<\$5	\$5-\$15	\$15-\$30	\$30-\$60	\$60-\$120	>\$120	Total
Light Infestations	26.8%	21.6%	15.0%	15.5%	8.0%	13.1%	100.0%
Medium Infestations	18.6%	15.7%	16.4%	13.6%	15.0%	20.7%	100.0%
Heavy Infestations	22.4%	14.9%	6.7%	14.2%	11.2%	30.6%	100.0%

Note: Does not include 'no responses'. Number of 'no response' is 43.4% in light infestations, 62.8% in medium infestations and 64.4% in heavy infestations.

The table above (**Table 3.2**) highlights the broad range of expenditure (cost profile) in infested areas, whereas **Table 3.3** highlights the difference between expenditure in the treatment site and the total infested area.

- The cost of control per ha in light infestations is:
  - \$44.00 in the treatment area; and
  - \$3.70 over the total area of infested land.
- The cost of control per ha in medium infestations is:
  - \$62.60 in the treatment area; and
  - \$8.00 over the total area of infested land.
- The cost of control per ha in heavy infestations is:
  - \$75.10 in the treatment area; and
  - \$10.80 over the total area of infested land.

**Table 3.3. Cost of Control (\$/Ha/Yr 2006)**

	Average Cost/Treatment Area (\$/ha/yr)	Average Cost Over Infested Area (\$/ha/yr)
Light Infestations	\$44.00	\$3.70
Medium Infestations	\$62.60	\$8.00
Heavy Infestations	\$75.10	\$10.80

**Implication:**

*There is a wide range of landholder expenditure (virtually \$0/ha to greater than \$100/ha) across varying densities of infestation on different control techniques. Where successful and effective, expenditure in the lower end of the expenditure profile would likely result in highly beneficial production outcomes.*

*Where landholders are able to successfully control lantana infestations in the lower end of the control cost profile, this would likely result in highly beneficial production outcomes in both the short and long term.*

*Landholders appear to treat lantana infestations in strategic locations rather than across the entire infested area and reportedly do so to maintain the environment and preserve the productive capacity of their land.*

### 3.5 Other Economic Impacts

Respondents considered the financial impact of lantana in many different ways. While some landholders considered lantana to have a significant impact and cost across the range of impacts identified, others indicated that the impacts were insignificant.

On the balance, few of the other economic impacts nominated rated as significant with only 'increased maintenance costs' (48.9%) considered by the balance of respondents as

having a significant economic impact. Just under half (45.8%) of respondents considered that the impact of 'reduced carrying capacity' also had a significant impact.

A relatively high proportion recorded the following as having an insignificant economic impact:

- Stock poisoning/health (67.8%);
- Increased mustering costs (77.0%);
- Other financial impacts (48.7%);
- Reduced carrying capacity (48.1%); and
- Land value (44.6%).

**Table 3.4. Perceived Significance of Production & Management Impacts to Landholders**

	Significant	Insignificant	Unsure	Total
<b>Production Losses:</b>				
Stock poisoning/health	21.3%	67.8%	10.9%	100.0%
Increased mustering costs	18.1%	77.0%	4.9%	100.0%
Reduced carrying capacity	45.8%	48.1%	6.1%	100.0%
<b>Management/Operation:</b>				
Increased maintenance costs	48.9%	44.5%	6.6%	100.0%
<b>Other:</b>				
Land value	37.2%	44.6%	18.2%	100.0%
Other financial impacts	20.8%	48.7%	30.5%	100.0%

Note: Does not include 'no response'. Number of 'no response' was recorded for stock poisoning/health (31.6%), increased mustering costs (35.4%), reduced carrying capacity (29.8%), increased maintenance costs (27.7%), land value (24.2%), other financial impacts (47.6%).

Of those respondents answering this question, the predominant number of landholders estimate they currently incur a cost of less than \$5/ha/year from lantana for:

- Increased mustering costs (62.5%);
- Stock/poisoning/health (57.7%);
- Other financial impacts (57.6%);
- Land value (35.8%); and
- Increased maintenance costs (30.7%).

**Table 3.5. Range of Production & Management Costs Experienced by Landholders (2006)**

	<\$5	\$5-\$15	\$15-\$30	\$30-\$60	\$60-\$120	>\$120	Total
<b>Production Losses</b>							
Stock poisoning/health	57.7%	17.9%	2.6%	5.1%	3.8%	12.8%	100.0%
Increased mustering costs	62.5%	15.3%	2.8%	6.9%	1.4%	11.1%	100.0%
Reduced carrying capacity	30.1%	18.3%	15.1%	9.7%	7.5%	19.4%	100.0%
<b>Management/Operation:</b>							
Increased maintenance costs (does not include control costs)	30.7%	21.6%	10.2%	14.8%	9.1%	13.6%	100.0%
<b>Other:</b>							
Land value	35.8%	9.0%	11.9%	7.5%	9.0%	26.9%	100.0%
Other financial impacts	57.6%	15.2%	6.1%	9.1%	3.0%	9.1%	100.0%

Note: Does not include 'no response'. Number of 'no response' was recorded for stock poisoning/health (79.3%), increased mustering costs (80.9%), reduced carrying capacity (75.3%), increased maintenance costs (76.6%), land value (82.2%), other financial impacts (91.2%).

The table above (**Table 3.5**) shows the spread of economic impacts in infested areas, where as **Table 3.6**, below, highlights the difference between impacts in infested areas and impacts over the total property area.

- The cost per ha in relation to stock poisoning/health is:
  - \$32.70 in the infested area; and
  - \$3.20 over the total property area.

- The cost per ha in relation to increased mustering costs is:
  - \$28.10 in the infested area; and
  - \$0.60 over the total property area.
- The cost per ha in relation to reduced carrying capacity is:
  - \$51.90 in the infested area; and
  - \$4.00 over the total property area.
- The cost per ha in relation to increased maintenance costs is:
  - \$44.60 in the infested area; and
  - \$1.20 over the total property area.
- The cost per ha in relation to land value is:
  - \$64.30 in the infested area; and
  - \$42.40 over the total property area.
- The cost per ha in relation to other financial impacts is:
  - \$27.50 in the infested area; and
  - \$1.70 over the total property area.

**Table 3.6. Cost of Control (\$/ Ha/Yr 2006)**

	Average Cost Over Infested Area (\$/ha/yr)	Average Cost Over Total Property Area (\$/ha/yr)
<b>Production Losses</b>		
Stock poisoning/health	\$32.70	\$3.20
Increased mustering costs	\$28.10	\$0.60
Reduced carrying capacity	\$51.90	\$4.00
<b>Management/Operation:</b>		
Increased maintenance costs (does not include control costs)	\$44.60	\$1.20
<b>Other:</b>		
Land value	\$64.30	\$42.40
Other financial impacts	\$27.50	\$4.70

Note: Number of respondents for 'Average Cost Over Infested Area' and 'Average Cost Over Total Property Area' for each item was as follows: stock poisoning/ health (78 and 54), increased mustering costs (72 and 29), reduced carrying capacity (93 and 64), increased maintenance costs (88 and 74), land value (67 and 26), other financial impacts (33 and 11).

**Implication:**

*The majority of landholders generally consider the other economic impacts of lantana to be insignificant. However, where occurring and quantified they equate to significant impacts in lost production and increased maintenance costs, which implies that landholders may underestimate the impact of lantana on their land.*

### 3.6 Triple Bottom Line (TBL) (Qualitative Impacts)

The rating scale below was used to rate the impacts outlined in the following table.

Rating Scale:

- 0 No impact;
- 1 Impact is unlikely to be measurable or observable;
- 2 Detectable, but not significant;
- 3 Observable but localised impacts;
- 4 Observable wider and longer term impacts; and
- 5 Easily observed and irreversible impacts.

**Table 3.7. TBL Impacts (Q6)**

	Weighted Average	TBL Aspect
<b>Negative Impacts</b>		
Removes and/or replaces native vegetation	3.6	Environmental
Reduces the conservation value of your land	3.5	Environmental
Reduces the scenic amenity of your land	3.4	Social
Restricts the movements of animals/humans	3.4	Social
Harbours feral animals	3.4	Environmental
Increases your management stress	3.3	Social
Restricts access	3.3	Economic
Increases the risk of fire	3.0	Environmental
Displaces native animals	2.9	Environmental
Impacts negatively on tourism	2.7	Economic
<b>Positive Impacts</b>		
Stabilises soil and prevents erosion	2.5	Environmental
Is aesthetically pleasing	2.3	Social
Provides a benefit in terms of improving soil for pasture renovation	2.1	Economic

**Implication:**

*The negative social and environmental impacts of lantana outweigh the perceived positive impacts, with replacement of native vegetation, loss of conservation values rating as the most significant detrimental impacts of lantana.*

## 4. Cost Benefit Analysis

### 4.1 Scenarios Examined

The following scenarios were examined to identify the current and future potential impact of lantana across various control initiatives.

- **No Control (Base Case):** Examined the expansion and associated impacts of lantana if all control methods ceased as of 2007.
- **Current Control:** Examined the impact of maintaining current control initiatives into the future.
- **Increased Control:** Examines the impact of increased control initiatives. This scenario was examined as a component of the sensitivity analysis for the Current Control scenario.
- **Biological Control:** Examines the level of expenditure that could potentially be justified in the development of a biological control program to control lantana for a range of assumptions.

Each of these scenarios were tested against a range (three) potential future maximum areas of infestation, as per CLIMEX modelling<sup>8</sup>.

### 4.2 Data Inputs

A range of data was required to form an estimate of the impact of lantana on the Australian grazing sector. The key inputs and drivers are outlined in the following tables.

#### 4.2.1 Current Estimated Area of Infestation

Table 4.1. Area of Current Grazing Land Infestation (by Statistical Division)

Statistical Division	Area (ha '000)	Hectares Infested ('000)				Percent of SD Infested (%)			
		Heavy	Medium	Light	Total Area	Heavy	Medium	Light	Total Area
Far North	26,900	181.3	61.8	12.3	255.4	0.7%	0.2%	0.0%	0.9%
North West	13,815	0.0	0.0	0.0	0.0	0.0%	0.0%	0.0%	0.0%
Northern	7,976	0.0	42.5	0.9	43.4	0.0%	0.5%	0.0%	0.5%
Mackay	9,014	0.0	216.4	8.5	224.9	0.0%	2.4%	0.1%	2.5%
Fitzroy	12,310	151.8	249.6	272.4	673.8	1.2%	2.0%	2.2%	5.5%
Wide Bay-Burnett	5,267	139.0	108.8	2.6	250.4	2.6%	2.1%	0.0%	4.8%
Darling Downs	7,069	33.3	28.0	5.1	66.5	0.5%	0.4%	0.1%	0.9%
South West	6,762	0.0	0.0	2.4	2.4	0.0%	0.0%	0.0%	0.0%
Moreton	1,838	131.1	27.5	2.3	161.0	7.1%	1.5%	0.1%	8.8%
Brisbane	423	8.8	4.6	0.0	13.5	2.1%	1.1%	0.0%	3.2%
<b>Queensland</b>	<b>91,375</b>	<b>645.4</b>	<b>739.2</b>	<b>306.6</b>	<b>1,691.2</b>	<b>0.7%</b>	<b>0.8%</b>	<b>0.3%</b>	<b>1.9%</b>
Richmond Tweed	1,029	129.5	1.0	0.7	131.2	12.6%	0.1%	0.1%	12.7%
Northern	7,976	0.0	42.5	0.9	43.4	0.0%	0.5%	0.0%	0.5%
Mid North Coast	2,547	250.6	34.8	0.2	285.5	9.8%	1.4%	0.0%	11.2%
Hunter	2,583	23.3	21.8	0.4	45.5	0.9%	0.8%	0.0%	1.8%
Central West	451	0.0	0.0	0.0	0.0	0.0%	0.0%	0.0%	0.0%
Sydney	1,243	0.0	0.0	0.0	0.0	0.0%	0.0%	0.0%	0.0%
South Eastern	2,205	4.5	0.3	0.0	4.9	0.2%	0.0%	0.0%	0.2%
Illawarra	850	8.8	3.8	0.6	13.2	1.0%	0.5%	0.1%	1.6%
<b>NSW</b>	<b>18,884</b>	<b>416.6</b>	<b>104.2</b>	<b>2.9</b>	<b>523.7</b>	<b>2.2%</b>	<b>0.6%</b>	<b>0.0%</b>	<b>2.8%</b>
<b>Total</b>	<b>110,259</b>	<b>1,062</b>	<b>843</b>	<b>309</b>	<b>2,215</b>	<b>1.0%</b>	<b>0.8%</b>	<b>0.3%</b>	<b>2.0%</b>

Source: NRW (Unpublished GIS analysis)

<sup>8</sup> Where the Climex modeling identified an area of infestation less than that currently infested, it was assumed Lantana had currently reached full potential area of infestation.

To identify the area of the individual mapping grid squares actually infested with lantana, the following percentages were used for each type of infestation (Heavy, Medium and Light). The analysis is conducted with all results reported for the maximum expectation, which is based on available published data (BRS, 2006), however, a minimum scenario is examined for completeness in the sensitivity section of the analysis.

**Table 4.2. Area of Mapping Grid Square Actually Infested with Lantana**

Infestation	Maximum <sup>(a)</sup>	Minimum <sup>(b)</sup>
Heavy Infestations	50.0%	12.50%
Medium Infestations	6.6%	5.30%
Light Infestations	1.0%	0.55%

Source: (a) BRS, 2006, (b) A. Clark, Lantana Coordinator (National Lantana Management Group) *pers. comm.* 14 November, 2006.

The area of future infestation was identified utilising CLIMEX modelling, and examined three future infestation scenarios, including:

- **Scenario 1 (Maximum):** Sum of areas identified as being a Highly Suitable, Suitable and Marginal growth environment for lantana.
- **Scenario 2 (Medium):** Sum of areas identified as being Highly Suitable and Suitable growth environment for lantana.
- **Scenario 3 (Minimum):** Areas identified as being Highly Suitable growth environment for lantana.

**Table 4.3. Future Suitability (infested Grazing Land by Statistical Division)**

Statistical Division	Area (ha '000)	Hectares Infested ('000)		
		Scenario 1 (Maximum)	Scenario 2 (Medium)	Scenario 3 (Minimum)
Far North	26,900	15,877.1	4,419.2	400.9
North West	13,815	2,349.0	0.0	0.0
Northern	7,976	2,577.1	699.0	43.4
Mackay	9,014	2,615.4	1,494.0	224.9
Fitzroy	12,310	2,960.1	1,470.4	1,243.1
Wide Bay-Burnett	5,267	1,953.0	1,350.5	946.4
Darling Downs	7,069	258.2	131.1	66.5
South West	6,762	119.9	2.4	2.4
Moreton	1,838	907.1	897.1	350.3
Brisbane	423	93.4	93.4	86.9
<b>Queensland</b>	<b>91,375</b>	<b>29,710.3</b>	<b>10,557.2</b>	<b>3,364.8</b>
Richmond Tweed	1,029	360.1	360.1	292.3
Northern	7,976	2,577.1	699.0	43.4
Mid North Coast	2,547	1,207.6	998.8	914.3
Hunter	2,583	461.9	249.6	225.4
Central West	451	13.9	0.0	0.0
Sydney	1,243	0.0	0.0	0.0
South Eastern	2,205	130.2	38.0	38.0
Illawarra	850	51.8	30.8	30.8
<b>NSW</b>	<b>18,884</b>	<b>4,802.5</b>	<b>2,376.3</b>	<b>1,544.3</b>
<b>Total</b>	<b>110,259</b>	<b>34,513</b>	<b>12,933</b>	<b>4,909</b>

Note: These scenarios do not consider climate change.  
Source: NRW (Unpublished GIS analysis)

#### 4.2.2 Infestation Rate

The average annual rate of expansion was estimated by calculating the area infested for each property, using the proportion of property infested and total property area as collected in the survey (currently and in the future), and calculating the average annual rate of increase between these two points.

**Table 4.4. Infestation Rate**

	Heavy	Medium	Light
Without Control	2.1%	2.1%	2.1%
With Control	1.0%	-0.4%	-2.0%

Source: AECgroup Lantana Survey (2006)

#### 4.2.3 Control Information

The areas actively controlled by landholders were classified into three categories as shown below:

- 12.6% for heavy infestations;
- 11.2% for medium infestations; and
- 7.4% for light infestations.

The above percentages were reduced by the proportion of productive land area managed by landholders who actively control lantana (87.6%). This was done to ensure that the area of land controlled was not overestimated.

The cost of control per hectare in the treatment area were:

- \$75.10 for heavy infestations;
- \$62.20 for medium infestations; and
- \$44.00 for light infestations.

#### 4.2.4 Other Economic Impacts

Other economic impacts identified through the survey analysis are outlined in the table below.

**Table 4.5. Other Economic Impacts**

Impact <sup>(a)</sup>	\$/ha	% Landholders Considering Impact Insignificant <sup>(c)</sup>
Stock Poisoning/ Health	\$6.40	73.9%
Increased Mustering	\$5.50	73.9%
Reduced Carrying Capacity	\$19.55	49.8%
Increased Maintenance <sup>(b)</sup>	\$11.33	32.3%

Note: (a) these impacts were reduced by the proportion of landholders that did not consider the impact to be significant (these percentages are shown in the RHS of the table) (b) Maintenance cost was reduced by 50% due to perceived double counting with control. (c) Adjusted to include exclude those landholders that were "Unsure".  
Source: AECgroup Lantana Survey (2006)

The magnitude of 'Other Economic Impacts' is expected to vary by region and terrain type. Results from a previously unpublished NRW study conducted in 2000 were used as a proxy to adjust the impact of lantana for each Local Government Area across Queensland (applied by Statistical Division). Adjusting the average 'Other Economic Impact' figure identified by the 2006 survey by the factors in the following table allowed a representative impact assessment to be applied to each Local Government Area.

**Table 4.6. Regional Cost Factors from Average**

Statistical Division	Minimum	Expected	Maximum
Brisbane	0.24	0.71	0.94
Darling Downs	0.19	0.44	0.74
Far North	0.33	0.65	1.05
Fitzroy	0.35	0.75	1.18
Mackay	0.39	0.66	1.00
Moreton	0.57	1.26	1.87
Northern	0.33	0.74	1.10
Wide Bay-Burnett	0.54	1.30	2.20
<b>Queensland</b>	<b>0.44</b>	<b>1.00</b>	<b>1.57</b>

Source: NRW (unpublished)

The impact on 'land value' was not included in the analysis as it is assumed to be adequately represented by the future flow of incomes and costs identified and, if included, would result in double counting. 'Other financial impacts' were also excluded due to perceived double counting in the survey responses.

It is interesting to note that there is little difference between the per hectare impact on the land value of infested areas compared to the overall property value. This implies that land value is impacted once lantana is present regardless of the level and extent of the infestation.

#### 4.2.5 Landuse Information

The area of land within each Statistical Division under grazing was estimated and applied to each Local Government Area examined.

**Table 4.7. Landuse Information**

Statistical Division	Grazing (as a % of total land area)
<b>Queensland<sup>(a)</sup></b>	
Darling Downs	54.9%
South West	88.6%
North West	92.4%
Brisbane	23.1%
Moreton	50.3%
Far North	75.4%
Northern	86.0%
Mackay	74.8%
Fitzroy	67.3%
Wide Bay-Burnett	49.0%
<b>NSW<sup>(b)</sup></b>	
Richmond Tweed	35.0%
Northern	50.0%
Mid North Coast	50.0%
Hunter	40.0%
Central West	57.5%
Sydney	0.0%
South Eastern	40.0%
Illawarra	30.0%

Source: (a) NRW (Unpublished GIS analysis). (b) A. Clark, Lantana Coordinator (National Lantana Management Group) *pers. comm.* 16 November, 2006.

### 4.3 Model

The CBA framework used in this analysis is described in **Section 1.3** and **Appendix A**. This section provides an overview of the model used in the identification of the impact of lantana to the Australian grazing sector.

The net benefit (*NB*) of controlling lantana is estimated by the equation below:

$$NB = RC - C$$

Where:

- NB = Net benefit of controlling lantana (\$).
- RC = Reduction in costs associated with having lantana on productive land areas (\$).
- C = Cost of control (\$).

The reduction in costs (*RC*) associated with having lantana on productive land areas is estimated using the equation below:

$$RC = \sum_{n=30}^1 [(AIN_{ht} - AIW_{ht}) \times (SP_{ht} + MC_{ht} + CC_{ht} + MT_{ht})] + \\ [(AIN_{mt} - AIW_{mt}) \times (SP_{mt} + MC_{mt} + CC_{mt} + MC_{mt})] + \\ [(AIN_{lt} - AIW_{lt}) \times (SP_{lt} + MC_{lt} + CC_{lt} + MC_{lt})]$$

Where:

AIN = Area infested (no control)  
 AIW = Area infested (with control)  
 SP = Cost of stock poisoning (\$/ha)  
 MC = Additional mustering costs (\$/ha)  
 CC = Reduced carrying capacity impacts (\$/ha)  
 MT = Additional maintenance costs (\$/ha)  
 h = Heavy infestation (ha)  
 m = Medium infestation (ha)  
 l = Light infestation (ha)  
 t = Time (Year)

The cost of controlling lantana (*C*) in infested areas is estimated using the equation below:

$$C = \sum_{n=30}^1 (AIW_{ht} \times TA_{ht} \times TC_{ht}) + (AIW_{mt} \times TA_{mt} \times TC_{mt}) + (AIW_{lt} \times TA_{lt} \times TC_{lt})$$

Where:

TA = Treatment area (% of infested area)  
 TC = Treatment cost (\$/ha)

The area infested by lantana with control (*AIW*) is estimated using the equation below:

$$AIW = [(AI_{ht-1} \times (1 - TA_{ht-1}) \times (1 + RN_{ht}) + (AI_{ht-1} \times TA_{ht-1} \times (1 + RW_{ht}))] + \\ [(AI_{mt-1} \times (1 - TA_{mt-1}) \times (1 + RN_{mt}) + (AI_{mt-1} \times TA_{mt-1} \times (1 + RW_{mt}))] + \\ [(AI_{lt-1} \times (1 - TA_{lt-1}) \times (1 + RN_{lt}) + (AI_{lt-1} \times TA_{lt-1} \times (1 + RW_{lt}))]$$

Where:

AI = Area infested (ha)  
 RN = Expansion rate (no control)  
 RW = Expansion rate (with control)

The area infested by lantana where there is no control (*AIN*) is estimated using the equation below:

$$AIN = (AIN_{ht} \times RN_{ht}) + (AIN_{mt} \times RN_{mt}) + (AIN_{lt} \times RN_{lt})$$

### 4.3.1 Converting Future Impacts to Today's Values

Because costs and benefits are specified over time it is necessary to reduce the stream of benefits and costs to present values. The present value concept is based on the time value of money – the idea that a dollar received today is worth more than a dollar to be received in the future. The present value of a cash flow is the value today that is equivalent to a cash flow in the future. The time value of money is determined by the given discount rate to enable the comparison of options by a common measure.

The selection of appropriate discount rates is of particular importance because they apply to much of the decision criteria and consequently the interpretation of results. The higher the discount rate, the less weight or importance is placed on future cash flows.

The choice of discount rates should reflect the weighted average cost of capital. For this analysis a base discount rate of 8.0% was examined with a range from 4.0% to 10.0% examined.

The formula for determining the present value is:

$$PV = \frac{FV_n}{(1+r)^n}$$

Where:

$PV$  = present value today  
 $FV$  = future value  $n$  periods from now  
 $r$  = discount rate per period  
 $n$  = number of periods

Extending this to a series of cash flows the present value is calculated as:

$$PV = \frac{FV_1}{(1+r)^1} + \frac{FV_2}{(1+r)^2} + \dots + \frac{FV_n}{(1+r)^n}$$

Once the stream of costs and benefits have been reduced to their present values the net present value (NPV) can be calculated as the difference between the present value of benefits and present value of costs. If the present value of benefits is greater than the present value of costs then the option or project would have a net economic benefit.

Because the NPV can result from the combination of any magnitude of benefits and costs it is not all that useful when comparing projects. A useful measure to use to compare between two different projects is the benefit cost ratio (BCR). The BCR is calculated by dividing the present value of benefits by the present value of costs. If the resulting BCR is greater than one (1) then the project has a net economic benefit. The higher the BCR the greater the quantified economic benefits compared to the quantified economic losses.

Note: a BCR should form only one part of the decision making process as it only indicates a superior option based on monetary values.

## 4.4 Results

### 4.4.1 Cost of Lantana to the Australian Grazing Sector

The presence of lantana is estimated to decrease the productivity (or output) of the Australian grazing sector through impacts such as stock poisoning/ health and reduced carrying capacity. Lantana is also expected to increase management requirements and expenses through increased time and labour in mustering and additional farm maintenance costs.

These impacts are currently estimated to total approximately \$104.3 million, and will continue to increase as the area infested with lantana increases.

#### **Implication:**

*The presence of lantana in Australia is currently estimated to cost the Australian grazing sector approximately \$104.3 million (2005/06) per annum in terms of lost productivity, and increased management expenses.*

#### **Sensitivity of Cost Assessment**

##### *Annual Cost of Control*

The annual cost of lantana is identified to total approximately \$104.3 million in Australia. To examine the variability of impacts between farms, regions and property managers, the analysis examined the impact of a change in the production losses and additional

management costs. The analysis identifies that even a 30% decrease in the on-farm impact of lantana will still result in a significant loss to the Australian grazing sector, of approximately \$73.0 million annually.

The following table highlights the impact of a change (increase or decrease) in lost production and increased management costs.

**Table 4.8. Annual Cost of Lantana in Australia (2005/06 \$'s)**

% Change in on-farm cost	Queensland (\$M)	NSW (\$M)	Australia (\$M)
-30%	\$49.6	\$23.4	\$73.0
-20%	\$56.7	\$26.7	\$83.4
-10%	\$63.7	\$30.1	\$93.8
-5%	\$67.3	\$31.8	\$99.0
0%	\$70.8	\$33.4	\$104.3
5%	\$74.4	\$35.1	\$109.5
10%	\$77.9	\$36.8	\$114.7
20%	\$85.0	\$40.1	\$125.1
30%	\$92.1	\$43.5	\$135.5

Note: The base case assessment is shaded.  
Source: AECgroup

#### Area Infested

Where there is no control, and lantana expands at 2.1% per annum (identified from survey analysis), the potential areas invaded and infested by lantana, based on CLIMEX modelling of future climate suitability, could result in a present value cost of approximately \$1.5 billion (represented in 2005/06 dollar terms), which is the base assessment conducted at 8.0% discount rate for the medium scenario (2). The range of potential impacts is listed in the table below (by infestation scenario and discount rate). A conservative estimate of the present value of these impacts is estimated to be in the order of \$1.2 billion and an upper estimate to be approximately \$2.4 billion.

**Table 4.9. Present Value of the Cost Impact of Lantana by level of infestation (2005/06 \$'s)**

Discount Rate (%)	Scenario 1 (High) (\$M)	Scenario 2 (Medium) (\$M)	Scenario 3 (Low) (\$M)
4.0%	\$2,432.0	\$2,398.6	\$2,261.9
6.0%	\$1,922.2	\$1,898.5	\$1,801.0
8.0%	\$1,564.1	\$1,546.8	\$1,475.4
10.0%	\$1,306.1	\$1,293.1	\$1,239.5

Note: The base case assessment is shaded.  
Source: AECgroup

#### 4.4.2 Current Control

Current control initiatives undertaken by landholders are expected to cost in the order of \$17.1 million per year (2005/06) (\$12.3 million in Queensland and \$4.8 million in NSW).

When considered in the context of the benefits delivered, the current control initiatives are not economically desirable, since the net present value (NPV) over 30 years is approximately negative \$219.7 million (at 8.0% discount rate for the medium scenario). This equates to a benefit cost ratio (BCR) of 0.11, or a return of \$0.11 for every dollar invested.

**Table 4.10. Net Present Value of Current Control Initiatives (2005/06 \$'s)**

Discount Rate (%)	PV Benefits (\$M)	PV Costs (\$M)	NPV (\$M)	BCR
4.0%	\$52.4	\$380.9	-\$328.5	0.14
6.0%	\$37.4	\$302.4	-\$265.0	0.12
8.0%	\$27.4	\$247.0	-\$219.7	0.11
10.0%	\$20.6	\$207.0	-\$186.4	0.10

Note: The base case assessment is shaded.  
Source: AECgroup

**Implication:**

*Expenditure on current control initiatives by landholders is estimated to be in the order of \$17.1 million per year (2005/06).*

*Whilst there are expected to be individual control sites that yield positive results, on average, there is no financial incentive for landholders to control lantana on their land, with existing control initiatives estimated to result in a negative net present value (NPV) over 30 years of approximately negative \$219.7 million.*

**Sensitivity of the Current Control Scenario***Area Infested*

The area infested is not expected to significantly impact the results of the analysis, as highlighted from only relatively small changes in the NPV from the base case.

**Table 4.11. NPV for Different Maximum Potential Areas of Infestation, Current Control (2005/06 \$'s)**

Discount Rate (%)	Scenario 1 (High) (\$M)	Scenario 2 (Medium) (\$M)	Scenario 3 (Low) (\$M)
4.0%	-\$329.6	-\$328.5	-\$323.7
6.0%	-\$265.8	-\$265.0	-\$261.4
8.0%	-\$220.2	-\$219.7	-\$216.8
10.0%	-\$186.9	-\$186.4	-\$184.2

Note: The base case assessment is shaded.

Source: AECgroup

*Area Controlled*

The area of infestation that is controlled has been examined as to its impacts on the desirability of controlling lantana for grazing production.

To examine the impact of increasing the control effort, the analysis examined changes in the area of infestation actively controlled by landholders. This analysis identifies that, as the area of land controlled increases the net benefits decrease. For example, a 10% increase in area actively controlled from the shaded cell (base case) in **Table 4.12** would result in a \$21.4 million decrease in NPV over 30 years.

This is due to the high cost of intensive control measures, the need for ongoing expenditure and the relatively small area of productive land reclaimed following control initiatives.

The following table examines the impact on the 30-year NPV of a change (increase or decrease) in the area of lantana actively controlled, and highlights that there is little incentive for landholders to control lantana for agricultural production.

**Table 4.12. Impact of Area Controlled by Level of Infestation, Current Control (2005/06 \$'s)**

% Change in area controlled	Scenario 1 (High) (\$M)	Scenario 2 (Medium) (\$M)	Scenario 3 (Low) (\$M)
-30%	-\$155.1	-\$154.6	-\$152.3
-20%	-\$176.9	-\$176.4	-\$173.9
-10%	-\$198.6	-\$198.1	-\$195.4
-5%	-\$209.4	-\$208.9	-\$206.1
0%	-\$220.2	-\$219.7	-\$216.8
5%	-\$231.0	-\$230.4	-\$227.6
10%	-\$241.8	-\$241.2	-\$238.3
20%	-\$262.6	-\$262.6	-\$259.6
30%	-\$284.0	-\$284.0	-\$280.9

Note: The base case assessment is shaded.

Source: AECgroup

#### Area of Mapping Grid Squares Actually Infested

**Table 4.2** highlights a range of assumptions regarding the area of mapping grid squares that are actually infested, where lantana is present. The conservative scenario, which is believed to underestimate the actual impact, is identified to have a current impact of approximately \$50.0 million annually to the Australian grazing sector. The impact of control across this scenario results in a negative NPV and is outlined in the table below.

**Table 4.13. Impact of a change in the Area of Mapping Grid Squares Actually Infested (2005/06 \$'s)**

Discount Rate (%)	PV Benefits (\$M)	PV Costs (\$M)	NPV (\$M)	BCR
4.0%	\$26.8	\$198.2	-\$171.4	0.14
6.0%	\$19.1	\$157.6	-\$138.5	0.12
8.0%	\$14.0	\$129.0	-\$115.0	0.11
10.0%	\$10.5	\$108.3	-\$97.8	0.10

Note: The base case assessment is shaded.

Source: AECgroup

#### 4.4.3 Development of a Biological Control Agent

It is apparent that whilst lantana has a significant and negative impact on the Australian grazing sector, the economically rational landholder does not have sufficient incentive to undertake control initiatives. The development of a biological control agent may assist in the fight against lantana.

It is estimated that if a biological control program is carried out with successful agent(s), the benefits to the Australian agriculture sector, and in particular grazing, would be significant. For instance, a research program undertaken for a period of 10 years costing approximately \$300,000 per year<sup>9</sup> with a five year establishment program and achieving 50% effectiveness (that is, reducing the impact of lantana by 50% at the end of year 15) would result in a NPV of \$206.2 million and a benefit cost ratio of approximately 91.4, which implies that for every dollar invested approximately \$91.40 of benefits would be returned.

The expected impacts of a successful biological control program are outlined in the following table for a range of discount rates.

**Table 4.14. Expected Benefits of a Successful Biological Control Program (2005/06 \$'s)**

Discount Rate (%)	PV Benefits (\$M)	PV Costs (\$M)	NPV (\$M)	BCR
4.0%	\$426.9	\$2.7	\$424.2	158.5
6.0%	\$296.0	\$2.5	\$293.5	119.7
8.0%	\$208.5	\$2.3	\$206.2	91.4
10.0%	\$149.1	\$2.1	\$147.0	70.5

Note: The base case assessment is shaded.

Source: AECgroup

#### **Implication:**

*A successful biological control program has the potential to return up to and over \$90 of benefit for every dollar invested.*

<sup>9</sup> Estimated annual cost of two full time researchers and associated on costs.

## Sensitivity of the Biological Control Agent Scenario

### Area Infested

The future potential area of infestation is not expected to significantly impact the benefits associated with the development of a successful biological control program, with all scenarios returning high NPVs.

**Table 4.15. NPV of Different Maximum Potential Areas of Infestation, Bio-Control (2005/06 \$'s)**

Discount Rate (%)	Scenario 1 (High) (\$M)	Scenario 2 (Medium) (\$M)	Scenario 3 (Low) (\$M)
4.0%	\$428.3	\$424.2	\$406.6
6.0%	\$296.3	\$293.5	\$281.3
8.0%	\$208.2	\$206.2	\$197.6
10.0%	\$148.4	\$147.0	\$140.8

Note: The base case assessment is shaded.

Source: AECgroup

### Efficacy of Control

Whilst the efficacy of control impacts on the overall benefits delivered by the biological control program, there are significant benefits associated with even a relatively small level of effective control, as shown in the following table. For instance, should a biological control program only deliver, on average, 5% efficacy across all infested areas then the program would be estimated to return approximately \$9.10 for every dollar invested.

**Table 4.16. Efficacy of a Biological Control Program (2005/06 \$'s)**

Efficacy of Control (%)	PV Benefits (\$M)	PV Costs (\$M)	NPV (\$M)	BCR
0%	\$0.0	\$2.3	-\$2.3	0.0
5%	\$20.9	\$2.3	\$18.6	9.1
10%	\$41.7	\$2.3	\$39.4	18.3
25%	\$104.3	\$2.3	\$102.0	45.7
50%	\$208.5	\$2.3	\$206.2	91.4
75%	\$312.8	\$2.3	\$310.5	137.1

Note: The base case assessment is shaded.

Source: AECgroup

### Length of Research

Whilst the length of the research program impacts on the overall benefits delivered by the biological control program, there are significant benefits associated with even the 20-year research program examined.

**Table 4.17. Length of Research Program, Bio-Control (2005/06 \$'s)**

Length of Research Program (years)	PV Benefits (\$M)	PV Costs (\$M)	NPV (\$M)	BCR
3	\$358.0	\$1.0	\$357.0	351.1
5	\$309.4	\$1.5	\$307.9	213.0
10	\$208.5	\$2.3	\$206.2	91.4
15	\$131.1	\$2.8	\$128.3	46.1
20	\$71.0	\$3.2	\$67.7	22.0

Note: The base case assessment is shaded.

Source: AECgroup

### Cost of Research

Whilst the annual cost of the research program impacts on the overall benefits delivered by the biological control program, there are significant benefits associated with even a 2.5 times increase in annual expenditure of the 10-year research program examined.

**Table 4.18. Cost of Research Program, Bio-Control (2005/06 \$'s)**

Cost of Research Program (\$/year)	PV Benefits (\$M)	PV Costs (\$M)	NPV (\$M)	BCR
\$50,000	\$208.5	\$0.5	\$208.0	443.5
\$100,000	\$208.5	\$0.8	\$207.7	250.5
\$250,000	\$208.5	\$1.9	\$206.6	108.6
\$300,000	\$208.5	\$2.3	\$206.2	91.4
\$500,000	\$208.5	\$3.7	\$204.8	55.9
\$750,000	\$208.5	\$5.5	\$203.0	37.6

Note: The base case assessment is shaded.

Source: AECgroup

## 5. Economic Impact

This section of the report details the expected economic impact to Australia as a result of lost productivity in the grazing sector from the presence of lantana. The analysis utilises an Input-Output (IO) methodology to identify the impact of lost production and productivity within the Australian grazing sector.

There is some additional economic activity generated by control initiatives of the grazing sector. The analysis assumes these expenditures would not be reinvested in production-based initiatives if lantana was not present and as such are netted off from the production impact when calculating the impact of lantana to the Australian economy.

### 5.1 Data Inputs

The analysis examines the impact of lost productivity through stock poisoning or reduced carrying capacity. The analysis does not include the cost associated with increased mustering or maintenance as these costs would be reinvested in general operational expenditure where they were not expended due to the presence of lantana.

These impacts comprise a total impact of approximately \$63.2 million (2005/06). Considering the \$17.1 million expended by the grazing sector on control initiatives, this creates an indicative net economic loss of \$46.2 million (2005/06).

### 5.2 Economic Impact

The indicative negative economic impact (net impact of \$46.2 million) of the presence of lantana on the Australian grazing sector is outlined in the following table.

	Output (\$M)	Value Added (\$M)	Income (\$M)	Employment (FTE)
Direct	\$46.2	\$24.4	\$7.6	525
Indirect	\$36.6	\$17.6	\$8.4	219
<b>Total</b>	<b>\$82.8</b>	<b>\$42.0</b>	<b>\$16.1</b>	<b>744</b>

Source: AECgroup

An indicative estimate of the detrimental impact of lantana on the Australian grazing sector includes the reduction of approximately:

- \$82.8 million in gross output, with direct<sup>10</sup> and indirect<sup>11</sup> impacts totalling \$46.2 million and \$36.6 million, respectively;
- \$42.0 million in value added or GDP, with direct and indirect impacts totalling \$24.4 million and \$17.6 million, respectively;
- \$16.1 million in wages and salaries paid, with direct and indirect impacts totalling \$7.6 million and \$8.4 million, respectively; and
- 744 FTE employment positions, with direct and indirect impacts of 525 and 219 FTEs, respectively.

It is expected that many of the direct employment positions identified would be absorbed by existing family labour.

#### **Implication:**

*The value of lost production (net of expenditure on control initiatives) of lantana to the Australian economy is estimated to be significant resulting in up to \$42.0 million lost in value added production and over 744 employment positions.*

<sup>10</sup> Direct impacts: are the first round of effects experienced in response to expenditure on goods and services.

<sup>11</sup> Indirect impacts: are the second and subsequent round effects of increased purchases by suppliers in response to increased sales. The indirect effect examined in this analysis is termed the industrial support effect.

## 6. Key Findings & Limitations

### 6.1 Key Findings

#### 6.1.1 Cost Impact

The presence of lantana in Australia costs the Australian grazing sector approximately \$104.3 million (2005/06) per annum in terms of lost productivity, and increased management expenses. This is comprised of approximately \$70.8 million in Queensland and \$33.4 million in NSW.

The majority of landholders generally consider the other economic impacts of lantana to be insignificant. However, where occurring and quantified, they equate to significant impacts in lost production and increased maintenance costs. This implies that landholders may not fully understand or appreciate the magnitude of the impact that lantana has on their land.

Land value is impacted once lantana is present regardless of the level and extent of the infestation. There is little variation between the average reduction in land value for the total property area (\$8.54/ha) and the infested areas (\$12.95/ha).

#### 6.1.2 Control Cost

There is a wide range of landholder expenditure (virtually \$0/ha to greater than \$100/ha) on different control techniques across varying densities of infestation. Expenditure on current control initiatives by landholders is estimated to be in the order of \$17.1 million per year (2005/06).

Control techniques employed by landholders appear to reduce the area of medium and light infestations. However, in areas of heavy infestation, control techniques are generally only expected to slow the rate of expansion, not reduce the area infested, however, individual cases of successful control have been reported.

In some cases it may be highly beneficial to clear lantana for agricultural use, however on average, there is no financial incentive for landholders to control lantana on their land. This is because, on average, the benefits from control do not outweigh the cost of control. This is highlighted by the indicative calculation in the following table for the control of a hectare of medium infestation.

**Table 6.1. Calculation of Indicative Benefits of Controlling Lantana (Medium Infestation)**

Description	Data
Cost of Lantana (\$/ha) (A)	-\$42.78
Control Cost (\$/ha) (Medium Infestation) (B)	\$62.60
Benefits of Controlling Lantana (\$/ha) (C)	\$42.78
Net Benefit From Control (\$/ha) (D = C - B)	-\$19.82

Note: The benefit of control (C) is equal to the removal of the cost impact of lantana (A).

It is expected that continuing with existing control initiatives will yield a negative net present value (NPV) over 30 years of approximately \$219.7 million. However, whilst on average there is no financial incentive to control lantana, landholders still manage and control lantana infestations in strategic locations. Where landholders are able to successfully control lantana infestations in the lower end of the control cost profile (reported in Section 3.4.3) this would likely lead to production benefits from controlling lantana in both the short and long term.

Aside from production benefits, landholders also control lantana for other intangible benefits, such as preventing environmental degradation, ease of management and property access and to preserve the future productive capacity of their land.

Where the continuation of the biological control program for lantana resulted in the release of successful control agents, it is expected this would result in significant production and non-production based benefits. To examine and test this, a hypothetical example was developed for production impacts. The hypothetical example examined a biological control research program undertaken for a period of approximately 10 years (costing approximately \$300,000 per year<sup>12</sup>) with a five year establishment program that resulted in the successful release of agents that achieved approximately 50% effectiveness (that is, reducing the impact of lantana by 50% at the end of year 15). This scenario was identified to be highly desirable, with the potential to return over \$90 for every dollar invested<sup>13</sup>.

### 6.1.3 Economic Impact

The presence of lantana decreases the productivity (or output) of the Australian grazing sector through impacts such as stock poisoning/ health and reduced carrying capacity. This subsequently reduces the contribution of the Australian grazing sector to the Australian economy through direct and flow-on (turnover of goods and services utilised in the agricultural production process) impacts. This loss in productivity is partially offset by investments made by landholders in the control of lantana, which also contributes to economic activity.

The value of lost production from the Australian grazing sector resulting from the presence of lantana is expected to be approximately \$46.2 million annually<sup>14</sup>. This has a total negative impact, direct and flow-on, to the Australian economy of approximately:

- \$82.8 million in gross output;
- \$42.0 million in value added or GDP;
- \$16.1 million in wages and salaries paid; and
- 744 full time equivalent employment positions.

### 6.1.4 Social and Environmental Impacts

Lantana was identified to have many social and environmental impacts, for which there was little quantifiable data available.

The negative impacts of lantana were identified to outweigh the perceived positive impacts. The most significant negative social and environmental impacts identified by landholders are outlined in the following table.

**Table 6.2. Qualitative Negative Impacts of Lantana**

Impact	Weighted Average <sup>(a)</sup>
Removes and/or replaces native vegetation	3.6
Reduces the conservation value of your land	3.5
Reduced scenic amenity of your land	3.4
Restriction in the movements of animals/humans	3.4
Harbours feral animals	3.4
Increases management stress	3.3
Restricts property access	3.3
Increases the risk of fire	3.0
Displaces native animals	2.9
Impacts negatively on tourism	2.7

Note: Weighted average across a 0-5 rating scale, with a maximum score of 5.

The following positive impacts were also recorded; however, their average scores indicate they are considered relatively insignificant.

<sup>12</sup> Estimated annual cost of two full time researchers and associated on costs.

<sup>13</sup> Assumes a 10-year research program (at \$300,000/ year), 5-year establishment program (at \$50,000/ year) and 50% agent efficacy.

<sup>14</sup> Net of expenditure on control initiatives

**Table 6.3. Qualitative Positive Impacts of Lantana**

Impact	Weighted Average <sup>(a)</sup>
Stabilising soil and preventing erosion	2.5
Aesthetically pleasing	2.3
Improved soil for pasture renovation	2.1

Note: Weighted average across a 0-5 rating scale, with a maximum score of 5.

Whilst the environmental or social impacts of lantana were rated qualitatively, no data was identified to accurately quantify these impacts. A study conducted by AECgroup (2003) examined the value and impact of environmental weeds in Queensland within areas of high conservation value, such as national parks. The study identified an average environmental impact value of \$72.5 million per annum (2003 values) in Queensland. The study identified using contingent valuation (dichotomous choice) by asking households their willingness to pay to protect areas of high conservation significance in Queensland from lantana, which was identified to be approximately \$55/household per year.

It is interesting to note that the quantified production and environmental value of lantana in Queensland on an annual basis is roughly equivalent.

## 6.2 Limitations of the study

The nature and extent of the impacts of lantana in this study were based on available information gathered from the survey and from the review of existing literature. The outcomes could be improved if the following information were also available:

- Reduced size of grid squares: Smaller grid squares utilised in CLIMEX modelling would lead to increased levels of detail and accuracy. Proxies were developed to more accurately estimate the actual areas of infestation in the analysis;
- Improved assumptions surrounding the base assumptions in the CLIMEX modelling: Anecdotal evidence suggests that perhaps some of these should be amended (for example: maximum altitude, temperature assessments);
- Validation of CLIMEX modelling: Where the current area of infestation exceeded the future maximum predicted by CLIMEX modelling the current area was used and assumed to be at maximum distribution;
- Land use by area: Paucity of data relating to the area of land classed as grazing use that is actually productive land verses natural habitat or bushland;
- Rate of expansion of existing infestations by density of infestation: Would assist in the development of detailed growth models examining infestation rates;
- Rate of expansion into new areas and establishment process: Would assist in the development of detailed growth models examining infestation rates; and
- Quantified environmental and social impacts: Would assist in understanding the less tangible impacts associated with lantana in non-production areas.

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## Appendix A: Cost Benefit Analysis

A cost benefit analysis (CBA) model is applied to the quantifiable components of the projects to identify their return on investment.

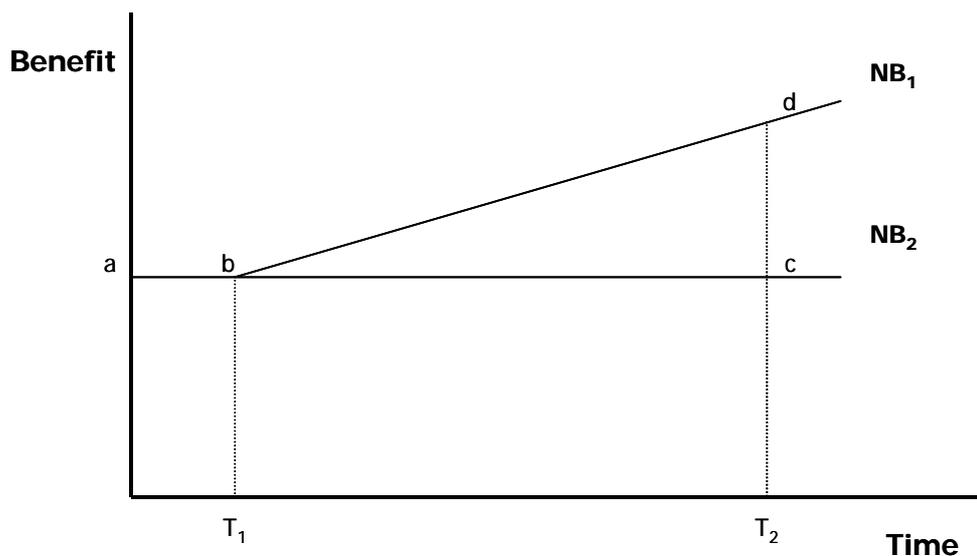
The CBA model used for each of the projects examined is also used to assess an indicative overall benefit flowing from an investment program. The process of steps to conduct a CBA is summarised in Figure A.1, and the key steps of the process, adapted from Sinden and Thampapillai (1995), are discussed below.

### Step 1. Define Scope and Boundary

To enable a robust determination of the net benefits of undertaking a given project, it is necessary to specify base case and alternative case scenarios. The base case scenario represents the “without project” scenario and the alternative or “with project” scenario examines the impact with the program in place.

The base case (without) scenario is represented by line  $NB_2$  (bc) over time  $T_1$  to  $T_2$  (Figure A.1). An investment at time  $T_1$  is likely to generate a benefit, which is represented by line  $NB_1$  (abd). Therefore the net benefit flowing from the investment initiative is identified by calculating the area (bcd) between  $NB_1$  and  $NB_2$ .

Figure A.1. With and Without Scenarios



Source: AECgroup

### Step 2. Identify Costs and Benefits

A comprehensive quantitative specification of the benefits and costs included in the evaluation and their various timings is required and includes a clear outline of all major underlying assumptions. These impacts both positive and negative are then tabulated and where possible valued in dollar terms.

Some impacts, such as environmental and social impacts may not be quantifiable. Where this occurs the impacts and their respective magnitudes will be examined qualitatively for consideration in the overall analysis.

### Step 3. Value Costs and Benefits

Each impact identified should be valued for inclusion in the CBA. Where the impact does not have a readily identifiable dollar value, proxies and other measures should be developed as these issues represent real costs and benefits. Where the application of

market or non-market valuation techniques is not possible, the issue should be described qualitatively with respect to the magnitude and extent, and if it is expected to occur in the short-term or long-term.

#### **Step 4. Quantify the Impact**

Each of the identified impacts should be quantified and where this is not possible due to data availability then the impact should be discussed qualitatively to describe the nature and extent of its impact.

#### **Step 5. Tabulate Annual Costs and Benefits**

The quantifiable benefits are tabulated to identify where and how often they occur. Tabulation provides an easy method for checking that all the issues and outcomes identified have been addressed and provides a picture of the flow of costs, benefits and their sources.

#### **Step 6. Calculate the Net Benefit**

This step adjusts for the time preference of money to enable the comparison of investment options by a common measure and requires the choice of a suitable discount rate.

The selection of appropriate discount rates is of particular importance because they apply to much of the decision criteria and consequently the interpretation of results. The higher the discount rate, the less weight or importance is placed on future cash flows.

The choice of discount rates should reflect the weighted average cost of capital. For this analysis a base discount rate of 8.0% was examined with a range from 4.0% to 10.0% examined.

#### **Step 7. Scenario and Risk Analysis**

Scenario and risk analysis allows for the testing of the key assumptions and the identification of the critical variables within the analysis to gain greater insight into the drivers to the case being examined. Variables such as the adoption rate or percentage of uptake may have a significant impact on the outcome of the analysis.

Decision Criteria and Interpretation

The decision criteria that are investigated in the CBA include:

- Net present value (NPV), which represents the present value of all benefits minus the present value of all costs;
- Benefit cost ratio (BCR), which is the present value of benefits divided by the present value of the costs; and
- Breakeven point, which indicates value of a critical variable required for the project to “breakeven” or return a NPV of zero.

These decision criteria will allow the determination of the most economically desirable investment alternative, as well as the level of benefits that can be expected to flow from the investment program. These results may be applied to future expenditure to identify the level of return that may be expected.

Due to the diverse nature of investment programs, not all investment programs will be suited to analysis within an economic framework.

## **Appendix B: Input-Output Analysis**

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### **Explanation of Terms**

#### **Output**

Output refers to the gross value of goods and services transacted, including the costs of goods and services used in the construction or manufacture of the final product. Output impacts generally overstate the economic impacts as they count all goods and services used in one stage of production as an input to later stages of production, hence counting their contribution more than once.

#### **Value Added**

Value added refers to the value of output after deducting the cost of goods and services inputs in the construction process. Value added defines the true net contribution made to the economy or Gross Regional Product (GRP). The GRP impact is the preferred measure for the economic impact assessment of a project.

#### **Income**

The income impact measures the additional amount of wages and salaries paid to employees of the industry under consideration and to other industries benefiting from the project.

#### **Employment**

Employment refers to the number of new part-time and full-time jobs created by the economic shock, both directly and indirectly, and is expressed in terms of full time equivalent (FTE) positions.

### **Limitations of Input-Output Analysis**

The key limitations of input output analysis include:

- The inputs purchased by each industry are a function only of the level of output of that industry. The input function is generally assumed linear and homogenous of degree one (which implies constant returns to scale and no substitution between inputs).
- Each commodity (or group of commodities) is supplied by a single industry or sector of production. This implies that there is only one method used to produce each commodity and that each sector has only one primary output.
- The total effect of carrying on several types of production is the sum of the separate effects. This rules out external economies and diseconomies and is known simply as the additivity assumption. This generally does not reflect real world operations.
- The system is in equilibrium at given prices. This is not the case in an economic system subject to external influences.
- In the static input-output model, there are no capacity constraints so that the supply of each good is perfectly elastic. Each industry can supply whatever quantity is demanded of it and there are no capital restrictions. This assumption would come into play depending upon the magnitude of the changes in quantities demanded.



# Appendix C: Survey Instrument

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# SURVEY INSTRUMENT

## 1. INTRODUCTION

AEC Group Limited, on behalf of the National Lantana Management Strategy and the Queensland Department of Natural Resources, Mines and Water (NRMW), is conducting this survey to identify the economic, social and environmental impacts of Lantana in Australia.

This survey is expected to take approximately 15 minutes to complete.

All responses to this survey are confidential. The results of the analysis will be published by NRMW in late 2006.

Please complete and return your survey via the attached reply-paid envelope before:  
**4<sup>th</sup> of August, (Friday), 2006**

## 2. LAND INFORMATION

	Question	Yes/No
2.1	Do you currently have lantana on your land?	<sub>1</sub> <input type="checkbox"/> Yes <sub>2</sub> <input type="checkbox"/> No <sub>3</sub> <input type="checkbox"/> Unsure
2.2	How long has lantana been on your land? (Years) (please tick only 1)	<sub>1</sub> <input type="checkbox"/> <5 Years <sub>2</sub> <input type="checkbox"/> 5-10 Years <sub>3</sub> <input type="checkbox"/> 10-20 Years <sub>4</sub> <input type="checkbox"/> 20-50 Years <sub>5</sub> <input type="checkbox"/> >50 Years <sub>6</sub> <input type="checkbox"/> Unsure
2.3	Does lantana impact on the:	
(a)	Management of your business?	<sub>1</sub> <input type="checkbox"/> Yes <sub>2</sub> <input type="checkbox"/> No <sub>3</sub> <input type="checkbox"/> Unsure
(b)	Profit of your business?	<sub>1</sub> <input type="checkbox"/> Yes <sub>2</sub> <input type="checkbox"/> No <sub>3</sub> <input type="checkbox"/> Unsure

2.4. Is your land/enterprise predominantly:

*(Tick the relevant box (Yes / No) for each land use AND fill in the area (ha) of relevant land):*

	Land Use	Yes/No	Area (ha)
(a)	Beef	<sub>1</sub> <input type="checkbox"/> Yes <sub>2</sub> <input type="checkbox"/> No <sub>3</sub> <input type="checkbox"/> Unsure	_____ha
(b)	Dairy	<sub>1</sub> <input type="checkbox"/> Yes <sub>2</sub> <input type="checkbox"/> No <sub>3</sub> <input type="checkbox"/> Unsure	_____ha
(c)	Mixed Cropping *	<sub>1</sub> <input type="checkbox"/> Yes <sub>2</sub> <input type="checkbox"/> No <sub>3</sub> <input type="checkbox"/> Unsure	_____ha
(d)	Nature Reserve, etc.	<sub>1</sub> <input type="checkbox"/> Yes <sub>2</sub> <input type="checkbox"/> No <sub>3</sub> <input type="checkbox"/> Unsure	_____ha
(e)	Commercial Plantation	<sub>1</sub> <input type="checkbox"/> Yes <sub>2</sub> <input type="checkbox"/> No <sub>3</sub> <input type="checkbox"/> Unsure	_____ha
(f)	Other (please specify)	<sub>1</sub> <input type="checkbox"/> Yes <sub>2</sub> <input type="checkbox"/> No <sub>3</sub> <input type="checkbox"/> Unsure	_____ha
(g)	Total Land Area (ha)	N/A	_____ha

\* Please note - If only "Cropping", then please continue to Section 7 (Survey Close) – page 9.

### 3. INFESTATION (EXTENT & DENSITY)

3.1. Over the past 5 years has there been any change in the area infested and density of the lantana infestation?

*(Tick the relevant box for BOTH (a) area infested & (b) density of infestation):*

		Stayed the Same	Increased	Decreased
(a)	Area Infested	<sub>1</sub> <input type="checkbox"/>	<sub>2</sub> <input type="checkbox"/>	<sub>3</sub> <input type="checkbox"/>
(b)	Density of Infestation	<sub>1</sub> <input type="checkbox"/>	<sub>2</sub> <input type="checkbox"/>	<sub>3</sub> <input type="checkbox"/>

3.2. Of your total land area, by density of lantana, what percentage would you estimate is currently infested?

*(Please enter a % figure in all boxes)*

*Description of infestation densities:*

- (b) Light: Scattered lantana*
- (c) Medium: Lantana starts to impede your ability to walk*
- (d) Heavy: Lantana prohibits any movement*

	Density of Infestation	Percent of Total Land Area (%)
(a)	Not Infested	%
(b)	Light	%
(c)	Medium	%
(d)	Heavy	%
(e)	<b>Total</b>	%

→ This column should sum to 100%

3.3. Of your total land area, by density of lantana, what percentage would you estimate will be infested in 5 years if current management/control techniques are maintained?

*(Please enter a % figure in all boxes)*

*Description of infestation densities:*

- (b) Light: Scattered lantana*
- (c) Medium: Lantana starts to impede your ability to walk*
- (d) Heavy: Lantana prohibits any movement*

	Density of Infestation	Percent of Total Land Area (%)
(a)	Not Infested	%
(b)	Light	%
(c)	Medium	%
(d)	Heavy	%
(e)	<b>Total</b>	%

→ This column should sum to 100%

3.4. Of your total land area, by density of lantana, what percentage would you estimate will be infested in 20 years if current management/control techniques are maintained?

*(Please enter a % figure in all boxes)*

Description of infestation densities:

- (b) Light: Scattered lantana
- (c) Medium: Lantana starts to impede your ability to walk
- (d) Heavy: Lantana prohibits any movement

	Density of Infestation	Percent of Total Land Area (%)
(a)	Not Infested	%
(b)	Light	%
(c)	Medium	%
(d)	Heavy	%
(e)	<b>Total</b>	%

→ This column should sum to 100%

3.5. If you ceased the current level of management and maintenance what proportion of your land do you think would be infested in:

*(Please enter a % figure in all boxes)*

	Time	% Infested
(a)	1 Year	%
(b)	5 Years	%
(c)	20 Years	%

#### 4. CONTROL

4.1. Do you actively control the lantana in:

*(Tick the relevant box for each type of area controlled [a – f]):*

	Type of Area Controlled	Yes/No
(a)	Production areas?	<sub>1</sub> <input type="checkbox"/> Yes <sub>2</sub> <input type="checkbox"/> No <sub>3</sub> <input type="checkbox"/> Unsure
(b)	Non-production areas?	<sub>1</sub> <input type="checkbox"/> Yes <sub>2</sub> <input type="checkbox"/> No <sub>3</sub> <input type="checkbox"/> Unsure
(c)	Council land?	<sub>1</sub> <input type="checkbox"/> Yes <sub>2</sub> <input type="checkbox"/> No <sub>3</sub> <input type="checkbox"/> Unsure
(d)	National Park?	<sub>1</sub> <input type="checkbox"/> Yes <sub>2</sub> <input type="checkbox"/> No <sub>3</sub> <input type="checkbox"/> Unsure
(e)	Natural Reserve?	<sub>1</sub> <input type="checkbox"/> Yes <sub>2</sub> <input type="checkbox"/> No <sub>3</sub> <input type="checkbox"/> Unsure
(f)	Other public areas?	<sub>1</sub> <input type="checkbox"/> Yes <sub>2</sub> <input type="checkbox"/> No <sub>3</sub> <input type="checkbox"/> Unsure

4.2. If you control Lantana in non-production areas, why do you do so?

*(If no control in Non-productive areas proceed to question 4.3)*

	Reason for Control	Yes/No
(a)	To prevent spread to productive areas	<sub>1</sub> <input type="checkbox"/> Yes <sub>2</sub> <input type="checkbox"/> No <sub>3</sub> <input type="checkbox"/> Unsure
(b)	To maintain environment	<sub>1</sub> <input type="checkbox"/> Yes <sub>2</sub> <input type="checkbox"/> No <sub>3</sub> <input type="checkbox"/> Unsure
(c)	To meet legislative requirements	<sub>1</sub> <input type="checkbox"/> Yes <sub>2</sub> <input type="checkbox"/> No <sub>3</sub> <input type="checkbox"/> Unsure
(d)	Other reason (please specify in area below)	<sub>1</sub> <input type="checkbox"/> Yes <sub>2</sub> <input type="checkbox"/> No <sub>3</sub> <input type="checkbox"/> Unsure

Other Reason:

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4.3. If you do NOT control Lantana in non-production areas, why is this?

Reason:

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4.4. What sort of control techniques do you use in productive and/or non-productive areas and which is most commonly used?

*(Tick the relevant box for each control technique [a – f] and then tick the (1) most commonly used):*

	Control Technique	Yes/No	Most Commonly Used Control Method (Tick only one)
(a)	Mechanical	1 <input type="checkbox"/> Yes 2 <input type="checkbox"/> No 3 <input type="checkbox"/> Unsure	1 <input type="checkbox"/>
(b)	Chemical	1 <input type="checkbox"/> Yes 2 <input type="checkbox"/> No 3 <input type="checkbox"/> Unsure	2 <input type="checkbox"/>
(c)	Manual Labour	1 <input type="checkbox"/> Yes 2 <input type="checkbox"/> No 3 <input type="checkbox"/> Unsure	3 <input type="checkbox"/>
(d)	Fire	1 <input type="checkbox"/> Yes 2 <input type="checkbox"/> No 3 <input type="checkbox"/> Unsure	4 <input type="checkbox"/>
(e)	Biological Control	1 <input type="checkbox"/> Yes 2 <input type="checkbox"/> No 3 <input type="checkbox"/> Unsure	5 <input type="checkbox"/>
(f)	Other (please specify)	1 <input type="checkbox"/> Yes 2 <input type="checkbox"/> No 3 <input type="checkbox"/> Unsure	6 <input type="checkbox"/>

Please specify other control techniques:

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4.5. What do you estimate you currently spend, on average, on controlling/maintaining lantana for each of the following infestation densities per year?

*(answer either by ticking the relevant category in the \$ / ha / yr column, OR in the Total \$/year)*

**Annual Per Hectare Estimate**

	Infested Area	\$/ha/year						OR	Total \$/year
		<\$5	\$5-\$15	\$15-\$30	\$30-\$60	\$60-\$120	>\$120		
(a)	Expenditure on Control in <b>Light</b> Infestations	1 <input type="checkbox"/>	2 <input type="checkbox"/>	3 <input type="checkbox"/>	4 <input type="checkbox"/>	5 <input type="checkbox"/>	6 <input type="checkbox"/>		\$ _____
(b)	Expenditure on Control in <b>Medium</b> Infestations	1 <input type="checkbox"/>	2 <input type="checkbox"/>	3 <input type="checkbox"/>	4 <input type="checkbox"/>	5 <input type="checkbox"/>	6 <input type="checkbox"/>		\$ _____
(c)	Expenditure on Control in <b>Heavy</b> Infestations	1 <input type="checkbox"/>	2 <input type="checkbox"/>	3 <input type="checkbox"/>	4 <input type="checkbox"/>	5 <input type="checkbox"/>	6 <input type="checkbox"/>		\$ _____

## 5. OTHER ECONOMIC IMPACTS

5.1. Can you please indicate whether lantana impacts on your business in any of the following ways, and if it is a significant or insignificant impact in relation to the overall operation of your business?

(answer either by indicating whether each impact [a – f] is:

- Significant / Insignificant; **AND**
- Tick the relevant category in the \$ / ha / yr column; **OR**
- Indicate the Total \$/year).

	Impact	Significant/ Insignificant (S/I)	\$/ha/year						Total \$/year
			<\$5	\$5-\$15	\$15-\$30	\$30-\$60	\$60-\$120	>\$120	
	<i>Production Losses:</i>								
(a)	Stock poisoning/health	<input type="checkbox"/> Significant <input type="checkbox"/> Insignificant <input type="checkbox"/> Unsure	1 <input type="checkbox"/>	2 <input type="checkbox"/>	3 <input type="checkbox"/>	4 <input type="checkbox"/>	5 <input type="checkbox"/>	6 <input type="checkbox"/>	\$ _____
(b)	Increased mustering costs	<input type="checkbox"/> Significant <input type="checkbox"/> Insignificant <input type="checkbox"/> Unsure	1 <input type="checkbox"/>	2 <input type="checkbox"/>	3 <input type="checkbox"/>	4 <input type="checkbox"/>	5 <input type="checkbox"/>	6 <input type="checkbox"/>	\$ _____
(c)	Reduced carrying capacity	<input type="checkbox"/> Significant <input type="checkbox"/> Insignificant <input type="checkbox"/> Unsure	1 <input type="checkbox"/>	2 <input type="checkbox"/>	3 <input type="checkbox"/>	4 <input type="checkbox"/>	5 <input type="checkbox"/>	6 <input type="checkbox"/>	\$ _____
	<i>Management/Operation:</i>								
(d)	Increased maintenance costs (clearing fences, tracks, firebreaks, etc – does not include control costs)	<input type="checkbox"/> Significant <input type="checkbox"/> Insignificant <input type="checkbox"/> Unsure	1 <input type="checkbox"/>	2 <input type="checkbox"/>	3 <input type="checkbox"/>	4 <input type="checkbox"/>	5 <input type="checkbox"/>	6 <input type="checkbox"/>	\$ _____
	<i>Other:</i>								
(e)	Land value	<input type="checkbox"/> Significant <input type="checkbox"/> Insignificant <input type="checkbox"/> Unsure	1 <input type="checkbox"/>	2 <input type="checkbox"/>	3 <input type="checkbox"/>	4 <input type="checkbox"/>	5 <input type="checkbox"/>	6 <input type="checkbox"/>	\$ _____
(f)	Other financial impacts	<input type="checkbox"/> Significant <input type="checkbox"/> Insignificant <input type="checkbox"/> Unsure	1 <input type="checkbox"/>	2 <input type="checkbox"/>	3 <input type="checkbox"/>	4 <input type="checkbox"/>	5 <input type="checkbox"/>	6 <input type="checkbox"/>	\$ _____

Please specify Other Financial Impacts:

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## 6. QUALITATIVE IMPACTS (TBL)

6.1. Could you please rate the following statements regarding the economic impacts of lantana, in terms of the impact that it currently has?

*(use the rating scale outlined below for both positive and negative impacts)*

**Rating Scale:**

- 0** No impact
- 1** Impact is unlikely to be measurable or observable
- 2** Detectable, but not significant
- 3** Observable but localised impacts
- 4** Observable wider and longer term impacts
- 5** Easily observed and irreversible impacts

	Impact	Rating (0-5)					
(a)	Impacts negatively on tourism (negative impact)	<input type="checkbox"/>					
		0	1	2	3	4	5
(b)	Restricts access (negative impact)	<input type="checkbox"/>					
		0	1	2	3	4	5
(c)	Provides a benefit in terms of improving soil for pasture renovation (positive impact)	<input type="checkbox"/>					
		0	1	2	3	4	5

6.1.1 Are there any other important factors that need to be considered to evaluate the economic impact of lantana? If yes, how would you rate them?

*(use the rating scale outlined previously: Question 6.1 – this page)*

	Other Impacts	Rating (0-5)					
(a)		<input type="checkbox"/>					
		0	1	2	3	4	5
(b)		<input type="checkbox"/>					
		0	1	2	3	4	5
(c)		<input type="checkbox"/>					
		0	1	2	3	4	5

6.2. Could you please rate the following statements regarding the environmental impacts of lantana, in terms of the impact that it currently has

*(use the rating scale outlined previously: Question 6.1 – this page)*

	Impact	Rating (0-5)					
(a)	Removes and/or replaces native vegetation (negative impact)	<input type="checkbox"/>					
		0	1	2	3	4	5
(b)	Displaces native animals (negative impact)	<input type="checkbox"/>					
		0	1	2	3	4	5
(c)	Harbours feral animals (negative impact)	<input type="checkbox"/>					
		0	1	2	3	4	5
(d)	Reduces the conservation value of your land (negative impact)	<input type="checkbox"/>					
		0	1	2	3	4	5
(e)	Stabilises soil and prevents erosion (positive impact)	<input type="checkbox"/>					
		0	1	2	3	4	5
(f)	Increases the risk of fire (negative impact)	<input type="checkbox"/>					
		0	1	2	3	4	5

6.2.1 Are there any other important factors that need to be considered to evaluate the environmental impact of lantana? If yes, how would you rate them?

*(use the rating scale outlined below for both positive and negative impacts)*

**Rating Scale:**

- 0** No impact
- 1** Impact is unlikely to be measurable or observable
- 2** Detectable, but not significant
- 3** Observable but localised impacts
- 4** Observable wider and longer term impacts
- 5** Easily observed and irreversible impacts

	Other Impacts	Rating (0-5)					
(a)		<input type="checkbox"/>					
		0	1	2	3	4	5
(b)		<input type="checkbox"/>					
		0	1	2	3	4	5
(c)		<input type="checkbox"/>					
		0	1	2	3	4	5

6.3. Could you please rate the following statements regarding the social impacts of lantana, in terms of the impact that it currently has

*(use the rating scale outlined previously: Question 6.2.1 – this page)*

	Impact	Rating (0-5)					
(a)	Reduces the scenic amenity of your land (negative impact)	<input type="checkbox"/>					
		0	1	2	3	4	5
(b)	Restricts the movements of animals/humans (negative impact)	<input type="checkbox"/>					
		0	1	2	3	4	5
(c)	Increases your management stress (negative impact)	<input type="checkbox"/>					
		0	1	2	3	4	5
(d)	Is aesthetically pleasing (positive impact)	<input type="checkbox"/>					
		0	1	2	3	4	5

6.3.1 Are there any other important factors that need to be considered to evaluate the social impact of lantana? If yes, how would you rate them?

*(use the rating scale outlined previously: Question 6.2.1 – this page)*

	Other Impacts	Rating (0-5)					
(a)		<input type="checkbox"/>					
		0	1	2	3	4	5
(b)		<input type="checkbox"/>					
		0	1	2	3	4	5
(c)		<input type="checkbox"/>					
		0	1	2	3	4	5

## 7. SURVEY CLOSE

7.1. Please complete the following stakeholder information.

Please note all information provided is confidential and is unable to be traced back to the respondent.

	Description	Input
(a)	State	<input type="checkbox"/> Queensland <input type="checkbox"/> NSW
(b)	Local Government Area (Council)	_____
(c)	Postcode	_____
(d)	Age of farm manager (years)	_____
(e)	Indicative annual farm turnover (\$)	_____

7.2. Are there any other issues that you would like to raise regarding the management and control of lantana or its impacts?

Please specify other issues/impacts:

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**Thank you for your assistance in completing this survey.**

Please return in the supplied reply paid envelope

**OR**

address to: AEC Group Ltd, Reply Paid Box 5804 MC, Townsville QLD 4810 (no stamp required)

**OR**

Fax - for the "Attention of Ashley Page" on (07) 3831 3899.

For clarification or additional comment regarding this survey or project, please contact:

Ashley Page  
Resource Economist (AEC Group Ltd)  
PO Box 942  
Spring Hill QLD 4004

Phone: (07) 3831 0577  
Fax: (07) 3831 3899  
Email: [ashley@aecgrouppltd.com](mailto:ashley@aecgrouppltd.com)

## **Appendix D: Survey Analysis & Results**



# **Economic Assessment of the Impact of Lantana in Queensland: Survey Results**

## **Survey Findings Report**

**Department of Natural Resources &  
Water**

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## Executive Summary

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The following comments and dot points consolidate the findings of the analysis.

### Respondent Mix

The following percentages indicate the range of enterprises/ land use activities the respondents were engaged in:

- 60.9% beef;
- 30.6% nature/ reserve;
- 9.8% mixed cropping;
- 8.0% commercial plantation; and
- 4.9% dairy.

76.6% of landholder respondents were from Queensland and 23.4% were from NSW.

### Infestation (Extent and Density)

For landholders undertaking control measures on average:

- The area infested is decreasing; and
- However, the density of the infestation is increasing.

With the continuation of existing control efforts, landholders expect to reduce the area of infestation over the next five years or so, with little progress made beyond that time.

With the continuation of existing control efforts, whilst the total infested area is expected to decrease, the density of infestation is expected to increase, as indicated by a:

- Slight reduction in the area infested over the next five years, with little change beyond that;
- Reduction in the areas 'light' infestation;
- Little change in areas of 'medium' infestation; and
- Increase in areas of heavy infestation.

Those actively controlling Lantana expect to have reduce the area of infestation.

### Cost/Financial Impact of Lantana

Landholders spend on average controlling Lantana:

- In light infestations approximately:
  - \$44.00/ha in the treatment area; and
  - \$3.70/ha over the total area of infested land.
- In medium infestations approximately:
  - \$62.60/ha in the treatment area; and
  - \$8.20/ha over the total area of infested land.
- In heavy infestations approximately:
  - \$75.10/ha in the treatment area; and
  - \$10.8/ha over the total area of infested land.

Landholders appear to spend significantly more in both the treatment area and per area of infestation than Government agencies.

The impact on land values of having Lantana appears to be disproportionately spread over the entire property value, perhaps due to the risk of expansion.

# 1. Introduction

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## 1.1 Purpose of Study

The AECgroup were commissioned by the Department of Natural Resources and Water (NRW) to undertake an assessment of the economic impacts of *Lantana camara* and *Lantana montevidensis* (collectively referred to as Lantana) in Queensland to provide information for policy development and funding decisions.

The purpose of the survey is to provide quantifiable data on the impacts and issues associated with Lantana and its subsequent control in Queensland (QLD) and New South Wales (NSW). The information will be used by NRW to assess the costs and benefits of Lantana on production, natural areas and other public areas.

## 1.2 Methodology and Process

A database of contact details of landholders and key stakeholders were made available to the AECgroup by NRW at the commencement of the project.

The following five-step process was utilised in the facilitation of the Lantana survey:

1. *Development*: A mail-out survey was designed in conjunction with NRW.
2. *Recruitment*: Telephone calls were conducted during August 2006 to invite landholders with Lantana to participate in the mail-out survey.
3. *Mail Out*: The mail out survey was distributed to those landholders in QLD and NSW region who agreed to participate in the survey.
4. *Follow Up*: Telephone reminders were undertaken to encourage a higher response rate.
5. *Analysis*: Survey results were processed using the relational database software, SPSS and Microsoft Access.

## 1.3 Sample Size and Confidence Interval

The survey was sent to 502 landholders in QLD and NSW region, with 385 responses received, which equates to a response rate of 76.7%. Of those 385 responses received, 376 responses were recorded and analysed, which delivers a confidence interval of approximately +/- 4.9%<sup>1</sup>. Nine (9) responses were excluded from the analysis due to landholders indicating that they no longer have Lantana on their land and partial completion.

## 1.4 Survey Content

The survey included questions on:

- Distribution;
- Rate of spread;
- Types of benefits and costs of Lantana across economic, social and environmental impacts (including control costs); and
- Quantification of benefits and costs, with a view of identifying per hectare values.

The survey instrument is attached as **Appendix A**.

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<sup>1</sup> Calculated on an average of 7,500 landholder population, assuming that between 5,000-10,000 landholders are in QLD and NSW.

## 2. Survey Results

### 2.1 Landholder

#### 2.1.1 Land Information

A high proportion of landholders have had Lantana on their land for:

- 20-50 years (31.1%);
- More than 50 years (26.6%); and
- 10-20 years (13.6%).

However, this could also be representative of the length of land ownership/management.

**Table 2.1: How Long Has Lantana Been on Your Land (Q 2.2)?**

Response	Proportion (%)
No response	1.1%
<5 Years	0.5%
5-10 Years	4.5%
10-20 Years	13.6%
20-50 Years	31.1%
>50 Years	26.6%
Unsure	22.6%
<b>Total</b>	<b>100.0%</b>

The majority (57.7%) of respondents indicated that Lantana has an impact on the management of their business, while 35.6% did not consider that Lantana impacted on their management.

**Table 2.2: Does Lantana Impact on the Management of Your Business (Q2.3a)?**

Response	Proportion (%)
No response	4.3%
Yes	57.7%
No	35.6%
Unsure	2.4%
<b>Total</b>	<b>100.0%</b>

A high proportion (49.5%) of respondents indicated that Lantana impacts on the profit of their business. However, 41.0% did not consider that Lantana impacted on business profit.

**Table 2.3: Does Lantana Impact on the Profit of Your Business (Q2.3b)?**

Response	Proportion (%)
No response	5.1%
Yes	49.5%
No	41.0%
Unsure	4.5%
<b>Total</b>	<b>100.0%</b>

A high proportion of respondents reported that their land/enterprise is predominantly:

- Beef (60.9%);
- Nature, Reserve (30.6%); and
- Mixed cropping (9.8%).

A small proportion (4.8%) have dairy on their land.

**Table 2.4: Is Your Land/Enterprise Predominantly (Q2.4):**

Response	Yes (%)
Beef	60.9%
Dairy	4.8%
Mixed Cropping	9.8%
Nature, Reserve	30.6%
Commercial Plantation	8.0%
Other	29.3%

Note: Total will not sum to 100% as respondents indicated more than one activity.

Other commonly specified land use include:

- Private/residential (23.6%);
- Native forest/bush (10.9%); and
- Horse (5.5%).

**Table 2.5: Other Specified (Q2.4 specified)**

Response	Proportion (%)
Private/Residential	23.6%
No Response	20.0%
Native forest/Bush	10.9%
Horse	5.5%
Orchard	1.8%
Hobby Farm	1.8%
Community Education	1.8%
Nursery Plant Stock	1.8%
House Agestment	0.9%
Sugar Cane	0.9%
Macadamia	0.9%
Deer Grazing	0.9%
Irrigated Pasteur	0.9%
Nursery	0.9%
Coffee Grazing	0.9%
Living and Working Area	0.9%
Non commercial grazing	0.9%
Fruit tree	0.9%
Tourism	0.9%
Floriculture	0.9%
Boat building Accommodation	0.9%
Roads and sheds	0.9%
Sheep	0.9%
Timber	0.9%
Horticulture	0.9%
Unproductive	0.9%
<b>Total</b>	<b>100.0%</b>

## 2.1.2 Infestation (Extent & Density)

A higher proportion of respondents indicated that over the past five years

- The **area** of infestation has decreased (46.2%); and
- The **density** of infestation has increased (39.2%). However, this was only marginally greater than the decrease in density (37.5%).

This indicates that where Lantana is actively controlled, its spread can be prevented, however, where it exists, density is most likely to increase.

**Table 2.6: Over the Past 5 Years, Has There Been Any Change in the Area Infested and Density of the Lantana Infestation (Q 3.1)?**

Response	Stayed the Same (%)	Increased (%)	Decreased (%)	Total
Area Infested	23.0%	30.8%	46.2%	100.0%
Density of Infestation	23.3%	39.2%	37.5%	100.0%

Note: Does not include 'no responses'. Number of 'no response' is 1.6% in area infested and 6.4% in density of infestation.

On average, respondents estimated that:

- 51.1% of their total land area is not infested;
- 22.6% is heavily infested;
- 15.8% is medium; and
- 10.5% is heavily infested.

**Table 2.7: Of Your Total Land Area, by Density of Lantana, What Percentage Would You Estimate is Currently Infested (Q3.2)?**

Response	Total Land Area (%)
Not Infested	51.1%
Light	22.6%
Medium	15.8%
Heavy	10.5%
<b>Total</b>	<b>100.0%</b>

Note: Only includes those respondents who answered Q3.2, Q3.3 and Q3.4 to ensure consistency of results.

On average, respondents estimated that in five years time, if current management/control techniques are maintained:

- 56.5% of their total land area would not be infested;
- 20.4% would be lightly infested;
- 12.3% would be medium; and
- 10.8% would be heavily infested.

**Table 2.8: Of Your Total Land Area, by Density of Lantana, What Percentage Would You Estimate Will be Infested in 5 Years if Current Management/Control Techniques are Maintained (Q3.3)?**

Response	Total Land Area (%)
Not Infested	56.5%
Light	20.4%
Medium	12.3%
Heavy	10.8%
<b>Total</b>	<b>100.0%</b>

Note: Only includes those respondents who answered Q3.2, Q3.3 and Q3.4 to ensure consistency of results.

On average, respondents estimated that in 20 years time, if current management/control techniques are maintained:

- 57.6% of their total land area would not be infested;
- 15.1% would be lightly infested;
- 14.7% would be medium; and
- 12.7% would be heavily infested.

**Table 2.9: Of Your Total Land Area, by Density of Lantana, What Percentage Would You Estimate Will be Infested in 20 Years if Current Management/Control Techniques are Maintained (Q3.4)?**

Response	Total Land Area (%)
Not Infested	57.6%
Light	15.1%
Medium	14.7%
Heavy	12.7%
<b>Total</b>	<b>100.0%</b>

Note: Only includes those respondents who answered Q3.2, Q3.3 and Q3.4 to ensure consistency of results.

On average, respondents estimated that if they ceased the level of management and maintenance:

- 38.5% of their land would be infested in 1 year;
- 44.4% of their land would be infested in 5 years; and
- 58.8% of their land would be infested in 20 years.

**Table 2.10: If You Ceased the Level of Management and maintenance, What Proportion of Your Land Do You Think Would Be Infested in (Q3.5)?**

Response	Total Land Area (%)
1 Year	38.5%
5 Years	44.4%
20 Years	58.8%

Note: Potential respondent error as infestation in one year is, on average, less than in previous questions.

### 2.1.3 Control

The most common areas of controlling Lantana are in:

- Production areas (71.8%);
- Non-production areas (58.8%);
- Adjoining Council land (26.6%); and
- Natural Reserve (21.8%).

**Table 2.11: Do you Actively Control the Lantana in (Q4.1)?**

	Yes (%)
Production areas	71.8%
Non-production areas	58.8%
Council land	26.6%
National Park	4.8%
Natural Reserve	21.8%
Other public areas	11.7%

Of those respondents who control Lantana in non-production areas:

- The majority (82.8%) do so to maintain the environment;
- 77.8% do so to prevent spread to productive areas;
- 9.0% do so to meet legislative requirements; and
- 24.0% nominating 'other' reasons.

**Table 2.12: If you Control Lantana in Non-Production Areas, Why Do You Do So (Q4.2)?**

	Yes (%)
To prevent spread to productive areas	77.8%
To maintain environment	82.8%
To meet legislative requirements	9.0%
Other reason	24.0%

The most frequently nominated control techniques used in productive and/or non-productive areas include:

- Chemical (78.7%);
- Manual Labour (69.9%); and
- Mechanical (54.0%).

**Table 2.13: What Sort of Control Techniques do you use in Productive and/or Non-Productive Areas (Q4.4)?**

	Yes (%)
Mechanical	54.0%
Chemical	78.7%
Manual Labour	69.9%
Fire	30.1%
Biological Control	10.1%
Other	3.5%

The most common method of controlling Lantana is:

- Chemical (34.3%); and
- Manual labour (26.1%).

**Table 2.14: Which is the Most Common Method (Q4.4)?**

Response	Most Common Method
Not Indicated	23.4%
Mechanical	13.3%
Chemical	34.3%
Manual Labour	26.1%
Fire	2.9%
<b>Total</b>	<b>100.0%</b>

Of those respondents that indicated a cost of controlling/maintaining Lantana, on average, a high proportion currently spend:

- Less than \$5 per ha per year on controlling Lantana in light infestations (26.8%);
- Less than \$5 per ha per year on controlling Lantana in medium infestations (18.6%); and
- More than \$120 per ha per year (30.6% of respondents) on controlling Lantana in heavy infestations.

**Table 2.15: What do you Estimate you Currently Spend, on Average, on Controlling/Maintaining Lantana for each of the Following Infestation Densities Per Year (Q4.5)?**

	<\$5	\$5-\$15	\$15-\$30	\$30-\$60	\$60-\$120	>\$120	Total
Light Infestations	26.8%	21.6%	15.0%	15.5%	8.0%	13.1%	100.0%
Medium Infestations	18.6%	15.7%	16.4%	13.6%	15.0%	20.7%	100.0%
Heavy Infestations	22.4%	14.9%	6.7%	14.2%	11.2%	30.6%	100.0%

Note: Does not include 'no responses'. Number of 'no response' is 43.4% in light infestations, 62.8% in medium infestations and 64.4% in heavy infestations.

**Table 2.15** shows the spread of economic expenditure in infested areas. **Table 2.16** highlights the difference between expenditure in the treatment site and the total infested area.

- The cost of control per ha in light infestations is:
  - \$44.00 in the treatment area; and
  - \$3.70 over the total area of infested land.
- The cost of control per ha in medium infestations is:
  - \$62.60 in the treatment area; and
  - \$8.00 over the total area of infested land.
- The cost of control per ha in heavy infestations is:
  - \$75.10 in the treatment area; and
  - \$10.80 over the total area of infested land.

**Table 2.16: Cost of Control (\$/Ha/Yr) (Q 4.5)**

	Average Cost/Treatment Area (\$/ha/yr)	Average Cost Over Infested Area (\$/ha/yr)
Light Infestations	\$44.00	\$3.70
Medium Infestations	\$62.60	\$8.00
Heavy Infestations	\$75.10	\$10.80

#### 2.1.4 Other Economic Impacts

On the balance, of those respondents answering this question, the majority of landholders consider that Lantana has a significant economic impact on 'increased maintenance costs' 48.9%.

Just under half of respondents considered that the impact of 'reduced carrying capacity' also had a significant impact.

Of those respondents answering this question, a relatively high proportion recorded the following as having **insignificant** economic impacts:

- Stock poisoning/health (67.8%);
- Increased mustering costs (77.0%);
- Other financial impacts (48.7%);
- Reduced carrying capacity (48.1%); and
- Land value (44.6%).

**Table 2.17: Can You Please Indicate Whether Lantana is a Significant or Insignificant Impact in Relation to the Overall Operation of Your Business (Q5.1)?**

	Significant	Insignificant	Unsure	Total
<b>Production Losses:</b>				
Stock poisoning/health	21.3%	67.8%	10.9%	100.0%
Increased mustering costs	18.1%	77.0%	4.9%	100.0%
Reduced carrying capacity	45.8%	48.1%	6.1%	100.0%
<b>Management/Operation:</b>				
Increased maintenance costs	48.9%	44.5%	6.6%	100.0%
<b>Other:</b>				
Land value	37.2%	44.6%	18.2%	100.0%
Other financial impacts	20.8%	48.7%	30.5%	100.0%

Note: Does not include 'no response'. Number of 'no response' was recorded for stock poisoning/health (31.6%), increased mustering costs (35.4%), reduced carrying capacity (29.8%), increased maintenance costs (27.7%), land value (24.2%), other financial impacts (47.6%).

Of those respondents answering this question, the predominant number of landholders estimate they currently incur a cost of less than \$5/ha/yr from Lantana for:

- Increased mustering costs (62.5%);
- Stock/poisoning/health (57.7%);
- Other financial impacts (57.6%);
- Land value (35.8%); and
- Increased maintenance costs (30.7%).

**Table 2.18: Can You Please Indicate Whether Lantana Impacts On Your Business in Any of the Following Ways (Q5.1)?**

	<\$5	\$5-\$15	\$15-\$30	\$30-\$60	\$60-\$120	>\$120	Total
<b>Production Losses</b>							
Stock poisoning/health	57.7%	17.9%	2.6%	5.1%	3.8%	12.8%	100.0%
Increased mustering costs	62.5%	15.3%	2.8%	6.9%	1.4%	11.1%	100.0%
Reduced carrying capacity	30.1%	18.3%	15.1%	9.7%	7.5%	19.4%	100.0%
<b>Management/Operation:</b>							
Increased maintenance costs (does not include control costs)	30.7%	21.6%	10.2%	14.8%	9.1%	13.6%	100.0%
<b>Other:</b>							
Land value	35.8%	9.0%	11.9%	7.5%	9.0%	26.9%	100.0%
Other financial impacts	57.6%	15.2%	6.1%	9.1%	3.0%	9.1%	100.0%

Note: Does not include 'no response'. Number of 'no response' was recorded for stock poisoning/health (79.3%), increased mustering costs (80.9%), reduced carrying capacity (75.3%), increased maintenance costs (76.6%), land value (82.2%), other financial impacts (91.2%).

**Table 2.18** shows the spread of economic impacts in infested areas. **Table 2.19** highlights the difference between impacts in infested areas and impacts on a whole property basis.

- The cost per ha in relation to stock poisoning/health is:
  - \$32.70 in the infested area; and
  - \$3.20 over the total property area.
- The cost per ha in relation to increased mustering costs is:
  - \$28.10 in the infested area; and
  - \$0.60 over the total property area.

- The cost per ha in relation to reduced carrying capacity is:
  - \$51.90 in the infested area; and
  - \$4.00 over the total property area.
- The cost per ha in relation to increased maintenance costs is:
  - \$44.60 in the infested area; and
  - \$1.20 over the total property area.
- The cost per ha in relation to land value is:
  - \$64.30 in the infested area; and
  - \$42.40 over the total property area.
- The cost per ha in relation to other financial impacts is:
  - \$27.50 in the infested area; and
  - \$1.70 over the total property area.

**Table 2.19: Cost of Control (\$/ Ha/Yr) (Q5.1)**

	Average Cost/ Over Infested Area (\$/ha/yr)	Average Cost Over Total Property Area (\$/ha/yr)
<b>Production Losses</b>		
Stock poisoning/health	\$32.70	\$3.2
Increased mustering costs	\$28.10	\$0.60
Reduced carrying capacity	\$51.90	\$4.00
<b>Management/Operation:</b>		
Increased maintenance costs (does not include control costs)	\$44.60	\$1.20
<b>Other:</b>		
Land value	\$64.30	\$42.40
Other financial impacts	\$27.50	\$4.70

Note: Number of respondents for 'Average Cost Over Infested Area' and 'Average Cost Over Total Property Area' for each item was as follows: stock poisoning/ health (78 and 54), increased mustering costs (72 and 29), reduced carrying capacity (93 and 64), increased maintenance costs (88 and 74), land value (67 and 26), other financial impacts (33 and 11).

### 2.1.5 Qualitative Impacts (Triple Bottom Line)

The below rating scale used to rate the impacts outlined in the following table.

Rating Scale:

- 0 *No impact;*
- 1 *Impact is unlikely to be measurable or observable;*
- 2 *Detectable, but not significant;*
- 3 *Observable but localised impacts;*
- 4 *Observable wider and longer term impacts; and*
- 5 *Easily observed and irreversible impacts.*

**Table 2.20: TBL Impacts (Q6)**

	Weighted Average	TBL Aspect
<b>Negative Impacts</b>		
Removes and/or replaces native vegetation	3.6	Environmental
Reduces the conservation value of your land	3.5	Environmental
Reduces the scenic amenity of your land	3.4	Social
Restricts the movements of animals/humans	3.4	Social
Harbours feral animals	3.4	Environmental
Increases your management stress	3.3	Social
Restricts access	3.3	Economic
Increases the risk of fire	3.0	Environmental
Displaces native animals	2.9	Environmental
Impacts negatively on tourism	2.7	Economic
<b>Positive Impacts</b>		
Stabilises soil and prevents erosion	2.5	Environmental
Is aesthetically pleasing	2.3	Social
Provides a benefit in terms of improving soil for pasture renovation	2.1	Economic

### 2.1.6 Landholder Details

The greatest proportion (28.7%) of respondents were aged 50-59 years, followed by 60-69 years (25.5%) and 10-49 years (17.3%).

**Table 2.21: Age (Q7.1d)**

Age	%
No response	10.9%
20 – 29 years	0.3%
30 – 39 years	5.3%
40 – 49 years	17.3%
50 – 59 years	28.7%
60-69 years	25.5%
70+ years	12.0%
<b>Total</b>	<b>100.0%</b>

A total of 288 landholder surveys were returned from Queensland while a total of 88 landholder surveys were returned from NSW.

**Table 2.22: State (Q7.1a)**

State	(%)
Queensland	76.6%
New South Wales	23.4%
<b>Total</b>	<b>100.0%</b>

## 2.2 Land Protection Officer (LPO) Survey Analysis

The majority of respondents have had Lantana on their management area for:

- Over 50 years (40.0%);
- 20-50 years (28.0%); and
- 10-20 years (24.0%).

**Table 2.23: How Long Has Lantana Been on Your Management Area (Q2.2)?**

Response	Proportion (%)
<5 Years	4.0%
5-10 Years	4.0%
10-20 Years	24.0%
20-50 Years	28.0%
>50 Years	40.0%
Unsure	4.0%
<b>Total</b>	<b>100.0%</b>

The size of LPO land management area ranged from 290 ha to 725,000 ha.

**Table 2.24: What is the Size of Your Land Management Area (Q2.4)?**

Response (ha)	Proportion (%)
No Response	4.0%
290	4.0%
3,425	4.0%
20,000	4.0%
25,000	4.0%
40,000	4.0%
45,000	4.0%
55,000	8.0%
60,000	4.0%
65,000	4.0%
79,000	4.0%
100,000	12.0%
110,000	4.0%
160,000	4.0%
166,000	4.0%
200,000	4.0%
222,000	4.0%
230,000	4.0%
260,000	4.0%
280,000	4.0%
315,000	4.0%
725,000	4.0%
<b>Total</b>	<b>100.0%</b>

Of the respondents that answered this question, a high proportion indicated that over the past five years, Lantana has increased in both density and infestation.

**Table 2.25: Over the Past 5 Years, Has There Been Any Change in the Area Infested and Density of the Lantana Infestation (Q3.1)?**

Response	Stayed the Same (%)	Increased (%)	Decreased (%)	Total
Area Infested	17.4%	56.5%	26.1%	<b>100.0%</b>
Density of Infestation	27.3%	40.9%	31.8%	<b>100.0%</b>

Note: Does not include 'no responses'. Number of 'no response' is 8.0% in area infested and 12.0% in density if infestation.

On average LPOs estimate that:

- 85.3% of their management area is not infested;
- 7.1% is lightly infested;
- 5.5% is infested in a medium nature; and
- 2.5% is heavily infested.

**Table 2.26: Of Your Total Land Area, by Density of Lantana, What Percentage Would You Estimate is Currently Infested (q3.2)?**

Response	Percentage of Total Land Area – Average (%)
Not Infested	85.3%
Light	7.1%
Medium	5.5%
Heavy	2.5%
<b>Total</b>	<b>100.0%</b>

Note: Only includes those respondents who answered Q3.2,Q3.3 and Q3.4 to ensure consistency of results.

On average, LPOs estimate that in 5-years time, if current management/control techniques are maintained:

- 83.9% of their management area would not be infested;
- 7.7% would be lightly infested;
- 5.8% would be medium; and
- 2.6% would be heavily infested.

**Table 2.27: Of Your Total Land Area, by Density of Lantana, What Percentage Would You Estimate Will be Infested in 5 Years if Current Management/Control Techniques are Maintained (Q3.3)?**

Response	Percentage of Total Land Area - Average (%)
Not Infested	83.9%
Light	7.7%
Medium	5.8%
Heavy	2.6%
<b>Total</b>	<b>100.0%</b>

Note: Only includes those respondents who answered Q3.2,Q3.3 and Q3.4 to ensure consistency of results.

On average, LPOs estimate that in 20-years time, if current management/control techniques are maintained is:

- 80.9% of their management area would not be infested;
- 8.9% would be lightly infested;
- 6.1% would be infested in a medium nature; and
- 4.1% would be heavily infested.

**Table 2.28: Of Your Total Land Area, by Density of Lantana, What Percentage Would You Estimate Will be Infested in 20 Years if Current Management/Control Techniques are Maintained (Q3.4)?**

Response	Percentage of Total Land Area - Average (%)
Not Infested	80.9%
Light	8.9%
Medium	6.1%
Heavy	4.1%
<b>Total</b>	<b>100.0%</b>

Note: Only includes those respondents who answered Q3.2,Q3.3 and Q3.4 to ensure consistency of results.

On average, LPOs estimated that if they ceased the level of management and maintenance tomorrow:

- 15.1% of the management area would be infested in 1 year;
- 17.9% of the management area would be infested in 5 years; and
- 22.2% would be infested in 20 years.

**Table 2.29: If the Current Level of Management and Maintenance Activities Ceased Tomorrow, What Proportion of the Total Land Area You are Responsible For, Do You Think Would Be Infested in (Q3.5):**

Response	Percentage of Total Land Area - Average (%)
1 Year	15.1%
5 Years	17.9%
20 Years	22.2%

### 2.2.1 Control

Frequently nominated control techniques used in controlling Lantana in productive and/or non-productive areas include:

- Chemical (84.0% of respondents);
- Manual Labour (68.0% of respondents); and
- Fire (60.0% of respondents).

**Table 2.30: What Sort of Control Techniques Do You Use in Productive and/or Non-Productive Areas (Q4.4)?**

	Yes (%)
Mechanical	44.0%
Chemical	84.0%
Manual Labour	68.0%
Fire	60.0%
Biological Control	52.0%
Other	0.0%

The most commonly nominated method of controlling/maintaining Lantana is chemical control (60.0%).

**Table 2.31: Which is the Most Common Method (Q4.4)?**

	Most Common Method
Not Indicated	28.0%
Chemical	60.0%
Manual Labour	4.0%
Fire	4.0%
Biological Control	4.0%
<b>Total</b>	<b>100.0%</b>

Of those LPOs nominating an investment amount for the control/maintenance of Lantana, the estimated expenditure on control is most commonly less than \$5 per ha per year in light, medium and heavy infestations.

**Table 2.32: What Do you Estimate you Currently Spend, On Average, on Controlling/Maintaining Lantana for each of the Following Infestation Densities Per Year (Q4.5)?**

	<\$5	\$5-\$15	\$15-\$30	\$30-\$60	\$60-\$120	>\$120	Total
Light Infestations	72.7%	0.0%	18.2%	0.0%	9.1%	0.0%	100.0%
Medium Infestations	70.0%	10.0%	20.0%	0.0%	0.0%	0.0%	100.0%
Heavy Infestations	70.0%	10.0%	10.0%	10.0%	0.0%	0.0%	100.0%

Note: Does not include 'no responses'. Number of 'no response' is 56.0% in light infestations, 60.0% in medium infestations and 60.0% in heavy infestations.

**Table 2.33** shows the spread of impacts in infested areas. **Table 2.34** highlights the difference between impacts in infested areas and those across a wider management area.

- The cost of control per ha in light infestations is:
  - \$14.10 in the treatment area; and
  - \$0.40 over the total area of infested land.
- The cost of control per ha in medium infestations is:
  - \$7.30 in the treatment area; and
  - \$1.40 over the total area of infested land.
- The cost of control per ha in heavy infestations is:
  - \$9.50 in the treatment area; and
  - \$1.70 over the total area of infested land.

**Table 2.33: Cost of Control (\$/ Ha/Yr) (Q4.5)?**

	Average Cost of Treatment Area (\$/ha/yr)	Average Cost Over Infested Area (\$/ha/yr)
Light Infestations	\$14.10	\$0.40
Medium Infestations	\$7.30	\$1.40
Heavy Infestations	\$9.50	\$1.70

## 2.2.2 Other Economic Impacts

A relatively high proportion (55.0%) of LPOs recorded increased maintenance costs as having a significant economic impact, and did not appear to consider other financial impacts as significant.

**Table 2.34: Can You Please Indicate Whether Lantana has any of the Following Impacts, and if it is a Significant or Insignificant Impact in relation to Your Overall Operational Tasks (Q5.1)?**

	Significant	Insignificant	Unsure	Total
<b>Management/Operation:</b>				
Increased maintenance costs (does not include control costs)	55.0%	35.0%	10.0%	100.0%
<b>Other:</b>				
Other financial impacts	9.1%	36.4%	54.5%	100.0%

**Table 2.35** highlights the differences between impacts in the infested areas and impacts across the wider management area.

- The cost of control per ha in relation to increased maintenance costs is:
  - \$30.50 in the infested area; and
  - \$0.10 over the total property area.
- The cost of control per ha in relation to other financial impacts is:
  - \$2.50 in the infested area.

**Table 2.35: Cost of Control (\$/Ha/Yr) (Q5.1)**

	Average Cost of Treatment Area (\$/ha/yr)	Average Cost Over Infested Area (\$/ha/yr)
<b>Management/Operation:</b>		
Increased maintenance costs (does not include control costs)	\$30.50	\$0.10
<b>Other:</b>		
Other financial impacts	\$2.50	N/A

### 2.2.3 Qualitative Impacts (TBL)

The below rating scale used to rate the impacts outlined in the following table.

Rating Scale:

- 0 *No impact;*
- 1 *Impact is unlikely to be measurable or observable;*
- 2 *Detectable, but not significant;*
- 3 *Observable but localised impacts;*
- 4 *Observable wider and longer term impacts; and*
- 5 *Easily observed and irreversible impacts.*

**Table 2.36: Could you please rate the following statements regarding the economic impacts of Lantana, in terms of the impact that it currently has?**

	Weighted Average	TBL Aspect
<b>Negative Impacts</b>		
Removes and/or replaces native vegetation	3.5	Environmental
Reduces the conservation value of your land	3.5	Environmental
Reduces the scenic amenity of your land	3.2	Social
Restricts the movements of animals/humans	3.2	Social
Harbours feral animals	3.0	Environmental
Impacts negatively on tourism	2.1	Economic
Restricts access	2.7	Economic
Displaces native animals	2.7	Environmental
Increases your management stress	2.7	Social
Increases the risk of fire	2.9	Environmental
<b>Positive Impacts</b>		
Is aesthetically pleasing	2.3	Social
Stabilises soil and prevents erosion	2.4	Environmental

Additional economic factors raised in the survey responses to be considered in the evaluation of Lantana include:

- Control efforts - use funds that could be spent elsewhere;
- Increase in other weed species;
- Grassing;

- Lantana has some positive habitat;
- Biodiversity protection; and
- Fire Control.

Additional environmental factors raised in the survey responses to be considered in the evaluation of Lantana include:

- Provide habitat for some native species (positive);
- Potential to increase severity of fire;
- Diversity;
- Increase in other weed species;
- Prevents regrowth of certain rainforest species; and
- Climate change.

Additional social factors raised in the survey responses to be considered in the evaluation of Lantana include:

- Respect for conservation employees within community;
- Community perception that reserved land managers can not manage effectively; and
- Local neighbour concern to infestations on reserve.

A total of 19 LPO surveys were received from QLD and a total of 6 LPO surveys were received for NSW.

**Table 2.37: State**

State	(%)
Queensland	76.0%
New South Wales	24.0%
<b>Total</b>	<b>100.0%</b>

The table below lists the LPO management regions from which responses were obtained.

**Table 2.38: Management Region**

Region	%
Burnett, Bundaberg City, Kolan, Perry	4.0%
Caloundra Caboolture	4.0%
Caloundra Maroochy	4.0%
Clermont, Belyando Shire	4.0%
Coffs Harbour, Bellinger, Nambucca	4.0%
Gold coast	4.0%
Dec Pwd	4.0%
Isis, Burnett	4.0%
Mackay, Mirani, Sarina, Broadsound	4.0%
Maroochy, Cooloola, Kilcoy	4.0%
Maryborough	4.0%
Maryborough and Hervey Bay	4.0%
Miriam Vale	4.0%
Mon Repos C/P	4.0%
Monto	8.0%
Mundubbera, Eidsvold, Gayndah	4.0%
New England	4.0%
Pine Rivers	4.0%
Shoalhaven & Kiama	4.0%
Warwick	4.0%
<b>Total</b>	<b>100.0%</b>



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