To Whom It May Concern,

My name is Brett Smith and I would like to submit to the senate inquiry concerning Native Vegetation Laws, a thesis I wrote in 2009 for a Bachelor of Agricultural and Resource Economics from UNE, Armidale.

The paper investigates the opportunity cost that landholders are bearing due the inability to clear native vegetation from their freehold land due to the Queensland *Vegetation Management Act 1999*.

Some of the key findings from my research were:

- An opportunity cost of lost production as an Net Present Value equal to $1083/ha
- Net Present Value for production of cleared land is 24 times greater than on uncleared land
- Very little consultation with landholders before legislation enacted
- Landholder knowledge of the landscape not taken into account
- No recognition sustainable land practices such as leaving individual trees and conservation clumps

I am unable to attend any of the proposed hearings as the dates clash with other commitments.

Regards,

Brett Smith

Economic Impacts of Native Vegetation Regulation in South West Queensland

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A dissertation submitted in partial fulfilment of the requirements for the Degree of a Bachelor Agricultural and Resource Economics

By

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October 2009

Declaration

I certify that this report does not incorporate, without acknowledgement, any material previously submitted for any degree or diploma in any University or other educational institution; and to the best of my knowledge and belief it does not contain any material previously published or written by another person, except where due reference is made in the text.

BRETT M. SMITH

October 2009

Acknowledgements

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Secondly I would like to thank my housemates Bouf and Lamby and classmates Hegs and Rosco for their encouragement and assistance throughout the process of undertaking this thesis, as the memories will be life long.

As well thank you to Roger and Jenny Hegarty who spent numerous hours proofreading and providing sound advice on improvements. Also I must thank the many people I spoke with throughout my research, your advice was invaluable.

Most of all I would like to dearly thank my family, in particular my parents for providing never ending support throughout my life and for giving me the motivation to pursue an education that has culminated in this thesis.

Abstract

The protection of remnant native vegetation has become a major issue concerning agriculture in Australia over the last two decades. This increased level of concern occurs as the majority of remnant native vegetation is found on private land that is used for primary production. As levels of native vegetation on agricultural land have a direct relationship with productivity its protection does come at a cost to landholders.

By performing a case study on a property adversely affected by regulations concerning the management of remnant native vegetation, the economic impacts of its protection has been analysed. From undertaking this analysis the opportunity cost was calculated, providing an estimate of how much primary producing landholders are bearing to protect remnant native vegetation for the rest of society.

The inefficiency of current regulation in protecting remnant native vegetation was defined and discussed. One major conclusion drawn from the research is that a better solution is required that involves all stakeholders cooperating to improve outcomes.

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Chapter One: Introduction

The management of native vegetation on private land has come into the political spotlight over the last twenty years due to changing attitudes and ever-increasing pressure from environmental lobby groups. Governments have responded by outlining objectives to improve the state of the environment and by introducing laws to prevent the removal of vegetation. However these laws have usually been introduced with minimal assessment of the potential effects on landholders (Productivity Commission 2004). This command-and-control attitude, taken by legislators, has led to serious impacts on landholders.

1.1 Background to the Issue

In comparison to other states of Australia, Queensland has very little of its land mass cleared of native vegetation for agricultural production. This is particularly true in the lower rainfall areas of the south west where merino sheep were previously the main enterprise for most landholders. With depressed wool prices over the last 18 years, there has been a widespread change to beef and grain production. This required the clearing of native vegetation to allow cultivation for crops and so that improved pastures could be sown to increase carrying capacity. The introduction of a land clearing moratorium in 2000 by the Queensland government put an end to this development and has been a hindrance to landholders wanting to sustainably expand their enterprises. Due to the density of some natural woodlands, native grasses are not able to compete for moisture and sunlight successfully, leaving vast areas of scrub with bare unproductive ground. This result is not sustainable for agricultural production and also affects the environment as plant and animal biodiversity is vastly reduced.

1.2 Case Study

The property chosen for the case study is located near St George in south western Queensland and has been owned and operated by the one family for the last 65 years. Due to its location east of St George, it has a long term average rainfall of 525 millimetres. Soils comprise a mixture of deep red loams rising to stony ridges at the western end with numerous heavier grey hollows dissecting the property. The majority of vegetation consists of Poplar Box *(Eucalyptus populnea* ssp. *bimbil)* mixed with Silverleaf Ironbark *(Eucalyptus melanoploia)*, Wilga *(Geijera parviflora)*, Cypress Pine *(Callitris glaucophylla)*, Kurrajong *(Brachychiton populneus* ssp. *populneus)* and increasing levels of Budda *(Eremophila mitchelli)*. This vegetation is found on the most productive parts of the property and on the specific 800 hectares in the case study. Currently the 4000 hectare property has 50% remnant vegetation which the landholder wishes to clear down to 30% to improve productivity and increase the economies of scale for the current enterprises. Under the Native Vegetation Management Act 1999, the landholder is not able to complete this further development of the property.

The current enterprise mix includes cereal cropping and a self replacing merino (SRM) flock of 4000 head. Crops grown include wheat, barley, sorghum and fodder crops such as oats and forage sorghum. Sorghum has not been grown as frequently in recent years due to erratic summer rainfall patterns and low sorghum prices. Lucerne is used in the pasture phase of rotation as a disease break and to restore soil nitrogen. Lucerne is the most profitable legume to use in the rotation when compared with legume crops such as chickpeas. Average micron of the sheep flock is 19.6 with an average lambing rate of 70% which is targeted for improvement in coming years. All progeny are retained for woolgrowing until cast for age at 7 to 8 years of age.

The owners of the property are currently considering diversifying into the breeding of prime lambs by joining a terminal sire to those merino ewes which are considered to be undesirable for joining back to a merino sire. A current constraint to this occurring is the lack of land suitable for growing improved pastures due to land clearing restrictions. Any land that is already developed is used as cultivation or as pasture for the current SRM flock.

The development of a further 800 hectares would allow the business to diversify its enterprises to spread risk and take pressure off already developed land to produce beyond its potential. The business could then move away from its reliance on woolgrowing, because an increased area could be cropped and a greater number of breeding ewes could be stocked. The improved pastures would also allow for better levels of ewe fertility to be maintained.

The ability to run more ewes would open up diversification opportunities, as merinos or first cross and prime lambs could be produced depending on the respective commodity prices. A larger number of ewes would also allow for more objective culling of undesirable animals to occur, creating a more productive flock.

When the current legislation was written there was very little consideration of the costs to affected landholders. Inflexibility encountered by landholders trying to work with laws also causes a great deal of frustration, particularly when future viability of properties is concerned. These impacts have flow-on effects such as children not being able to return to family properties due to decreased returns, and the inability of farm businesses to expand.

1.3 Objectives of Research

This research investigates the costs of such laws in Queensland on landholders, through an investment analysis of a case study property. The objectives of this research are to estimate the costs primary producers are bearing as the result of legislation introduced to benefit the rest of society and to explore how these can be reduced to achieve a more efficient outcome for all concerned.

The research will estimate the opportunity cost of not being able to manage native vegetation to increase production benefits from land still covered in remnant timber. Opportunity cost will be measured by comparing profit levels when land is cleared with profit levels when it is left with full vegetation cover.

1.4 Methodology

Two alternative scenarios were drawn up for 800 hectares to calculate the opportunity cost of the laws on the case study property. Scenario A^0 is what is currently occurring with the regulation and A^1 is what is possible if the landholder could clear the land to their own sustainable specification. Gross margin analysis of the various enterprises was conducted. This provided data to calculate net present values for the two alternative scenarios.

The method involved a case study on the selected property which will produce a development plan for the property which will be titled A^1. This development plan will involve the clearing required to bring the land into a more profitable state and increasing the enterprises' long term viability. The development plan will include the expenses imposed to clear and a gross margin analysis of the new activities on the developed land. The proposed activities will include cultivation of the land for wheat production for the first five years and then the area will be planted down to improved pastures for livestock production.

Net present values allow the opportunity cost to be estimated as NPV A^1- NPV A^0. Sensitivity testing was done on the NPV's to scope what effects the variables of price and yield would have on the results as these take account of fluctuations of rainfall and commodity prices.

Production and profit figures were then calculated for the cleared land using a gross margin analysis of the landholders preferred production mix of beef, lamb and wool. This was conducted over a fifteen year period to gain a real understanding of the full costs that primary producers are bearing.

1.5 Outline of Dissertation

CHAPTER 1: The first chapter has provided an introduction and overview of the topic being investigated in the thesis. A background to the scenario and the issues surrounding the problem has also been given.

CHAPTER 2: The second chapter will contain the literature review covering what work has previously been conducted on the subject, describing what findings where made and commenting on how it was performed. Previous research was reviewed and analysed for similarities and relevance. This included work done by Sinden (2002, 2005) on the Moree Plains Shire of New South Wales, Kenny and Beale (2003) on the Murweh Shire of Queensland and Australian Bureau of Agricultural Resource Economics publications by Davidson et al (2006) covering both Northern New South Wales and the rangelands of Southern and Western Queensland. Both scientific and financial measures of production losses were covered in these reports. A Productivity Commission Report was also extensively reviewed.

CHAPTER 3: This chapter will contain all the main research data and the calculations used to formulate the final results. The first part will give an overview of the two alternative scenarios that were investigated. A description of the gross margin and investment analysis shows what is involved in these processes. Sensitivity analysis is undertaken to gauge changes in price and yields. Also cost of family labour was placed in the gross margins as the case study property is family owned and operated and the reasons for doing so are stated.

CHAPTER 4: The results and discussion concerning all factors involved will be presented. It will look at the potential of undertaking further development of land currently under native vegetation and the long term impacts of its protection on society as a whole. The figures from the investment analysis such as the net present value of restricting native vegetation will be presented ultimately as the opportunity cost. An overview concerning equity will be given, examining why landholders have to bear the costs resulting from these regulations when no other members of society have to and the social issues that stem from this.

CHAPTER 5: This final chapter will be a summary and conclusion which reflects the findings of the thesis and what conclusions can be drawn from the research. There will also be a Bibliography and Appendices attached. The appendices contain the complete gross margins and investment analysis as they are reasonably large. Calculations for sensitivity testing are also shown.

Chapter Two: Literature Review

2.1 Introduction

There has been much research already conducted into the costs faced by landholders due to remnant native vegetation protection policies. A variety of different studies have been undertaken using both scientific and economic methods to calculate opportunity costs. This opportunity cost has been presented as both production losses and decreases in property values.

Economic welfare is the goal that benefit-cost analysis assesses when investigating the desirability of alternatives. Desirability is assessed by the benefits and costs of all possible outcomes from an alternative and this in particular includes the environmental outcomes. For this research the environmental outcomes were considered as measured by the landholder, due to their extensive knowledge and long term goal of sustainability. Even though a monetary value was not placed on this outcome the landholder wishes to continue using the land profitably for many years beyond the time that was analysed for this research.

2.2 Australian Bureau of Agricultural and Resource Economics (ABARE)

Research has already been conducted into the impacts of legislation regarding remnant native vegetation management throughout the states of Australia. The majority of the work reviewed in this thesis was based on land situated in Southern Queensland and Northern New South Wales.

The Australian Bureau of Agricultural and Resource Economics have completed much research investigating the costs of native vegetation preservation in terms of its effect on productivity and efficiency. Davidson et al (2006) focused on the costs of forgone rangelands development for southern and western Queensland so was of high relevance to this work. Their researched valued the cost of forgone development opportunities in regards to both reduced levels of production and lowered property values as a consequence.

The basis of determining these estimate values was to formulate a more flexible regime of regulation that would reduce the costs of protecting remnant native vegetation.

One conclusion drawn was "on its own, command and control regulation to manage native vegetation is unlikely to allow the net benefits to society from using native vegetation to be maximized either across regions or through time", (Davidson, et al., September 2006, Pg 3). Their report claims that current regulation is not providing adequate outcomes efficiently and Davidson states "An improvement in economic efficiency requires that a reallocation between agricultural and environmental outcomes increases society's net return", (Davidson, et al., September 2006, Pg 7). Productivity growth and improvements in efficiency for agriculture have trended upwards for a long time and on the majority of properties in the region, this included changes to stocks of native vegetation. This had ensured viability for producers who were trying to maximize profits whilst conserving land for future users.

One fault identified in the legislation is that no differentiation is made between the two phenomena's of tree thickening and scrub invasion. Even though both reduce carrying capacity, they occur in different forms.

2.3 Productivity Commission

A Productivity Commission Inquiry (PCI) conducted in 2004 found that the current regime of legislation is unworkable and is creating inefficiencies as environmental objectives are not being met. This report covered all aspects concerned with the debate surrounding native vegetation controls.

The PCI found considerable inflexibility within the regulations due to their blanket type application across individual states. As land types and vegetation vary widely across Queensland, there are adverse consequences on landholders who have to deal with the same rules regardless of their situation. The inquiry found that there are numerous negative impacts that the regulations have on land management practices.

They include:

- Preventing the expansion of agricultural activities
- Preventing changes in land use and adoption of new technologies
- Inhibiting routine management of vegetation regrowth and clearing of woodland thickening to maintain areas in production; and
- Inhibiting control of weeds and vermin

(Productivity Commission 2004 Overview Pg XXX)

Other problems such as increased pressure on already cleared land to produce beyond its capabilities and adverse decisions by landholders regarding what vegetation is left were also identified in the report.

The Productivity Commission identified that greater fundamental reform is required to achieve regulatory best practice and to overcome certain limitations. This is deemed necessary for the following reasons:

- Regulation of native vegetation clearing is inflexible, prescriptive and ‘input’ rather than ‘outcome’ focused;
- Regulation of clearing is a partial measure – it does nothing to ensure ongoing management of native vegetation or its regeneration. Indeed, landholders are faced with disincentives to care for and regenerate native vegetation: and
- Jurisdictional regulation by design or accident has muddied the issue of landholder and community responsibility

(Productivity Commission 2004 Overview Pg XXXVI)

Regulation can be an efficient instrument when applied in the right situations but when there is insufficient information concerning the nature of the problem being addressed inefficiencies will become apparent. Also any alternatives to the proposed regulation need to be analysed to investigate the costs and benefits of both forms of regulation. This will ensure the most efficient outcome can be achieved.

The inquiry recognized that local landholder knowledge of the landscape will be vital in formulating a set of criteria for vegetation management. Combining this information with sound scientific facts will make for a better solution to be drawn that takes all sides of the issue into account.

The promotion of private conservation and its cost sharing was another area investigated by the Commission. It found that generally one advantage of private or voluntary mechanisms is that the outcome will more than likely enhance community welfare as the activity will only be undertaken if benefits outweigh costs. Some constraints that hinder the private provision of native vegetation and biodiversity were identified.

These include:

- Lack of access to information about sustainable agricultural practices and their benefits, and difficulties in signalling sustainable practices to consumers or investors
- Short-term financial constraints arising from unviable farm size or external 'shocks' such as drought price fluctuations
- Native vegetation regulations themselves, if uncompensated, which discount the private value of native vegetation
- 'Free-rider' issues that weaken community efforts to solve local problems such as salinity and poor soil and water quality; and
- The public-good nature of some environmental services (such as biodiversity or carbon sequestration) which inhibits (though does not rule out) private solutions.

(Box 5, Productivity Commission 2004 Overview XXXVIII)

It was recognized that often under-provision of conservation occurs as the benefits accrue 'offsite' which means government authorities potentially could have more direct involvement to help spread the cost of this. This is when the benefits of retaining native vegetation are experienced throughout the community and cannot be charged for therefore making it a public good.

In this case, 'free-riding' by the rest of society is occurring so landholders are not likely to provide an optimal level of native vegetation as far as the community is concerned. It was stated "beyond this point, native vegetation conserved for biodiversity purposes means that the landholder loses income because the land could be put to more profitable uses from a private perspective." (Productivity Commission 2004 Overview Pg XXXIX)

Clarification of landholder and community responsibilities was another issue looked at by the Commission against the theme within the literature that both landholders and the community should share the cost of environmental public goods. Also, landholders should bear the costs of actions that contribute to improving the sustainability of the land as they received the benefit of increased long-term viability. Society's responsibilities would be to bear the costs of any actions that promote public-good environmental services. It was specified to achieve environmental outcomes that society desires on private land, in the most effective and efficient manner, several requirements will need to be met.

They are as follows:

- Clear specification of the environmental outcomes demanded; and
- The ongoing cooperation, knowledge and effort of landholders who ultimately must deliver those outcomes on their land.

(Productivity Commission, 2004 Overview Pg XLI)

The Commission observed that by having governments purchase environmental services from landholders would mimic private transactions that occur voluntarily in a market place. Both parties would have prospects of gaining from this, so it would have numerous advantages compared to prescriptive regulation to private conservation of public-goods.

These advantages would include:

- A process of buying environmental services will require more precise specification of the environmental outcomes demanded.
- An approach that can be flexible, taking account of local variations, utilizing local knowledge and encouraging innovative and cost effective solutions.

- Therefore, a given level of environmental services is more likely to be provided at minimum cost.
- A requirement to pay will place some discipline on the community's 'demand' for environmental services and compel prioritization of environmental demands.
- For the landholder, native vegetation would become an asset rather than a liability.

One of the final recommendations made by the Commission was the devolving of responsibility to regional institutions that can provide genuine local consultation and decision making. This would require a sufficient level of flexibility, authority and resources so that initiatives could be implemented.

In conclusion, concerning the current regulations the Commission stated: "policies that fail to engage the cooperation of landholders will themselves ultimately fail. In addition greater transparency about the cost-benefit trade-offs involved in providing desired environmental services would facilitate better policy choices." (Productivity Commission, 2004 Overview Pg XLVI)

2.4 Sinden and other researchers

Scientific research used to calculate carrying capacity on land that is adversely affected by native vegetation management regulations was conducted by Kenny and Beale (2003). Their investigation was based on the Murweh Shire of Queensland which is located to the west of the case study property. This area has similar land types but receives a lower rainfall, which means livestock production is the sole agricultural land use. This report also provided evidence of vegetation thickening occurring and the great cost this imposes on landholders. These costs were quantified via reduced stocking rates and greater expenses to maintain regrowth at desirable levels.

The work that Kenny and Beale completed also substantiated the fact that increased levels of tree cover have a negative impact on carrying capacity as trees out-compete grasses for moisture and sunlight. Since carrying capacity is a major determinant of on farm cash operating surplus (Slaughter 2003), increased levels of native vegetation will continue to have dire economic effects on landholders in grazing enterprises.

Sinden (2002) investigated the costs being imposed on landholders in the Moree Plains Shire of northern New South Wales by the Native Vegetation Conservation Act 1998. This area has similar enterprise mixes and rainfall to the case study. Sinden quantified the cost borne by landholders through both lowered production levels and decreased land values. Land is a primary producer's most valuable asset, which provides the majority of collateral when capital is borrowed. With native vegetation regulation, Sinden found that farm land values had dropped by some 20-21% and annual per hectare farm gross margins were lowered by at least 10%. It was concluded that landholders are paying up to 31 times more for remnant native vegetation protection than do urban citizens.

A willingness by landholders to retain a certain level of remnant native vegetation was also found by Sinden, although this factor was not adequately taken into consideration when legislation was designed. In conclusion, to improve the current policy to achieve a better outcome Sinden (2002) argues that four areas of national policy need to be readdressed: "appropriateness, effectiveness, efficiency and equity."

Another paper reviewed was the research report compiled by Lockwood, Walpole and Miles in 2000. This work was based on the Murray River region of southern NSW and northern Victoria investigating the economics of conserving native vegetation on private land. It was found that "remnant vegetation can be regarded as an environmental good, and thus it may be possible to determine its market value through transactions of properties that contain it". The associated costs to landholders from remnant native vegetation protection included lowered productivity and increased management requirements for fencing, weed and feral animal control. One of the main conclusions drawn from this report is that for effective remnant native vegetation management to occur, encouragement must be given to landholders rather than hindrance as this makes landholders more willing to cooperate.

2.5 Conclusions

A number of common themes appeared from all of the literature reviewed. These included the very low levels of consultation with landholders regarding legislation and the high level of inflexibility that arose from this. Other common findings were that the amount of income being forgone by primary producers is substantial and that often the required outcomes are not being achieved efficiently or equitably.

Chapter Three: Methodology

3.1 Introduction

Primary data were drawn from records held on the case study property. These records included historical crop yields, stocking rates, ewe fertility levels and wool production per head, as well as current costs of production and development cost figures. From these data, gross margin tables were created so that profit levels could be determined and placed into an investment analysis. Net present values (NPV) could then be calculated to determine the opportunity cost of the legislation.

3.2 The Alternative Scenarios

To calculate the opportunity cost of vegetation management regulations two scenarios were drawn up. The first, Scenario A^0, represents the current situation of not being able to clear and Scenario A^1 demonstrates what could be possibly done without restrictions.

3.2.1 Scenario A^0

Scenario A^0 consists of grazing Merino wethers cutting 6 kilograms of 21 micron wool on country that this is covered in remnant vegetation with the only disturbance being ringbarking that was undertaken approximately 80 years ago. The pasture base consists of native grasses, shrubs and a small amount of low trees available for browsing. As native grasses are the main component of this grazing system and are continually diminishing due to a number of factors the long term viability of this enterprise is in serious doubt. The wethers are property bred coming from the ewe flock that is run as another enterprise on a more improved part of the property. It is assumed that as they are bought across from another part of the property they are of no cost to A^0. Once these sheep reach approximately 7 or 8 years of age they are sold as cast for age (CFA) with the proceeds from this not being counted in A^0 as they are prepared on another part of the property before sale. The variance in selling age is due to decisions regarding individual animal productivity and seasonal conditions as well as wool and sheep prices.

3.2.2 Scenario A^1

If there was not any legislation regarding the removal of native vegetation the area could be cleared while still leaving scattered individual trees, shade lines and clumps for conservation purposes. Broadacre cultivation could then be undertaken to produce cereal crops for both grain and forage production. In the second scenario A^1, once the land was cleared and cultivated, wheat would be grown for 6 years with lucerne being undersown with the sixth crop in preparation for the pasture phase of the rotation. This is necessary as soil nutrient levels slowly decrease to the point where prime hard wheat (>13% protein level) can no longer be grown without using additional fertiliser. Adding fertiliser is not very profitable and is detrimental to the condition of the soil.

Once the lucerne pasture is established, at the end of the seventh year, merino ewes joined to a terminal meat breed sire (White Suffolk or Poll Dorset) are run on the pasture. All progeny from this joining are sold as prime lambs once target weights are reached. The ewes required would come from the main self replacing merino flock also run on the property and consist of the older portion of the flock. These are proven breeders but are not as genetically improved as the younger ewes. The target weight for the lambs would be for a 22 kilogram carcase to be sold into the export market. This of course would depend on seasonal conditions and the viability of supplementary feeding to be able always to achieve this target weight. Prime lamb production continued until the conclusion of this analysis which was at the end of year 15.

Having additional land cleared opens up numerous diversification opportunities for the landholder compared to when the land was covered with remnant vegetation. This allows for a reduction in risk the enterprise would be exposed to, as land use can be changed to a form of production that would be more profitable as physical and financial constraints demand.

3.3 Data Collection

All of the data used for this research project was primary data sourced from the case study property. It was collected through consultation with the owners of the property and by going over property records. Due to the property being owned by the one family for the last 65 years there was an extensive collection of data concerning rainfall, carrying capacities, yields, costs of production and sustainable land use. The owner of the property also has a vast knowledge of the country due to a lifelong involvement with the property which provided a solid grounding for the data used.

3.3.1 Family Labour Component

Labour is one variable input factor that is of high importance to primary production due to the high level of skills required and the seasonal nature of agriculture. This makes it a great cost to the producer and the amount needed is very different for the two alternatives. As the case study property is mainly operated by family labour, labour costs were factored in to give a genuine profit figure for the enterprise. This was included despite the fact that this is one cost that usually goes unpaid or if paid for, paid at a lot lower rate than what calculations would suggest.

The family who own and operate the case study property undertake the majority of annual operations besides wool removal and handling done at shearing and crutching. A contractor is used to cart wheat from the property and contractors and additional bought in labour were used for the development of A^1. The owners do not own the necessary machinery or skills to undertake these tasks, which must be done along with the daily running of the property placing constraints on time available. As well the required machinery for scrub pulling and stickraking is of great expense to both buy and maintain, particularly when it will be only used in a one-off or infrequent use manner at various stages throughout the time spent developing the property. The high level of interest to be paid often makes owning this machinery unviable, particularly for smaller producers, which compounds the problems now faced with regulation.

Throughout the year it is considered that two labour units are required to run the property, consisting of the owner and a combination of his wife or sons. To calculate this figure it was considered the sons could be earning as a first year graduate from university a salary of $55,000 per annum. During that year in the graduate job the son would work on average 40 hours per week for 48 weeks which equates to $28 per hour. The owner with his vast array of knowledge and large bank of skills would be worth 3 times that value to the business so should be paid at $84 per hour. From consultation with the available records the number of labour hours required for each of the enterprises was calculated. The number of hours was then multiplied by the cost of labour, with the owner undertaking half of the hours and another family member completing the rest of the hours. The expense for labour for each enterprise was then calculated and is shown in Appendix A.

3.4 Gross Margin Analysis

A gross margin analysis of each of the enterprises involved for both A^0 and A^1 was conducted to compare the relative profitability of each scenario and these are shown in Appendix A. The gross margins consist of a breakdown of the operating costs and revenues received for each enterprise. They are gross incomes minus the variable or direct costs and do not take into account fixed overhead costs. This was done as the enterprises in both A^0 and A^1 are considered just to be individual activities occurring within the operation of the whole case study property.

By doing this, any overhead costs such as infrastructure which would include fencing and watering points, were considered to already exist and so did not need to be included in calculations. As the owner was already cropping other land on the property all required machinery was already available.

The gross margin gives a figure for the whole 800 hectare area which is divided by the area to give gross margin per hectare. It was assumed that input costs would remain the same throughout the whole life of the project and sensitivity testing was undertaken on price and yield figures after the benefit-cost analysis was performed.

3.5 Investment Analysis

Investment analysis was chosen as the most appropriate method for determining opportunity cost. It allows for the relative desirability of competing alternatives to be compared in terms of their economic worth to society. In this case, the competing alternatives are the clearing of native vegetation to increase agricultural production, compared to the protection of native vegetation for environmental preservation. A certain amount of native vegetation removal is considered to be very desirable for primary producers looking to earn a sustainable living from their land. This opinion is not widely held by many in society who desire to see native vegetation protected for its environmental values. Investment analysis is able to provide a useful economic comparison and is the most frequently-used method of evaluation due to the technique's well developed theoretical foundation.

The basis for undertaking investment analysis is that developed countries such as Australia tend to have broad goals, namely:

- Improve economic welfare, and well being
- Improve social equity, and
- Improve the quality of the environment

Completing an investment analysis draws comparisons between the competing scenarios as it allows for benefits and costs other than those directly received by the landholder to be calculated. By definition investment analysis is a method to assess the relative desirability of competing alternatives, where desirability is measured as economic worth to society.

This demonstrates that there are flow-on effects from the primary producer losses incurred by the legislation and that firms are worse off.

Once the gross margin figures were calculated they were placed into a table so that the appropriate levels of discounting could be applied and net present values determined. The investment analysis is tabulated in Appendix A.

The main purpose of the investment analysis was to perform discounting so that the opportunity cost could be placed into current money terms. The discounted present value is calculated by applying the discounting formula of:

$$PV=S*(1/(1+0.09)^{t}$$

Where ***S*** is the income in year ***t***, 0.09 represents the 9% discount rate chosen and ***t*** represents the number of years from project commencement. A discount rate of 9% was chosen as this would be the estimated average of the interest rate the landholder would have to pay on borrowed capital. At this point the calculated gross margin was multiplied by the discount rate to give an NPV.

Net present value is the sum of a flow of annual net benefits, each of which is expressed as a present value. This sum is exactly equivalent to the difference between the present value of benefits and present value of costs. In this study the gross margin is taken to be the annual net benefit that the landholder is forgoing due to the legislation restrictions.
The formula used in this case study is:

$$NPV=\sum PVt+\Delta LVT$$

PV represents the discounted yearly gross margin from the respective enterprise and ***t*** is the 9% discount rate multiplied by the number of years since the project commenced to give the rate of time discount factor. ***ΔLV*** stands for the change in land value due to the introduction of restrictions and ***T*** is the end of the planning horizon. For this case study it was considered to be zero as the landowner did not wish to sell the property within the foreseeable future so changes in land value were omitted.

For A^0 this discounting process was applied to each year's gross margin over the whole 15 years and hence the discounting effect became heavier later in the time period.

In A[1] the first year will be taken up with the development of the land and in years 2 to 7, the land is cropped with wheat and a lucerne based pasture undersown in year 7. At the start of year 8 the country will be grazed by merino ewes joined to terminal sires to produce first cross prime lambs. This activity will continue until the end of year 15.

It is assumed that there will be adequate rainfall in year 7 to allow for the establishment of pasture. If enough rain is not received to achieve this it would obviously delay the project and incur further costs. These costs would concern having to replant the pasture and the loss of wheat production which is covered by the sensitivity analysis.

3.6 Sensitivity Analysis

Sensitivity analysis was undertaken to see how changes in prices and yields would affect the overall NPV. This step can be defined as: "a recalculation of net social benefits with different data, together with the reinterpretation of the relative desirability of the alternatives".
This was determined by calculating the elasticity (e), which is given as:

e = percentage change in NPV / percentage change in variable.

The elasticity represents how much a 1% change in a variable factor has on NPV in percentage terms. These elasticity calculations were undertaken for prices and yields of all commodities involved concerning both upward and downward shifts in their value.
Covering the two factors of price and yield allowed for changes in two of the main variables associated with primary production, which are rainfall and commodity prices. The calculations and figures derived in the sensitivity testing are shown in Appendix C.
No sensitivity analysis was undertaken for the costs of production.

Chapter Four: Results

4.1 Introduction

The data were analysed by undertaking a gross margin analysis on each of the different scenarios for the case study property (Appendix A). The analysis with these gross margins included an investment analysis so that net present value could be calculated (Appendix A). The opportunity cost of native vegetation regulation was calculated from these net present values. Sensitivity analysis was then undertaken on the NPV results to assess any changes in prices and yields from each of the respective production systems.

Table 4.1 presented below gives the gross margin figures for the total area, per hectare and the totals for each of the enterprises for their duration in the project. The total gross margins for each scenario over the 15 year project life are also shown.

TABLE 4.1

GROSS MARGIN RESULTS ($)

	ANNUAL TOTAL	PER/HA	PROJECT TOTAL*
WOOL	4,699	5.87	70,485
WHEAT	276,800	346.00	1,660,800
LAMBS	116,166	145.21	929,325
A0			70,485
A1			2,590,125

* Over all 15 years of project

4.2 Net Present Values

The net present values for both A^0 and A^1 scenarios were assessed for the 800 hectare area concerned, discounted at a rate of 9% for project lifetime of 15 years and this NPV figure was then divided by 800 to give a per hectare basis NPV (Appendix A). For A^0 this came to a NPV of $37,877 which equates to $47.35 per hectare. After undertaking the development in scenario A^1, returned an NPV of $904,356 which gives an $1130.44 per hectare value. (TABLE 4.2)

TABLE 4.2

NET PRESENT & OPPORTUNITY COSTS

Scenario	NPV	NPV/HA
AO	$ 37,877	$ 47.35
A1	$ 904,356	$ 1,130.44
Opportubity Cost (A1-A0)		
Overall	$ 866,479	$ 1,083.10

To determine the true opportunity cost that the landholder is bearing, the NPV of A^0 was deducted from A^1. The landholder would receive a return that would be approximately 23 times larger if they were able to develop the area currently under native vegetation. That figure was calculated by dividing the NPV of A^1, $1130.44/ha by the A^0 NPV of $47.35/ha.

4.3 Sensitivity Analysis

Sensitivity testing was performed to determine the effects of changes in the two major contributing factors of price and production risk on the net present values (Appendix C). In A^0 the production risk was considered to be a change in wool cut per head of 0.5 kg up or down due to pasture availability. The price risk included fluctuations in wool prices from as low as $5.00/kg to an upper value of $6.50 per kilogram.

The results (TABLE 4.3) from this sensitivity analysis found that a 1% reduction in wool prices has a 2.90% negative change in NPV whereas a 1% increase of wool price will increase NPV by 2.92%. A change in the kilograms of wool cut per head by 1% up or down had a 2.92% and 2.93% change in NPV respectively.

TABLE 4.3

SENSITIVITY ANALYSIS OF NPV'S

Downwards Shift in Prices	Wool 1%	Wheat 1%	Lamb 1%
Reduction in NPV	2.90%	2.02%	0.31%

Downawards Shift in Yields	Wool 1%	Wheat 1%	Lamb 1%
Reduction in NPV	2.93%	2.01%	0.32%

Upwards Shift in Prices	Wool 1%	Wheat 1%	Lamb 1%
Increase in NPV	2.92%	2.02%	0.28%

Upwards Shift in Yields	Wool 1%	Wheat 1%	Lamb 1%
Increase in NPV	2.92%	2.01%	0.32%

For the sensitivity analysis of A^1, production risk consisted of wheat yields decreasing or increasing by 0.5 tonnes per hectare, and ewe fertility fluctuating up or down by 20% for the prime lamb component of the enterprise. Price risk in A^1 involved wheat prices moving $20 per tonne, either positively or negatively and lamb prices shifting $1 per kilogram carcase weight either side of the original prices.

A 1% reduction or increase of wheat price would lower or raise the NPV by 2.02% respectively. For wheat yields the change in NPV was 2.01% when calculated for either 1% lower or higher yields. For prime lambs, a 1% downward shift in both price and yield reduced NPV by 0.31% and 0.32% respectively which would mean price and production risk are both similar in sensitivity for downward movements. An increase in lamb prices and yields by both 1% would increase NPV by 0.28% and 0.32% respectively.

The sensitivity figures for the prime lamb enterprise are considerably smaller than those drawn from the A^0 wool and A^1 wheat enterprise. The main reason for this is that prime lambs are only produced later in A^1, from years 8-15, so the revenues are discounted more heavily than both A^0 and particularly when compared to the wheat section of A^1. As well, due to the lower returns for prime lambs compared to wheat production, prime lambs contribute a lot less to the overall NPV of A^1 compared to the contribution wheat provides. This combined with a greater level of discounting makes the prime lamb enterprise less sensitive when contributing to NPV.

4.4 Effects on Management

From the results presented it can be seen that the impacts of regulating native vegetation management are very large and place a considerable financial burden on affected landholders.

The largest change in net present value that occurred during the sensitivity analysis was when wool production decreased, as a 1% drop in production lowered NPV by 2.93%. This figure (-2.93%) is a major concern for A^0 as wool cut is expected to steadily decrease over time if the same stocking rate is maintained. This gradual decrease is due to a number of factors related to the increasing density of native vegetation, and therefore to the quantity and quality of pasture available.

Whereas the price received for the wool clip can be managed with techniques such as forward marketing and classing of the clip to present the most saleable clip possible. With a small number of sheep being shorn, these management techniques cannot always be fully implemented as there is not the quantity of wool to make this profitable. So with regulations imposed the producer loses control over the most sensitive factor out of both scenarios.

In the long term native vegetation thickens due to changed land management practice which has direct implications on the amount of pasture available as there is less moisture and sunlight for grass. Vegetation thickening has been demonstrated in various cases and in other research done (Beale 2004). Therefore, both during and beyond the 15 year period investigated in the case study for A^0, without control of native vegetation, wool quantity and quality will be reduced substantially. As the kilograms of wool cut per head decreases, profitability will be reduced at a greater rate when compared to the other enterprises as it has the most sensitive NPV.

Added to this problem is that over time there are fewer desirable plant species which has a detrimental effect on wool quality. Undesirable plant species will increase the amount of vegetable matter (VM) content in the wool clip, which lowers wool yield and hence incurs higher discounts, further lowering the price received. This lower price, combined with a reduced wool cut, will significantly reduce profits at an ever declining rate after year 15. This is a particularly risky situation for A^0 as under its current state of native vegetation, wool growing is the most viable long term enterprise option.

This leaves little scope for diversification without a large outlay of money for additional capital to adapt infrastructure, leaving the landholder in a position of continually diminishing returns as the land gradually loses productivity.

Other impacts such as reduced diversity of grass species, exposure to other forms of land degradation like erosion, and increased bushfire risk all add to the worsening situation of scenario A^0. All of these factors put together result in reduced viability and in the long term, a form of land management that is not sustainable for either agricultural production or the environment.

Being able to undertake sustainable and responsible removal of native vegetation from country, such as that in A^0 increases productivity as shown in A^1. From the net-present values (TABLE 4.2), it is very clear that both landholders and society would be better off if land could be cleared.

The benefits would include increased productivity which would lead to an improvement in profitability. This allows primary producers to gain better economies of scale, greater returns on investment and improved levels of welfare derived from higher incomes. Society gains through increased spending in rural areas from greater expenditure on agricultural inputs, both direct and indirect employment opportunities and as farm profits increase, more tax revenue would be generated for government.

There are also environmental outcomes to be gained from undertaking the removal of native vegetation although these are not commonly accepted by the general community. These outcomes include the removal of invasive woody weeds, a greater number of beneficial plant species and higher levels of groundcover which will lower erosion potential. All of these benefits combined allow for improved soil and water quality. This also has a direct benefit to the landholder as it will provide for a more profitable and sustainable landscape in the long term which is goal of any genuine primary producer.

For society, the benefits are that members of the public can live in the knowledge that the land is being managed in a sustainable manner, that they have a more secure source of food and fibre, and through the increased spending by primary producers. Even though clearing native vegetation alters the landscape it allows for land to be managed in a more sustainable manner. Scenario A^1 allows for a conservation approach to land management in comparison to a preservation approach. This allows for the notion of sustainability being directly linked to profitability to be exercised and allows people who have the greatest knowledge of the landscape to remain in managerial control.

When the data collection was undertaken and analysis performed it was assumed that the method of clearing is done in a sustainable manner allowing the land to then be in an improved state. The improvement in land management allow for greater control of future land use which is definitely proven by the NPV result figures between A^0 and A^1.

4.5 Implications for Policy

The blanket application of the current legislation may not provide outcomes of maintaining biodiversity and protecting land from degradation. It is providing protection for the remnant vegetation that still remains but this is happening at a very high cost. This cost is imposed on landholders, as proven by comparing the NPV figures between A^0 and A^1, with flow on effects into the rest of the economy. This provides a strong case for a change in policy to occur that will provide outcomes which are more desirable for both agriculture and the environment. A more desirable policy for agriculture would be regulation that is more workable so that sustainable clearing can continue.

Spreading the costs of native vegetation protection beyond just affected landholders would also allow for a more equitable outcome for all concerned. Legislation that would allow for more flexibility would also have benefits in terms of preventing land degradation and would allow for an increase in biodiversity.

Overall landholders want to conserve land in a manner that improves sustainability as this is what drives long term viability of primary producers. Under current legislation this is not able to occur and hence the current protection measures for native vegetation are actually working against what would be the most desirable outcomes.

Chapter Five: Conclusion

5.1 Introduction

This chapter will discuss the findings of the research and the issues surrounding the implications of these findings. The chapter will also discuss further work that could be undertaken

5.2 Summary of Results

The net present values were $47.35/ha for land that contains protected native vegetation (A^0) compared to $1130.44/ha for land where the vegetation could be cleared (A^1). The clearing alternative would earn a profit approximately 23 times larger than what is currently allowed to occur. An opportunity cost of $1083.10/Ha is considered to be a large value that landholders are paying in lost production opportunities to preserve remnant native vegetation for the rest of society.

5.3 Implications for Landholders

This case study indicates that a landholder who has willingly retained remnant native vegetation, before regulation, is now bearing a large opportunity cost for doing so. Remnant native vegetation was left with the presumption that further development of that land could occur. This situation changed considerably when the Queensland government introduced the Native Vegetation Management Act 1999 to phase out all broadscale clearing by the end of 2006.

The aim of the Act is stated as being to "conserve remnant 'endangered' and 'of concern' regional ecosystems; prevent land degradation and the loss of biodiversity; manage the environmental effects of clearing and reduce greenhouse emissions" (NRM 2005).

Without this planned expansion, there are numerous flow-on effects. The future viability of properties must be questioned as the ability to increase levels of production and opportunities to diversify into alternative enterprises and improve efficiencies through adoption of technology are compromised. Australian primary producers are facing ever declining terms of trade and one way to counteract this is to improve on-farm productivity. For properties such as that of the case study, large gains in productivity could be made by the sustainable clearing of native vegetation. In this context of sustainable clearing, even though a physical change of the landscape occurs, agricultural production will be able to continue for many years after without any degradation occurring.

Environmental aims of the legislation included preventing land degradation and loss of biodiversity. As landholders are on the ground and constantly monitoring the state of the country they manage, they have a knowledge of the landscape. The landholder in this case study and many others interviewed for previous research by Sinden (2002), Kenny & Beale (2003) and ABARE (2006) will testify this aim is not being met.

Erosion is increasing both in size and severity on land with high levels of native vegetation but very little ground cover. The increase in erosion levels from decreased ground cover is a flow on effect of a reduced body of grass as trees out-compete it for moisture and sunlight. Land that is protected under this legislation therefore becomes degraded over time and so this aim of the legislation is not being reached.

Considering the loss of biodiversity, landholders are seeing decreased levels of native plants, particularly grasses, mainly because the carrying capacity of the land is gradually declining. This means that native animals have less fodder available so they move to other areas, particularly land that has been already developed which offers improved feed and water supply. The resulting “preserved” ecosystems often become barren of both flora and fauna species.

The third and fourth aims of the act were, as stated previously, to "manage the environmental effects of clearing and reduce greenhouse emissions". Any landholder that is a genuine primary producer who cares for their land does not want to see the environment, particularly soil, to degrade because of clearing vegetation. This is because the producer wishes for the land to continue to be viable to be able to justify the expense of clearing and so that the land can be farmed for generations to come.

A reduction in greenhouse gas emissions has been achieved by the legislation because land clearing levels have fallen to zero which means no carbon is released from this land use change. However this has also meant that landholders who had freehold rights over these trees are not able to sell any possible carbon credit from their trees, as they are already been used up to meet current standards such as the Kyoto protocol.

In the landholders opinion any individual scattered trees, shade lines and conservation clumps retained after clearing, are not recognized as part of the property's assessable area of vegetation. Essentially this vegetation is then not protected and so can be removed at any time particularly if the land was to change ownership. Leaving these trees comes at great expense to the landholder when clearing country and incurs further costs while cropping is being undertaken. These costs include reductions in crop yields and hindering the adoption of new technologies. Individual scattered trees reduce potential efficiency gains from utilizing technology such as GPS guidance systems and the use of wider machinery. Removing these trees would reduce inputs costs substantially and allows graingrowers to be more globally competitive.

Primary producers have to find an optimal level of vegetation to retain, that which is both viable for their business and sustainable for the environment. To achieve the highest level of efficiency from the available technology for cropping it is desirable to remove all trees from the area to be cropped. This is not the best solution as far as the environment is concerned or what genuine primary producers want to see and so they are often willing to reduce profits for this to occur.

Cooperation on the issue needs to start by all stakeholders coming together with the mutual goal of achieving a solution that is best for all concerned. Currently this has not happened as environmentalists and landholders appear to be arch enemies with governments then using blanket legislation which has not helped to solve the problems. A starting place must be a greater education of legislators and the general public so that all concerns can be adequately voiced.

If all stakeholders where able to meet and state what their preferred goals and aspirations are considering the protection of remnant native vegetation, a lot of common ground could be found. One particular unheard side of this debate is that all responsible landholders wish to maintain a certain area of remnant native vegetation and are willing to do so voluntarily. If this could be realized by both environmentalists and policymakers inefficient blanket legislation that is currently being used would not be necessary and a more flexible approach could be achieved. This would need to involve a more on the ground approach by government agencies to actually scope what is occurring.

A more understanding approach to gauge what processes are actually taking place on land still timbered with native vegetation is necessary. This will provide an outcome of greater efficiency than what is currently being achieved by command and control regulation. Progress needs to be made to conserve an altered landscape that is sustainable, as opposed to preserving an ever degrading landscape at high cost.

5.4 Shortcomings of the Research

All research has faults that cannot be avoided due to time constraints and potential improvements. One of the major shortcomings of the present research is that it was only a single case study and therefore can only represent a small section of the problem under investigation. As this case study only looks into the effects of protecting native vegetation on one property, it can only provide an estimation of what the costs could be if applied to other areas. Limitations such as soil and rainfall make the figures presented unique to the case study property and can only be used as a generalization to calculate the economic impacts of this type of legislation across the industry.

Due to the nature of the study and time constraints a complete assessment of the environmental impacts was not able to be undertaken. Any conclusions drawn regarding the effects on the environment of this legislation were based on landholder knowledge gathered during the research. Drawing on this experience based knowledge meant that an economic figure of environmental value either lost or gained by the legislation was not able to be included as part of the assessment process. This work only presents the opportunity cost of lost agricultural production to the landholder.

A final shortcoming of the work is that the choice of enterprise mix was just what the landholder is currently operating, even though this is an uncommon combination for the region. No comparisons against other possible enterprise mixes were made as it was assumed that the producer is maximizing profits. This shortcoming gives scope for other researchers to investigate and compare other possible enterprise combinations.

5.5 Future Research

Further work into this area could involve taking a broader study of the cost for the whole of Australian agriculture by compiling data from all regions adversely affected by regulations. This would allow for a national figure to be produced that would give further insight into the issues of inequity that this legislation is causing and begin to draw the required political attention to allow for improvements.

Another area that a further in-depth economic analysis is required would be into the environmental and rangeland science to add further weight to the argument that land is becoming degraded due to this legislation. If this were conducted it could help to verify landholder's knowledge and opinion on the subject. Once this could be quantified financially it will help landholders and environmentalists to find more common ground which would allow for mutual goals concerning the conservation of remnant native vegetation to be formulated.

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Appendix A

Labour requirements and costs for each enterprise as used in main table:

Table 1

	WOOL	WHEAT	LAMBS
FAMILY LABOUR (HR/PA)	100	600	200
OWNER OPERATOR@$84/HR	4,200	25200	8400
OTHER FAMILY@$28/HR	1,400	8400	2800
TOTAL LABOUR COST	**$ 5,600**	**$ 33,600**	**$ 11,200**

The figures of total labour cost from Table 1 are placed in each of the gross margin tables for their respective enterprises that are found in further in this appendix.

Scenario A^0: Annual cash flows of woolgrowing on remnant timber country

WOOL GROWING ON REMNANT TIMBER COUNTRY (A0)					YEAR 1	Totals for Whole Life of Project
INCOME						
Wool	**number**	**Type**	**kg/hd**	**$/kg**	**$**	
CRUTCHING	400	wethers	0.2	2.63	210	
SHEARING	400	wethers	6	5.83	13,992	
				A. Total Income:	**$ 14,202**	
VARIABLE COSTS						
Shearing	400	wethers	5.21		2,084	
Crutching	400	wethers	0.76		304	
Wool Levy			2.00%		284	
Commission, warehouse, testing charges (per bale)			38.85		505	
Wool-cartage	13	bales	10.97		143	
-packs	13	packs	8.59		112	
Labour Costs					5,600	
Sheep Health				Number of Treatments		
Broadspectrum Worm Drench (per dose)	400	wethers	0.25	1	100	
Narrowspectrum Worm Drench (per dose)	400	wethers	0.3	1	120	
Lice Backliner (per dose)	400	wethers	0.63	1	252	
				B. Total Variable Costs:	**$ 9,503**	
				GROSS MARGIN (A-B)	**4,699**	**$70,485**
			0.09	**DISCOUNT FACTOR 9%**	0.9174	
				NET PRESENT VALUE	4,311	**$37,877**
				NPV/HA	5.39	**$47.35**
				GROSS MARGIN /HECTARE	5.87	

In Scenario A^0,the gross margin from each year is discounted by 9% to give Net Present Value and this figure is divided by 800 to give the NPV/HA. All data are annual and all figures are assumed to remain constant over the 15 years. The total figures for the whole life of the project are given in the right hand column.

Scenario A[1]: Annual cash flows of wheat and lamb production in years 1-15

WHEAT & LAMB PRODUCTION (A1)				YEAR 1	YEAR 2	YEAR 3-6	YEAR 7		YEAR 8-15	Totals for Whole
					CROPPING PHASE				**LAMB PHASE**	Life of Project
WHEAT GROSS MARGIN										
Income:	Tonnes/ha	Price/tonne			Per ha($)	Per ha($)	Per ha($)		Per ha($)	
	2	260			$ 520	$ 520	$ 520		$ 199	
TOTAL INCOME (C)					**$ 416,000**	**$ 416,000**	**$ 416,000**		**$ 159,200**	
Variable costs										
Fuel	10000L @ $1.20				$ 12,000	$ 12,000	$ 12,000	Variable costs	$ 32,390	
Seed	35KG/HA @ $200		=		$ 5,600	$ 5,600	$ 5,600			
Lucerne seed 3KG/HA @ $10000			=				$ 24,000			
Fertiliser 25KG/HA @$1100			=		$ 22,000	$ 22,000	$ 22,000			
Chemicals $15/HA			=		$ 12,000	$ 12,000	$ 12,000			
Harvesting $25/HA			=		$ 20,000	$ 20,000	$ 20,000			
Cartage $20/tonne			=		$ 32,000	$ 32,000	$ 32,000			
Machinery depreciation			=		$ 2,000	$ 2,000	$ 2,000			
Interest costs			=	$ 20,456	$ 20,456					
Family labour					$ 33,600	$ 33,600	$ 33,600	Family labour	$ 11,200	
TOTAL VARIABLE COSTS (D)					**$ 159,656**	**$ 139,200**	**$ 163,200**		**$ 43,590**	
GROSS MARGIN (C-D)			=	**$ (225,016)**	**$ 256,344**	**$ 276,800**	**$ 252,800**		**$ 115,610**	
(TOTAL INCOME-TOTAL VARIABLE COSTS)										
GROSS MARGIN PER/HA			=		$ 320	$ 346	$ 316		$ 145	
GROSS MARGIN PER/HA MINUS										
DEVELOPMENT COSTS			=		$ 269	$ 295	$ 265			
TOTAL LOSS OVER 5 YEARS			=	$ 215,432	**$ 1,077,160**				**$ 796,000**	**$ 1,617,206**
LOSS PER YEAR			=	**$ (225,016)**	**$ 215,432**	**$ 215,432**	**$ 211,888**		**$ 159,200**	**$ 107,814**
DISCOUNT FACTOR 9%		0.09	=	0.9174	0.8417	0.7722	0.5470		0.5019	
NET PRESENT VALUE (NPV)				-$ 206,437	$ 181,325	$ 166,353	$ 115,910		$ 79,897	**$ 904,356**
NPV PER HA			=	-$ 258.05	$ 226.66	$ 207.94	$ 144.89		$ 99.87	**$ 1,130.44**

Scenario A[1]: Prime lamb production on improved pastures, years 8-15

INCOME					
Wool	**Number**	**Type**	**kg/hd**	**$/kg**	**$**
CRUTCHING	1600	ewes	0.2	2.63	842
	1300	lambs	0.1	2.00	260
SHEARING	1600	ewes	5.5	5.83	51,304
Lamb Sales			**$/hd**		
85% Lambing from number of ewes joined	650	lambs	78.5	(22kg cwt)	51,025
	650	lambs	86.5	(22kg cwt)	56,225
				A. Total Income:	**$ 159,656**
VARIABLE COSTS					
Shearing	1600		5.21		8,336
Crutching	2900		0.76		2,204
Wool Levy			2.00%		1,048
Commission, warehouse, testing charges (per bale)			38.85		505
Wool-cartage	48	bales	10.97		527
-packs	48	packs	8.59		412
Labour Costs					11,200
Sheep Health				Number of Treatments	
Broadspectrum Worm Drench (per dose)	1600	ewes	0.25	2	800
	1340	lambs	0.12	3	482
Narrowspectrum Worm Drench (per dose)	1600	ewes	0.3	1	480
Lice Backliner (per dose)	1600	ewes	0.63	1	1,008
Blowfly Backliner	1600	ewes	1	2	3,200
Lambmarking	1350	lambs	0.3	1	405
Pregnancy Scanning	1600	ewes	0.9	1	1,440
Livestock Marketing					
Cartage	1360	lambs	3	1	4,080
Commission on Lamb Sales			5%		5,363
Levies					2,000
				B. Total Variable Costs:	**$ 43,490**
				GROSS MARGIN (A-B)	**116,166**
			0.09	**DISCOUNT FACTOR 9%**	0.9174
				NET PRESENT VALUE	106,574
				NPV/HA	133.22
				GROSS MARGIN /HECTARE	145.21

Appendix B

Development Plan for 800 hectares (A[1])

Costings		
Scrub pulling @$50/ha	=	$ 40,000
($500/hr @10/hr)		
Fuel($1.20/L @160L/hr for 80 hrs)=		$ 15,360
Stickraking @$120/ha	=	$ 96,000
($120/hr @1ha/hr)		
Fuel($1.20/L @40L/ha for 800 HRS)=		$ 38,400
TOTAL FOR CLEARING (A)	=	**$ 189,760**
Fuel to prepare ground	=	$ 9,600
(8000L @$1.20/L)		
Labour to prepare ground	=	$ 3,200
(160 HRS @$20/hr)		
Machinery depreciation	=	$ 2,000
TOTAL FOR GROUND PREPARATION (B)=		**$ 14,800**
TOTAL COSTS (A+B)		**$ 204,560**
Cost/ha		$ 255.70

The result for total costs (A+B) of $204,560 is used annual cash flows table for A[1] that is found in Appendix A.

Appendix C

The sensitivity testing formulas

Price elasticity=

$$\frac{\text{(New NPV – Original NPV)*100}}{\text{Original NPV}} \; / \; \frac{\text{(Original price- New price)*100}}{\text{Original price}}$$

Yield elasticity=

$$\frac{\text{(New NPV – Original NPV)*100}}{\text{Original NPV}} \; / \; \frac{\text{(Original yield – New yield)*100}}{\text{Original yield}}$$

The results:

Sensitivity of Prices & Yields			
Wool price $/kg	5	5.83	6.5
A^0	$ 22,142	$ 37,877	$ 50,580
NPV/ha	$ 27.68	$ 47.35	$ 63.22
Wool cut kg/hd	5.5	6.0	6.5
A^0	$ 28,607	$ 37,877	$ 47,088
A^0 NPV/ha	$ 35.83	$ 47.35	$ 58.86
Wheat Price $/tonne	220	260	300
A^1	$ 649,818	$ 904,356	$ 1,176,605
NPV/ha	$ 812.27	$ 1,130.44	$ 1,470.76
Wheat yield tonne/ha	1.5	2	2.5
A^1	$ 485,198	$ 904,356	$ 1,341,226
A^1 NPV/ha	$ 605.50	$ 1,130.44	$ 1,676.53
Lamb price (c/kg cwt)	$2.5/$2.9	$3.5/$3.9	$4.5/$4.9
A^1	$ 822,525	$ 904,356	$ 978,393
NPV/ha	$ 1,028.16	$ 1,130.44	$ 1,222.90
Fertility (Lambing %)	65%	85%	105%
A^1	$ 836,913	$ 904,356	$ 971,798
NPV/ha	$ 1,046.14	$ 1,130.44	$ 1,214.75
Number of Lambs Sold	1,000	1,300	1,600