Policy responses to invasive native species: issues of social and private benefits and costs

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Abstract

Farm and catchment managers in Australia face decisions about controlling invasive native species (or scrub) which may infest agricultural land. The treatment of this land to remove the infestation and re-establish native pastures is likely to be expensive for landholders. Yet there are potential social benefits from such remediation and so a policy question arises of what to do to about facilitating such change. New South Wales state government legislation addresses this issue through regulations, and the Catchment Management Authorities are responsible for administering public funds to achieve associated natural resource improvements. However, the extent of the private costs and social benefits associated with such changes are not known, which precludes benefit-cost analyses using the traditional welfare economics framework. This paper reports results of a social and private economic analysis of the impacts of a typical infestation remediation decision. We show that for the landholder the private costs exceed the benefits achieved from increased livestock productivity. However, there are social benefits expressed by the willingness to pay by members of the local catchment community for improvements in native vegetation and biodiversity. When these social benefits are included, the economic analysis shows a positive social net benefit. This raises questions of how to reconcile the public and private accounting, and whether any changes to policies, regulations or procedures for natural resource management in New South Wales are warranted.

Key words: Invasive native scrub, environmental values, choice modelling, financial, economic, Namoi catchment

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1. Introduction

Farm and catchment managers in Australia face decisions about controlling invasive native species (or scrub) (INS) which may infest agricultural land. In north-west NSW, White Cypress Pine (*Callitris glaucophylla*) is estimated to cover approximately 5,000 ha in the Nandewar region and 120,000 ha across the Namoi catchment. Past land management practices have contributed to this infestation, resulting in private agricultural (soil erosion, loss of productivity) and public (lessening of biodiversity) land impacts. In many cases these infestations occur on private lands and treatment is costly to landholders.

The NSW Government has recognised that there are potential private and social benefits from controlling and reversing these INS infestations, and has legislated to facilitate remedial action. The Catchment Management Authorities (CMAs) in NSW are the institutions charged with promoting and administering improvement in natural resource condition within catchments. They provide incentives to landholders to deal with INS infestations, but funds for this purpose are limited.

State Government policy is based on the existence of community (private plus social) benefits and costs from improved natural resource management, but information on the quantum of these amounts is lacking. Knowing these amounts is beneficial for at least two reasons. First, quantifying private landholder costs will allow better targeting of the CMA incentive grants to landholders in controlling INS. More importantly, a quantification of the social and private benefits and costs of alternative natural resource management action provides CMAs with information as a basis for prioritising actions across catchments.

Ideally, in an environmental economics sense, plans and actions should be subject to rigorous analysis of social and private costs and benefits. Only where community benefits exceed community costs and private costs exceed private benefits should policies, plans or practices be supported. In addition, if sufficient information is available the choice between alternative policies, plans or actions can be made based on the relative magnitudes of benefits exceeding costs. That is, a benefit-cost framework would ideally be used as a basis for natural resource management decisions. In the past, the use of such a framework has been constrained by a lack of information about these amounts. In this paper we quantify these amounts for a particular case where treatment of INS is being considered.

2. Policy framework

2.1 State Government policy

The *Native Vegetation Act 2003* (see http://www.nativevegetation.nsw.gov.au and http://www.nativevegetation.nsw.gov.au/fs/changes.shtml) deals with conserving native vegetation and INS in NSW. It has the stated intention of putting an end to broad scale land clearing in the state.

Clearing native vegetation

The regulations accompanying the Native Vegetation Act define routine agricultural management activities that are exempt from the Act. The Act also provides a framework for deciding whether clearing proposals maintain or improve environmental outcomes. This is implemented through a system of voluntary negotiated agreements between individual landholders and their local CMA, known as Property Vegetation Plans (PVPs). Landholders must demonstrate that any proposed clearing (and agreed offset or mitigating action) will maintain or improve environmental outcomes at the property scale for each of four criteria – biodiversity, soils, water quality, and salinity. A system of offsets was introduced which allows farmers to clear an area of native vegetation, provided they agree to plant, improve or better manage other vegetation on their own property or elsewhere.

This legislation is accompanied by public funding to assist landholders repair degraded landscapes, and there are also funds for structural adjustment assistance for landholders who experience financial hardships as a result of the new laws.

This Act includes a regulatory system capable of ending illegal clearing and a more effective control regime.

Clearing INS

The *Native Vegetation Act 2003* also sets out procedures for clearing INS which is classified as remnant vegetation.

INS comprises:

1. A plant species that invades vegetation communities where it has not been known to occur previously, or a species that regenerates densely following natural or artificial disturbance, *and*
2. The invasion and/or dense regeneration of the species results in change of structure and/or composition of the vegetation community, *and*
3. The species is within its natural geographic range or distribution.

Dense growth-locked Cypress Pine is a native plant to NSW that is classified as invasive. Allowable INS treatments include clearing of plants in paddocks with nil to minimal disturbance to soil and groundcover, for example by chaining, slashing or roping.

The clearing of INS is assessed by CMAs in NSW using the PVP Developer and an INS Tool. The INS Tool sets out the treatments that allow landholders to clear INS to restore open woodlands and native grasslands. Offsets are not required when using the INS Tool. After assessing a clearing proposal using the INS Tool a PVP is prepared by the landholder and the CMA. Up to 80% of the extent of INS on a property can be treated, but at least 20% of the INS extent on a property is to remain untreated. The maximum diameter of trees that can be cleared is specified by regulation.

The regulations also specify whether introduced pasture plants (eg Lucerne) can be used as part of INS management, and whether cropping can be used as part of INS management.

These legislative and regulatory systems seem to be working well; landholders can manage and remove INS successfully without discord or controversy.

2.2 CMAs and funding for treating INS

Funding is available for treating INS on individual properties. Incentive grants are available from Namoi CMA (see http://www.namoi.cma.nsw.gov.au/). However, these grants are competitive and are assessed within a limited budget.

The importance of INS is recognised in the Namoi CMA Catchment Action Plan through its Management Targets for Biodiversity – Native Plants and Animals (MTB3), which aims to reduce the threat to biodiversity and sustainable agriculture posed by invasive plants and animals. Among the means of reducing the environmental and economic impacts of invasive plants is the application of strategic control measures to existing invasive plant populations, particularly where species are a threat to native vegetation and habitat and cause other environmental damage such as erosion.

2.3 Public and private interests in land-use change

The presence of potential social and private impacts from a land-use change aligns with a policy development framework elaborated by Ridley and Pannell (2007) and Pannell (2008) – see Figure 1. This framework emphasises that there may be public and private net benefits or costs from proposed land-use changes, and that the resulting classification can have implications for recommending policy responses. Figure 1 relates to salinity management but the same framework can be applied to other natural resource management questions.

The value of the Figure 1 framework is in raising awareness by catchment and state communities, and policy advisors, that there are both benefits and costs to individuals and society from taking (or not taking) action to improve the natural environment. This approach is part of the overriding welfare economics framework which is available for public policy decision making, but which is often not widely appreciated in the community. A logical next step from Figure 1 is to begin quantifying the extent of benefits and costs for different environmental options, and this paper conducts these calculations for one particular case.

3. Assessing costs and benefits from INS clearance

The clearance of INS and replacement with native vegetation may improve farm profitability (see http://www.nativevegetation.nsw.gov.au/fs/fs_01.shtml), but this is an empirical question. In this section we discuss how the assessment of social and private benefits can be undertaken to achieve improved environmental outcomes for communities and individuals.

3.1 Landholder actions in controlling INS

Remediation of land covered by White Cypress Pine is costly for most landholders as it not only requires labour-intensive work involving the use of chainsaws and brush-cutters, but there is also an opportunity cost of lost animal production while the cleared land is rested to allow re-colonisation of native forbs. Further, conservation works and re-alignment of fencing and watering points, or fencing to improve grazing management, is expensive and generally only warranted on land that can generate high returns. Country with invasive pine is heavily discounted in value, with anecdotal evidence of prospective property purchasers being deterred by areas of INS.

A further complication is the legislative requirement for use of the PVP Developer that potentially limits clearing.

3.2 A case study

A case study of planned clearance of White Cypress Pine from a property in north-west NSW (west of Manilla, near Tamworth) is being conducted to investigate the practical management and economics of such an action. This project will demonstrate the best means of rehabilitating and managing the landscape to stabilise soils, increase productivity and improve biodiversity to provide a productive and sustainable landscape. An area of 270 ha is being cleared of White Cypress Pine and native pastures re-established.

Other research associated with the project involves measuring biophysical changes associated with clearance of INS and re-establishing native vegetation. Such information can add to knowledge about whether such changes will maintain or improve the associated biodiversity. An example of such work is shown by McHenry *et al*. (2006) and McHenry (2007).

The project objective is to demonstrate the best means of rehabilitating and managing the landscape to stabilise soils, increase productivity and improve biodiversity. We don’t really know what the landscape looked like in its pre-European form. Perhaps it was heavily timbered with Eucalypts, but the aborigines managed these landscapes with fire. The objective of this project is to take the landscape back to an open woodland landscape, which is far more like what it might have been prior to the arrival of Europeans than its current state (David Walker, Executive Officer of the Liverpool Plains Land Management Committee, personal communication).

3.3 Measuring improvements in biodiversity

A component of the above project involves measuring soil and vegetation responses to the INS control options so that impacts of biodiversity can be gauged. A similar activity has been reported by McHenry *et al.* (2006). The issues surrounding regrowth and soil erosion in the semi-arid woodlands of NSW have been canvassed by Eldridge *et al.* (2003). Existing knowledge of the relationship between ground cover, regrowth and erosion is often lacking in terms of empirical data. Ground cover is considered to be generally beneficial in terms of rainfall interception, infiltration enhancement and sediment trapping. But key knowledge gaps have been identified, including the relationship between regrowth density and ground cover, the extent of surface degradation through sheet and rill erosion, the extent and degree of activity of gully erosion, and the biodiversity value of regrowth by comparison with other land uses.

In the current project it is likely biodiversity will be enhanced with revegetation of native forbs (Dr. Brian Wilson, NSW Department of Environment and Climate Change, personal communication), but we do not have estimates of the amount of such change. Therefore for this analysis no effect of improved biodiversity is included.

3.4 Method of analysis

Economic and financial analyses were undertaken to determine the impacts of treating an INS infestation on one property within a particular catchment. Economic and financial appraisals can be distinguished for considering the impacts of changes or investments by business or government entities. An economic appraisal differs from a financial appraisal in that it considers a wider range of costs and benefits (NSW Treasury 1997).

Ideally, the consideration of alternative proposals for environmental improvement would involve:

1. a social economic (benefit cost) analysis; followed by
2. a private economic (benefit cost) analysis; and
3. a private farm cash analysis.

Step 1 determines whether the project should be conducted at all. If the social benefits exceed the socialc costs (and after comparison with other proposals), steps 2 and 3 can then be conducted to determine the incentives for the individual landholder. If the private incentives are negative then a policy framework like Figure 1 can be used to consider appropriate policy actions.

The comparison in this paper relates to a base (status quo or no action) scenario compared to clearing an INS infestation, which is treated as an investment proposal by the landholder and the Liverpool Plains Land Management Committee. The appraisals are conducted based on predicted changes from the status quo as the development works are undertaken. A 20-year time frame is used for the financial and economic appraisals.

The current stocking rate is 1.5 Dry Sheep Equivalents (DSE)/ha (for a discussion of livestock feed requirements and DSEs see Rickards and Passmore 1977 and NSW Department of Primary Industries http://www.dpi.nsw.gov.au/agriculture/farm-business/budgets/ livestock/ sheep/background/dse). In the base case the landholder estimated that taking no action on the INS infestation would result in further pasture deterioration from the current stocking rate. He estimated that in 20 years 50% of the area would revert to half of the current stocking rate, and that for the other 50% the stocking rate would decline to 10% of the current rate. This base case is compared with the investment case where the stocking rate is zero for the 3 years of restoration and then 2.5 DSE/ha thereafter. The resulting difference in stocking rate is shown in Figure 2.

In this paper a social economic analysis for the Namoi community and private economic and cash analyses are presented for the landholder. The farm cash analysis (called Cash Impact) includes the changed cash flows from the existing sheep enterprise (comprising cash income and cost patterns over 20 years), the estimated cash costs of INS clearance, the cash costs of pasture re-establishment, and the capital costs (fencing, watering points) of upgrading the farm infrastructure to allow improved pasture management in the future. The farm economic analysis (called Cash plus Income Foregone) includes the Cash Impact effects as well as wool income foregone in the first 3 years. Capital gains have not been incorporated here because the effects of increased carrying capacity are included in the cash flows and to then include capital gain would be double counting.

The analytical method used for the Cash Impact and Cash and Income Foregone analyses is a partial discounted cash flow budget, based on Makeham and Malcolm (1993) and NSW Treasury (1997). The budgets are used to assess the net present value (NPV) of cash flows from the investment over a period of 20 years, and cumulative cash flow patterns are presented. The analysis is prepared in nominal terms which include the effect of inflation. The analysis does not account for any benefit the producer may obtain from the pasture providing out of season feed. Values used in the analysis were supplied by the producer during an interview undertaken to establish a base line of site productivity (see Table 1). Sensitivity analysis was used to evaluate a range of values for these unknowns and to illustrate the risks investment associated.

Cash flow assumptions

The area is to be de-stocked from the currently-estimated stocking rate of 1.5 DSEs/ha for a period of 3 or more years to allow for pasture regeneration. In the fourth year the area will be re-stocked at an assumed stocking rate of 2.5 DSE/ha. The change in stocking rate will be an additional carrying capacity from the base case where the carrying capacity is predicted to gradually decline over 20 years (see Figure 2). For the investment analysis it is assumed that pasture and stock have a salvage value which will occur in year 20. Establishment costs for the treatment have been calculated as $99,410. Most costs are associated with fencing, fertiliser and capital works (see Table 2). In addition to this cost in year 1 there is an amount of $11,628 of wool income foregone. The discount rate used was 7% with sensitivity analyses of 4% and 10%, as specified by NSW Treasury (1997).

Measuring and incorporating public values into the analysis

Natural resource management which leads to improved native vegetation and biodiversity outcomes can be beneficial to both landholders and catchment communities. But how can the community benefits from such improvements be measured or valued for inclusion in an economic analysis like this?

Farquharson *et al.* (2007) discussed environmental economic valuation methods and the use of benefit-cost analysis in making decisions about natural resource management. They proposed use of the stated-preference method of Choice Modelling (Bennett and Blamey 2001, Morison, Bennett and Blamey 1999, Rolfe and Bennett 2006) to develop estimates of the values that catchment communities hold for the non-use benefits associated with environmental improvements. Two possibilities arise – the conduct of specific studies to investigate such values for a particular case or question, or investigation of the existence of values from related studies in nearby locations and adaptation of such results for use in the particular case or question (a process called Benefit Transfer (van Beuren and Bennett 2004, Morison and Bennett 2004, Windle and Rolfe 2007)). Gillespie Economics *et al*. (2008) have reviewed the evidence from Choice Modelling studies of the ecosystems services provided by Australian farmers.

A concurrent project titled ‘Optimisation Framework to Support CMA Decisions at a Catchment Scale’ (see Optimisation Framework Project Team 2008) has conducted a

Choice Modelling survey to develop implicit prices for environmental attributes in NSW. A survey was conducted of households in the Hawkesbury-Nepean, Namoi and Lachlan Catchments and in Sydney. The environmental and social attributes investigated were area (km^2) of native vegetation (NV), number of endangered species saved (NS), length (km) of healthy waterways revived (HW), and extra people employed in agriculture (PA). The survey was preceded by a focus group process to refine the questionnaire (Mazur and Bennett 2008). The results of this survey are used here in a process of Benefit Transfer.

The development of non-use values for environmental improvements within 3 NSW catchments is currently being completed (Mazur and Bennett 2009). The preliminary results of that study are included in the social economic analysis.

4. Results

4.1 Private economic analyses

Annual landholder cash flows illustrate the substantial upfront costs and loss of income in the following 3 years, and these amounts for the Cash plus Income Foregone case are shown in Figure 3. The additional loss in year 4 is associated with the purchase of stock. Enterprise returns are positive in year 5 and continue until year 20 where it is assumed the stock flock is sold.

The NPVs for each analysis are shown in Table 3. As expected the NPVs are lower when wool income foregone in included. Also as expected the NPVs are generally negative for this investment in INS clearing and native pasture re-establishment. The magnitude of the loss depends on the discount rate for future cash income and losses. At the preferred discount rate of 7% the NPV is -$6,257 for Cash Impact and -$32,877 when wool income foregone is included.

A cumulative cash flow pattern for this investment is shown in Figure 4. This cash flow does not include income foregone, but does account for the effects of income tax and interest payments. The cumulative effects are not positive until year 17, and so this is a more realistic view of the financial picture from the landholder's perspective. Peak debt is around $115,000 in year 4.

4.2 Social economic analysis

The estimated implicit prices (derived from the Choice Modelling survey) for natural resource improvements at a low scale (10%) within the Namoi catchment are given in Table 4. These prices represent the willingness to pay by surveyed households for the environmental improvements listed in section 3. They were presented in the survey questionnaire as annual payments by the household over 5 years, and NPVs of these payments were developed for the calculation of aggregate social benefits.

The physical environmental benefits from the land-use change in this project were estimated to be 270 ha of land rejuvenated from INS to native pastures capable of grazing sheep and cattle, and 10 km of streams having 30% less sediment load due to a reduction in erosion (David Walker, personal communication). This rejuvenated native pasture was assumed to be close to a pre-European state. These figures are, to some extent, guesstimates, but they are used here to illustrate the type of analysis possible. We interpret the social economic results to be a rough idea of the possible social benefits from this case of INS clearance.

Other factors included in the calculation of public values include the NPVs of the 5-year willingness to pay amounts, the number of households (15,774 in the Namoi (Mazur and Bennett 2009)), and a survey response factor. Although the survey to determine implicit prices for environmental improvements is meant to derive estimates of willingness to pay by the whole population of households, we act conservatively in applying the resulting estimates. The survey response rate is calculated as the ratio of survey questionnaires completed and returned compared to the surveys distributed. This was 65% for the Namoi. We assume that for the survey responses not returned the implicit prices were zero, and so the prices applied to the population of households was only for a proportion of the population according to the survey response.

After including these factors the estimated aggregate social benefits are shown in Table 5. At 7% discount the estimated aggregate social benefit in the Namoi catchment was around $420,000. This can be set against the private cost of $33,000.

5. Discussion

In considering incentives to invest in INS clearance on this property the social economic analysis indicates a positive outcome (a Namoi community NPV of around $400,000). With this information the Namoi CMA can compare these net benefits with those from other possible natural resource projects.

In further consideration of this proposal, the private economic analysis indicates a substantial cost to the landholder with a peak debt of $115,000 in year 4, negative cash flows for 16 years, and a considerable negative NPV. These results place this project in the upper left quadrant of Figure 1. Similar analyses for other projects will allow a more complete comparison of projects in that social benefit-cost framework.

Existing public policy involves provision of incentive funding for landholders by the Namoi CMA. This analysis gives an idea of the amount by which such funding might be required. This information allows consideration of whether the state government budget allocated to this CMA for this type of work is sufficient. Another potential use of the social environmental values is facilitating CMAs in developing priorities for natural resource improvement priorities and plans across the catchment.

6. Conclusion

The private costs of treating a White Cypress Pine infestation on one property in north-west NSW are in the order of $33,000. Yet there is evidence of social benefits from an increase in the area of native vegetation and associated waterway improvement in an amount of around $400,000. Existing government policies and programs offer assistance to landholders for such purposes, and the results of this analysis provide evidence of the likely private costs and social benefits from such actions.

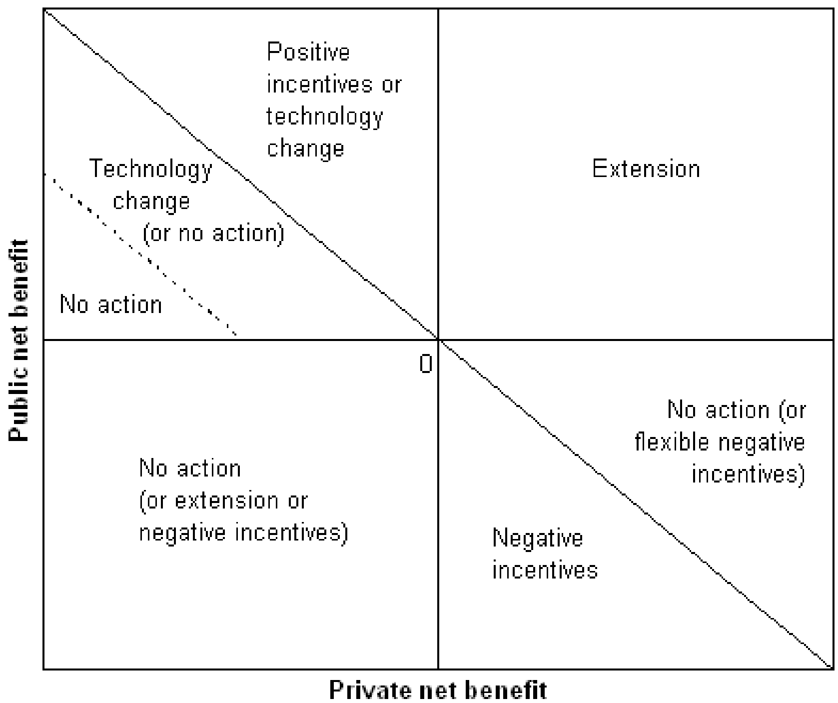

Figure 1. Recommended efficient policy mechanisms based on a simple set of rules (see Pannell 2008)

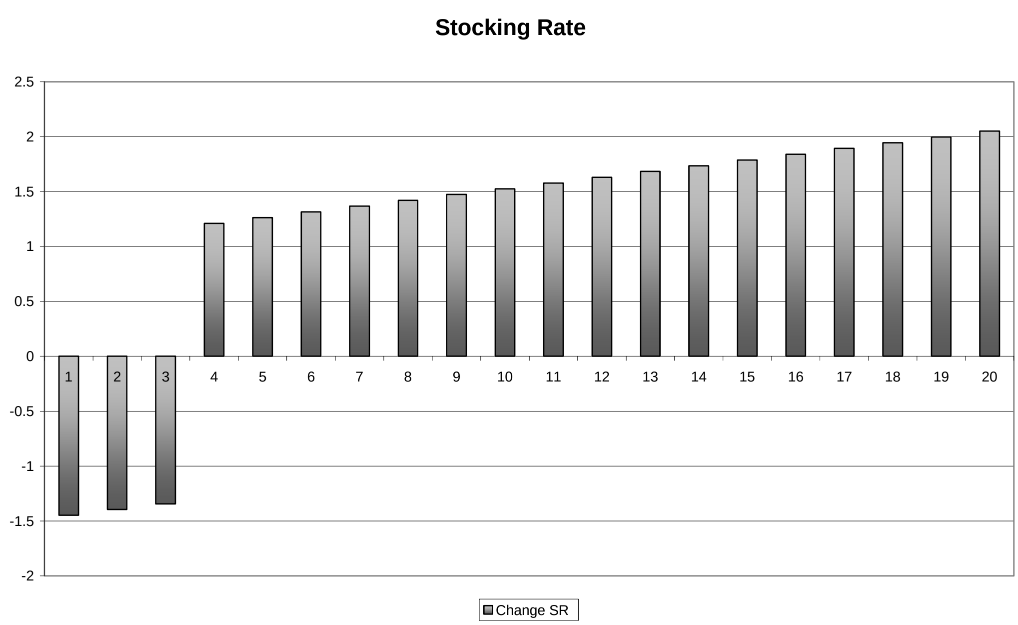

Figure 2. Change in sheep stocking rate (DSE/ha) over the analysis period

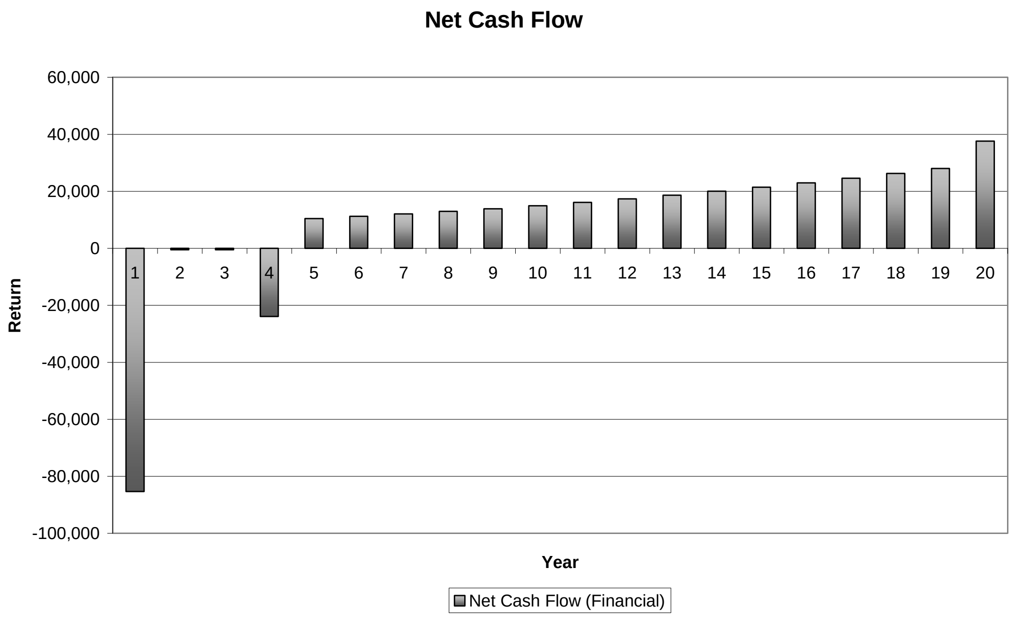

Figure 3. Cash flow including wool income foregone

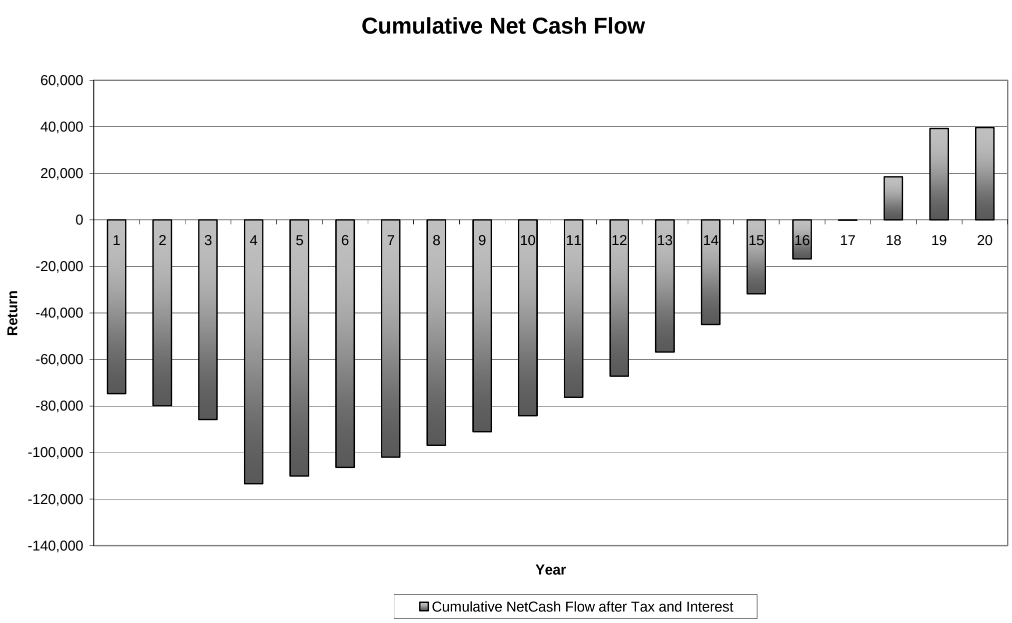

Figure 4. Cumulative cash flow after tax and interest

Table 1. Base information and assumptions for cash flow analysis

Farm and Site Information.
• 650mm rainfall
• Approx 30km West of Manilla
• Soils are predominantly derived from shales and conglomerate
• 270 ha site
• White Cyprus Pine monoculture
• Runs fine 15 micron wether flock, cutting 3.5kg
• Undulating to hilly with arable foothills
• Cleared areas support native grasses, wiregrass, wheatgrass, speargrass, kangaroo grass and annual clovers.
• White box grassy woodland, other tree species include ironbark, grey box and stringybark.
• Shrubs include wattles, sheoak, hopbush and native olive.
Establishment Process.
• August 2008 – Commence clearing and capital works.
• October 2008 – Destock and commence realignment of fences
• Autumn 2009- Establish pastures
Maintenance
• Follow up seedling removal in 4th year
Production Without
• Cleared land runs approximately 2.5 DSE/ha with conservative set stocking
• Site estimated to carry 1.5 DSE/ha
• Potential for additional loss in grazing land as invasive pine spreads
• Loss of grazing area increases pressure on remaining grassland
Production With
• Grazing management will be controlled for pasture persistence
• Hopes to achieve what is run on the rest of the farm 2.5+ DSE/ha
• Expects to be able to improve control of seedlings with intensive grazing.
• Additional benefits due to reduction in water energy across property and slowing gully erosion
• Improvement in property value
Motivation
• To improve the carrying capacity of the farm and control invasive species
• Improve visual amenity and leave property in good state for next generation
• Halt expansion of pine as worried will lose additional productive country
Assumptions
• 15 Micron wether enterprise. $12/kg wool. Cut 3.5kg.
• Sheep enterprise returns are sourced from grower
• Costs of capital works are provided in project application
• Land values were derived from communication with stock and station agents in the area.

Table 2. Establishment costs for treatment of 270 ha INS

Cost category	Cost $
INS clearance	
- heavy infestation area	8,100
- moderate infestation	9,450
- light infestation	3,038
Pasture establishment	
- fertiliser	10,886
- seed	4,320
- application	2,541
Capital costs	
- area 1	6,750
- area 2	5,400
- area 3	4,725
- area 4	10,000
Fencing	34,200
Total	99,410

Table 3. Net Present Values for INS treatment: landholder perspective

Discount	Private Economic Analysis	
Rate	Cash Impact	Cash plus Income Foregone
7%	-$6,257	-$32,877
10%	-$26,528	-$51,826
4%	$25,707	-$2,358

Table 4. Implicit prices, Namoi respondents

Attribute	NV[a]	NS[b]	HW[c]	PA[d]
Unit	(km^2)	(species)	(km)	(persons)
Location				
Namoi	$0.13**	$9.28	$0.97**	$3.09***

[a]Area of Native Vegetation, [b]Number of Endangered Species saved, [c]Length of Healthy Waterways restored, [d]Number of extra Persons in Agriculture
*Significant difference in Implicit Price from zero at 1 (***) and 5 (**)%

Table 5. Aggregate community (social) environmental benefits

	Discount rate (%)	**Namoi $**
Native Vegetation	**4**	16,195
(NV) (km^2)	**7**	14,755
	10	13,676
Healthy Waterways	**4**	447,548
HW (km)	**7**	407,766
	10	377,929
Total	**4**	463,743
	7	422,521
	10	391,605

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