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AN INVESTIGATION INTO THE NET BENEFITS OF REVEGETATING AGRICULTURAL LAND WITH INDIGENOUS SPECIES IN THE DRYLAND SECTION OF THE GOULBURN-BROKEN CATCHMENT AREA

Lindsay Trapnell[1]

ABSTRACT

Benefits ascribed to the revegetation of farming landscapes include enhancement of biodiversity, reduction in the advance of dryland salinity, sequestration of greenhouse gases, control of soil erosion, greater protection of agricultural activities from adverse weather conditions and an improved aesthetic value of rural lands. In this paper, economic analyses were performed to determine the net benefits to landholders of carrying out revegetation. Where the net benefits were insufficient to allow reasonable returns to be earned on the investment of marginal capital, an assessment was made of the amount and type of assistance that would be necessary to encourage landholders to adopt this improved system of land management.

Key Words: Biodiversity, Economic and Financial Analyses, Environmental Degradation, Land Management, Revegetation

[1] Lindsay Trapnell is a PhD student in the Department of Food Science and Agribusiness of the Institute of Land and Food Resources at the University of Melbourne.

INTRODUCTION

Background

This paper was written to assist the Goulburn-Broken Catchment Authority to make decisions about the worth of providing assistance to farm families to enable them to carry out revegetation with indigenous species of trees and shrubs in the dryland section of the Goulburn-Broken Catchment Area.

Over-clearing of native forests over the past 150 years or so has generally been blamed for serious problems with land degradation now faced by Australian agriculture. Among those is dryland salinity. According to Schofield (1990), Macumber (1991), and Hatton and Nulsen (2001), trees are important for controlling salinity by assisting in the management of the hydrological cycle.

But whilst addressing problems of increasing rates of dryland salinisation is an extremely important issue, Environmental Scientists believe that landholders should pay greater attention to increasing biodiversity across agricultural landscapes. There has therefore been significant encouragement for landholders to revegetate part of their agricultural holdings with indigenous trees and shrubs with the view to greatly enhancing the biodiversity of catchment areas. Biodiversity, an abbreviation of biological diversity, is an extremely broad concept which includes the broad spectrum of ecosystems present on planet Earth with their enormous array of life-forms composed of a myriad of genetic material (Burgman and Lindenmayer 1998). The term, biodiversity, can be used as a synonym for the richness of the various species that inhabit catchment areas. Improving the biodiversity of catchment areas means re-creating or re-establishing areas of indigenous vegetation and thereby encouraging a proliferation of native indigenous fauna within them.

Benefits from indigenous tree species

Some of the benefits from planting indigenous species of trees and shrubs for enhancement of the biological resource across catchment areas are:

- Restoration of hydrologic balance thus assisting in the control of dryland salinity described previously.

- Greenhouse gases are sequestered by trees thereby improving the quality of air in the atmosphere and modifying the deleterious effects of global warming.

- Belts of trees and permanent pastures control soil erosion by reducing overland flow of water and binding soil particles together

- Blocks of trees, particularly indigenous vegetation, harbour native fauna which are active in controlling pests and diseases of crops and pastures.

- Shelterbelts protect crops and livestock from the harmful effects of bad weather conditions.

- Wildlife corridors of indigenous vegetation provide havens for the access of native fauna across open pastured landscapes.

- Belts of indigenous species improve the aesthetic nature of Victorian farming landscapes.

Landowners, however, have been slow to adopt the beneficial strategy of revegetating cleared landscapes with indigenous species. Part of the reason is that most of the benefits listed do not have dollar values at the moment or are of an intangible nature.

Barriers to the re-vegetation of farmlands

One of the main barriers preventing farmers from carrying out revegetation planting is the uncertainty about the effects that withdrawing land from agricultural land-use would have on their farm profits and cash flow. The main issue is that most broadacre farm businesses do not produce sufficient cash surpluses to allow for reasonable living standards, investment in the farm business and investment in resource protection and the environment. Farm performance data for broadacre farms throughout Australia reveal that average farm business profits were minus $4,149, minus $9,530 and minus $5,600 for the years ending 30th June 1998,1999 and 2000 respectively (ABARE 2000). Although these figures include an imputed payment for farm family management and labour, they demonstrate that most farms have insufficient resources to permit them to invest in farm management practices that may jeopardise the profitability of their businesses. The fact of the matter is that with the exception of larger wealthier farms, dollars invested in improved farm management strategies today must reap significant cash benefits quickly, or most Australian farmers will be unable to take advantage of them.

The problem for adoption of land management practices where significant farming areas are retired for the establishment of indigenous vegetation is exacerbated where the operators of farm businesses are older and do not expect to transfer the farm to another family generation (Barr 1999). Further, the need for many farm families to increasingly rely on off-farm income also has a significant effect on their ability to adopt practices aimed at re-establishing tree plantations and other measures for improving the sustainability of farming systems (Collier 1995 and Curtis 1996).

Although the scientific and technical possibilities of restoring hydrologic balances are well understood, farmers are reticent to diversify from traditional grazing and cropping activities. One of the main barriers causing the non-adoption of revegetation is their uncertainty of the effects that such diversification would have on their farm profits and cash flow.

The study area

This paper is set in the dryland section of the Goulburn-Broken Catchment Area. The area contains 1.8 million hectares. The northern boundary is a short stretch of the Murray River downstream from Yarrawonga. To the west the boundary is the Mount Camel Range which forms the divide between the Goulburn-Broken and the Campaspe catchments. The long southern boundary is comprised of foothills and mountainous areas of the Great Dividing Range. The eastern boundary comprises a mountainous region between Mount Howitt and Mount Buller then follows hills to the east of Tatong and Molyullah near Benalla, runs along the Warby ranges divide between the Ovens River and along a range of low hills back to the Murray River near Yarrawonga.

Rainfall varies enormously in the study area with areas in the Goulburn Highlands receiving an average annual rainfall of 1,038 mm whilst the drier parts in the Broken Plains have an average annual rainfall of 523 mm.

Soils too vary greatly. The best soils are highly fertile kraznozems found in the Mount Camel Range and near Mount Major and the Dookie Hills that are derived from the weathering of Cambrian basalt. They are high in clay but because of their composition containing iron and aluminium oxides together with kaolinite, even their subsoils are friable and permeable. On the other hand, soils derived from the weathering of Devonian granites are highly acidic, sodic, and prone to waterlogging.

For the purposes of describing the attributes of the study area, it has been divided into five main sub-catchment zones being Goulburn Highlands, Broken Highlands South West Goulburn, Goulburn Plains and Broken Plains. These sub-catchment zones are shown on the following map of the study area.

Figure 1 shows the breakdown of the study area into its constituent sub-catchment zones whilst Table 1 reveals characteristics of the land areas contained therein and the total dryland section of the Goulburn-Broken Catchment Area. Notice that the cleared arable areas that are available for revegetation are substantially less than the total areas of the various sub-catchment zones. Arable areas available for revegetation with a slope of greater and less than 18 degrees are also shown in Table 1. These were derived from an examination of data available from Geographical Information Systems (GIS) resources (B. Robb *pers. comm.*)[2]. A study of land use characteristics in the various sub-catchment zones derived from data obtained from the Australian Bureau of Census and Statistics and confirmed by on-ground observations is shown in Table 2.

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2 Bernard Robb is an SALM Extension Officer employed by DNRE at Benalla.

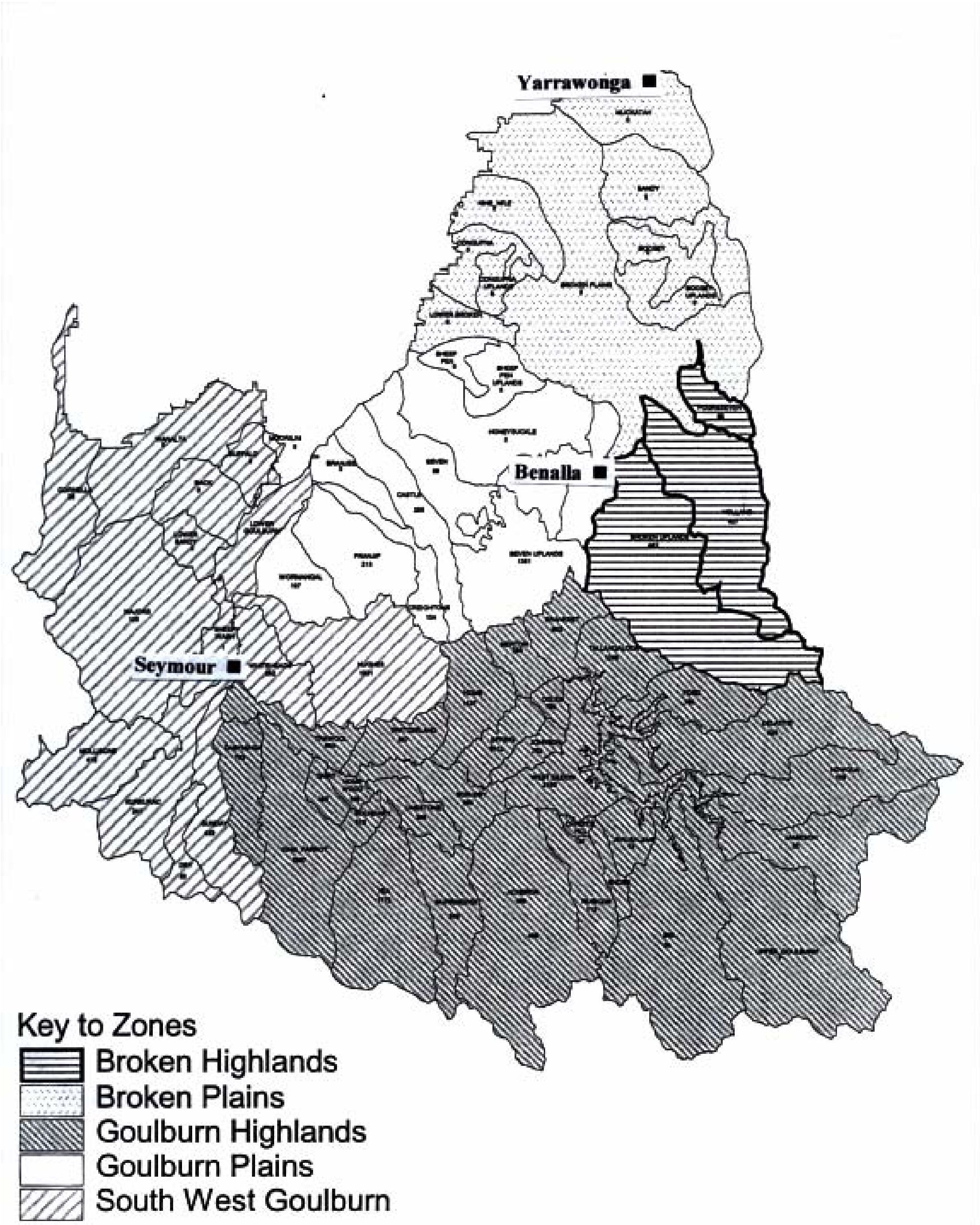

Figure 1 **Sub-catchment Zones for the dryland section of the Goulburn-Broken Catchment Area**

Table 2. Land use in the Sub-catchment Zones of the dryland section of the Goulburn-Broken catchment Area

Sub-Catchment Zone	Land use				
	Crop	Pasture	Grazing activity		
			Stocking rate[a]	Sheep	Cattle
	%	%	Dse/ha[b]	%	%
South-West Goulburn		100	9	60	40
Goulburn Highlands		100	11	20	80
Broken Highlands		100	11	30	70
Goulburn Plains	30	70	7	60	40
Broken Plains	60	40	6	90	10

a Stocking rates shown are for stock carried on land with a slope less than 18 degrees. The stocking rates on the steeper less productive land with a slope of greater than 18 degrees were a third of those rates.

b Dry sheep equivalents per hectare.

AIMS OF THE STUDY AND APPROACH USED IN THE ANALYSIS

Within the various sub-catchment zones there are many individual farms. But for the purposes of determining the net benefits arising from revegetating parts of the farming landscape, the areas available for revegetation in the sub-catchment zones were treated as being one large farm for each sub-catchment zone. Thus the sizes of the large farms were 203,646 hectares for the South West Goulburn, 198,167 hectares for Goulburn Highlands, 58,534 hectares for the Broken Highlands, 188,252 hectares for the Goulburn Plains and 212,671 hectares for the Broken Plains sub-catchment area.
(See Table 1)

The main area of interest to the Goulburn-Broken Catchment Management Authority is how much financial assistance would they have to provide to farming families in the dryland section to encourage them to carry out revegetation procedures? Answering that question is made difficult by the fact that as was described previously, that most of the benefits listed do not have dollar values at the moment or are of an intangible nature. In order to estimate the magnitude of assistance measures that would need to be offered to effect the adoption of revegetation with indigenous species, four scenarios were examined. Those scenarios were:

- Despite the claims of environmental scientists that revegetated areas confer substantial benefits on other farm activities such as increases in gross income for grazing and crop production, no hard evidence has so far been tendered as to what the magnitude of those benefits might be. Further, until such time as the Australian government signs the Kyoto Protocols, income earned from carbon credits for the sequestration of green house gases will not be available. Thus the first scenario examined was that no biodiversity benefits would be conferred on other farming activities and no income would be earned from carbon credits.

- The second scenario was that biodiversity benefits amounting to an estimated increase of 10 per cent of gross income from grazing and cropping activities could in fact be earned but income from carbon credits would continue to be unavailable.

- The third scenario was that no biodiversity benefits would be conferred on other farm activities but that carbon credits amounting to an income of $50 per hectare of revegetated land would soon become available.

- The fourth and final scenario was that biodiversity benefits amounting to an increase of 10 per cent of gross income from grazing and cropping activities could be earned and income of $50 per hectare of revegetated land would be earned.

Thus the aim of the study for those four scenarios was to calculate over a period of 40 years, the dollar value of assistance measures provided that would cause the Net Present Value (NPV) of farms with revegetated areas to be exactly the same as the NPV for the original farms that were without revegetation. The calculation of NPV's was carried out in accordance with procedures outlined by Sinden and Thampapillai (1995).

In carrying out those calculations, it was assumed that 10 percent of land with a slope of less than 18 degrees would be revegetated using the direct seeding method for establishment and that the total area of land with a slope of greater than 18 degrees would be revegetated by fencing it off and allowing dormant seeds to germinate.

ASSUMPTIONS USED IN THE ANALYSES

General assumptions

It was assumed that prime lamb and beef production were the grazing activities carried out in the ratios for the various sub-catchment zones shown in Table 2. The sheep activity had a gross margin per dry sheep equivalent (dse) of $20 (gross income less variable costs) and livestock capital per dse of $25 over the entire flock at ages of ewes ranging from 1.5 to 5.5 years at lambing. The gross margin for the beef activity was also $20 per dse and the investment in livestock capital over the herd was $40 per dse.

Sheep were run on both the less steep and the steep country but cattle were confined to land with a slope of less than 18 degrees

The gross margin per hectare for cropping activities was $285 per hectare. Cropping was conducted on areas with a slope of less than 18 degrees.

The method used for revegetating land with a slope of less than 18 degrees was by direct seeding. On land with a slope of greater than 18 degrees the area was fenced off and revegetation occurred by the germination of dormant seeds.

After the 5th year of establishment for the revegetated areas when the trees had become sufficiently large and robust to withstand grazing between them, they were opportunistically stocked with sheep. The stocking rates were low at 20 per cent of what they had been prior to revegetation being carried out.

Assumptions made for the analysis of profitability

- An inflation rate of 4 per cent per annum was assumed. Inflation was applied to all income received and costs paid. All dollar values and interest rates were therefore expressed in nominal terms. That is, nominal dollar values for income and costs were trended over time by an inflation rate of 4 per cent per annum. Nominal interest rates means that the interest rate includes a component for expected inflation. The nominal market rate of interest (m) comprises a component of real gain (r) plus an inflation component (f) i.e., $m = r + f + rf$.
- Taxation was charged at an average marginal rate of 20 per cent. (This is lower than the actual rate of 47 per cent that would apply to a large farm in the study area but was used as a mimic for the rate that would apply if the large area corresponded to a combination of many small holdings).

- An after tax discount rate of 15 per cent per annum was assumed as the rate which would allow the farmer a margin for profit over the interest rate that had to be paid on the use of borrowed funds. The rate of interest paid on borrowed funds was assumed to be 12 per cent per annum before tax or 10 per cent per annum after tax.

- Interest of course was not included as an operating cost in the analysis of profitability. If it had have been, then there would have occurred a serious case of double counting. But interest had to appear in the calculation of tax payable for the original non-revegetated farm and for the farm with revegetation. Thus it was assumed that the farm business had zero cash at the start of the period. Interest was paid at a before tax rate of 12 per cent per annum. It was charged at the full rate on the cumulative deficit carried forward. The annual deficit was approximated as an overdraft accumulated over a year but spread evenly throughout the year. The interest charged on the annual deficit was calculated by multiplying the annual deficit by 12 per cent. The resulting value was then annualised through multiplying it by 0.55. This assumed that the overdraft would increase evenly for each month of the year (Makeham and Malcolm 1993).
- Interest could be earned on cumulative and annual surpluses at a nominal rate of 5 per cent per annum.
- Total interest paid during the year contained two components. The first part was interest calculated on the net cash flow before tax for that year. That was added to the second part which was interest calculated on the deficit for the previous year.

In calculating taxation arrangements for carrying out revegetation with indigenous species, the capital expenditure was treated in the same way as expenditure for landcare operations where the capital cost was treated as an outright deduction in the year in which the expenditure occurred.

RESULTS

Works and expenses schedules for carrying out revegetation by direct seeding or by allowing dormant seeds to germinate are shown in Appendix 1. Table 3 shows the value of assistance measures pertinent to the four scenarios described previously. Appendix 2 shows an example calculation for farms with and without revegetation for the Broken Plains Sub-catchment Zone for scenario 1 where no biodiversity benefits were conferred on other farming activities and no income was earned from carbon credits.

Table 3: Assistance measures to attract farm families to undertake revegetation for various combinations with and without benefits that could be earned from the receipt of 10% increases in gross income from other farming activities and earning rates of $50 per hectare from carbon credits.

Scenario	Attributes of scenario	Sub-Catchment Zones					Totals for Goulburn - Broken Catchment Area	
		South West Goulburn	Goulburn Highlands	Broken Highlands	Goulburn Plain	Broken Plain		
		$	$	$	$	$	$	$/ha
1.	No biodiversity benefits conferred on other farming activities and no carbon credits available							
	Grant for establishing revegetated areas	11,602,126	11,199,846	3,335,149	10,725,960	12,133,058	48,996,139	432
	Grant for fencing off revegetated areas	9,281,700	8,959,877	2,668,119	8,580,768	9,706,446	39,196,910	346
	Present value of annuities paid over 39 yrs.	27,499,380	32,191,007	7,967,961	30,885,054	40,386,872	138,930,274	1,225
	Total	48,383,206	52,350,730	13,971,229	50,191,782	62,226,376	227,123,323	2,003
2.	Biodiversity benefits amounting to increases of 10% in the gross income from other farm activities but no carbon credits available							
	Grant for establishing revegetated areas	9,165,679	8,399,884	1,227,335	10,725,960	12,133,058	41,651,916	367
	Grant for fencing off revegetated areas	7,332,543	6,719,907	1,534,169	8,580,768	9,706,446	33,873,833	299
	Present value of annuities paid over 39 yrs.	0	0	0	6,221,338	12,739,895	18,961,233	167
	Total	16,498,222	15,119,791	2,761,504	25,528,066	34,579,399	94,486,982	833
3.	No biodiversity benefits to other farm activities but carbon credits can be earned at the rate of $50 per hectare of revegetated land							
	Grant for establishing revegetated areas	11,602,126	11,199,846	3,335,149	10,725,960	12,133,058	48,996,139	432
	Grant for fencing off revegetated areas	9,281,700	8,959,877	2,668,119	8,580,768	9,706,446	39,196,910	346
	Present value of annuities paid over 39 yrs.	20,988,681	20,929,913	6,865,296	26,332,068	34,427,688	109,543,646	966
	Total	41,872,507	41,089,636	12,868,564	45,638,796	56,267,192	197,736,695	1,743
4.	Biodiversity benefits amounting to increases of 10% in the gross income from other farm activities and carbon credits earned at the rate of $50 per hectare of revegetated land							
	Grant for establishing revegetated areas	4,988,914	0	800,436	6,328,316	12,133,058	24,250,724	214
	Grant for fencing off revegetated areas	3,991,131	0	640,349	5,062,653	9,706,440	19,400,573	171
	Present value of annuities paid over 39 yrs.	0	0	0	0	6,780,711	6,780,711	60
	Total	8,980,045	0	1,440,785	11,390,969	28,620,209	50,432,008	445

DISCUSSION AND CONCLUSIONS

A discussion with members of the Implementation Committee for the Dryland Section of the Goulburn-Broken Catchment Management Authority of the results depicted in Table 3 for the four scenarios investigated revealed that the amounts of assistance calculated were far too high to be countenanced. Although the amount of $445 per hectare of land revegetated for scenario 4 where biodiversity benefits amounting to a 10 per cent increase in the gross income of other farm activities plus an income of $50 per hectare earned from carbon credits could be received was reasonably well accepted, the factors mitigating against it were the large total amount of assistance of $50.4 million based on revegetating 113,340 hectares and the fact that carbon credits are not currently available. Additionally, whilst an increase of 10 per cent in the gross income of other farm activities seems reasonable, it has yet to be proven that such responses would occur in practice.

The general feeling was that some levels of regeneration using indigenous trees and shrubs would be important for increasing biodiversity in the catchment area, but these should be restricted to the steeper areas where slopes are greater than 18 degrees and where revegetation can take place by the less expensive alternative of fencing off the land and allowing dormant seeds to germinate.

In the meantime it will be useful to examine the economics of using other methods of achieving revegetation on land with a slope of less than 18 degrees. Such methods could involve attracting timber investment firms such as Timbercorp or Yates to lease farming land for establishing commercial plantations for the production of sawlogs, firewood and wood chips. The benefits of using that approach would obviously be that farm businesses would have an immediate return from leasing fees and the Catchment Management Authority would be absolved from having to make large assistance payments to achieve the task of increasing the amount of tree cover in the catchment area.

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Appendix 1: Works and expenses schedules for revegetation using the direct seeding and germination from dormant seeds method of establishment

1.1 Establishment of vegetation by fencing off and allowing seeds present in the soil to germinate

Year	Operation					$	$
1	**Spraying by hand**						
	Knockdown herbicide						
	Chemical					23.00	
	Labour						
	Family labour	1.0	hr/ha.@	$15.00	per hour	15.00	
	Tractor and spraying equipment running costs	1.0	hr/ha.@	$14.32	per hour	14.32	
	Total						52.32
2	Weed control as above						52.32
3	Weed control as above						52.32
4	Weed control as above						52.32
5	Weed control as above						52.32
Total cost over 5 years							$261.61

1.2 Establishment of vegetation by direct seeding

Year	Operation						$	$
1	**Plantation establishment**							
	Knockdown herbicide							
	Chemical						23.00	
	Application						3.41	26.41
	Pre-plant weed control							
	Chemical						14.60	
	Application						3.41	18.01
	Contract direct seeding							
	Seed	450	gram/ha	@	$800	per kilogram	360.00	
	Sowing						110.00	470.00
	Post planting weed control							
	Chemicals						42.00	
	Application						3.41	45.41
	Tractor driving labour	0.7	hours	@	$15	per hour		10.71
	Total							570.54
2	Post planting weed control							
	Chemicals						42.00	
	Application						3.41	
	Tractor driving labour	0.7	hours	@	$15	per hour	10.71	56.12
	Slash between rows X 1							
	Tractor costs	6.13	per ha.	X	1		6.13	
	Tractor driving labour	0.4	hours	@	$15	per hour X 2	6.00	12.13
3	Slash between rows X 2							
	Tractor costs	6.13	per ha.	X	2		12.26	
	Tractor driving labour	0.4	hours	@	$15	per hour X 2	12.00	24.26
4	Slash between rows X 2							
	Tractor costs	6.13	per ha.	X	2		12.26	
	Tractor driving labour	0.4	hours	@	$15	per hour X 2	12.00	24.26
5	Slash between rows X 2							
	Tractor costs	6.13	per ha.	X	2		12.26	
	Tractor driving labour	0.4	hours	@	$15	per hour X 2	12.00	24.26
Total cost over 5 years								$711.57

APPENDIX 2 (four sections) from Excel file goes in here.

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