Is the design you have selected viable on your farm?

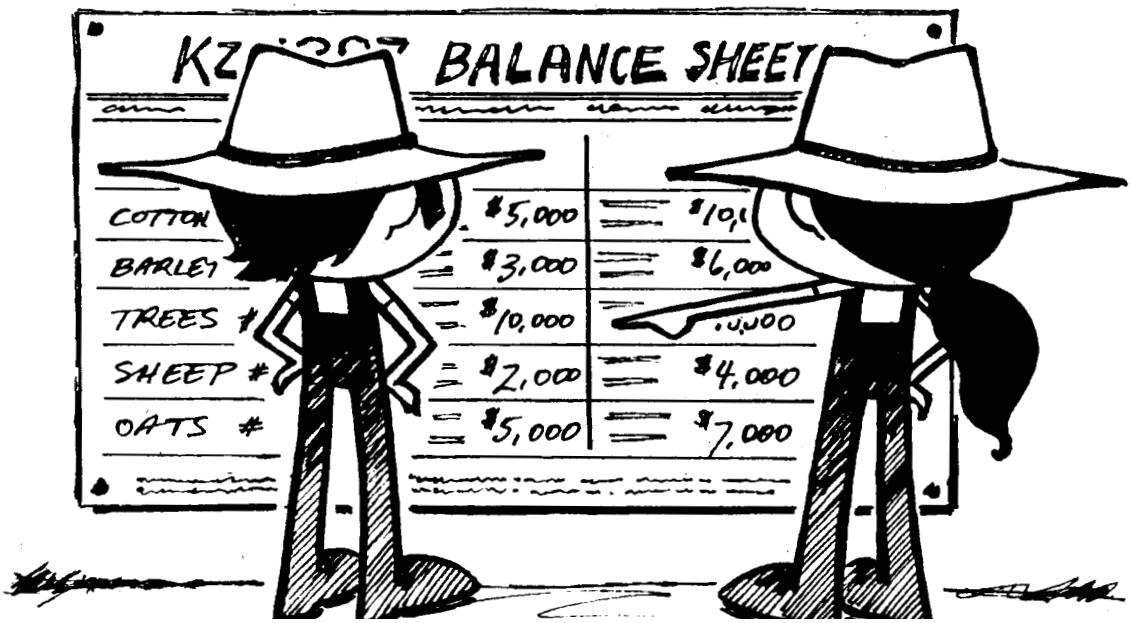
Introduction

Cost benefit analysis, if done accurately, can be very complex and may need professional advice (ie taking into account discount rates, taxation issues etc). However, for the purposes of comparing alternative agroforestry designs, the following will be useful.

Let us assume that a farmer plants a shelterbelt with a total area of one hectare across the windward side of a paddock. The trees will provide shade and shelter and help decrease soil erosion. They will also help lower the rising water-table which is causing salinity problems and will assist in improving the habitat for native species as they will form a corridor between two areas of remnant vegetation. The trees will be harvested sequentially for firewood and fence posts.

Because the trees will be used for shelter and low value wood products, the farmer will keep costs down by direct seeding the trees and by using the existing fence to protect trees from stock at the back of the shelter belt. An electric fence will be used across the front of the trees to protect them from stock until the trees are larger.

Let us assume that the trees will grow to 15 m high and will provide maximum protection for ten tree heights (ie 150 m) downwind. Thus, a total area of three hectares will be protected (Figure 35).



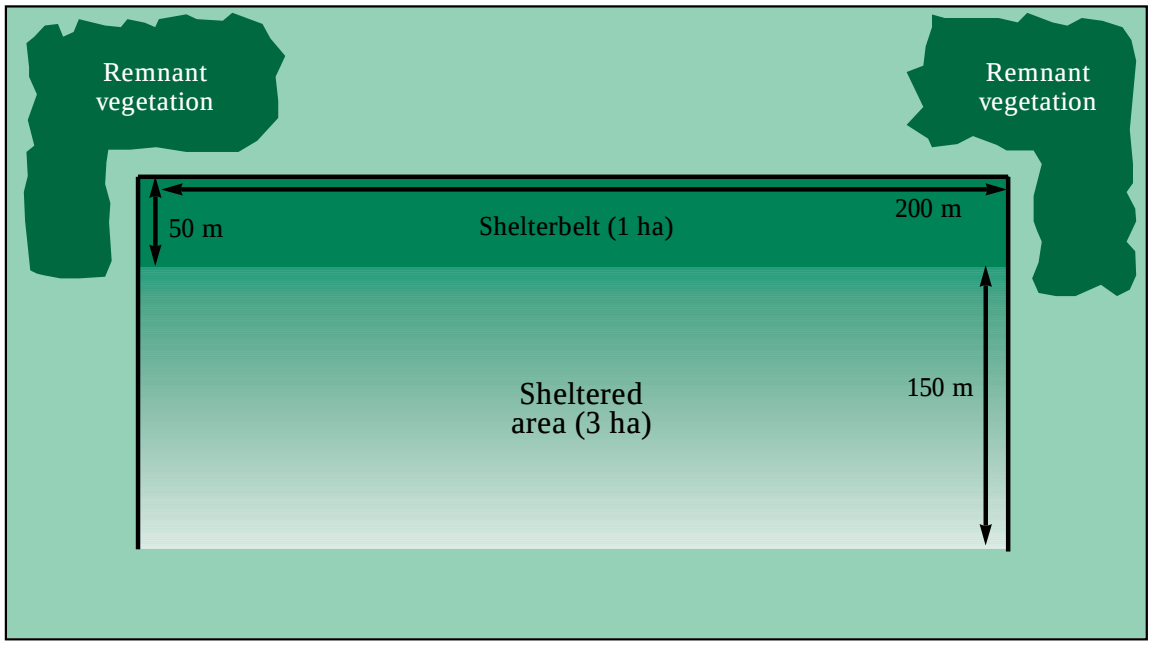


Figure 35: Plan diagram for worked example. 1 ha of trees is planted to provide 3 ha of shade

Identifying benefits and costs

Identifying costs and benefits is easiest if we draw up a table. In the first column of Table 9 we state what we are going to do, and then identify the benefits. Next we identify the costs associated with what we would like to do.

Table 9: Indicative framework for identifying benefits and costs

Activity	Benefits	Costs
	On-Farm	On-Farm
Trees planted	Increased production (shade/shelter)	Short-term production foregone
	Lowered water-table	Tree establishment
	Reduced soil erosion	Tree fencing
	Added aesthetic value	
	Increased production (biodiversity contribution)	

Valuing benefits and costs

Now that we have identified the benefits and costs, we can put dollar values on them.

In addition to income from the agricultural enterprise on the 3-hectare area, we need to include agroforestry income from firewood and fence posts as well as production increases due to shelter, biodiversity activity, lowered groundwater and reduced soil erosion.

These values vary between sites and seasons: for example, sheep farmers may receive great benefit from shelter at lambing in winter, but few from shelter in summer. (However, they may receive benefit from shade in summer.) The values are also different for cropping and livestock enterprises. While the values are not 'fixed', quite a lot of research work has been done which provides an indication of what these values are for many regions.

You can take two approaches to determining these values:

- think about how much (lambs, tons of grain, kg of extra stock feed) you currently lose or have to buy per hectare each year from not having the benefits of trees, and use this figure; or
- ask your regional economist/farm adviser/consultant to give you some idea of these values.

Comparing income

To see if agroforestry is going to increase your income you will need to compare the income from agroforestry with your current farming system. Because a dollar today (from harvesting a crop or selling stock) is worth more than a dollar received in the future (from harvesting trees), it is important when making decisions regarding future benefits and costs that their valuation takes explicit account of the time at which they occur.

The standard approach to valuing items which occur at different times is to reduce the stream of future benefits or costs to represent an equivalent amount of today's dollars. This discounted figure represents the net present value (NPV) of future benefits or costs.

Table 10: Indicative value of benefits and costs resulting from planting trees

Item	Unit	Farm income	Farm Costs	Information Source
TREES				
Direct seeding trees	$/ha		100	Existing regional data
Electric Fencing	$/100 m		200	Existing regional data
Tree maintenance	$/ha/yr		25	Existing regional data
Tree harvest (yr 5)	$/ha	400		Net market value
Trees harvest (yr 10)	$/ha	400		Net market value
Lowered water-table	$/3 ha/yr	15		Regional and research precedents
Shelter/shade	$/3 ha/yr	50		
Reduced soil erosion	$/3 ha/yr	25		
Added aesthetic value	$/3 ha/yr	24		Real estate agent
Biodiversity benefits to production	$/3 ha/yr	15		Estimate

Table 11: Calculating the financial NPV of your current farming system without trees

Year	1	2	3	4	5	6	7	8	9	10
Enterprise income ($/4 ha)	680	680	680	680	680	680	680	680	680	680
Enterprise costs ($/4 ha)	160	160	160	160	160	160	160	160	160	160
Enterprise margin ($/4 ha)	520	520	520	520	520	520	520	520	520	520
Discount factor (6%)	1	.94	.89	.84	.79	.75	.71	.67	.63	.59
Discount x margin ($/4 ha)	520	490.4	462.8	436.3	411.8	388.4	366.6	345.8	326.0	307.3

Calculating NPV for the current farming system

Step 1

First you have to know when the trees will be harvested because this is when you will receive the bulk of your income. In our worked example, we will harvest our trees every 5 years – the first in 5 years, the second in 10 years and so on. We calculate the NPV over 20 years, a suitable time horizon for many farmers. A table is constructed to tabulate the data. Note that in the sample tables – 11 & 12 – data for only ten of the twenty years are shown.

Step 2

Enter your normal yearly income per hectare on the land you wish to put into trees. In this example the farmer normally uses the land for livestock grazing which returns $170 per hectare per year. This is income in the 'no trees' scenario.

Step 3

Enter your normal costs per year for each year.

Step 4

Subtract your costs from your income to calculate your margin over 4 hectares (ie the area to be affected under the agroforestry option).

Step 5

Multiply the margin by the discount figure for each year to calculate the discounted return.

Step 6

If we add up the discounted return figures, we get the NPV for the usual farming system which is $6 319 for 4 hectares over 20 years.

This NPV is the figure that we use to compare with the NPV from the farming system with shelter trees.

Calculating the NPV with trees

To calculate the NPV for the enterprise with shelter trees we simply follow the same steps.

Step 1

Once again we make up a table for 10 years.

Step 2

In the income column we put the dollar value of the benefits which we have determined for the trees in the year in which they occur. In this example we will plant one hectare of the trees on the windward side of a paddock, producing benefits of shade and shelter. If we add together lowered water-table, shade/shelter, decreased erosion, increased property amenity and biodiversity benefits to production they come to $129 per year over the 3 hectares. However, it will be about 3 years before the trees are big enough to provide the full value, so we do not identify agroforestry benefits to production until year 3.

Table 12: Calculating the NPV of your current farming system with trees

Year	1	2	3	4	5	6	7	8	9	10
Enterprise income ($/3 ha)	510	510	510	510	510	510	510	510	510	510
Enterprise costs ($/3 ha)	120	120	120	120	120	120	120	120	120	120
Enterprise margin ($/3 ha)	390	390	390	390	390	390	390	390	390	390
Agroforestry income ($/ha)	–	–	–	–	500	–	–	–	–	500
Agroforestry costs ($/ha)	300	25	25	25	25	25	25	25	25	25
Agroforestry margin ($/ha)	-300	-25	-25	-25	475	-25	-25	-25	-25	475
Agroforestry benefits to production	0	0	129	129	129	129	129	129	129	129
Gross margin ($/4 ha)	90	365	494	494	994	494	494	494	494	994
Discount factor (6%)	1	.94	.89	.84	.79	.75	.71	.67	.63	.59
Discount x margin ($/4 ha)	90	344	440	414	787	369	348	329	310	587

The farmer will harvest half of the trees in year 5 (for firewood and fence posts). This gives a net income of $400. The other half of the trees will be harvested in year 10 for the same products.

Note: because we have taken 1 hectare of land out of production to plant trees, we only count farming system income for 3 hectares but add to it the agroforestry income from the 1-hectare shelterbelt.

Step 3

Enter the costs associated with the trees in the years in which they occur.

Step 4

Subtract the costs from the benefits for each year.

Step 5

Multiply the margin by the discount rate.

Step 6

Add the discounted figures together to give the NPV, which is $6 544 for the 4 hectares over 20 years.

Since the NPV with shelter trees is greater than the NPV of the 'no trees' option, it is worthwhile to invest in this agroforestry design. Different designs may give quite different answers. For example, if the windbreak was only 15 m wide (as opposed to 50 m in the worked example), a wider area of grazed land would be sheltered and less would be occupied by trees. In this case and using similar assumptions to those above, the NPV would be $6 976 over 20 years. If the tree crop was managed for sawlogs, higher management costs would be incurred but there would also be a higher cash return on harvest. An NPV of $7 435 after 20 years might be expected.

HINT

As a rough rule it is usually worthwhile to plant up to 10% of the farm to trees, even if the trees bring in little income from the wood. This is because of the benefits trees give from shade and shelter, erosion and salinity control

Try doing a 'sensitivity analysis', too – by changing the values of different benefits or costs we can test how 'sensitive' our analysis is to these factors and determine whether differences make a significant impact on financial viability.

What discount rate should I use?

There is ongoing debate about which discount rates to use. In the example above, we have used an 6% discount rate, as this is the figure often used in government forecasting.

To complicate matters further, the discount rates for natural resource such as timber may be different to those for agricultural commodities. Therefore, to allow for these variations you may wish to use either higher or lower discount rates than the ones used above.

However, unless you think that the price of wood is going to rise substantially more than agricultural commodities it may be wisest to use the same discount rate in all scenarios when doing a comparison of income.

Figure 36 summarises the steps we have just undertaken in our benefit cost analysis.

Economic models

If you require a more complex analysis of agroforestry income there are a range of agricultural economic models on the market. While many have been designed to analysis general farm income only, the model FARMTREE has been specifically designed to estimate the financial returns from agroforestry.

FARMTREE provides rough projections for a fairly wide range of species and layouts for which there are few data. It includes the benefits from timber and shelter but excludes other benefits (unless you are able to put them in yourself).

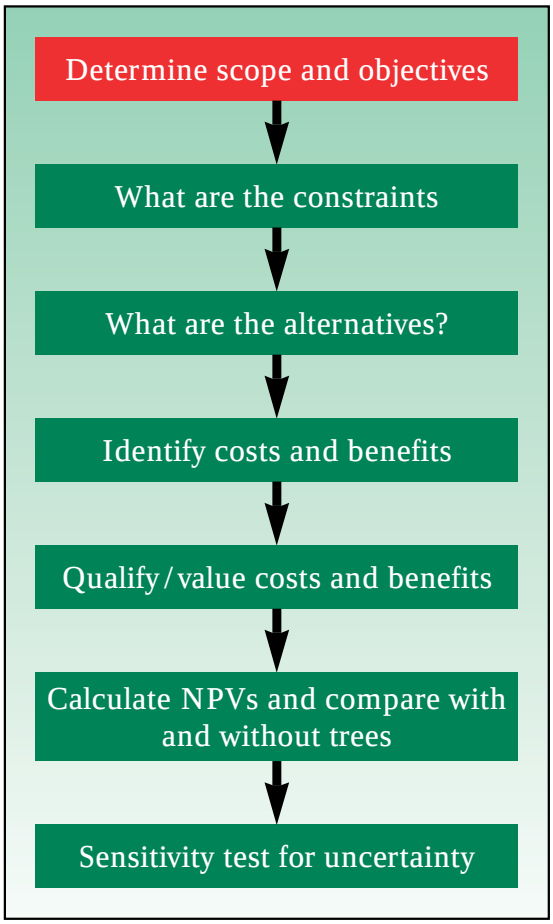


Figure 36: Key steps in benefit cost analysis
Adapted from: Department of Finance (1991)

FARMTREE covers:

- the type of spatial layout – whether shelterbelt, woodlot etc;
- species;
- thinning and pruning regime;
- age at harvest;

- likely costs;
- effects on other enterprises through competition or enhancement;
- growth rates – these are based on available measurements, not models of growth processes. Points are fitted to a sigmoid curve selected as a 'best bet' by matching with similar species, sites and spacings;
- trees are partitioned at harvest into debris, firewood, posts, sawlogs and clear sawlogs;
- value of products based on current prices, allowing for species, type of wood, diameter, defect, distance from mill and other factors. Alternatively, costs of harvesting, processing, transporting and marketing are deducted from revenue based on current prices, or the user can specify prices.

The agroforestry enterprise is appraised in the context of other enterprises, so trade-offs can be estimated. The model runs on IBM-compatible personal computers.

FARMTREE is currently being tested by extension officers and farmforestry advisors and a Windows version is being developed. For moreinformation, contact: Bill Loane; Ph (03) 9412 4787.

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