Comparing the economics of agroforestry versus traditional grazing in steep country

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A case study comparing the economics of agroforestry versus traditional grazing in steep country

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INTRODUCTION

In 2010 Bob and Robyn Gray decided to further diversify their farming business to improve the sustainability of land use on their farm "Tarmaroo". Larger mobs of big, heavy cattle (breeding cows) were causing significant soil and pasture damage across the property. This was particularly apparent through wet winters. The soil at Tarmaroo is a gradational clay loam over impervious sandstone. During extended wet periods, it becomes saturated and prone to waterlogging, which can cause landslips, tunnel erosion, pugging, pasture damage and surface run-off (resulting in topsoil loss) to occur.

In 2010, a plantation feasibility report was prepared covering the development of an agroforestry enterprise across steeper areas of the property. A plantation comprising a suite of species (including yellow stringybark[3], southern mahogany[4] and silvertop[5]) was recommended for management over a 25 year rotation. The agroforestry plantation was to be established on steeper sections of the property around temporary and semi-permanent waterways that had already been revegetated through Landcare and Melbourne Water programs.

In 2011, 15 hectares was prepared and planted with yellow stringybark, southern mahogany and spotted gum[6]. These species were selected primarily for their natural durability, marketability, sawn timber characteristics and suitability to site. The production of high value sawn products was targeted to offset the higher plantation establishment and harvesting costs associated with plantation development on steeper country.

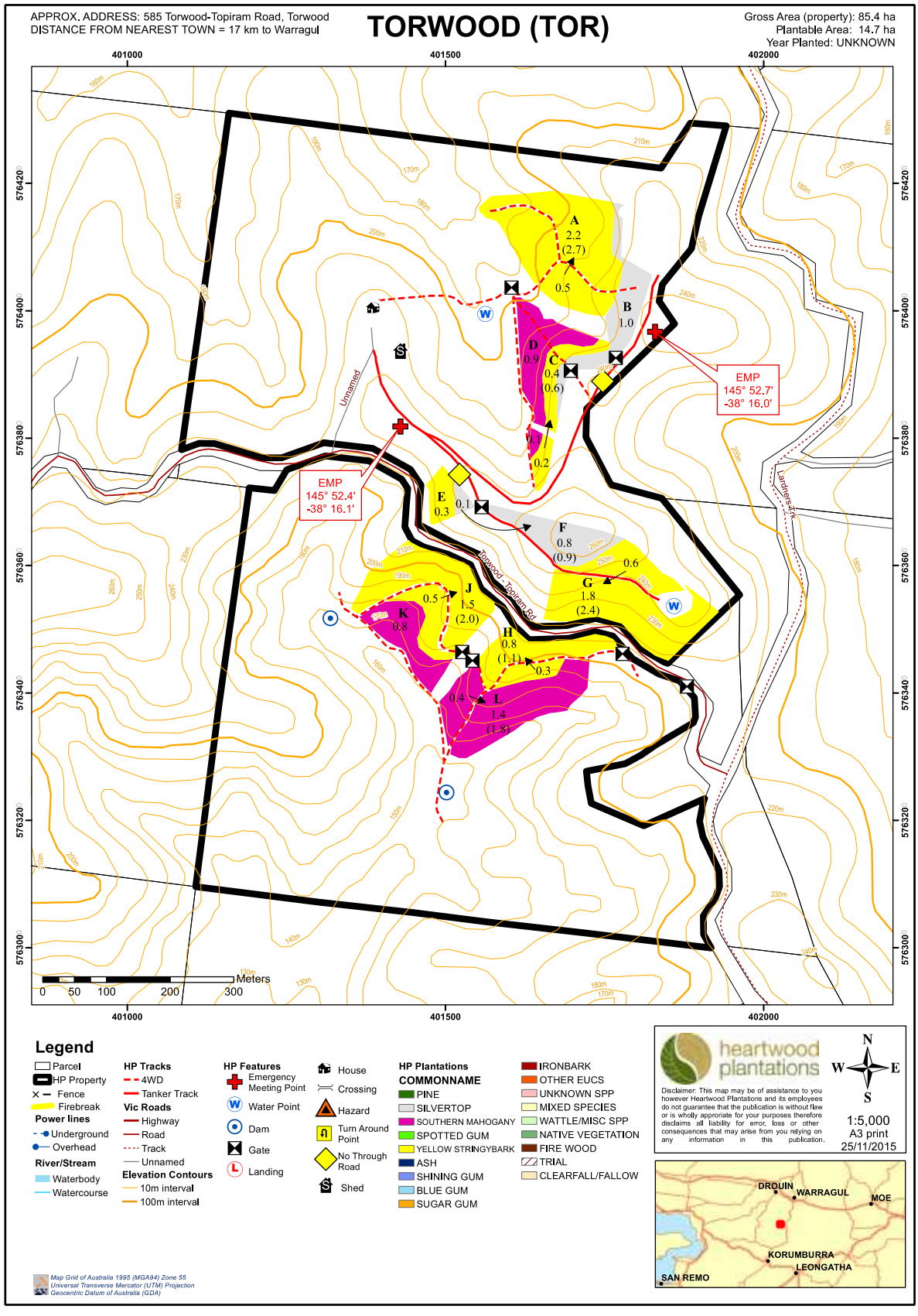
Previous experience with agroforestry at Tarmaroo, indicated that it would be beneficial to secure professional forestry advice on a regular basis, so a professional forester was engaged to provide advice on an annual basis.

Estimating the monetary returns from an agroforestry enterprise can be difficult due to the long lead time to harvest (~25 years at Tarmaroo). To assist with this, Bob and Robyn approached Western Port Catchment Landcare Network (WPCLN) with a submission to establish a demonstration site in their plantation. The demonstration would aid financial comparisons between agroforestry and agriculture on their property and document the results as an example for other farmers – particularly those on steep country. The project was approved and commenced in 2014.

A prime objective of the project was to establish permanent sample plots (PSP's) across the plantation to be measured annually over a three year period, providing a basis from which to compare economics of agroforestry to traditional grazing.

[1] Forest Scientist with Just Add Trees
[2] Farmer and owner of "Tarmaroo".
[3] *Eucalyptus muelleriana*.
[4] *Eucalyptus botryoides*.
[5] *Eucalyptus sieberi*.
[6] Silvertop was initially preferred over spotted gum, however suitable silvertop nursery stock could not be sourced in time for planting.

Figure 1. Tarmaroo plantation map



METHOD:

1. To ascertain the growth performance of a stand of trees it is common forestry practice to sample 1 to 2% of a plantation. Using this rationale at Tarmaroo – the 14.7ha plantation required 3 to 7 PSP's.

2. To adequately represent the variation in site factors and the three tree species established, six locations were earmarked for plot establishment – three in yellow stringybark, two in southern mahogany and one in spotted gum.

3. PSP's were established at representative locations[7] across the plantation. This involved reviewing the plantation map (figure 1) and discussing site variables with Bob.

4. Plots were surveyed and marked out with steel pegs. Plots were 20x20m in dimensions, equating to an area of 400m^2. This means approximately 40 trees are measured in early years. Following thinning operations (up to 4 are usually performed), approximately 5-10 trees are left within the PSP in the final years of the rotation.

5. The GPS coordinates of the north east corner of each plot were recorded for future reference.

6. Each tree within the PSP was assessed for diameter at breast height (dbh - 1.3m) and the dominant tree in each row was assessed for height. Data was generally recorded using an electronic device that facilitated efficient downloading and analysis. Tree form data was also collected, to allow decision making regarding intervention to improve tree form;

7. Observations regarding tree health and general appearance were also made during PSP assessment.

[7] Representative location means that, where possible, all significant site and tree species variables (e.g. topography, aspect, and species) are covered by the geographic location of the plot to enable the results to be applied to the majority of the plantation area, so estimates of projected return are indicative of future performance.

RESULTS

The measurement data collected during the project is shown in Table 1. Graphical presentation of this data (figures 2 to 7) can be particularly powerful in providing a snapshot of performance. The value of this snapshot is enhanced where it can be compared to an industry benchmark. Heartwood Plantations (HP) was generous in providing a subset of their PSP dataset for Gippsland to enable this comparison.

Table 1. Permanent sample plot data for Tarmaroo 2015, 2016 and 2017.

Species	Year	Age (yrs)	Stocking (trees ha-1)	Mean DBH (cm)	DBH Inc. (cm)	Basal area (m2/ha-1)	Mean Ht. (m)	Ht. Inc. (m)	Vol (m3/ha-1)	CAI	MAI	Form score (1-3)
Yellow Stringybark	2014	3.1	875	7.8	2.5	5.1	6.1	2.0	10.3		3.3	
	2015	4	837	10.6	3.7	8.5	7.9	1.7	22.9	14	5.7	1.7
	2016	4.9	837	13.2	2.6	11.5	9.8	1.9	37.6	16.3	7.5	1.7
	2017	6.1	837	16.4	2.7	18.8	12	1.9	75.4	31.5	12.4	1.7
Total Increment					**11.5**			**7.5**				
Southern Mahogany	2014	3.1	1020	10.5	3.4	9.0	9.4	3.1	28.8	na	9.3	
	2015	4	1020	12.6	2.3	13.0	10.9	1.5	47.3	20.5	11.9	1.8
	2016	4.9	583	15.2	2.6	10.6	12.5	1.6	43.8	-3.9	9.2	1.4
	2017	6.1	583	18.3	2.7	15.4	15	2.1	77.1	27.8	13.1	1.3
Total Increment					**11**			**8.3**				
Spotted Gum	2014	3.1	905	6.7	2.2	3.4	4.4	1.4	5	na	1.6	
	2015	4	857	8.5	1.8	4.6	7.8	3.4	12.1	7.9	3	2.2
	2016	4.9	857	10.9	2.4	8.8	8.9	1.1	25.8	15.2	5.2	1.9
	2017	6.1	857	12.8	1.6	11.7	10.1	1	39.3	11.2	6.4	2.0
Total Increment					**8**			**6.9**				

This data shows how each species within the plantation have performed for height, diameter at breast height (dbh) and volume during the 2014-17 period against the Heartwood dataset. The data shows plantation stocking, mean diameter and height, and how much the trees have grown in the past 12 months. The volume figure (derived from diameter and height data) shows how much wood was onsite at the age of measurement. Stand basal area8 is a function of diameter and is an important indicator of competition between trees. CAI (current annual increment) shows the change in wood volume over the preceding 12 month period. MAI (mean annual increment) averages total volume growth since establishment. Target growth rates are often expressed as MAI in timber plantations. Tree form was scored on as a 1 (>6m potential sawlog length), 2 (3-6m potential sawlog length or 3 (no sawlog potential).

Following is a sample of what we can learn from this data for each of the species planted;

[8] Stand basal area is the cross sectional area of all trees at breast height per hectare of forest (m^2/ha).

Figure 2. Yellow stringybark dbh growth at TOR11 v HP/JAT[9] resource

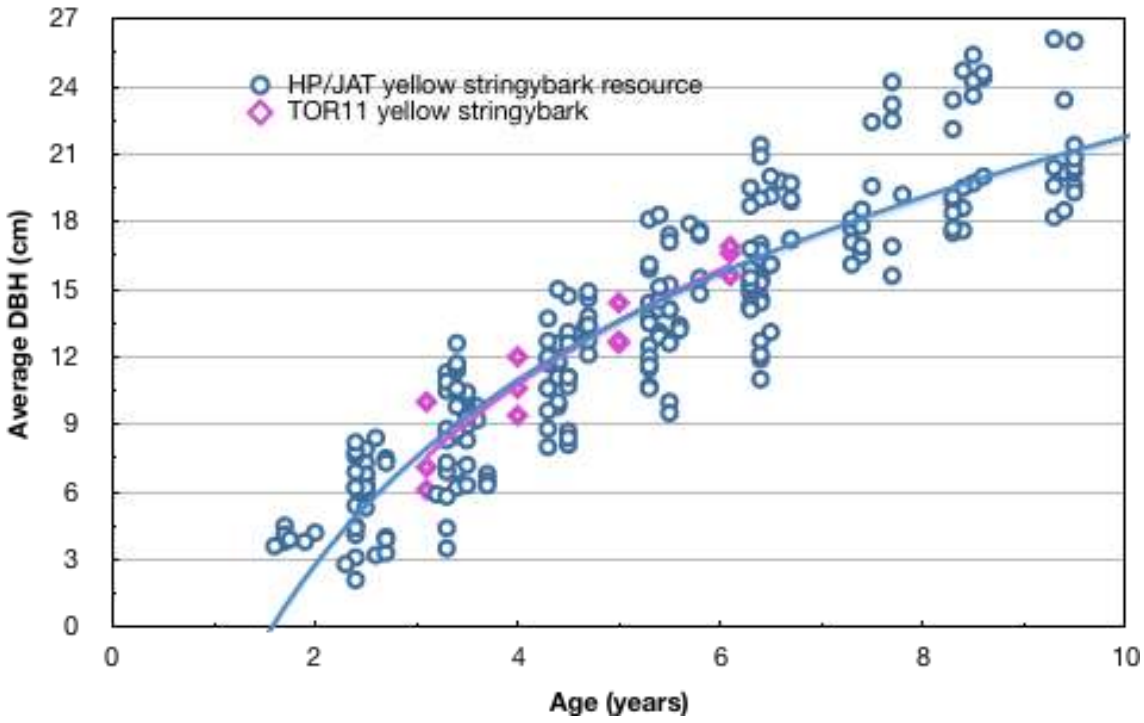
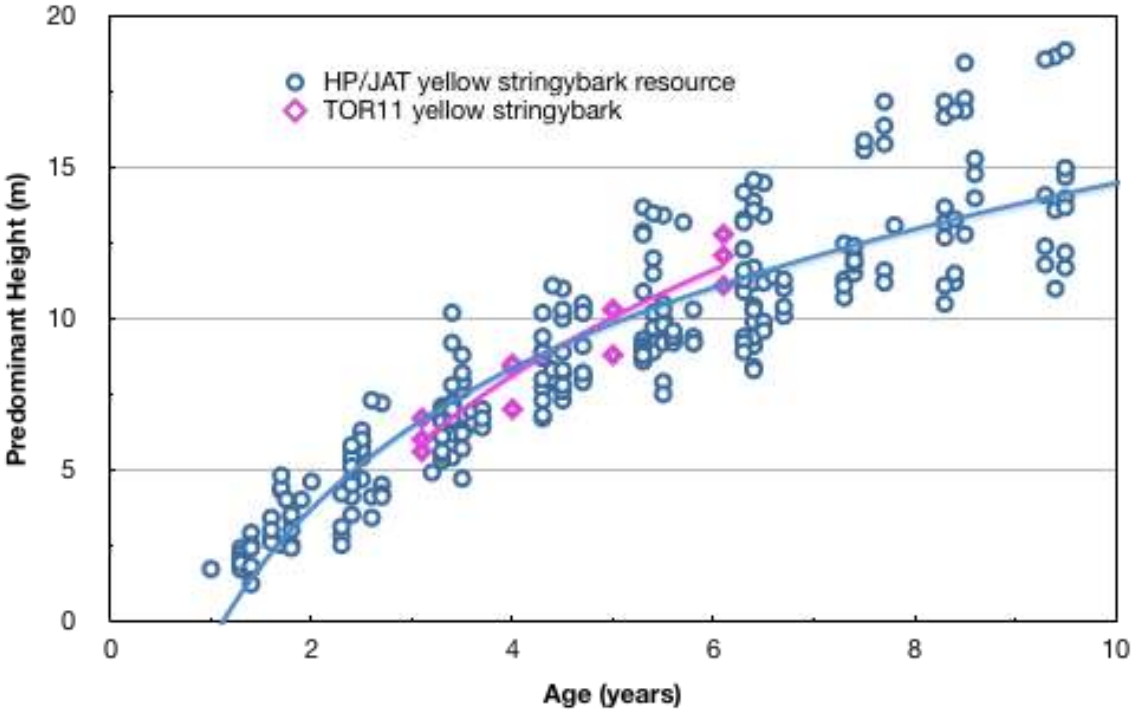


Figure 3. Yellow stringybark height growth at TOR11 v HP/JAT resource



[9] Industry PSP data has been provided by Heartwood Plantations (HP) and Just Add Trees (JAT).

Figure 4. Southern mahogany dbh growth at TOR11 v HP/JAT resource

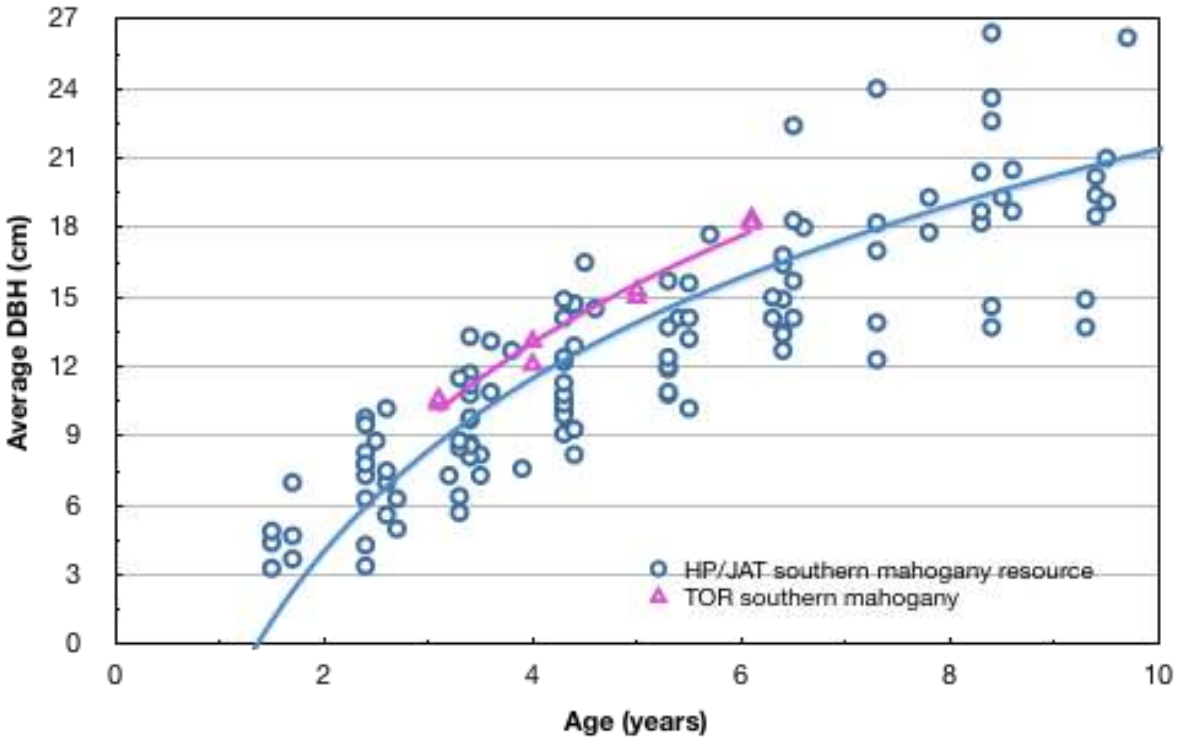


Figure 5. Southern mahogany height growth at TOR11 v HP/JAT resource

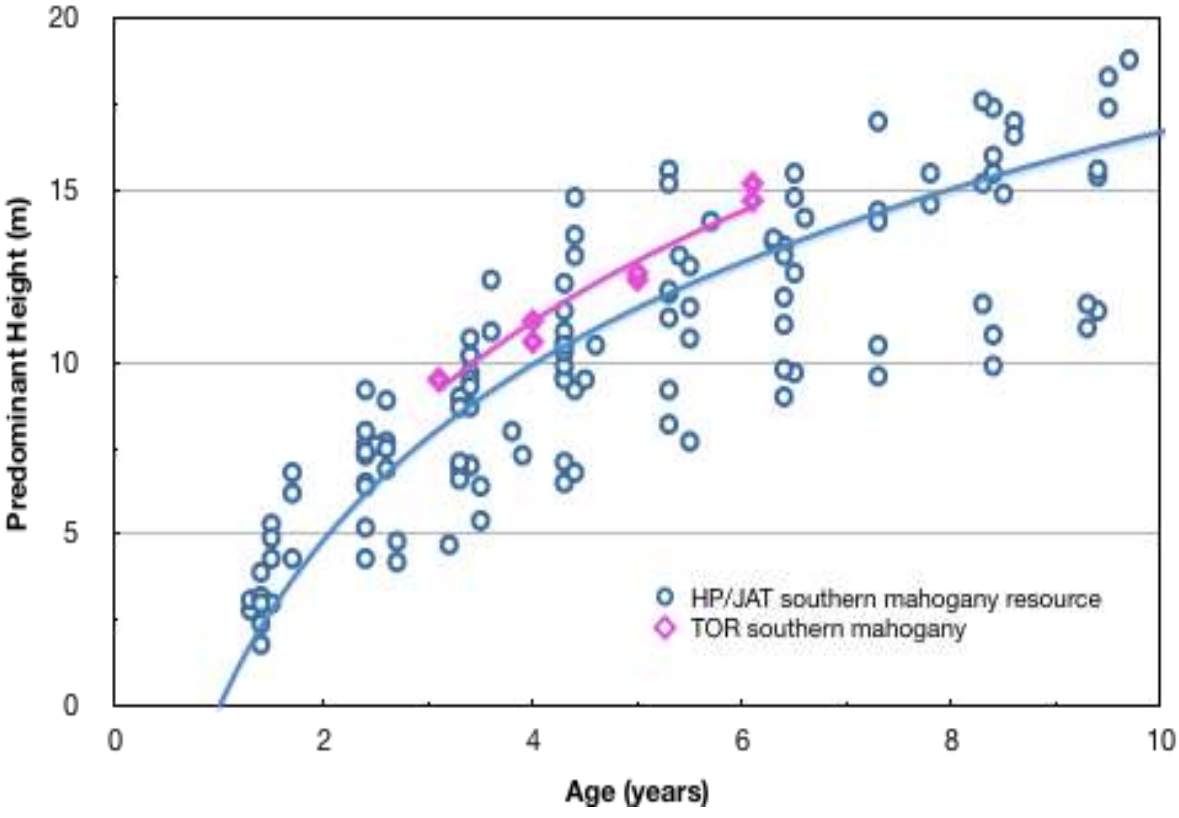


Figure 6. Spotted gum dbh growth at TOR11 v HP/JAT resource

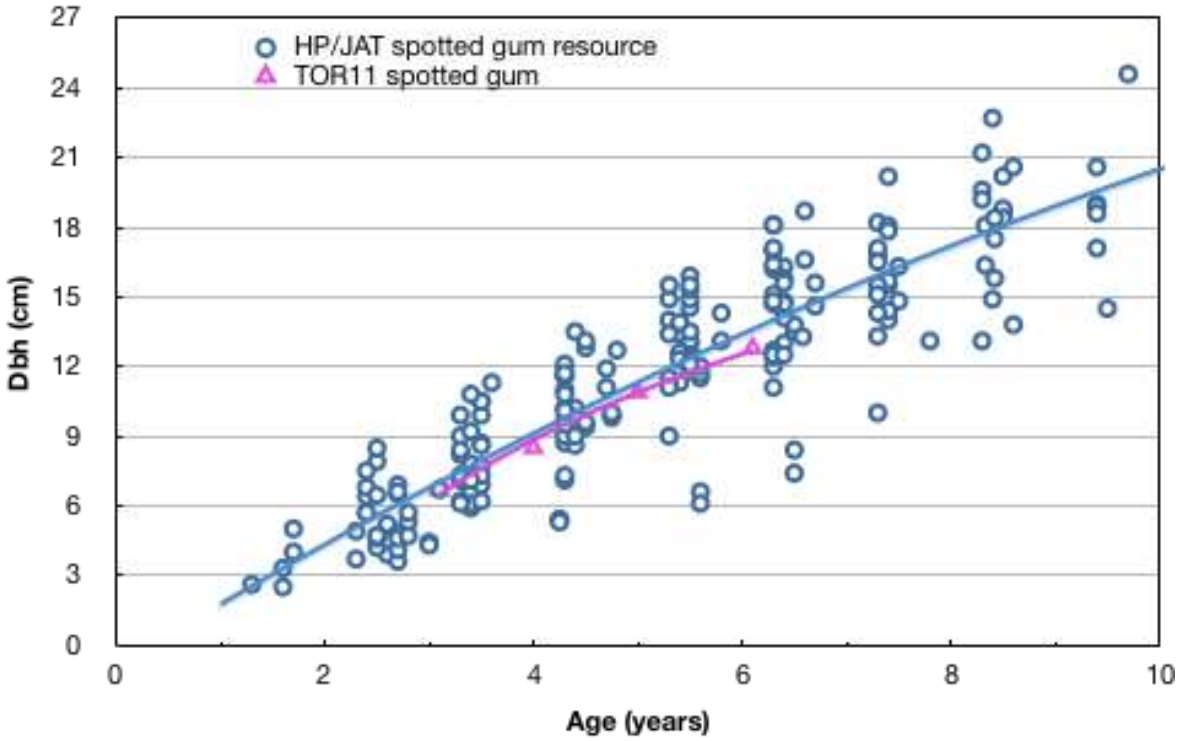
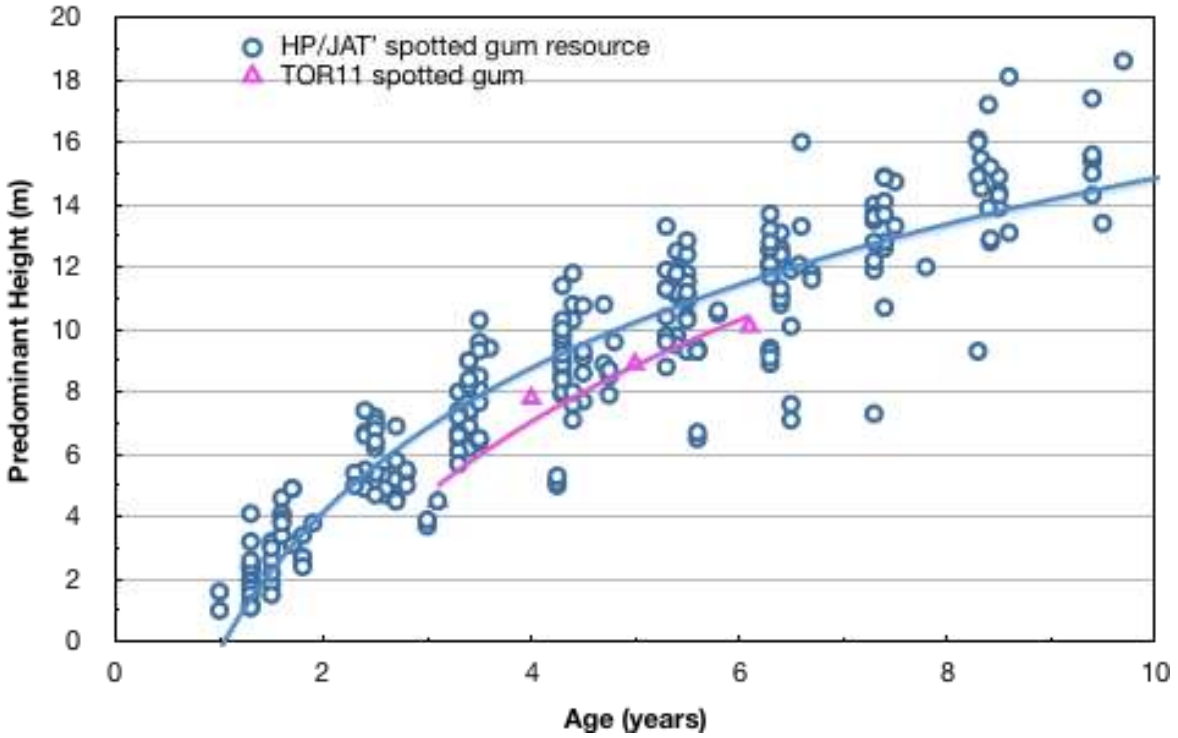


Figure 7. Spotted gum height growth at TOR11 v HP/JAT resource



Yellow stringybark

- Diameter and height increment was good across all three PSP's. Diameter growth remains good at >2cm/yr indicating that there is no need to thin at this stage. However reviewing the data at plot level shows that dbh increment of PSP3 is slowing down. Significant leaf drop within this compartment confirms that competition between trees is high, and thinning is required in this section of the plantation to maintain health and satisfactory diameter increment;
- The upward trend of diameter and height against other plantations of same species (figure 1 and 2) affirms current management practice;
- The mean tree height across all plots (in 2017) is >9 metres, so second lift stem pruning should be completed by August 2018. All plots are likely to be greater than 12 metres in height by the end of spring 2018, so third lift stem pruning to 6.3 metres will be required in 2019;
- The volume data at age 6.1 shows the plantation is on track to achieving the target mean annual increment (MAI) of 15-20m3/ha/yr at age 20-25. CAI is >25 meaning that the MAI is trending strongly upward at this stage - a pleasing sign because the MAI is already an excellent 12.4.

Figure 1: Yellow Stringybark 2015 Compartment A - age 4yrs

Figure 2: Yellow Stringybark 2017 Compartment G - age 6.2yrs

Southern mahogany

- Diameter and height increment is good. Since 2015 when growth was beginning to slow, increment for height and dbh has increased, indicating that the thinning completed across 2016 has satisfactory reduced competition. Improved tree health and reduced leaf drop, confirm this conclusion;
- The upward trend of diameter and height against other plantations of same species affirms current management practice;

- The mean tree height across all plots is >12 metres, so third lift stem pruning (to 6.3m) should be undertaken. Branch size can blow out with thinning in this species, so 3rd lift pruning must be completed by August 2018;
- The volume data shows that at age 6.1 we are on track to achieving the target mean annual increment (MAI) of 15-20m3/ha/yr at age 20-25. CAI is >25 meaning that the MAI is trending strongly upward at this stage - a pleasing sign because the MAI is already an excellent 12.6.

Figure 3: Southern mahogany 2015 Compartment D - age 4yrs

Figure 4: Southern mahogany 2017 Compartment D - age 6.2yrs

Spotted Gum

- In contrast to the other species, diameter and height increment have reduced over past 12 months;
- The basal area_/diameter ratio is relatively high (11.7/12.8) for this species, indicating excessive competition for site resources. Therefore thinning is required before August 2018;
- The recent downward trend for diameter compared to other spotted gum plantations, indicates a need to review current management practice. At Tarmaroo this means thinning plus fertiliser application to improve growth and form;
- Tree form has deteriorated since 2016. This confirms observations in 2016 that upper crown growth, and stem form was sub optimal. This species will benefit from upper stem form pruning and, most importantly, fertiliser application that fosters the development of a strong central leader and improved crown density to fuel better growth;
- The mean tree height is >9 metres so second lift stem pruning (to 4.5m) should also be undertaken before spring 2018;
- The volume data shows that at age 6.1 we are slightly behind schedule to achieve the target mean annual increment (MAI) of 10-15m3/ha/yr at age 20-25. CAI is greater than the MAI, meaning that the MAI is still trending upward at this stage. Timely thinning and fertiliser application should continue to improve MAI.

Figure 5: Spotted Gum 2015 Compartment B - age 4yrs

Figure 6: Spotted Gum 2017 Compartment B - age 6.2yrs

With age, tree volume becomes more important as the quantity of wood in each product grade is calculated. PSP data empowers the seller when it comes time to plan, harvest and market the wood. It provides the information to firstly sell at the optimal time, and secondly to negotiate price, because they know what they have. Subsequently, firm quotes from the market and harvesting contractors can be sought well in advance.

The rapid height growth at Tarmaroo shows that the plantation should attain the industry preferred six metre sawlog. In fact, this site is likely to produce at least two lengths of six metre sawlog, which usually means a lower harvesting rate per unit of wood produced. The PSP data provides base information to facilitate the promotion of height growth (through altered thinning regimes and/or fertiliser application) if required.

COSTS AND RETURNS[10]

Tarmaroo plantation economics – gross margins

The initial feasibility study included a cashflow budget based on 2010 prices. The cashflow budget only includes variable costs[11] directly associated with the agroforestry enterprise. Using this cashflow budget as a basis, the following indicative gross margin has been calculated. Please note that the growth figures from the PSP's have been used to refine yield estimates and 2016/17 prices have been inserted into the original (2010) cashflow budget.

Table 2. Indicative agroforestry gross margin analysis for a 25 year rotation

Item	No landholder labour (fully costed)		Provision of Bob's labour at no cost[12]	
	Per ha	Per ha/yr	Per ha	Per ha/yr
Gross Income	$36000	$1440	$36000	$1440
Total Expenditure	$11700	$468	$8200	$328
Gross Margin	$24300	$972	$27800	$1112

The 25 year rotation of the agroforestry venture combined with significantly varying annual cashflow makes it difficult to compare to gross margins for farming operations such as beef and sheep/lamb that produce returns annually. To aid this analysis, costs and returns incurred in different years need to be discounted to a present day value. In forestry this usually involves undertaking a discounted cash flow (DCF) analysis to provide a net present value (NPV). The NPV is calculated by adding all the discounted returns or losses over the rotation.

NPV calculations are a standard feature of spreadsheet software packages (e.g. Excel, Numbers) and can be calculated by listing the cashflow in each year of the rotation and then applying a discount rate. A discount rate is like an interest rate. If $1000 is invested today at 5%, in 25 years time we know it will be worth $3386. Using the same method we can estimate in 25 years time what Bob's wood is worth and then by discounting or reversing the interest process we can calculate how much it is worth in today's dollars. If the NPV is positive, the project is considered financially viable at the discount rate used. If the NPV is negative, the project is making a financial loss at the selected discount rate.

The selection of discount rate is critical when evaluating longer term projects like agroforestry plantations. There are two common approaches:

1) The cost of borrowing the money. If money for the project can be borrowed at x% per annum (excluding inflation), this value can be used as the discount rate. If the return from the project is greater that what the money can be borrowed at, it is financially viable. If the financial return is less than what the money can be borrowed at, the project is financially unviable at the selected discount rate.[13]

[10] This section extensively references the "Economics and Farm Forestry" section (p109-122) in The Farmers Forest – Multipurpose Forestry for Australian Farmers. Australian Master TreeGrower. R. Reid and P. Stephen. RIRDC Publication No. R01/33. For a full explanation of plantation economics you are encouraged to read the above referenced chapter. This chapter is available in full at agroforestry.net.au

[11] No farm overhead costs included.

[12] Based on actual figures during first 6 years and projections for the balance of the rotation. By applying his own labour at no cost, Bob's total expenditure is expected to be 70% of the fully costed cashflow budget in the feasibility study.

[13] The Farmers Forest – Multipurpose Forestry for Australian Farmers. Australian Master TreeGrower. R. Reid and P. Stephen. RIRDC Publication No. R01/33. p115

2) The return from alternative investments (opportunity cost). The discount rate is set to reflect the return that can be achieved from another project e.g. interest rate on term deposit, return from another crop or livestock option.[14]

Generally a discount rate of 4-8% is used to evaluate forestry projects[15]. To help explain the principle of discount rate at Tarmaroo, four rates have been used (Table 3 below). To aid the comparison with agriculture, annuity figures for both the cashflow budgets detailed in Table 2 are provided. An annuity is the average amount paid by the plantation project each year throughout the rotation at a set discount rate. It is a good way of comparing yearly agricultural returns with yearly plantation returns[16].

Table 3. NPV and Annuity (for whole project - 15ha) for two plantation cashflow budgets

Discount rate	No landholder labour (fully costed)		Provision of Bob's labour at no cost[17]	
	NPV	Annuity[18] ($/ha/yr)	NPV	Annuity ($/ha/yr)
5%	$44,763	$3176	$78,065	$5,539
6%	$17,839	$1395	$49,215	$3,850
7%	-$2,544	-$218	$27,138	$2,329
8%	-$17,920	-$1,679	$10,264	$961

These figures show that both cashflow budgets are profitable at the 5 and 6% discount rates. However only where landholder labour is not costed does the agroforestry enterprise remain profitable at the 7 and 8% discount rates. By effectively giving his time at no charge to the project, Bob has significantly improved the financial performance of the agroforestry plantation on paper.

Tarmaroo sheep gross margin analysis

Cross bred ewes are purchased at 18 months of age and joined to Poll Dorset rams. They remain for about 5 to 6 years and are then sold as cast for age (too old for breeding). Lambing is in spring with all lambs sold between Christmas and the end of April when prices are historically highest. The soil and rainfall allow this somewhat out of season system. The stocking rate for the sheep enterprise is about 12 ewes per hectare. This includes an allowance for some grazing obtained from the forestry blocks. Bob's labour is not costed in this analysis.

[14] The Farmers Forest – Multipurpose Forestry for Australian Farmers. Australian Master TreeGrower. R. Reid and P. Stephen. RIRDC Publication No. R01/33. p115

[15] The Farmers Forest – Multipurpose Forestry for Australian Farmers. Australian Master TreeGrower. R. Reid and P. Stephen. RIRDC Publication No. R01/33. p115

[16] The Farmers Forest – Multipurpose Forestry for Australian Farmers. Australian Master TreeGrower. R. Reid and P. Stephen. RIRDC Publication No. R01/33. p116

[17] Based on actual figures during first 6 years and projections for the balance of the rotation. By applying his own labour at no cost, Bob's total expenditure is expected to be 70% of the fully costed cashflow budget in the feasibility study.

[18] An annuity is calculated by dividing the NPV by an annuity factor. An annuity factor is a function of rotation length and discount rate.

Table 4. Gross margin analysis – sheep 2016

Item	Tarmaroo sheep gross margin analysis 2016	
	$/ewe	$/ha/yr
Gross Income	$159	$1908
Total Expenditure	$91	$1096
Gross Margin (2016)	$68	$816
Gross Margin (2013)	$67	$804

Tarmaroo beef gross margin analysis

Dairy cross cows are purchased as heifers and joined to Angus bulls for ease of calving. Spring calving results in vealers being ready for market in the autumn again when price rises often occur. Calves which fail to make vealer quality (~30%) are carried over and fattened for sale in about December. Carrying cows with calves over the late summer/early autumn require supplementary feeding with silage and hay made on the property. The stocking rate for the enterprise is about 1.2 cows per hectare. Bob's labour is not costed in this analysis.

Table 5. Gross margin analysis – beef 2016

Item	Tarmaroo beef gross margin analysis 2016	
	$/cow	$/ha/yr
Gross Income	$1275	$1530
Total Expenditure	$637	$764
Gross Margin (2016)	$600	$764
Gross Margin (2013)	$200	$245

Based on the assumptions made (refer to Appendix 1) the gross margin analysis (GMA) demonstrates that agroforestry compares favorably with the main agricultural options at Tarmaroo. However the GMA does not account for the time lag associated with plantation returns. The NPV and associated annuity returns detailed in Table 3, attempt to address this delay until returns and therefore improve the comparison between the plantation and agriculture ventures. The figures relating to the provision of labour at no cost are comparable to the agricultural GMA in tables 4 and 5, because similar to the agricultural GMA, they do not include a cost for direct landholder labour. At the 8% discount rate, the annuity for the plantation venture ($961) is comparable to the Bob's annual gross margin for sheep ($816).

After allowing for the delay in positive cash flow, the plantation still compares favorably up to and including the 8% discount rate. A profitable outcome from the plantation is highly dependent on a good outcome at final harvest at age 25. To analyse the sensitivity to variations in the major variables of wood price and growth rate, a sensitivity analysis was undertaken (Table 6.).

Table 6. Sensitivity analysis for wood price and growth rate

	Wood price		Mean annual increment m3/ha/yr	
	-20%	+20%	13.6 (-20%)	20.4 (+20%)
NPV (5%)	$22,549	$133,672	$45,174	$111,932
Annuity (5%)	$1,594	$9,484	$3,205	$7,942
NPV (7%)	-$9,325	$63,601	$6,372	$48,454
Annuity (7%)	-$800	$5,458	$547	$4,158

Sensitivity analysis helps to quantify risks. In this case it shows that the plantation favorably compares with Bob's main agricultural options of sheep and beef at the 5% discount rate when wood price or growth rate are reduced significantly by 20%. Alternatively if wood price or MAI increase by 20% returns are far superior to the previewed agricultural options at the higher discount rate of 7%. This analysis shows that the financial return for the venture is more sensitive to movement in wood price relative to growth rate.

To minimize the risk of low prices affecting financial performance, Bob should aim to diversify the market options for the highest value wood products produced from his plantation because they represent the majority of return at clearfall. In practice this could mean selling into more than one sawlog market. Milling and drying a proportion of timber on-site is another option worth considering.

To reduce the risk of a growth rate reduction (meaning less wood to sell) Bob needs to manage his plantation proactively. This means taking action (e.g. thinning and/or fertilising) before potential issues become major problems. The best way to do this is to regularly assess PSP's (e.g. annually) so that decisions and subsequent strategy are based on solid, empirical evidence rather than reacting to a "feeling". Where PSP's are regularly monitored, growth rates can be forecast with more precision, particularly where "best practice" silviculture is applied. In this instance, PSP data shows that growth at age 6 is meeting expectations at the ¼ way point of the rotation.

Temporal scale and risk

A fundamental factor when considering agroforestry as a landuse option is the temporal scale of the project. Temporal scale refers to the length of time a venture spans before it concludes and products grown are sold. A plantation managed for high value sawlogs has a greater temporal scale than an annual crop because it takes much longer to produce the desired product. This feature of sawlog plantations in particular, means that they will be exposed to a higher risk of multiple drought, storm and fire events than many agricultural options.

Options exist to reduce these risks, such as choosing fire tolerant species and applying rigorous site/species matching processes. Financial risk can be mitigated to varying degrees by taking out appropriate insurance (at additional cost). Emotional trauma associated with such events is more difficult to account for. Nevertheless, such risks can be somewhat accounted for by choosing a higher discount rate when evaluating the economics of the venture. An example of this would be to increase the discount rate by an amount that is at least equivalent to annual insurance cost.

Non-wood benefits

The plantation offers Tarmaroo substantial non-wood benefits including:

- Improved aesthetic values;
- Reduction of erosion incidents;
- Improved quality of water running off into dams and off site during wetter months;
- Shade and shelter for stock;
- Personal satisfaction of seeing "hands on" management contributing to the production of good quality trees

These benefits have not been included in this analysis. Nevertheless such benefits should be considered when siting trees to optimise their many values on farm and across the wider landscape.

SUMMARY

Based on actual growth performance and expenditure to age 6, along with forecast costs and returns, Bob's agroforestry plantation compares favorably with the alternative agricultural options of sheep and beef at Tarmaroo. A distinguishing characteristic of the agroforestry plantation is the 25 year rotation. The length of time till the major return at clearfall means that discounted cash flow analysis is a more appropriate tool for assessing financial performance of agroforestry than gross margin analysis.

Regular measurement of the PSP's and associated data analysis has facilitated the development of a robust management strategy. Importantly, the data collected allows the plantation to be managed proactively – aiming to detect issues before they become significant and more difficult to remedy. The PSP data also allows the performance of the plantation to be benchmarked against similar plantations within a region, giving stakeholders a relevant guideline regarding where their plantation is positioned from growth performance against similar plantations in the region. Such comparisons can be used to evaluate existing practice.

The thorough planning that preceded the development of the Tarmaroo agroforestry plantation is playing a significant part in the early success of this venture. It is an excellent model for aspiring agroforesters to follow.

KEY LEARNINGS FROM DEMONSTRATION

The key learning's from this demonstration are as follows:

- Agroforestry plantations grown for high value wood production offer a competitive financial return for steeper areas of Tarmaroo that are otherwise prone to soil conservation and water quality related issues when used exclusively for grazing over the long term;
- PSP assessment and subsequent data analysis provides sound, scientific evidence for both short and long term decision making. In particular such data facilitates the development of a robust management strategy that can be preemptively actioned in response to growth trends.
- When comparing agriculture and agroforestry returns, the length of the agroforestry rotation must be factored into the decision-making process. This can be done in a tangible way using discounted cash flow analysis to provide a net present value (NPV) figure;
- Through appropriate use of a discount rate, the common risks associated with agroforestry (e.g. fire) can be accounted for. Risk can also be minimised through appropriate planning before commencing agroforestry ventures;
- Thorough planning is essential to optimize the holistic value of an agroforestry venture to a farm.

ACKNOWLEDGEMENTS

Thanks to Heartwood Plantations for the use of their PSP dataset to provide benchmarks to compare PSP data from Tarmaroo.

REFERENCES

The Farmers Forest – Multipurpose Forestry for Australian Farmers. Australian Master TreeGrower. R. Reid and P. Stephen. RIRDC Publication No. R01/33.

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APPENDIX 1.

AGROFORESTRY COST AND RETURN DETAILS

Actual costs and growth rates are used for the first six years of the 25 year rotation. Assumptions for the remainder of the rotation are as follows:

Assumptions

- Inflation, tax deductibility and land value have all been ignored and current prices used throughout the analysis;
- Where Bob's labour has not been used, prices include materials, plant hire and contractor labour cost;
- Plantation has a net area of 15 hectares;
- Later age fertiliser regime applied at age 6 and between 1st and 2nd commercial thinnings;
- Track maintenance required before each harvest event;
- No provision for plantation insurance;
- The only financial gain calculated from agroforestry is wood production. Other benefits such as inter-row grazing, shade and shelter, erosion mitigation etc. are not accounted for in this case study;
- No provision for carbon sales;
- Domestic large and small sawlog market in Yarram;
- Export wood and firewood market at Port of Melbourne;
- The plantation will achieve a mean annual increment of 17m^3/ha/yr;
- 1 tonne of wood = 1m^{3_3} of wood
- Financial returns are based on 2017 mill door prices in Victoria;
- All commercial harvesting is professionally managed by forestry company.

The only difference between "no landholder labour" and the "provision of Bobs labour at no cost" is that Bob's labour is not given a dollar value in the latter. In the "no landholder labour" scenario, all operations are fully costed to include labour.