



PRIVATE FORESTS
TASMANIA

A Case Study Using the Farm Forestry Toolbox to Determine Timber Volumes, Values and Financial Outcomes for Farm Forests.

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Abstract

The Farm Forestry Toolbox (FFT) computer package of ‘tools’ – which among other things can assist farmers, farm foresters, tree growers and consultants to; monitor tree growth, estimate standing timber volumes and values and estimate the ideal time to harvest trees, depending on market demand, prices, and the forest owner’s objectives.

This case study exercise demonstrates how; with field inventory data:-

- (1) the *Inventory Tool* with known log grades and prices, can analyse the stand information; to estimate wood volumes and values; and
- (2) the *Stand Manager Tool*, with an available growth model, can grow the stand forward to a clearfell age; and can perform financial analysis to estimate financial outcomes, based on past and future regime operational events and costs.

The financial outcomes from different scenarios can be used to assist tree growers in harvest decision making. Scenarios for a range of clearfell ages can help to decide harvest time. Scenarios for log price fluctuations can provide options for harvest planning and scheduling.

1.0 The Farm Forestry Toolbox Package

The *Toolbox* package was initially developed by Private Forests Tasmania (PFT) in the late 1990’s with funding support from the Natural Heritage Trust. There have been continuous improvements and updates since. The current Version 5.3 was funded under the Forest Industries Climate Change Research Fund program by the Federal Department of Agriculture, Fisheries and Forestry. It is available free from the Private Forests Tasmania’s website; <http://www.pft.tas.gov.au/index.php/services/services/41-farm-forestry-toolbox>.

The package consists of a collection of user friendly ‘tools’ or programs, grouped into *Hand Tools*, *Power Tools*, *Editor Tools* and *Health Tools*. These tools can assist farmers, farm

foresters, tree growers and consultants to plan, monitor, manage and make decisions about their shelterbelts, plantations and native forests.

2.0 The Case Study

This case study is intended to be read with the presentation delivered at the AFG Conference, or read with an operating version of the Farm Forestry Toolbox, so that the case study steps can be readily followed.

This case study demonstrates the practical use of two complex *Power Tools* - the *Inventory Tool* and the *Stand Manager Tool*, which are often used together for forest management and

decision making. Readers should familiarise themselves with the downloadable Toolbox Manual, Workshop Manual, and video clips.



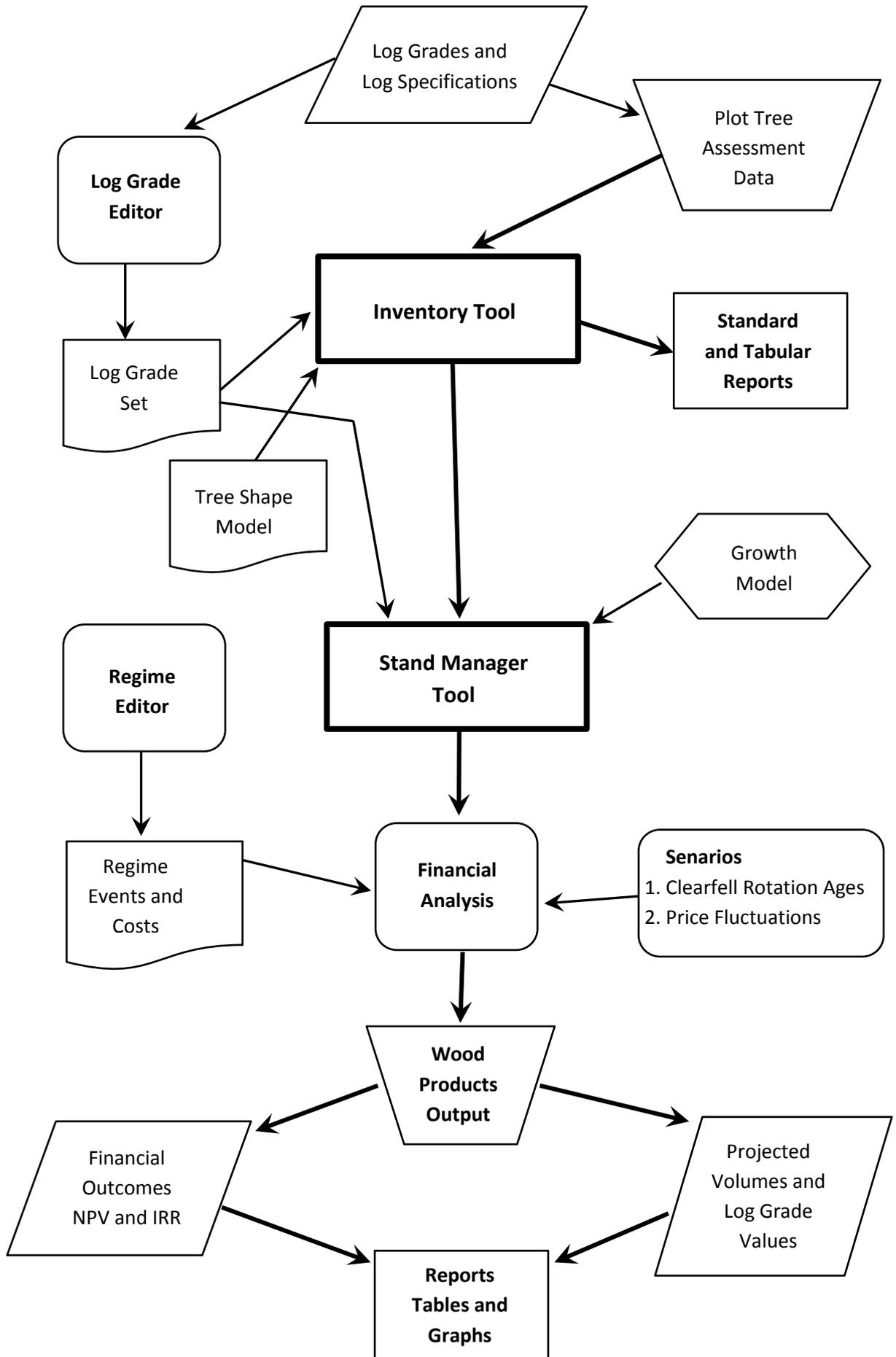
This study is based on a January 2013 ‘fixed area plot’ inventory of a 13.9 hectare Radiata Pine (*Pinus radiata*) plantation (owned by the winner of the 2011 Tasmanian Tree Farmer of the Year Award). The stand was planted in 1997 on a steep ex-native forest site considered marginal for farming. It has fertile Red Basalt soils, is

150m above sea level and receives 1200mm/annum rainfall. The plantation (see map) is located 8 km south from the coastal town of Ulverstone in North West Tasmania.

2.1 Stand History

Date	Event
April 1997	Following native forest harvest, site was burned
June 1997	Pre-plant spray
August 1997	Planting and spot fertiliser (NPK) 1000 seedlings/ha
March 2002	First prune lift 350 stems/ha to 2.7m
August 2003	Second prune lift 300 stems/ha to 4.8m
February 2005	Third prune lift 287 stems/ha to 6.7m
April 2005	Thinned to waste to leave 287 stems/ha
January 2013	Stand inventory assessment and Toolbox modelling

2.2 Flow Chart — Inventory and Stand Manager Tools



2.3 The Inventory Tool

The *Inventory Tool* has two tools; the '*Inven*'(tory) *tool* for a plot (sample of trees in a fixed area) and the '*tree*' *tool* for a single tree. This case study uses the '*Inven*' *tool*. Both '*Inven*' and '*tree*' tools require a *Log Grade Set*, to be created using the '*Log Grade Editor*'. It is important that the field tree assessment corresponds with the log grade set, with the appropriate market log grades and acceptable log size and length dimensions. Initially create a new '*Series*' for the stand, setting the appropriate Plot Type, Stand Area, Log Grade Set, Mean Dominant Height, Standard Diameter Height and Stump Height. Then create a new '*Plot*' for each plot, setting the Planting and Measurement Dates, Location and Plot Area. Finally, create all the trees in the plot with; Tree Number, Species Tree Shape Model, Diameter at Breast Height, Tree Height and the Assessed Grades.

An analysed stand statistics summary 'Standard' report can be saved or printed. There is also a range of 'Tabular' format summaries. The stand statistics for this case study are summarised in Table 3.

2.3 The Stand Manager Tool

Before applying the *Stand Manager Tool*, use the '*Regime Editor*' to create the 'Regime' for the stand, detailing all the expenditure and income for all the past and future operations and events for the stand rotation. Table 4 shows the regime events and costs for a 20 year clearfell rotation. Then create a 'New Scenario', setting the appropriate 'Wood Products' Scenario Output, 'Inventory SERIES file' Source of Forest Data, 'TAS_1 [11]' Growth Model and the Regime file.

A set of Regime files can be created for a range of clearfell rotation ages; 10, 25, 30 and 35 years. Note the Forest Practices Plan event must be the same as the clearfell year.

The financial NPV and IRR results and Wood Products 'Tables' and 'Graphs' summaries can be displayed on screen, and saved as PDFs or printed as a report with or without Tables or Graphs.

This financial analysis can be performed using scenarios for different clearfell rotation Regime files. The financial results of various rotation age scenarios are shown in Table 5. The NPV and IRR can assist in choosing the potential harvest clearfell year(s). Additional financial analysis scenarios of log price fluctuations can also be performed for a particular

favourable clearfell year, by adjusting the log grade set, increasing or decreasing log prices by say 5% or 10%. This simulates price changes, allowing tree growers to time wood sales with potential market conditions.

3.0 Mid-rotation and Pre-harvest Inventory Assessments

A mid-rotation stand assessment can be analysed by the *Inventory Tool* to:

- Estimate tree standing values, to assist in property sale valuation,
- Estimate commercial thinning volumes and returns,
- Track growth rate of the stand, when comparing with past measurement(s),
- Provide statistics for the *Stand Manager Tool* to conduct growth projection and financial analysis.

A pre-harvest or clearfell assessment is usually carried out just before the end of rotation harvest. The mature stand statistics, log grade volumes and values generated by the *Inventory Tool* can be used to:-

- Bargain with potential buyers in the market for higher stumpages,
- Carry out financial analysis to simulate short term price changes,
- Schedule and stagger the harvesting operation to fit into the landowner's timeframe and economic circumstances.

3.2 Log Grade Set and Market Log Specifications.

Log buyers have desired log specifications and requirements for a list of log features for every log grade. The list of log features are small end diameter (SED), large end diameter (LED), length, sweep, knot (branch) size, spike knot, nodal swelling, fluting, wobble, roundness, number of whorls, cut face, draw wood, splits, slabbing, machine damage, sap-stain, scars, rot etc. Not all of these need to be assessed during field tree assessment. Specifications for features like; slabbing, splits, machine damage, scarf faces, scars and rots are used by the logging crew during log-making.

Table 1: Log Grade Set

Name	Code	Length		SED	LED	Value \$/m ³	Preferred	Overcut	Pruned
		Min (m)	Max (m)	Dub Min (cm)	Dub Max (cm)		Length Step (cm)	Length (cm)	
Pruned Log	Pr	3.9	5.9	40.0	999.0	120.00	200		<input checked="" type="checkbox"/>
A Grade	A	3.9	5.9	30.0	999.0	80.00	200		<input type="checkbox"/>
K Grade	K	3.9	5.9	20.0	999.0	65.00	200		<input type="checkbox"/>
KI Export	KI	3.9	5.9	30.0	999.0	50.00	200		<input type="checkbox"/>
Pulp	P	3.9	5.9	10.0	999.0	40.00	200		<input type="checkbox"/>
Waste	X	0.0	999.0	0.0	9,999.0	0.00			<input type="checkbox"/>

Table 1 is the export log grade set for this study and it only deals with log diameter and length requirements for the various log grades. Hence, it is not necessary to assess them in the field, as the *Inventory Tool* uses the log grade set to segregate all trees into the various grades, according to the predefined diameter and length limits. The other field assessable features include; sweep, knot size, spike knot, nodal swelling, fluting, wobble, roundness, whorls frequency, maximum knot limit and scars.

3.3 Tree Assessment – some time saving ideas

It is a good idea to carry Q-card(s) with a summary of the assessable features. The two more frequently assessed features are sweep and knot size, as the others occur occasionally.

Table 2 shows the specification requirements for sweep and knot size for the log grades. Note that the Pruned (Pr) grade is omitted as the pruned sections are knot-free and straight as they were pruned according to the sweep requirements by pruning contractors many years ago.

Table 2: Sweep and Knot Size Requirements for Export Logs

Log Grade	Knot Size Requirements	Sweep Requirements
A Grade	Maximum 1/3 SED up to 12cm	Maximum 1/4 SED for log length < 6.1m
K Grade	Maximum 1/3 SED up to 10cm	Maximum 1/4 SED for log length < 6.1m
KI Export	Maximum 1/2 SED up to 25cm	Maximum 1/4 SED for log length <4.6m; Maximum 1/3 SED for log length >4.6m
Export Pulp	No limits	Maximum 1/3 SED for log length <4.6m; Maximum 1/2 SED for log length >4.6m

From experience, it is a good idea to assess and record both 'A' and 'K' grades as 'A'; as they both have same sweep and straightness. Their knot size limits are the same with maximum 1/3 SED, although 'A' can have a maximum of up to 12cm and 'K' has a maximum to 10cm. Because size difference between 10cm and 12 cm branches up the trees are difficult to differentiate, it makes sense just to use 10cm limit for 'A'. Hence both 'A' and 'K' can now be combined together during field assessment. The *Inventory tool* log grade set will segregate the smaller diameter sections of the 'A' into 'K'.

Any unpruned tree sections with knots bigger than 10cm will be assessed as 'KI' grade with a maximum limit of 25cm. Although there is the restriction of 'no more than 3 knots bigger than 20cm per 3 meter length', this is a rare occurrence. Remember that 'KI' sections of 'out-of-spec' will be downgraded to Pulp by the log grade set. Note that 'KI' size branches tend to occur in later rotation ages in lower stocked pruned stands that have been thinned very early, usually after final pruning lift.

Remember the waste grade or unusable non-wood products must also be recorded. They can be; damaged or scarred feature, the fork region where double leaders occur (and needs to be physically cut out), the area above the broken top and any badly twisted or kinked section. All these unusable features are Waste 'X' grade in the log grade set. Note that the default stump height is pre-set when creating a new 'SERIES' in the *Inventory Tool* program and will be segregated into waste grade.

3.3.1 Merchantable Double Leaders and Side leaders

Where a merchantable side leader occurs, the main stem is straight with no change in taper. Usually the side leader is a lot smaller. Hence, this side leader region of the main stem needs to be assessed as 'KI' or 'P' and not 'X'. Let the log grade set perform the segregation. The entry of the side leader diameter in the current toolbox version is entered as a % of the main parent stem. The current logic used in the *Inventory Tool* is that the 'Sum of the basal area of the main stem and the side leader above that fork equals to the basal area below the fork'.

From experience this is not always true. For a main stem with no apparent change in taper, you need to enter the side leader diameter close to 0%, which means the generated diameter is 'near-zero' diameter. This % of the main parent stem is more applicable to double leaders, where both leaders are frequently similar size and one leader can be set at 50% of the main stem. The log grades for both side leader and double leaders need to be assessed separately.

Note that the ‘Y’ shape fork region of trees with double leaders needs to be recorded as waste and has to be cut out. You need to estimate and record the leader diameters above the fork, along with their log grades. If the toolbox generated diameters of both leaders are larger than recorded diameters, you can enter a certain length above the fork as waste to where the estimated diameters occur. Future versions of the toolbox will allow fork diameters to be entered.

3.3.2 Inventory Assessment Form

Field assessment data can be entered directly into the Toolbox or recorded on one of several standardised EXCEL forms (including the Master Tree Growers form) which can be imported into Toolbox. These forms have appropriate columns for; tree number, diameter at breast height, total height and several extra columns for the different log grades and the top heights from ground level. From experience, it may be a lot easier to assess and record the estimated lengths of all the log grades. During data entry into the toolbox, each log length can be added to the top height of the last entered log grade. This way, you do not have to keep remembering the height of the last log assessed, and it is much easier to assess each grade and length as you move up the tree.

Note that total heights are measured for at least 4 or 5 good-form trees per plot, representing a range of diameters. These height trees are used by the *Inventory Tool* to generate the diameter/height curve, in order to assign estimated heights for those trees with no measured heights, to enable the estimation of log grade volumes for all trees in each plot.

4.0 Inventory Reports

After entering all the assessed data, at the ‘Series’ window level, you can view the inventory summary by clicking the ‘Reports’ option. There is ‘Standard Inventory Report’ and a set of Tabular Inventory Reports which can be saved as PDF format, print or export as Excel format. These reports provide stand/plot statistics, log grade volumes and values. Table 3 shows the stand statistics, log grade volumes and values at the time of plot measurement.

Table 3: 1997 Radiata Pine Stand Summary (Jan 2013)

<u>Attribute</u>	<u>Unit</u>	<u>Value</u>
Age	years	15.5
Mean DBHob	cm	44.3
Stocking	stems/ha	288
Basal Area	m ² /ha	44.6
Mean Dominant Height	m	26.6
Mean Annual Increment	m ³ /ha	24.4
Total Volume	m ³ /ha	379.9
Saleable Volume	m ³ /ha	360.3
Average Tree Volume	m ³ /tree	1.31
Stand Value (wharf)	\$/ha	26,945
Pruned Grade Value	\$/ha	4,277
A Grade Value	\$/ha	13,530
K Grade Value	\$/ha	7,581
Pulp Grade Value	\$/ha	1,554

5.0 The Stand Manager Tool Reports

Following the inventory tool exercise, open the *Stand Manager Tool* and select 'Wood Products' Scenario Output. The source of data is the Inventory plot or series. Note that using; the inventory data, the 'Species', 'Log Grade Set' and 'Tree Shape' function are already pre-selected, hence greyed out. Select the appropriate 'Growth Model' to grow the inventory data. The *Regime Editor* is used to create the stand management 'Regime File' to reflect all various past and future operational events and costs, as well as setting an appropriate 'Financial Base interest rate'. Clicking the 'Run' button will initiate 'financial analysis' to generate NPV and IRR financial outcomes, as well as the outputs of stand summaries and clearfell wood product log mix, volumes and values.

The Scenario can be changed to various clearfell ages, by creating several copies of the same Regime file with different 'Clearfell Age'. The set of financial results can be used for decision making, e.g. what is the potential harvest time frame? Other scenarios can be used to simulate the effect of rise or fall in market log prices; by amending the log values in the log grade set. The outcomes can assist owners stagger their harvest schedules to suit their financial objectives.

5.1 The Regime Files – Scenarios of different rotation clearfell ages

Use the *Regime Editor* to create the rotation’s management regime detailing all past and future operational events and costs, with a specified financial base Interest Rate. Table 4 lists a regime for 20 years rotation.

Table 4: Regime Events and Costs for 20 Year Clearfell Rotation

Regime: NW Tas Harvest at 20 yr							
R	Date	Yrs	Age	Event	Description	Cost \$	Revenue \$
1	1/06/1997	-0.2	-0.2	 Spraying	pre plant spaying	120 /ha	0
1	1/06/1997	-0.2	-0.2	 Nursery costs	seedling \$350/1000	350 /ha	0
	1/08/1997	0.0	0.0	 Financial Base	Interest Rate 5.0%; Include previous	0	0
1	1/08/1997	0.0	0.0	 Planting	1000/ha; [Survival 100%]	150 /ha	0
1	3/08/1997	0.0	0.0	 Fertilizing	© MARKER: {NO3(0); NH4(0); UREA(0) kg,	400 /ha	0
1	22/03/2002	4.6	4.6	 Pruning	Lift 1; 2.7m; 287/ha	600 /ha	0
1	30/08/2003	6.1	6.1	 Pruning	Lift 2; 4.8m; 287/ha	600 /ha	0
1	1/02/2005	7.5	7.5	 Pruning	Lift 3; 6.7m; 287/ha	600 /ha	0
1	1/04/2005	7.7	7.7	 Thinning	© T1; Waste; Out 0; 287/ha;	500 /ha	0
1	1/06/2017	19.8	19.8	 Forest Practices Plan	Forest Practices Plan	600	0
1	1/08/2017	20.0	20.0	 Clear felling	Commercial;	0 /ha	0

5.2 Financial Analysis Results.

By running the various Scenarios, a set of financial outcomes are generated for the different regime rotation age options. Table 5 displays the Stand Revenue (\$/ha), Net Present Value (NPV \$/ha) and Internal Rate of Return (IRR %) for the various rotation clearfell ages analysed.

Table 5: Stand Net Revenue, Net Present Value and Internal Rate of Return

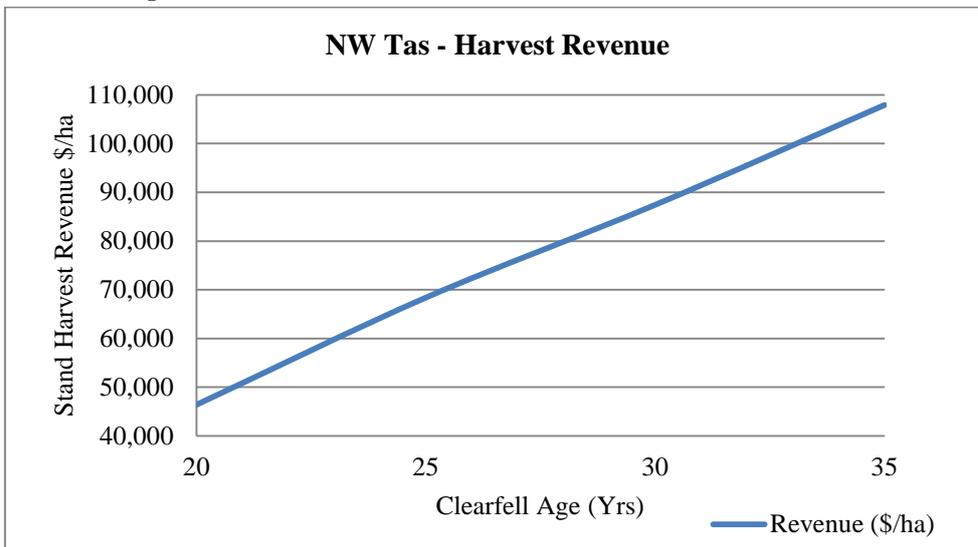
Clearfell age (yrs)	Net Revenue (\$/ha)	NPV (\$/ha)	IRR (%)
15.5	26,945	-	-
20	46,385	14,546	17.33
25	68,383	17,307	15.20
30	87,434	17,383	13.25
35	107,927	15,841	11.63

Remember these financial outcomes are based on the fixed assumptions used; i.e. growth model projected volumes for the log grades, log prices, the regime past and future operational costs, logging and cartage costs, and the discount/compound interest rate. In this case study the logging and cartage costs are borne by the contractor and the interest rate is set at 5%.

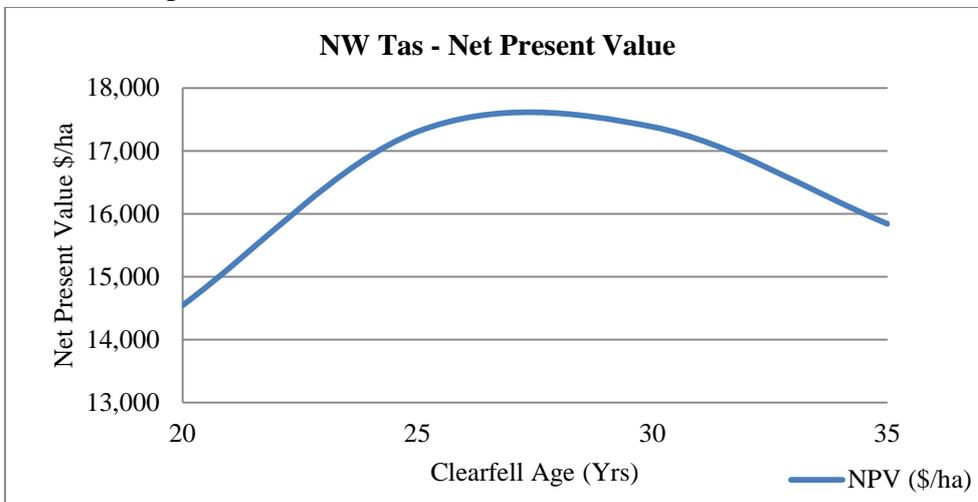
5.3 Graphical Interpretation

Using Excel Spreadsheet Program, the financial returns in Table 5 can be graphically displayed. The graphs are useful for decision making. For example; when should the stand be harvested, what is the timber value at different clearfell ages, etc. Graphs 1, 2 and 3 display the Stand Harvest Net Revenue (excluding harvest and cartage costs), Net Present Value and Internal Rate of Return for the various analysed rotation clearfell ages.

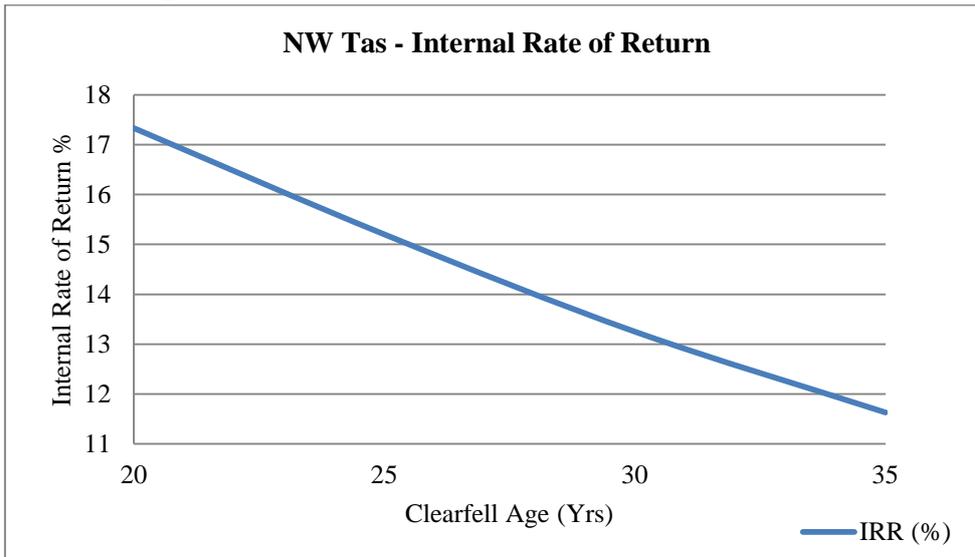
Graph 1 – Stand Harvest Net Revenue



Graph 2 – Net Present Value



Graph 3 – Internal Rate of Return



5.4 Decision Making – When should the stand be harvested?

The Stand Harvest Net Revenue line reflects the increase in the projected growth volumes and values of the higher premium log grades ‘Pr’ and ‘A’. Revenue increases about \$20,000 every 5 years.

A tree grower wants to know when he should harvest his trees to realise returns on the money invested since planting the stand. NPV and IRR can be used to aid this decision. NPV is the net sum of the discounted values of the future incomes and costs associated with the investment. That is the amount of extra money he would have in current dollar terms above what he earned at the specified rate of return, at the end of the investment life. For a long term investment like a tree crop, many foresters tend to pick the year with the highest NPV and in this case study it is about 27 years as seen in Graph 2.

IRR is the discount rate that sets the NPV of the investment to zero, i.e. the breakeven discount rate for the investment. If all the money for the investment was borrowed, the IRR would be the maximum interest rate the tree grower could afford to pay on the loan without losing money. The higher the IRR, the more attractive the investment.

It is advisable not to use IRR by itself as a deciding factor, but rather use it in combination with NPV results, especially for long term investments such as a rotation of trees.

5.5 Further Financial Analysis – Price Fluctuation

With the favourable harvest time of 27 years, you may wish to analyse the impact of market log price fluctuations. Using the *Log Grade Editor*, make copies of the log grade set, and change the log prices, i.e. decrease or increase of say 5% or 10% or 15%. Then in the *Inventory Tool*, make copies of the SERIES with their names reflecting the different price fluctuations. You can now produce reports with stand values for various log grade sets of different price fluctuations. Alternatively, you can create user-defined scenarios similar to the measure stand, and examine the effects of the log price directly.

For example; use the *Regime Editor* to create a new Regime file with 27 years rotation. Then in the *Stand Manager Tool* create a set of new Scenarios with different price fluctuation names. For each scenario select the corresponding inventory SERIES which has the assigned price fluctuation log grade set. Running the scenarios will generate the new NPV and IRR financial returns as well. Hence the grower can decide which price fluctuation will fit his financial objectives, or he may stagger the harvest over his preferred time-frame.

Acknowledgements

Special thanks to the following:-

- Brian and Jan Bonde, owners of the case study plantation (winner of the AFG 2011 Tasmanian Tree Farmer of the Year Award), for the use of the case study inventory assessment data.
- Arthur Lyons, Private Forests Tasmania and Adrian Goodwin, Bushlogic (Developer of the Farm Forestry Toolbox) for their invaluable review of this paper.