HARVESTING TECHNICAL NOTE

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A Woodlot Analysis Tool – Design and Initial Testing

Summary

A Forest Growers Research project developed a simple tool to improve the knowledge and skills of small-scale forest owners in planning for the harvest of their woodlot or small forest. A model, called the Woodlot Analysis Tool, was designed and developed, first as a spreadsheet version in May 2019, and later in 2019 as a web-based version. The spreadsheet version of the Woodlot Analysis Tool included eight main worksheets covering inputs and outputs of the model. Testing of the spreadsheet version of the model is detailed in this report. Further testing of the web-based version is underway.

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INTRODUCTION

An FGR project to develop a simple tool to assist owners of small-scale forests, as they prepare for harvest, was commenced in March 2019.

The aim of the project is to make freely available, a simple tool to calculate net returns in dollars, dollars per hectare and dollars per tonne from the harvesting of a specific woodlot, given commonly available inputs, such as the quarterly log price index reported by the Ministry for Primary Industries (MPI, 2019) or Indicative Average Current Log Prices (PF Olsen, 2019), or the Log Price Report (AgriHQ, 2019).

The model can then be re-run, changing input values to estimate the effect of changes in, for example, volume per hectare, or yield by log grade, or harvesting and cartage costs.

This model will help to explain the range of likely returns to growers if harvest volumes are reduced, or if costs are higher than expected due to difficult access to the forest, the terrain driving high harvesting costs, or the distance from the forest to local markets resulting in high cartage costs.

In this way, net returns to growers can be calculated, to avoid unrealistic expectations and ultimately disappointment after harvesting and marketing of forest produce is completed.

The model, called the Woodlot Analysis Tool, was designed and developed, first as a spreadsheet version in May 2019. The web-based version of the Woodlot Analysis Tool was completed in mid-August 2019.

Figure 1: Screenshot from the Location page of the web-based version of the Woodlot Analysis Tool

STRUCTURE OF THE MODEL

The spreadsheet version of the model included a number of worksheets covering inputs and outputs:

1. Summary
2. Harvest Planning
3. Roads and Landings
4. Machinery Transport
5. Harvesting
6. Cartage
7. Management Fee
8. Other

Summary

The summary worksheet is where inputs regarding the woodlot are entered (such as forest area, region or Woodlot Zone, terrain classification, and distance from woodlot to the

public road, access, and forest yield and price information). Outputs are also shown such as total volume, gross returns, total costs, and net returns. All values are exclusive of GST.

New Zealand is divided into seven regions or Woodlot Zones; Northland, Central North Island, East Coast (excluding Hawkes Bay), Southern North Island (including Hawkes Bay), Nelson/Marlborough, Central South Island, and Otago/Southland.

Harvest Planning
This worksheet includes costs for pre-harvest inventory, plan preparation, resource consent application fees and resource monitoring fees. The total costs vary with harvest area and Woodlot Zone. Consent fees are based on a web-search and are predicted to be higher for Woodlot Zones where there is a lot red zoned area.

Roads and Landings
This worksheet includes costs for roads and landings. They vary with terrain and Woodlot Zone. Costs (per landing or per metre of road) are based on information gathered by University of Canterbury School of Forestry (Visser, 2018).

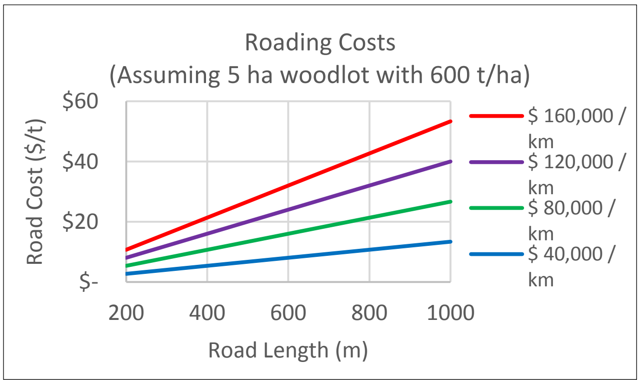

Figure 2: Roading costs can be significant for small woodlots

Landing intensity (hectares of forest per landing) is based on information gathered by University of Canterbury School of Forestry. Roading densities (metres of road per hectare of forest) were first based on data from a large forest estate but were found to over-estimate roading densities common in woodlots. It was assumed that approximately 2/3 of road construction in woodlots would be new roads and 1/3 would be road upgrade – this assumption was based on information from a large forest owner that also harvests woodlots. This is discussed further in the section on Model Testing.

Machinery Transport
This worksheet includes costs of transporters and pilot vehicles to move equipment between woodlots but does not include lost production time due to machine movements. It differs between ground-based and hauler operations. Data was gathered from four sources, including a web-site, a harvesting contractor, a woodlot harvesting management consultant, and a large forest company.

Harvesting
The harvesting cost worksheet is based on a Harvesting Cost model developed at University of Canterbury from data in the FGR benchmarking database collected by University of Canterbury School of Forestry (Visser, 2018). Data has been re-analysed to derive a regional adjustment factor for each of the seven Woodlot Zones. Costs vary with average slope, volume per hectare, woodlot area, and number of log sorts.

Cartage
Sawmills and wood processing plants in New Zealand are published in a Forest Products Industry Map by the New Zealand Forest Owners Association (NZFOA, 2018).

The log cartage worksheet is based on a model developed from more than 160 harvest unit/mill or port combinations supplied by a large forest company. It was compared with limited AgriHQ cartage costs and woodlot cartage costs collected by University of Canterbury School of Forestry.

The corporate cartage costs were adjusted to be more in line with Woodlot and AgriHQ costs. Costs vary with lead distance to mills or ports (Figure 3). The distance to the closest mill or port of the appropriate log type is automatically determined in the spreadsheet version. For example, if the log type is an export grade, the destination is the closest port. Cartage costs,

weighted by volume, are summed to obtain total cartage costs for the woodlot.

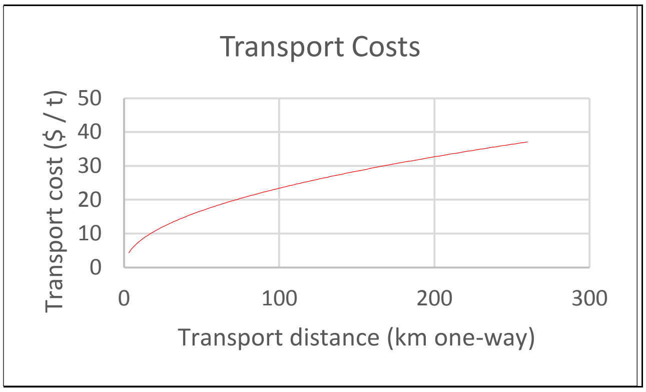

Figure 3: Effect of cartage distance on transport costs

Management Fee
This worksheet contains a value for the percentage of net revenue (gross returns less all costs other than management fee). Values ranging between 3 and 8% of net returns appear to be typical in New Zealand.

Other
Other costs in this worksheet include the values for the Forest Growers Levy at 27c per tonne, standard weighbridge and docket costs at 36c per tonne, professional advice, and post-harvest site rehabilitation costs (water bars etc., based on the terrain classification).

JAS Conversion Factors
A worksheet is included that contains conversion factors for JAS m3 to tonne conversions for each of five key export grades for each of the Woodlot Zones. It is based on a very large data set relating to the 2018 calendar year. The user can use this table to adjust $/JAS log prices to $/tonne prices if required.

Mill Locations
This worksheet contains the latitude and longitude coordinates of each the mills and ports in New Zealand. It also contains the type of destination:

- E = Export
- A = Appearance (for pruned logs)
- S = Structural Saw Log
- F = Fibre

This information formed part of the Google Map-based distance calculations in the web-based version of the Woodlot Analysis Tool.

RESULTS OF MODEL TESTING: CASE STUDY 1

Case Study 1
A 31-hectare woodlot that was harvested recently (March/April 2019) in the Bay of Plenty was selected as a case study for testing of the model. The woodlot owner had detailed information on projected and actual yields and prices, as well as costs and was able to provide insight on the sources of differences between the model and actual net returns.
Four sets of testing were carried out:

1. Forecaster was used to determine total yields and yield allocation (FY). Log prices were obtained from PF Olsen's website relating to the harvest period (PFO). Costs were as included in the model and described above (OC).
2. As for Test 1 above for total yields and yield allocation (FY) and log prices (PFO). Costs were refined in the model, particularly the costs for roading, based on better information (RC).
3. As for Test 1 above for total yields and yield allocation (FY). Log prices were those obtained from the woodlot harvesting management consultant (WHM). Refined costs were used as for Test 2 above (RC).
4. Pre-harvest inventory data was provided by the woodlot owner (PHI). Log prices were those used in Test 3 (WHM). Refined costs were used as for Test 2 above (RC).

The four sets of testing allowed determination of the major sources of difference in net revenue calculations.

Test Set 1 – FY_PFO_OC

- Total yields were under-estimated using Forecaster by 5.1%.

- Gross revenue ($) was under-estimated by 15.0%. The major source of difference (~10%) was due to recovery of much greater volumes of pruned wood by the woodlot owner than that predicted by Forecaster.
- Total costs were over-estimated by 5.1%.
- Net revenue ($) was under-estimated by 24.6%.

The major source of difference was related to the prediction of roading costs. This was partly due to a quarry being adjacent to the woodlot (lower $ per metre of roading), and partly due to no new roading required (just an upgrade as a road had been built through the woodlot about 10 years previously to access a neighbour's woodlot), and partly due to higher roading densities being predicted by the model.

To improve information on woodlot roading densities, Google Maps was used to select 60 woodlots that were currently being harvested or had recently been harvested. These were scattered around New Zealand and on a range of terrain types. Road length and harvest area were measured using Google Maps. Internal roading densities (excluding access road to the edge of the woodlot) in woodlots were found to be less than half those on a large forest estate.

Roading densities on easy terrain were found to be about 60% of those on moderate, steep, or very steep terrain. Road densities in the model were updated using this data.

Cartage costs and management fee costs were under-estimated, but since these are both linked directly or indirectly to total volume, no changes were made to the model.

Other costs were over-estimated, but since these included costs for site rehabilitation, which was yet to be carried out, no changes were made to the model.

Test Set 2 – FY_PFO_RC

- Total yields were under-estimated using Forecaster by 5.1%.
- Gross revenue ($) was under-estimated by 15.0%. The major source of difference (~10%) was due to recovery of much greater volumes of pruned wood by the woodlot owner than that predicted by Forecaster.
- Total costs were over-estimated by 0.7%.
- Net revenue ($) was under-estimated by 22.5%.

Test Set 3 – FY_WHM_RC

- Total yields were under-estimated using Forecaster by 5.1%.
- Gross revenue ($) was under-estimated by 11.8%. The major source of difference (~7%) was still due to recovery of greater volumes of pruned wood by the woodlot owner than that predicted by Forecaster.
- Total costs were over-estimated by 1.1%.
- Net revenue ($) was under-estimated by 17.9%.

Test Set 4 – PHI_WHM_RC

- Total yields were over-estimated using pre-harvest inventory by 0.2%.
- Gross revenue ($) was over-estimated by 2.3%. The difference was largely due to recovery volume with a different grade distribution than that predicted by PHI.
- Total costs were over-estimated by 7.5%.
- Net revenue ($) was under-estimated by 0.1%.

The major sources of the cost over-estimates were:

- Roading and landing costs (actual costs were lower due to only upgrading being required and rock being available at low cost from an adjacent quarry).
- Harvesting costs were over-estimated by $0.90 per tonne and cartage costs were over-estimated by $0.26 per tonne.
- Other costs, such as site rehabilitation was scheduled for later in the year and had not been completed.
- Harvest planning costs, other than a resource monitoring fee, had not been reported separately by the woodlot owner. These may

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have been included as part of the Management Fee.

- Management fee costs were over-estimated since they were based partly on gross returns which were, themselves, over-estimated.

CONCLUSIONS FROM CASE STUDY 1

Testing of the spreadsheet version of the Woodlot Analysis Tool, with a single case study on easy terrain, indicated that the largest sources of error in Net Revenue prediction are likely to be the absence of good inventory data (with a reliance on volume and grade forecasting models) and the variability in the costs of roads and landings.

The model does include a warning that use of a model is no substitute for professional advice. Given reasonable inventory data (PHI), the model did predict gross revenues that were within 3% of actual, and costs that were within 8% of actual.

As a result of carrying out Case Study 1, refinements to the model were made.

NEXT STEPS

- Since the development of this spreadsheet, the web-based version of the Woodlot Analysis Tool was completed in mid-August 2019. The model can be run on a desk top computer, on a tablet, or on a smartphone (Figure 4).

Figure 4: User testing the web-based version of the Woodlot Analysis Tool

- Once the web-based version was completed a second case study, largely on steep terrain, was carried out which lead to further refinements to the costs included in the model.

RESULTS OF MODEL TESTING: CASE STUDY 2

Case Study 2

A second case study was carried out for a steep terrain woodlot in Hawkes Bay. A 13.3-hectare woodlot that was harvested in April/July 2018, was selected as the second case study for testing of the model. The woodlot owner had information on estimated yields and actual yields and prices, as well as costs, and was able to provide insight on the sources of differences between the model and actual net returns.

Three sets of testing were carried out:

1. Forecaster was used to determine total yields and yield allocation (FY). Log prices were obtained from PF Olsen's website relating to the harvest period (PFO). Refined costs were as derived from the model and described above (RC).
2. As for Test 1 above for total yields and yield allocation (FY). Log prices were those obtained from the woodlot harvesting management consultant (WHM). Refined costs were used as for Test 1 above (RC).
3. Estimated inventory data (EI) was provided by the woodlot harvesting management consultant (WHM). Log prices were those used in Test 2 above (WHM). Refined costs were used as for Test 1 above (RC).

The three sets of testing allowed determination of the major sources of difference in net revenue calculations.

Test Set 1 – FY_PFO_RC

- Total yields were under-estimated using Forecaster by 1.7%.

- Gross revenue ($) was under-estimated by 4.7%. The major source of difference was due to recovery of greater volumes of pruned wood by the woodlot owner than that predicted by Forecaster.
- Total costs were under-estimated by 7.1%.
- Net revenue ($) was under-estimated by 0.8%.

The management fee was significantly higher than predicted and was based on gross, not net revenue. Harvest Planning and Other costs were included in the management fee. Roading and landing costs were over-predicted by over 90%.

Test Set 2 – FY_WHM_RC

- Total yields were under-estimated using Forecaster by 1.7%.
- Gross revenue ($) was under-estimated by 13.2%. The major source of difference was due to lower prices across all grades.
- Total costs were over-estimated by 7.6%.
- Net revenue ($) was under-estimated by 24.2%.

Test Set 3 – EI_WHM_RC

- Total yields were over-estimated using Estimated Inventory by 19.2%.
- Gross revenue ($) was under-estimated by 26.3%. The difference was largely due to the large discrepancy in total recovered volume and the recovery of a pruned logs (25% vs 13% estimated).
- Total costs were under-estimated by 10.8%.
- Net revenue ($) was under-estimated by 40.1%.

The major sources of the under-estimate in costs were:

- the under-estimate of total recovered volume
- actual roading and landing costs were lower due to less roading having to be constructed
- harvesting costs were under-estimated by $3.40 per tonne and cartage costs were under-estimated by $0.70 per tonne
- The management fee was greatly under-estimated due to: the management fee being based on net, not gross, revenue in the model; and under-estimates of both total volume and pruned log volume. As noted above, the management fee included Harvest Planning and Other costs.

CONCLUSIONS FROM CASE STUDY 2

Case Study 2 again emphasised the importance of having good inventory data as the basis for determining potential net returns. The under-estimates of total volume and pruned log grade recovery, used in Test Set 3, led to large errors in Gross Revenue, Net Revenue and Costs.

With reasonable inventory data (as in Test Set 1, albeit based on a model), predicted net revenue was very close to actual net revenue. This may have been fortuitous, since actual roading costs were less that that predicted, and the management fee was up on what was predicted (due to Harvest Planning and Other costs that were included).

No changes were made to the model. After testing on two case studies, it was considered ready for demonstration to the wider industry.

NEXT STEPS

- The web-based model was briefly loaded onto FGR's website. This resulted in some feedback on its ease of use. The model was revised January 2020 based on this feedback.
- At this stage FGR then suggested that further testing be carried out. Since then, the developers have circulated the Woodlot Analysis Tool to a number of industry experts for further testing and validation in different forest conditions.
- Once feedback has been received from the expert panel, and further revisions made, the web-based version of the Woodlot Analysis Tool will be uploaded to the FGR website, with a link to it on the NZ Farm Forestry Association website.

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