

Simwood Pilot-projects: South and Eastern Region, Ireland

Pilot Project 1: Mobilising additional wood fuel from conifer first thinning

Introduction

Veon has been working with a harvesting contractor and researchers in Waterford Institute of Technology on a study investigating the potential to mobilise additional wood fuel from conifer first thinning. The rationale for this work is that it is estimated that approximately 40%-50% of the above ground tree biomass is left in the stand in conventional first thinning. research trials were carried out to look at different approaches to mobilising additional wood fuel from conifer first thinning; the purpose of which was to determine the quantity of biomass removed by each method and the supply chain cost per unit production. Results from experimentation works suggest that a 200% increase in volume with one of the thinning approaches – Integrated - compared to normal harvesting (Cut to Length). (Integrated Harvesting is the cutting of the tree into 2 assortments, small sawlog (Pallet) and bio-energy (pulp, branches and tops).

Cut to Length	Integrated	Whole tree
63 m ³ /ha	127 m ³ /ha	118 m ³ /ha

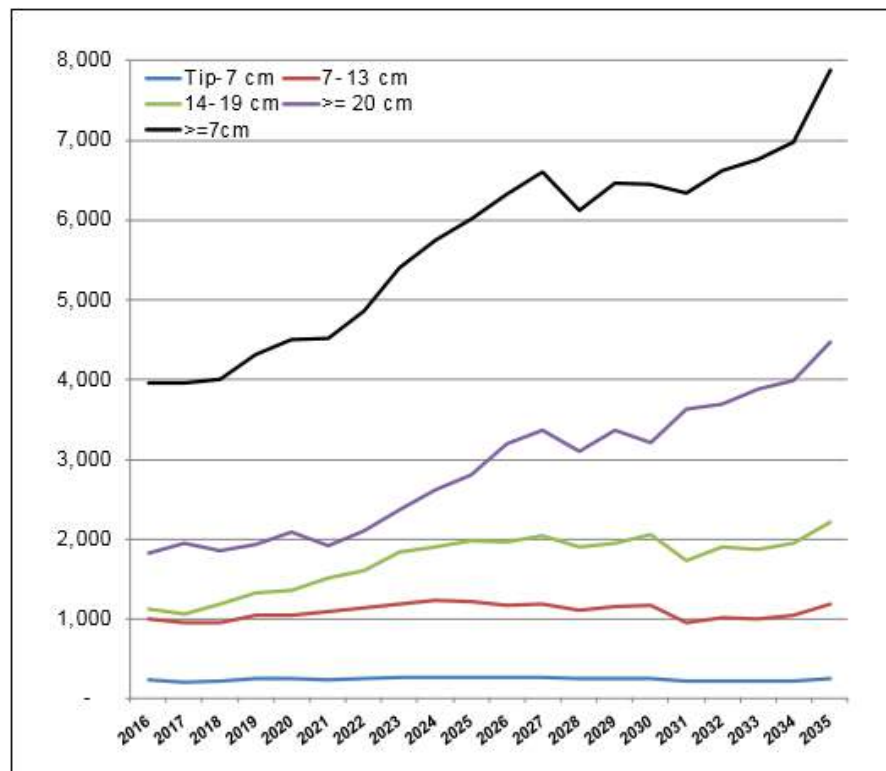
The results of this project are now published in Irish Forestry¹

Step 1 Definition of the priority target for enhanced mobilisation

Forestry in Ireland is considered young by European standards. State forestry began a little over a hundred years ago while private forestry began in the late 1980s and continues to this day. Private forestry is characterised by small often isolated holdings averaging 8 hectares. The majority of forest owners are farmers who have no tradition of forestry and therefore little knowledge.

Recent timber mobilisation forecasts suggest timber from the private forests will expand dramatically over the coming decades (All Ireland Roundwood Production Forecast 2016-2035)

On the other hand, demand for forest products is also expected to increase dramatically in the same period as Ireland moves away from a reliance on fossil fuels to more sustainable indigenous energy sources. Wood will play its part in this energy mix. Estimated Roundwood



demand will be about 6 million m³ while supply will be 4.5 million m³ by 2020 showing a gap in supply. Most of the predicted increase in demand will be from the bioenergy sector which uses low quality material in the form of pulpwood, branches and tops from forests.

Technology exists and experiments have shown that more low grade material can be recovered from forests during harvesting. However, there is a lack of knowledge amongst forest owners and forestry practitioners in the harvesting methods that can mobilise this timber.

Further, forest owners are motivated by profit when it comes to harvesting. This is especially true at first thinning when a harvesting road must be constructed to facilitate timber extraction. This is a costly exercise, even with state aid for forest roads. As first thinning normally consists of a high proportion of low value pulpwood, it is often the case that the road/first thinning operation is done at a loss. In many cases therefore first thinning is not carried out and the forest left to a no thin regime.

Increasing volume from the harvesting operation can increase revenue which in turn can increase the amount of plantations thinned thus mobilising more timber to the market place. Integrated Harvesting is a solution to this problem

However it is recognised that integrated Harvesting cannot be carried out on all site types for various reason like soil capacity, slope and access. Indeed it may not be required due to the quality of trees being good enough to yield a profit for the owner. Therefore it is necessary to develop a decision support Tool (DST) to help forest owners and practitioners decide.

The challenges to be addressed in this project were

- Knowledge of owners/practitioners of thinning practices and appropriate site selection;
- The target is in line with the strategy of our company to enhance wood mobilisation in the region;
- The forests which currently stand on well-drained sites are a critical mass of additional wood which could potentially be put on the market in a short and mid-term future provided that professional practitioners would know how to actively deal with them.
- Results from experimentation works show that a substantial increase in volume with Integrated Harvesting compared to cut to length harvesting; and this has resulted in increased profit for the forest owner. However, the traditional timber sale contract was found not to be appropriate to this method of sale. This was because it was based upon measurement over a weighbridge. The wood energy assortment is left on site to dry for a long period. The drier it gets, the lighter in weight it becomes and therefore the forest owner can lose out. On the other hand, the drier the material the higher the calorific value and therefore the value of this material goes up. The contract needs to be adjusted to reflect this value for the forest owner through referencing the sale of the bio-energy material to price in gigajoules. Indeed foresters and forest owners need to learn how to convert between tonnes/cubic metres and gigajoules.

The Theory of Change on which this project is based goes as follows:

Development and uptake of a DST and participation at demonstration events increases knowledge and skills required to mobilise wood sustainably among foresters and forest owners, thereby improving their attitudes towards wood



mobilisation as an economically viable activity, and their confidence in their ability to use this method. This leads to its adoption and hence increased wood mobilisation.

Step 2 Experimentation of promising measure to overcome identified barrier

With the preliminary work completed an action plan was developed to address the target audience and market potential of integrated Harvesting in the model region. This work formed the basis for field days carried out in 2016 and 2017. The preliminary work raised a number of issues that needed to be evaluated. These were:

1. Where are the forests that can use this method
2. What soils can take this kind of harvesting?
3. Where are the markets for the material
4. Is it sustainable – nutrient loss, rutting.
5. How should wood energy be sold – tonnes or gigajoules
6. Drying and length of time at roadside
7. Access

Once these criteria were assessed we could move on to disseminating knowledge to our audiences.

The key inputs were:

- Time spent by staff generating interest in this approach amongst forest owners, site selection, application for felling licences and consultation with relevant stakeholders.
- Time and money spent preparing field events, advertising, ringing around, site preparation, travel and preparation of materials
- Cost of field data collection to provide baseline data on volumes and costs
- Dissemination of information through press and other media.
- Training of foresters in the new method.
- Field testing the DST on a selection of sites where first thinning will be carried out by FEL.

Outputs delivered through the project are:

- Collection of data from demonstration sites.
- Three field events for targeted audiences
- DST for foresters – field tested
- Overview of potential of the method in the model region. A map showing plantations where this method could be used for the model region, plus new maps showing Soil damage and Nutrient loss risks to determine site suitability to Integrated Harvesting.
- Development of a relationship between FEL and the harvesting contractor who has the equipment
- Opportunities created to thin plantations and have a market for biomass material.
- Reports from demonstration sites targeting foresters and forest owners showing methods, applicability and outputs
- Survey of harvesting contractor and foresters to see if the method is being taken up. Has the pilot project helped this?
- Survey of the forest owners on their attitudes to the method. Were they happy with it? Did it change their mind to thin their plantation, etc.

The Potential market for harvesting of biomass

It is important when developing a new harvesting service that we identify the market, estimate the potential size and where it is. Work began on the GIS and Decision Support Tool in late 2015. This analysis and resulting data comes from work carried out by Ardao Rivera (UCD), Nieuwenhuis (UCD) and Little (Veon). In this study, spatial information on soil types, forest cover and nutrient loss were generated. A GIS was created where we asked questions about the geographic distribution of forests ready for thinning in the next number of years, the associated soil type and potential nutrient loss. Much work went into researching the potential for soils to be damaged as it was seen as the most important criteria in determining whether the harvesting could be carried out and to what extent material could be recovered.

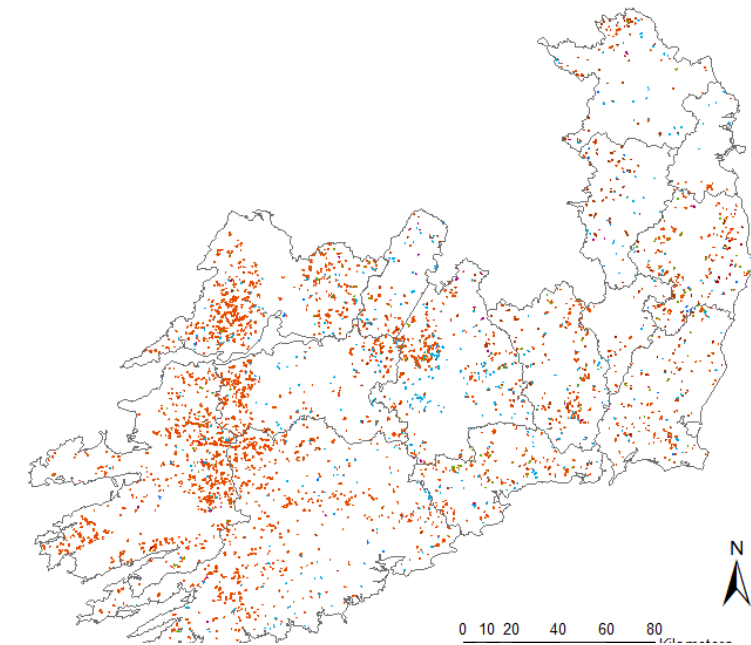
In addition we integrated a layer of the current bioenergy end users within the region to examine the distance to the market for candidate forests. It was intended to identify the ranges of biomass products and how to access markets and stock requirements. It is widely acknowledged that the market will increase in size, but where and what type of biomass will it require? We consulted widely on this in the course of the project, noting that the market is still very young and highly fluid in terms of biomass requirement and specification.

Using datasets already described we were able to show the forests that were within a few years of harvesting (15 -20 years old) as shown in the figure XX below. The map shows that many of the plantations that will be harvested in the next 5 years are concentrated in the southwest of the region and are dominated by Sitka spruce. The Soil Damage Risk map and Nutrient Loss Risk map shows that this is also an area of higher risk. However, as has already been shown there is still potential to extract more biomass from these forests with improved techniques and machinery. Our work with the data was able to combine the Soil Damage Risk map and Nutrient Loss Risk maps to derive a new dataset of 'restrictions'. Each restriction category defines the potential for extra biomass material from the forests. With data from harvesting we are able to estimate the sustainable amount of extra biomass that can be extracted from each category. In order for this table to be truly valuable we need to populate it with more data from harvesting operations. As we are using this tool as an enabler of first thinning and bearing in mind that removing too much biomass can damage the long term sustainability of the forest, we are only using Integrated Harvesting in first thinnings.

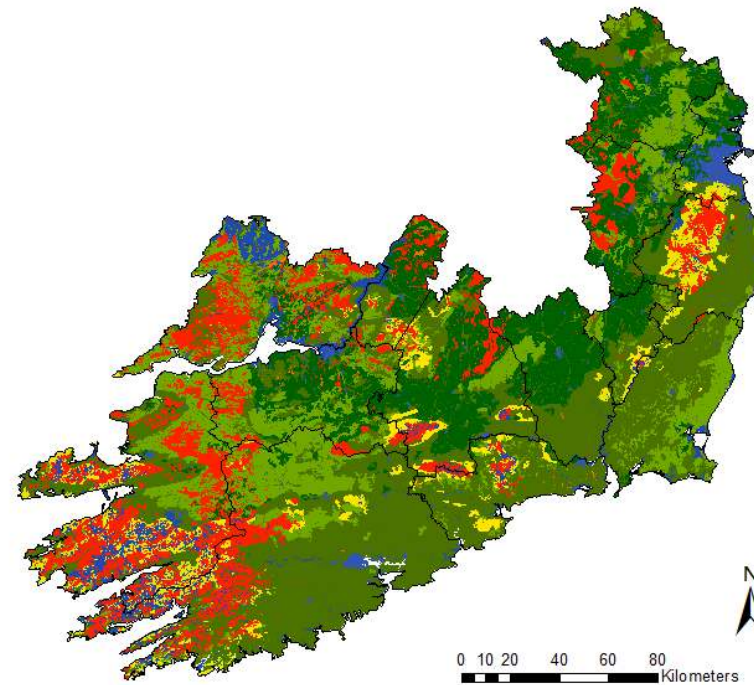
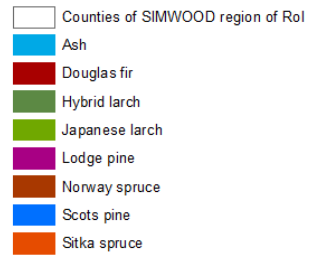
The table below shows the area in hectares of forests within the region categorised according to these restrictions.

No restrictions	Low restrictions	Moderate Restrictions	High restrictions	Very high restrictions	Restricted	No Data
2,858	6,026	3,034	0	10,328	16,999	3,218
7%	14%	7%	0%	24%	40%	8%

As can be seen, 21% of the forests (8,884 ha) have little or no restrictions meaning that substantial amounts of extra biomass can be extracted in these forests with little risk of damaging the soil or nutrient balances. However, 64% (27,327 ha) are highly or completely restricted and to extract extra biomass may damage the forest.



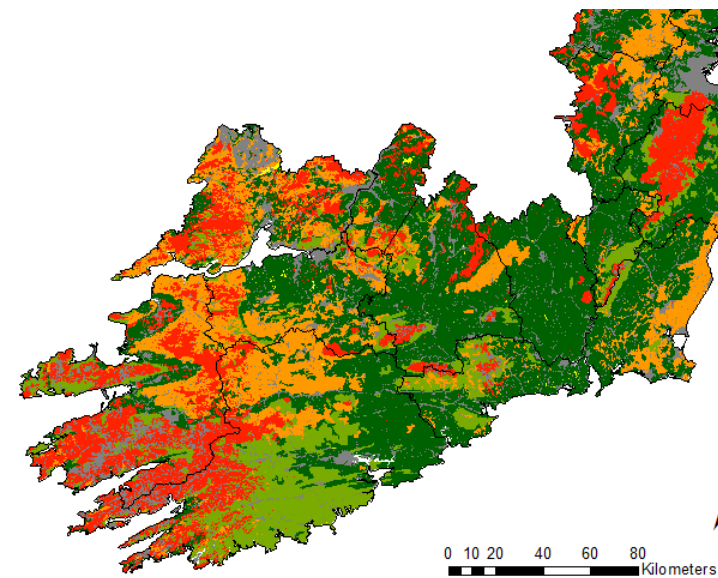
Productive forests of suitable age for first thinning in the SIMWOOD region



Soil Damage Risk

Counties SIMWOOD Region

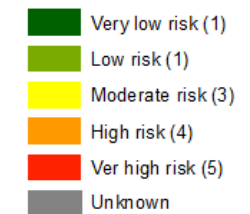
Soil Damage Risk - Soil Conditions, Ground Conditions and Site Roughness -



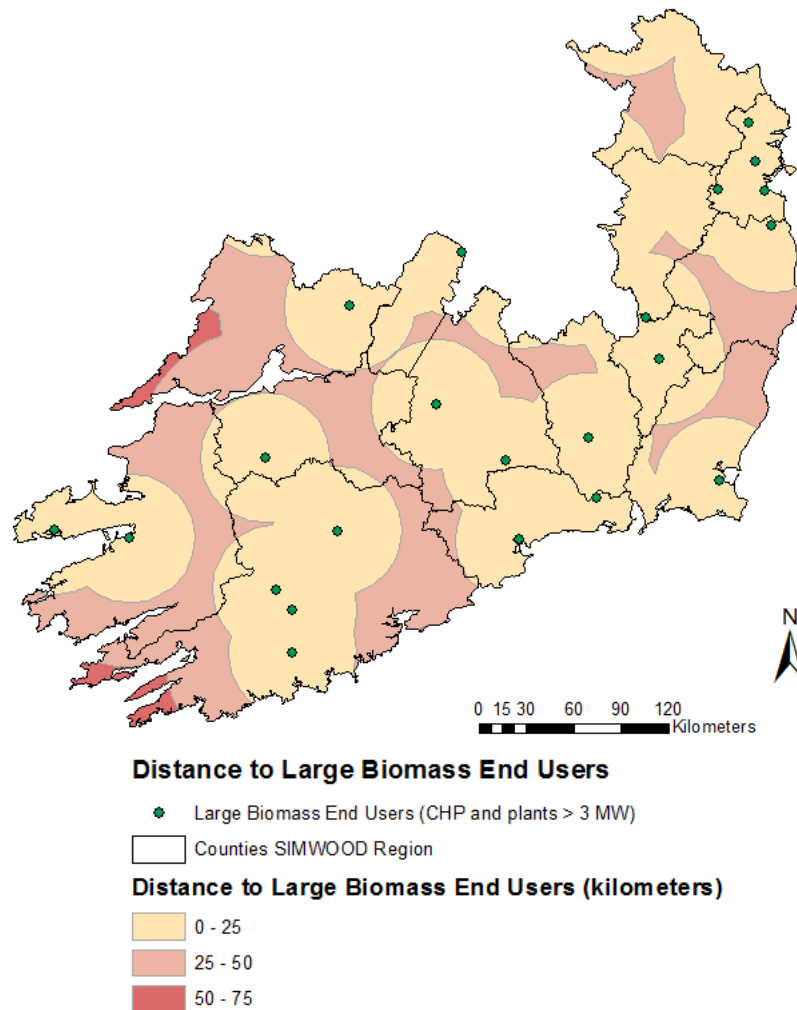
Nutrients Loss Risk

Counties SIMWOOD Region

Nutrient Loss Risk according to General Yield Class predictions



Work was also carried out to find out where the markets are in Ireland for the material. This work involved surveying end-users based upon a database obtained from the Sustainable Energy Authority of Ireland. This database was loaded into the GIS. The following map shows the larger end users – those having a heat requirement of over 3MW.



While this map shows the distance to the end users, it does not address the issue of the capacity in the region to take up all available biomass. This work proved beyond the scope of this pilot project but is an important issue to be addressed. Indeed, many of the facilities examined have very specific requirements for biomass in terms of chip size and quality. Integrated Harvesting produces a very variable chip which suits large more general biomass boilers. There are only a few of these large boilers in Ireland.

The Decision Support Tool

The Decision Support Tool (DST), brings the macro work done in the GIS to the forest level and addressed more issues such as access, tree quality and distance to market. If the forest still qualifies it is a profitability decision based upon the restrictions. The design work consisted of looking at the criteria in the DST describing them and providing guidance to the target audiences. This is backed up by evidence gathering in the field. As an example, work was carried out to assess soil rutting and damage to see if integrated Harvesting causes more damage than conventional harvesting. On the sites assessed, it was found that damage was no worse than conventional sites and in some cases less as the forwarder could use tops to reinforce racks

as damage occurred. The figures below show Integrated Harvesting on a surface water gley type in Co. Kerry.



Little damage – during dry weather



Some damage – during wet weather



Main extraction route – most damage

During the course of this work a Biomass Expansion Model for Sitka spruce was developed by Waterford Institute of Technology to help determine the total biomass in a forest. The Biomass Expansion Model was an additional output for the pilot project but one which is very valuable in determining total volume available in a plantation before harvesting. The model also determines the optimal timber assortments (including total biomass) that can be derived from the forest. With this model forming the starting point, we can then work out the total amount of material harvested and subsequently brought to roadside using harvest loss factors to represent material that will never be recovered.

Integrated Harvesting takes 6-9 months longer than conventional harvesting with the bioenergy material stacked at roadside and in the plantation during this time. In conventional harvesting, timber is traditionally sold in tonnes over a weighbridge. The heavier the material the better for the forest owner. However, with the wood energy assortment drying at roadside it is getting lighter and if sold over weighbridge the forest owner has the potential to lose out. This has been a concern of foresters and forest owners. A way had to be found to address this issue. At first sight this would appear to be a simple solution of separating the roundwood from the wood energy and selling the former in tonnes and the latter in gigajoules. Extensive work was done to look at the best and simplest solution that would satisfy all parties to a contract.

On a related point the length of time the operation takes was also seen as a barrier to taking up this service. A number of ways were looked at to shorten the operation. The main reason for the prolonged time was the drying of the wood energy material, so focus was on reducing this as much as possible. Firstly, the tops of the trees were left in the forest to drop their needles and then brought to roadside. This had the added benefit of reducing nutrient loss. Secondly, a new form of stacking was developed by the harvesting contractor to speed up drying. It is a crisscross stacking arrangement that allows air to pass through the stack thus increasing drying times



When technical issues were sufficiently addressed, we moved on to training our own staff and preparing for future field events with the target audiences. Training of our foresters covered all the details above and was used to improve the DST and information gathering exercises.

Intensive work was carried out to encourage forest owners and foresters to attend field events. This was through advertising, direct marketing through our own database, editorial, ringing around and influencing key decision makers. Site selection was an important consideration for Health and Safety but also enough space for large groups and a site that was able to show Integrated Harvesting in conjunction with all the criteria of the DST.

In the course of the pilot project 3 demonstration events were carried out.

Date	Target Audience
April 2014	Forest Owners, Foresters
November 2016	Forest Owners
February 2017	Foresters

The first event was held in conjunction with Teagasc, the farm advisory service in Ireland. This event was covered in the National farming newspaper (Irish Farmer's Journal). The event attracted over 140 participants. Waterford Institute of Technology carried out detailed research work on this site comparing conventional thinning to Whole Tree Harvesting and Integrated Harvesting and presented their findings at the event. This work is now published in Irish Forestry¹. The event and field trial was used to improve the method over the following months. A survey was carried out by Teagasc to get feedback from those who attended.

The second event was held on a midlands forest where Integrated Harvesting of Norway spruce and Sitka spruce/Japanese larch was ongoing. The event was targeted at forest owners. Approximately 30 forest owners attended from an area approximately 75 km around the site. the majority of the audience had not thinned their plantations as yet and were considering their options – hence their attendance at the event. The audience were given demonstrations of the

¹ Coates, E, Cronin, B, Kent, T, *A comparison of biomass production and machine system productivity using three harvesting methods in a conifer first thinning*. Irish Forestry 73: 122-140.

harvesting, forwarding and chipping. Discussions were held on the main criteria of the DST, namely tree quality, soils, access and markets. At the end of the event forest owners completed a survey.



The third event was held on the same site as the second. The target audience was foresters. The event was attended by approximately 75 foresters who had travelled from every region in Ireland. Many had stated they had heard of Integrated Harvesting and wanted to learn more about it. The event was organised with the professional body for forestry in Ireland – The Society of Irish Foresters and was part of the Society’s Continuous Professional Development programme. The audience, being of a technical nature, was given more detailed information on Integrated Harvesting, road and bridge construction. Discussions were had on tree quality, future management, soil capacity, access/road design, markets, units of measurement, timber sale contract, length of operations, security, the supply chain and trust. At the end of the event participants were asked to complete an online survey.



Step 3 Evaluation of impact and transfer of success stories

The pilot project intended to have a number of outcomes and impacts aimed at mobilising timber from forests using Integrated Harvesting. Outcomes from the project were designed around the surveying of the targeted audiences focusing on knowledge and skills, attitudes and aspirations and practice.

Short surveys were carried out on the target audiences after each event. The level of response to the surveys was in the region of 40-50%. These surveys will be evaluated in the context of the headings already described.

At the outset of each survey foresters and forest owners were asked if they had attended similar events in the past. In the case of forest owners 42% had attended harvesting demonstrations but only 25% had thinned their plantations. Of these all had thinned using traditional cut to length thinning. Those who had not thinned believed their plantations were too young (44%), access was not good enough or a harvest road not built (66%) and 33% said they did not know enough about harvesting.

A slightly different question was posed to foresters focusing whether they had attended harvesting events focusing on biomass. Of this audience 55% said they had attended such events but that only 5% had carried out a thinning using Integrated Harvesting. The main reasons were as follows:

Reason	%
Lack of trust in service providers	6
Lack of knowledge about bioenergy market	12
Too far from market	29
Believed operations would take too long and therefore not a profitable service for me to offer	29
Lack of contractors capable of carrying out this work	29
Lack of Knowledge	35
Did not see it as a viable option for forests I manage	41
Believed that removal of tops and branches would damage soil and drainage	47

Knowledge and Skills/Attitudes and Aspirations

Having established the target audience position before the demonstration, surveys went on to find out if the target audience knowledge and skills had been improved as a result of the information provided and demonstrations and if attitudes and aspirations changed as a result. In the case of forest owners 93% of respondents said that they were encouraged to harvest their plantation, citing increased profit/income (78%) as the main reason. 43% cited increased knowledge and 28% cited increased trust in the service providers. Asked what their key learnings were, many made the connection between increased production and income, better utilisation of the site to gain more material and knowledge of the leaders helping them understand harvesting in general. Through one-to-one contacts on the day, not reflected in the surveys, many appreciated the importance of planning in advance in terms of roading/access and markets. This is indicative of the number of forest owners who attended and who had not built access to their plantations yet.

In the survey of foresters, after having seen Integrated Harvesting, 78% said they would, having attended this event, be encouraged to offer it as a service to their clients. They cited increased



profit/income for the forest owner as the main reason (79%) with increased knowledge on their part (43%) also cited. They did not see increased income for themselves or the fact that they manage similar plantations as a deciding factor. Of the remaining 21% who were not encouraged, they cited the amount of time and fee income for themselves as the main issues.

Much work went into deciding which form of dissemination would encourage foresters and forest owners to change their attitude and aspirations. It is clear from the demonstration events that 'hands-on' events where the audience can see the operation in action has a significant role in changing the attitude of the audience. When a forester/forest owner can relate what he/she is seeing to his/her plantation they are more encouraged. Comments collected during the events also cited the knowledge, professionalism and openness of the leaders and harvesting contractor in helping them gain more knowledge and trust.

A recent survey of our foresters suggests that more work is required to increase their confidence in the method. Some who have carried it through to completion are more confident than those who have not. Similar reasons are mentioned to the survey of foresters but as our company has been working with this method for some time, our own foresters are more concerned about the capacity of the contractor to deliver within a timeframe. This is because there is only one contractor working in this space at the moment with limited amount of machines.

Practices

Within our company, Integrated Harvesting is built into our harvesting service. It is seen as a solution especially in challenging forest mixtures and poorly formed crops where conventional cut-to-length harvesting is not economically viable. It has enabled such plantations to be thinned profitably. The primary parts of the projects that have changed practices are, the relationship with the contractor, who was willing to take on new ideas to improve the service and the training and information provided to our foresters.

On a more general point, it is too early to say if foresters' practices have changed as a result of the pilot project. However, with the positive responses of the foresters attending the last event, it will no doubt be taken up by more in time. Similar to our own foresters, it will be necessary to hold more events and or disseminate more information through different channels to build knowledge and confidence. Foresters like to see hard facts and the more successful plantations treated in this way the more accepted it will be. Indeed, the market for offering harvesting services to forest owners is competitive, so as Integrated Harvesting wins more forest owners through their motivation for profit, it will encourage more foresters to offer it as a service.

Impacts

The results from the few harvest sites completed has been quite variable due to local factors, species mixes, soils, etc. However, on every site where it has been carried out, there has been a very substantial increase in output. Below is a list of sites where which we have completed.

Site	Restriction category	Silvicultural Prescription	Estimated Cut-to-length tonnage	Actual tonnage achieved	Variance	% increase over cut-to-length
1	Very high	1 in 7 rack and selection, JL dominant and poor remove all	384	607*	223*	58
2	Moderate	1 in 7 rack and selection	442	620	178	40
3	Moderate	1 in 7 rack and selection. SP poor remove all	530	1111	581	52
4	Low	1 in 7 rack and selection, JL dominant and poor remove all. Remove suppressed NS	1170	2280*	1110*	95

*Project not completed. These figures are estimates

Part of the variation seen above is the silvicultural prescription. In a number of the cases above, it was prescribed to remove Japanese larch from the plantations. In effect this was a crown thinning of large poorly formed trees which were difficult to measure and quantify before harvesting began.

The GIS has also shown the potential of harvesting biomass from forests in the region. It is hoped this will have an impact on those considering investing in specialised harvesting equipment and also those considering constructing bioenergy plants. In time when the accuracy of the DST is better, the GIS can be used to model the potential extra biomass available in the region over and above conventional wood products.

During the course of the pilot project the harvesting contractor invested in new more specialised harvesting equipment designed to be less impactful on the soil while also able to retain more branches on the stemwood. This investment is the result of increased confidence on his part in the method and increased sales in addition to that done with our company. We discussed harvesting biomass from thinnings with other harvesting contractors. Their main concern was that they were wary of investing in specialised machines for a business case that has not become the norm. They were also concerned about the possibility of damaging soil by taking too much brash from the forest. A one-to-one meeting strategy is envisaged over the coming months to build confidence and explain the method to them.

Finally, the pilot project has raised the profile of our company as a solution provider for early thinnings of forestry plantations. Enquiries from forest owners has increased but many have to yet converted. On a national scale, it will take time to quantify how much impact this has had on increased wood mobilisation in the context of already increased harvesting in the private sector. However, we do know that forest owners who have attended our events have proceeded to thin their plantations using conventional harvesting or Integrated Harvesting. It is our experience with these forest owners that they need to be ‘touched’ multiple times during the sales process before they will make a decision. This is a trust/knowledge issue that is not solved by one event. The information in the form of the guide, DST and GIS along with testimonials, and other forms of media will help them along the way to making the decision to thin sustainably and profitably.