The Problem: Low Profitability of Forestry

Different Perspectives of a Problem

Introduction

There are several challenges to improved profitability of forestry and innovative solutions are needed to reduce the cost of steep terrain forest harvesting, as Keith Raymond, Harvesting and Logistics Theme Leader at Future Forests Research Ltd explains.

A Forest Manager went up in a hot air balloon to survey the forest and after a while he realized he was lost. He reduced altitude and spotted a guy with a hi-viz vest and a yellow helmet below and shouted, “Excuse me, can you help me? I promised to meet someone half an hour ago, but I don’t know where I am”. The man below looked at his GPS and replied, “You are in a hot air balloon hovering approximately 10 metres above the ground. You are at 38 degrees, 20 minutes, 16 seconds South latitude and Longitude 176 degrees 20 minutes and 5 seconds East longitude”. “You must be a Forest Engineer,” said the balloonist. “I am,” replied the man, “How did you know?” “Well,” said the Forest Manager, “everything you told me is technically correct, but I have no idea what to make of your information, and the fact is, I am still lost. You haven’t been much help.” The logger responded, “You must be a Manager”. “How did you know?” replied the balloonist. “Well,” he said, “you don’t know where you are or where you’re going. You have risen to where you are due to a large quantity of hot air. You have made a promise, which you have no idea how to keep, and you expect me to solve your problem. The fact is you are in exactly the same position you were before we met, but now, somehow, it’s my fault!”

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The above story illustrates the situation and to some extent the relationships prevalent in the forestry value chain today. There are many challenges facing the forest industry, as a result of decisions taken in the past. In the 1980s and 1990s the plantation forest industry in New Zealand experienced significant growth and many areas of marginal pastoral terrain throughout New Zealand were planted in pine trees in places that sheep and goats had difficulty staying upright, far distant from towns and cities, sawmills and ports.

Although some small forest owners will commence harvesting their post-1989 forests from about 2015 onwards, the large scale forest owners who own 77% of the pre-1990 forest (age class 21+ as at April 2010) will continue to dominate the harvesting scene [1]. So in the traditional wood products market, the forest estate models of the large forest owners are telling their Forest Managers that these forests are almost ready for harvest and the Forest Managers are turning to the loggers and saying “Excuse me, I need some help”. The challenges for profitability in these forests are many, including harvest planning, roading and harvesting.

Harvest planning and roading challenges

According to the 2011 National Exotic Forest Description [1] 56% of the estate is first rotation forest. Of the identified first rotation forest, 64 percent is aged 16+ years, which is available for harvest within the next ten years. Deducting the area of the next two years’ harvest (approx 100,000 ha) which is probably roaded and harvest ready, of the forest that is due to be harvested in the next 10 years there is approx 500,000 ha that has few logging roads (apart from the original planting tracks) built in these forests. This situation is exacerbated by their relative isolation, steep terrain and small forest size (lower harvest volume to offset against roading expenditure). Not only will significant expenditure be required to build roads for harvest access in these forests, but it is doubtful that the forest industry has the skilled harvest planning and engineering resources for this task.

Harvesting challenges

The steep terrain and fragile soils of New Zealand and our environmental constraints demand harvesting by cable haulers. The cost of mainly manual steep terrain harvesting methods exceeds that of the more cost-effective mechanised ground-based systems by 50-100% (minimum $10.00/m3), although in most places there is no choice of system. Over the last 35 years cable logging has tripled from 15-16% of harvested volume [2] to currently 45% of volume and 60% of average harvesting cost (ground-based plus cable). By 2020 cable logging will increase to 58% of harvesting volume (and 70% of average harvesting cost) and to 66% by volume and 77% of cost by 2030. This annual increase in the proportion of cable logging alone will drive average harvesting costs up by almost 1% p.a. with no change to logging rates. Therefore cable logging costs will have to be reduced just to keep pace with current average harvesting cost.

Based on the FFR benchmarking database [3], the average crew size is 9 workers with four machines cutting 200 tonnes per day (23tonnes/PMH) for
about $32.00 per tonne logging rate [4]. The intensive silvicultural management practised over the last 30 years in many of these forests (pruning and early thinning to wide final crop spacing) was such that the final tree crop is now large (2.5 – 4.0 tonnes per tree) and heavily branched above the pruned log, a tree not conducive to efficient mechanised harvesting systems. Tree felling is still mostly manual by chainsaw (77%) and in over half of harvesting operations (56%) processing is motor-manual.

Extraction is commonly done with tower haulers (70%) or swing yarder (30%). Most operations (90%) extract to a primary landing (single stage extraction). The most common rigging systems are scab skyline and North Bend. Methods have not changed much in the last 35 years. The last major innovation was the introduction in 1987 of the swing yarder (which can operate on small log landings) and the widespread conversion from wheeled loaders to knuckle boom loaders in the early 1990s.

From the early days of log grade segregation (primarily pulp and saw logs, with one or two long length export grades) there has been an explosion of log grade complexity. The average number of log sorts (grades/lengths) cut in New Zealand based on 2010 benchmarking data is twelve, but examples of more than 20 log sorts can be found. This presents a challenge in terms of log processing productivity and cost, landing space, and loader operator workload.

So from a traditional wood product point of view, high forest production costs are driven by steep terrain, isolated small forests and challenges to mechanisation, resulting in lower than desirable profitability.

Solutions to Low Profitability of Forestry

Little can be done about the forests maturing quietly on those marginal hillsides, or about their sub-economic timber crops or about the domestic or FOB export log prices (that are too low either way!). Add to those ongoing increases in fuel costs, steel costs and the likely fall in the NZ dollar exchange rate back to historic levels which will drive up new equipment costs. For example, the recent drop in NZD value from 0.81 to 0.76 USD results in a 7% increase in the cost of a machine worth USD 500,000. Owning costs (driven by capital costs, resale and machine life) comprise almost half of the machine rate in cable logging. But little can be done about the NZD/USD exchange rate, or international shipping rates (which are driven more by the steel market than the wood market). It is our problem. So what can be affected and controlled by the forest management company?

The profitability of forestry can be improved significantly through reducing the cost of forest harvesting. The good news is that cable yarding is a commonly used and well known harvesting method in New Zealand. With almost half of the harvesting currently being done by cable logging systems there is a core of innovative entrepreneurial contracting firms in the cable logging sector. How to reduce cable harvesting costs is literally a $90 million dollar question. Innovations in steep terrain harvesting can reduce cable logging costs by 25% on the average cost of $32.00/tonne. Given the current annual harvest of 26.12 million cubic metres (year ended 31 Dec 2011) and current cable logging proportion of 47% this will give benefits to the industry of over $90 million.

There is no “silver bullet” but the vision to achieving these savings is “no worker on the slope, no hand on the chainsaw”. To achieve this vision a robust research and development programme has been commenced by Future Forests Research Ltd (FFR), in conjunction with the Ministry of Primary Industries (MPI), through the Primary Growth Partnership (PGP). A strategy has been developed through strong engagement with the forest industry aimed at improving productivity, reducing harvesting costs by at least 25%, lowering the cost and social impact of accidents and making harvesting jobs safer and more desirable for workers. As part of this programme the harvesting machinery industry in New Zealand has been given support to grow substantially in order to future-proof the growth of the forest industry.

So how can we achieve a 25% reduction in steep country harvesting costs? Integrated process improvement is key! Innovations are occurring in all phases of the forest value chain from forestry planning to harvest planning, roading construction, tree felling and cable extraction.

Forest Planning

The forester can help a lot in maintaining or allowing economics of scale in harvesting operations. One example is in planning harvest areas to be as large as possible. One of the limitations on volume production may be the size of the contract area and the time lost in moving the location of operations. Recent research has shown that maintaining large harvest setting areas is a positive factor in improved productivity [3]. The FFR benchmarking database relates productivity to various harvesting attributes:
Yarder Prod (t/hr) = \(-3.3 + 1.44 W + 1.14 M + 3.2 MP + 0.021 V + 0.15 HA – 0.065 S - 3.2 DF\) 
\(r^2=0.54\);

Where:
- \(W\) = number of workers
- \(M\) = number of machines
- \(MP\) = 1 if mechanised processing, 0 if not
- \(V\) = volume per hectare (m³/ha)
- \(HA\) = size of harvest area (ha)
- \(S\) = average slope (%)
- \(DF\) = difficulty factor: easy=0, medium=1, hard=2

For 2010 data the average harvest area size was 14.9ha (ranging from 4.6ha to 38.1ha). Other factors being equal, a reduction in harvest area size of 5 ha results in reduced daily production by about 6m³ per day. The underlying principle is that it is more economical to keep the harvest areas as large as possible to allow the maximum production harvesting crew to work (due to the high daily cost) than to try and put a large crew into a small harvest area.

In the southern states of USA harvest blocks are about the same size as in New Zealand (usually in the range of 16-20 hectares). Previous studies have shown a reduction in average harvesting costs as tract size increased [4, 5]. As expected, lower capitalised systems cost less to move, because there are fewer machines and lower fixed costs, and larger highly mechanised systems cost more. Therefore the importance of scale of harvest area and reduced frequency of moving becomes more important with mechanised systems.

Harvest Planning

The flexibility of skyline yarding systems and the ability for partial suspension of the payload make them the preferred harvesting practice in steep terrain around the world. But the success of skyline harvesting operations is strongly influenced by the type of skyline selected for an operation and by how well the skyline is positioned on the terrain. Good planning is needed to develop well-positioned skyline spans.

Poor positioning of skyline spans can result in little suspension, excessive soil disturbance; hang-ups on obstacles, reduced production, rope failure, equipment breakdowns, unsafe operations and unworkable harvest areas where tree stems cannot be extracted. Good positioning of skyline spans permit hauling an optimal volume (payload) of logs in each yarding cycle, which results in the best solution for production, rope wear, suspension and hence soil disturbance.

To maintain a consistent volume and provide a balance between harvesting production and road construction, planning must be supported by an analytical planning process where a full range of alternatives is considered for each area. Computer software tools for cable harvest planning have been available for many years (e.g. LOGGERPC, PLANS, and CYANZ). In these earlier models, calculations of maximum span, deflection and payload were necessarily done separately then the setting boundaries and hauler positions and skyline spans were manually transferred onto the topographic logging plan. The level of convenience provided by these early computer methods was insufficient to encourage planners to thoroughly analyse full-rotation, total catchment area harvest plans. Considerable effort was required to digitize profiles needed to develop thorough plans for large areas. Because exhaustive calculations of payload and load path for many profiles were required, often fewer profiles were analysed or these calculations were done by approximation [6].

One innovation in cable harvesting planning is the recent development of CHPS (Cable Hauler Planning System), an extension for the ArcGIS desktop. This integrates the computer software planning package CYANZ within a geographic information system (GIS). When using the cable planning package in the GIS environment, harvest planners can sketch an intuitive network of skyline harvest settings directly onto the topographic map layer including such detail as proposed roads, landings, and rough hauler setting boundaries, and directly calculate payloads for proposed hauler spans. This is the starting point for an interactive process of computer-aided design which encourages the logging planner to analyse a trial design, alter its parameters, and reanalyse it to converge on a better feasible solution rather than just accepting the first feasible solution found.

Tools such as simple hand-held GPS have been used to measure landing size and location to improve harvest planning [7]. The significant factors influencing landing size have been identified as daily crew production, the number of log sorts produced and whether the landing was unused (new), in use or whether harvesting had been completed:

\[
\text{Landing Size (m}^2\text{)} = 390 + 560 \times \text{Landing Age} + 173 \times \#\text{Log Sort} + 3.5 \times \text{Daily Prod.}
\]

Where Landing Age =0 when new; =1 when in use; and =2 when complete.

From the above relationship the landing size required will increase by almost 700 m² for every 4 log sorts added to the cut plan. At average cable logging
production of 200 tonnes per day, a crew with a cut plan of 7 log sorts requires a planned landing size of 2300 m², whereas the same crew with a cut plan of 11 log sorts requires a landing of 3000 m², and if the cut plan is expanded to 15 log sorts the landing size must be planned to be 3700 m². This equates to an increase in landing density (loss of forest production) of 25% for every 4 additional log sorts. Is this value recovery or future value destruction?

**Roading Operations**

Innovations can occur by questioning the “status quo”. Is it more economical to keep the investment in roads as low as possible and shift the logging crew when the conditions worsen or to build all-weather roads and keep the logging crew working? In the past in New Zealand, with permanent forest ownership and stumpage sales the exception rather than the rule, roads were considered as an asset to the forest and capitalised. With the shift to forest lands changing ownership, at the conclusion of current rotations, expenditure on harvest access becomes a sunk cost (similar to the stumpage sales scenario) unless the new land owner gives some sort of credit for road construction.

One alternative is to build roads as low a standard as possible and when it rains and the water table rises and skid trails start rutting and haul roads start to collapse, shift the harvesting crew to the next harvest block. This is the scenario used in the east coast of the USA (swamp loggers!). This is because timber in these areas is commonly purchased on a lump sum stumpage basis. Any expenditure on roading is a sunk cost and consequently there is a tendency to avoid large expenditures on roading [8]. The underlying principle in New Zealand has been that it is more economical to undertake a good standard of roading to keep the harvesting crews working (due to the high daily cost) and keep the trucks rolling, than it is to shift. Increasing environmental pressure and the fact that roading costs in some parts of New Zealand (such as the East Coast) are much higher than the New Zealand average may stimulate a review of these principles in these areas.

**Tree Felling**

The aim of tree felling is to aid the subsequent extraction phase. While it may be self evident what the goal of tree felling is, it is useful to reflect, as common practice will show this is often overlooked. The goal of tree felling is to fell the tree in such a direction that the following operations (delimming, extraction etc) are helped as much as possible. A pre-requisite is that the work is performed in a safe way [9].

The safety and productivity benefits of mechanical felling are well known and often quoted but the value recovery benefits of mechanised felling are often overlooked. Reduction in stump height through mechanised felling is a significant saving. In the average radiata pine clearfell block a 10 cm reduction in stump height will recover about 6 m³/ha of pruned log volume – worth $700/ha. As is well known and understood large radiata pine trees break during felling (often at relatively short tree lengths). The stem volume of the broken stem is therefore low relative to its diameter, reducing the potential value able to be produced from these broken stems [10]. Many studies have indicated that with manual tree felling (current practice) considerable value is being lost. In the past a lot of emphasis has been placed on trying to improve manual tree felling practice to achieve satisfactory conversion into the desired log grades. However with the high physical workload associated with good practice, labour turnover and shortage of skilled workers, harvesting practices that maximise value recovery such as low stump heights and cross-slope felling are not common. Mechanised felling is the only practical way to consistently perform cross-slope felling and hence gain a reduction in felling breakage.

New machines and systems are being developed to mechanise the felling and pre-bunching on the slopes with the aim of eliminating manual chainsaw felling in cable operations. Successful operations are using excavator-type loaders bunching on slopes, and two of the more innovative approaches involve cable-assisted feller bunchers either tethered to a bulldozer with a winch, as well as a steep country feller buncher with an advanced built-in winch to aid traction (the Trinder ClimbMax).

**Cable Extraction**

A recent survey of current yarder operations showed that very few cable-logging crews use rigging configurations that are higher productivity such as motorised carriages and grapples. One innovation is a new grapple restraint has been developed by Scion to improve grapple control [11]. This cost-effective solution to the uncontrolled movement of rope grapples has undergone extensive testing in the field and has now been released to logging contractors across the industry. It was found that the time saved through better control of the grapple was only 5 seconds per cycle but the grapple restraint resulted in a payback on the $1500 investment in less than one month. Innovations in the use of improved radio controlled hydraulic grapple carriages such as the Alpine Logging grapple [12], or the Falcon Forestry Claw [13] for either two-drum or three-drum uphill and downhill yarding will also increase productivity of cable logging, through reduced grapple loading times.
Swing yarders and their ability to operate on smaller landings or at roadside, often coupled with two-stage extraction to de-phase extraction and log making functions, have the potential to increase cost-effectiveness. Two-staging involves an extra machine (usually a skidder) and an operator to extract from the primary extraction machine to the processing area (which is an extra cost to the contractor). Only 10% of all harvest areas in the 2010 benchmarking survey were two-stage operations. The average two-stage distance recorded was 320 metres (ranging from 50-1200m) which at an average road cost of $20,000/km is worth $6,400 or over $0.50 per tonne over the average setting volume of 11,500 tonnes. Two stage operations tended to be in larger harvest areas and resulted in shorter average haul distances. When all other factors were taken into consideration two-staging was 13% more productive and resulted in a lower average harvesting cost (by $1.40/m3) over single stage extraction.

Conclusion

So what does the future of cable harvesting look like and what will it change into? Mechanical felling and bunching using the Trinder ClimbMax and grapple yarding using the Alpine or Falcon radio controlled hydraulic grapple carriage is the solution for difficult terrain harvesting. The ability to mechanically fell and bunch safely on all steep slopes opens up the opportunity to delimb on steep slopes, to reduce tree weight and extract with smaller faster cable yarders.

Imagine a system where there are no landings, where innovative low-ground pressure high speed cable yarders walk down ridge lines and perch out as far as necessary (without guy lines) to access all the wood in a setting, without having to build a road to the yarder (or a landing). Bunched wood is extracted by grapple to the nearest ridge line and then two-staged to a separate processing area with an all-terrain forwarder and loaded directly to truck. No hand will touch the wood and no worker will be on the slope. This vision will put steep terrain harvesting on a pathway to growth, with reduced costs, continuing record harvest levels and total elimination of lost time accidents in felling, breaking out and extraction. New investments in machinery and new employment opportunities in safer, higher skilled jobs will result. In this vision the government will also continue to make new investments in harvesting research and development to support the forest industry at large to become an even bigger earner of export revenue for NZ. This future would be assured long term if we could address the issues that are draining the lifeblood of forestry profitability: high cost harvesting of our steep terrain forests.

References


