HARVESTING TECHNICAL NOTE

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Valentini V1500 Cable Yarder

Summary

A brief study of an Italian-made Valentini V1500 cable hauler working in Northern Italy was undertaken in June 2013. Data were collected on 36 continuous cycles of the two-machine three-man operation working on a roadside area no bigger than 100 m^2. The rigging configuration was a standing skyline over one intermediate support using a Seik motorised carriage. The operation produced approximately 129 m^3 per day with a long term average of 80 m^3 per day taking into account shifting and relocation. The inhaul and outhaul speeds were timed at 2.8 m/sec and 3.1 m/sec respectively.

From our observations, the Valentini V1500 hauler would be applicable to New Zealand operations in a standing skyline configuration using a carriage. Intermediate supports would be required for the system to work effectively in difficult terrain. Applying the productivity information to New Zealand costings showed the cost of production to be competitive to a Madill 172 yarder in a comparable situation. The manufacturer, Valentini SLR, have indicated they are prepared to build a larger machine suited to New Zealand conditions.

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Introduction

Cable harvesting operations in New Zealand generally reflect those of the Pacific North West of USA and British Columbia, Canada. This is not surprising when the majority of the haulers in New Zealand are of Pacific North West or Canadian origin (with the exception of the New Zealand-made Brightwater range). North American haulers have large cable capacity, tall towers and winch sets powered by large capacity engines. The haulers used in New Zealand range from the new Madill 124 to haulers over 50 years old, with many dating back to the 1980s.

Currently there are approximately 300 hauler crews operating in New Zealand (Visser, 2013), and FFR predicts that New Zealand will require 100 more hauler crews to cut the volume potentially available by 2020. With demand for more hauler crews over the next few years, and rising fuel, labour and equipment capital costs, there is an opportunity to consider more automated and fuel efficient cable logging machines.

European manufactured haulers tend to have shorter towers, engines of lower rated capacity, winch sets with lower line pull, and run smaller diameter cables than North American models. European yarders typically have low fuel consumption, and remote control and semi-automation options allowing reduced labour input. European hauler operations invariably run multi-span systems which have a very low environmental footprint. European hauler manufacturers are placing more emphasis on fuel efficiency and automation.

In the past New Zealand loggers have been skeptical about the ability of European haulers to handle New Zealand logging conditions. With our preference to overcome terrain and deflection issues using tower height and horsepower rather than multi-spanning, the skills in rigging intermediate supports have never been developed in New Zealand. Without intermediate supports all the European haulers would lack the required mainline drum pull for ground pulling through difficult New Zealand terrain.

Haulers used in New Zealand typically have mainline pull at mid drum of 30 tonnes or more, up to five times that of the European haulers. Given that the safe working load of a 22-mm swaged mainline is 14.2 tonnes, it is obvious this pulling power is unnecessary and would result in excessive tension and wear in the mainline.

Labour and fuel account for half of the daily logging cost of a New Zealand cable logging operation, and are therefore target areas to contain or minimise costs. One option to reduce labour and fuel costs is automated and fuel efficient cable yarders.

Valentini V1500 Cable Yarder

The Valentini V1500 yarder, manufactured by Valentini SLR in Cles, Italy, was highlighted in an earlier field visit to Europe by some New Zealand loggers in 2011 (Figure 1). The Valentini V1500 is

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one of the larger European yarders on the market and has a skyline capacity of 1500 metres of 26-mm cable It was suggested that this yarder may have potential for harvesting in New Zealand's steep country.

Figure 1: Valentini V1500 Cable Yarder in 2011

An opportunity arose to study the Valentini V1500 hauler in the Dolomite region of Italy in June 2013, to assess its suitability for New Zealand steep country harvesting. The Valentini Company manufactures five other models of cable yarder and the Valentini V1500 is a prototype larger yarder. It has an 18-m tower supported by six guy lines. The tower construction is box section and telescoping. It has no cab and is remote controlled by the processor operator and the breaker out.

The Valentini V1500 was mounted on an Iveco Astra 8x8 truck with 560 hp engine power, but could be mounted on a track base if required. The specifications for the Valentini V1500 yarder are given in Table 1.

Table 1: Drum Specifications of the Valentini V1500

Drum	Cable Length	Cable Diameter	Pulling Power (tonne)	Line Speed
Skyline	1500 m	2 6mm	19.4 (max)	3.0
Mainline	1700 m	13 mm	5.2 – 6.6	7.2
Tailrope	3200 m	12 mm	5.2 – 6.6	7.2
Strawline	3600 m	10 mm	2.0 - 3.9	3.2
Guylines	90 m	20 mm		

Note: If another cable diameter is preferred, the following equation can be used to calculate the cable drum capacity:

$$\text{Length cable2} = (\text{Length cable1} \times \text{Cable1 diameter}^2) / \text{Cable2 diameter}^2$$

For example if 32-mm skyline is used, drum capacity is 990 m.

The electronic control system has a built-in computer for controlling drum synchronization, automatic braking and safety and alarm devices. Line tension was controlled by the hauler through hydraulic pressure and an external line tension monitor. If safe tensions are exceeded the hauler automatically stops and lowers the skyline to reduce tension.

The mainline pulling power is 6.6 tonnes at empty-drum and a maximum potential speed of 7.2 m/s. The pulling power of the mainline could be increased to 10 tonnes for New Zealand conditions. The skyline drum was split into two compartments, one for high torque and the other for storage. The skyline pulling power was 19 tonnes (empty) for the high torque compartment of the skyline drum.

All drums had motorised hydraulic cable guides to ensure even spooling. The mainline drum also had a motorised hydraulic unwinding device to keep the cable tensioned on the mainline drum.

The Valentini V1500 was powered by the 560 hp truck engine delivering power through a transmission to three inline Rexroth hydraulic pumps. The pumps were configured in closed loops. The pumps could deliver 340 l/min of hydraulic flow. Each drum was powered by a Rexroth hydraulic motor and had a hydraulic negative braking and planetary system (Figure 2).

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Figure 2: Hydraulic motor, brake and planetary system

The hauler remote control system (Figure 3) had three levers, one to control the skyline and mainline, one to control the strawline and the third to control the tailrope.

Figure 3: Hauler remote control

The system could be converted to operate in a two or three drum configuration at the turn of a switch. The remote control also had an engine start/stop switch and RPM control.

The cable system was running a motorised Seik Skybull 30 Fire carriage, manufactured in Italy (Figure 4). The specifications of the Seik carriage are shown in Table 2.

The carriage was also controlled by a separate remote control system operated by the breaker out. Electronic releasing chokers were also used, again on a separate remote control (Figure 5).

Figure 4: Seik Skybull 30 Fire motorised carriage

Table 2: Specifications of Carriage

Type	SFM 30 FIRE
Engine	Fiat Turbo Diesel 64kW
Power transmission	Full hydraulic
Line pull	Max 6.0 tonnes
Brakes	Two safety brakes: one operating, the other as safety negative brake
Speed	to 4 m/s
Operation	Remote control with two transmitters and data transmission
Drop Line	Length 170 m of 12-mm diameter

Figure 5: Hauler remote control (left) carriage remote control (centre) and self-releasing choker control (right).

Harvesting System Study

The operation visited was Gurndin Logging Limited owned by Helmut Gurndin, a logging contractor based in northern Italy and operating throughout Europe.

The operation consisted of two machines, the Valentini V1500 yarder and a Skogsjan 495 wheeled harvester with a Woody 560 processor head. The crew consisted of three workers, the processor operator, one breaker out and one tree faller.

The skyline was Teufelberger Perfection F30 26-mm double swaged "new generation" rope with breaking load of approximately 74.3 tonnes. The skyline pre-set tension was 38 tonnes, not the safe working load but more representative of the elastic limit of the cable, beyond which the cable would be damaged (H. Gurndin, pers. comm.). If the tension in the skyline reached 38 tonnes the skyline would slowly lower until the tension reduced. On two occasions during the inhaul the carriage stopped due to line tensions being exceeded; the tensions were checked and the hauler reset.

The area being harvested was a mixed species forest of spruce and maple. Only the spruce was being harvested. This operation was typical of Italian operations where the harvesting was selective cutting. A narrow skyline corridor (6-8 m) was felled and 40 m on either side of the skyline corridor was selection thinned. The trees to be extracted were marked prior to felling. The allowable volume was one cubic metre per metre of skyline length, which equated to extracted volume of approximately 125 m^3 per hectare. In this operation the distance to the tail tree was 550 m and therefore only 550 m^3 could be extracted, approximately four days' harvesting.

Each skyline setup was reported to take around one day depending on how many intermediate supports were required (20% of total time was setting up the rigging). The highest number of intermediate supports per skyline corridor rigged by this crew was seven. In this setting, one intermediate support was being used.

The intermediate support was hung from one tree (Figure 6). The intermediate support tree was secured by four guy lines of 13-mm diameter cable. The intermediate support and the tail tree were not required to be topped and the guy line trees for the hauler were not required to be felled, which is different from New Zealand practice.

Figure 6: Multispan tree and jack

The skyline was tensioned enough for the carriage to run over the intermediate support jack (approximately 7 tonnes). The change in angle of the skyline at the jack determined how much tension was held in the skyline to ensure easy passage of the carriage over the jack. In the setting studied, the change in angle was approximately 15 degrees and the deflection was 6% to 7%.

Outhaul speed of the carriage was measured at 3.1 m/s (less than the 7.2 m/s quoted in the specifications). The hauler electronic control system included an automatic path device that controlled the speed of the carriage over the intermediate support jack and when to stop the carriage at the break out position and at the hauler.

A second automated function controlled the carriage to stop when it arrived at the roadside. As a safety mechanism, the processor operator would signal the hauler that it was all clear to enter the chute area. A third automated function controlled the lowering of the trees to the ground and the release of the Ludwig radio-controlled chokers.

The capital cost of the hauler was 700,000 EUR, which at the time of writing converted to NZ$1.1M (Gurndin, pers. comm.). Typically production ranged between 80 and 150 m^3 per day depending on haul distance and the number of the intermediate supports rigged.

Productivity

Data were collected from 36 continuous cycles (Table 3) to provide an estimate of production in the observed operation, and more importantly to provide

an estimate of what may be possible in a New Zealand operation.

Table 3: Cycle time and load information

Element	Time (min)	Confidence limit
Raise Rigging	0.23	0.09
Outhaul	1.76	0.15
Breakout	4.43	1.37
Inhaul	1.96	0.13
Total Cycle time	8.38	
Tree size	1.29 m^3	0.004
Trees per cycle	1.75	0.006
Volume per cycle	2.26 m^3	0.006
Distance	329 m	0.14

The average cycle time was 8.38 minutes, of which 4.43 minutes were breakout time which incorporates all the time from when the carriage stopped at the end of outhaul to the start of inhaul. The outhaul time averaged 1.76 minutes which equated to an average speed of 3.1 m/s. The inhaul time averaged 1.96 minutes, which equated to an average inhaul speed of 2.85 m/s.

The average tree size was estimated at 1.29 m^3 and the average cycle volume was 2.26 m^3. The daily production was estimated to be 129 m^3.

The inhaul and outhaul times were very consistent for the distance travelled. The variation in cycle time was therefore related to the breakout function. The advantages of the breakerout controlling the carriage were:

- improved safety, and
- better control of extraction around obstacles.

The breaker out controlled all the functions of the hauler and carriage through the initial break out function using the remote control, providing improved safety. Obstacles and difficult-to-extract trees could be better controlled. The breaker out repositioned the carriage to avoid damage to crop trees.

Environmental Performance

This operation had a very small environmental footprint. There was very little soil disturbance due to partial suspension of all trees (Figure 7).

Figure 7: Limited ground impact from intermediate support and carriage system.

Other factors resulting in low environmental impact included no landing construction due to roadside operation. The operation also had low fuel usage due to the hauler engine operating at optimum RPM.

Intermediate Supports

The ground profile shows limited deflection (Figure 8). Such a setting in New Zealand would likely have been harvested without an intermediate support, resulting in more damage to the site.

Intermediate supports are seldom used in New Zealand because;

- Rigging time is slow compared to other systems
- Two staging from a hauler pad is seen as a cheaper option to achieve deflection
- Rigging intermediate supports is considered hazardous
- There is a limitation to the change in angle at the intermediate support jack
- There are restrictions to payload due to pre-tensioned skyline.

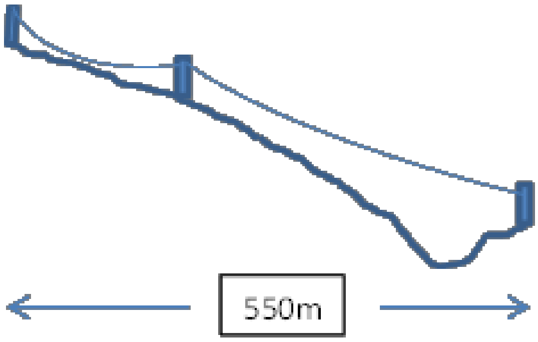

Figure 8: Profile of the skyline corridor

However there is a place for intermediate support operations in order to reduce roading density and improve harvesting of trees on difficult convex terrain.

As a rule of thumb the payload for an intermediate support system is one-sixth to one-seventh of the safe working load of the skyline. For example a 26-mm swaged skyline (18.6 tonnes) held at 6% deflection would achieve a payload of only around 3 tonnes.

However in an intermediate support system where tensions are monitored and shock loadings are eliminated it is feasible to run at higher than safe working load tensions without damaging the skyline cable. Alternatively, using a larger diameter skyline would allow higher payloads over intermediate supports.

In this respect the Valentini V1500 hauler would be suited to New Zealand steep country skyline harvesting with a carriage operating either in a single span or over intermediate supports depending on deflection.

Economic Analysis

An indicative daily costing for the Valentini V1500 hauler operating in a multispan operation with a slack pulling carriage in a New Zealand situation is presented in Table 4.

Compared to the Gurndin Logging Ltd operation in Italy, a New Zealand equivalent operation would require at least seven workers.

Table 4: Indicative daily cost for a Valentini operation in New Zealand.

Valentini Operation			
MACHINERY	Units	Hours	$/Day
24 Tonne Excavator	1	8	799
Log Processor	1	8	1,432
4x4 Double Cab Work Ute	2	2	156
Madill 172	0	8	0
Chainsaw	1	8	39
Valentini Slackpulling Carriage	1	8	269
Bowman Slack Pulling Carriage	0	1	0
Vallentini V1500	1	8	1,549
PERSONNEL			
Operation Foreman/Owner	1	8	360
Machine Operators	2	8	608
Faller	1	8	280
Breakerouts	1	8	280
Pre-setters	2	8	560
CONTRACTOR OHEADS			
Contractor Management	$7.7		54
Training	$12.0		84
BUSINESS OVERHEADS			
Based on Annual Figure	$16.7		117
OPERATING SUPPLIES			
Tools, Equipment, etc ($/Man/Day)	$14.7		103
Basic Unit Total			**6,690**
ADD: Allowance for Profit	$0.1		669
TOTAL DAILY RATE REQUIRED			**7,359**

Another difference in the Gurndin Logging operation was that the load out was via self-loading trucks arranged by the log purchaser.

New Zealand logging crews would be required to:

- load trucks,
- maintain log quality control, and
- have two pre-setters if intermediate supports were used to reduce set up delays.

After the next skyline corridor is rigged one pre-setter would break out and the other would undertake quality control. Compared to only four log products in the Italian operation, New Zealand loggers typically cut, sort and stack 8 to 12 log products on a landing. If supply chain processes could be simplified, then further savings in labour inputs could be made.

A comparison with a standard hauler operation costing in New Zealand is presented in Table 5.

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Table 5: Indicative day cost for typical New Zealand hauler operation

Madill 172 Operation			
MACHINERY	Units	Hours	$/Day
24 Tonne Excavator	1	8	799
Log Processor	1	8	1,432
4x4 Double Cab Work Ute	2	2	156
Madill 172	1	8	1,897
Chainsaw	1	8	39
Valentini Slackpulling Carriage	0	1	0
Bowman Slack Pulling Carriage	1	8	313
Vallentini V1500	0	8	0
PERSONNEL			
Operation Foreman/Owner	1	8	360
Machine Operators	3	8	912
Faller	1	8	280
Breakerouts	1	8	280
Pre-setters	2	8	560
CONTRACTOR OHEADS			
Contractor Management	$7.7		62
Training	$12.0		96
BUSINESS OVERHEADS			
Based on Annual Figure	$16.7		134
OPERATING SUPPLIES			
Tools, Equipment, etc ($/Man/Day)	$14.7		118
Basic Unit Total			**7,437**
ADD: Allowance for Profit	$0.1		744
TOTAL DAILY RATE REQUIRED			**8,180**

Indicative daily production has been based on estimates of time to perform the work cycle (Table 6).

For the Valentini V1500 operation, the inhaul and outhaul times have been calculated using the line speeds calculated from the time study. The inhaul and outhaul times for the Madill 172 comparison were based on previous studies (see references). Hook-on time is based on previous time studies with extra time added for the new safe retreat rules under the new Approved Code of Practice.

The economic analysis shows the unit rate for the Valentini operation is 4% lower than the unit rate for a comparable multispan operation using a Madill 172.

This system therefore has potential in New Zealand and creates the opportunity to develop multi-spanning systems.

Table 6: Production and unit rate comparison of a Valentini multispan operation compared to a multispan New Zealand tower operation.

Elements	Valentini V1500 Intermediate Supports	Madill 172 Intermediate Supports
Piece Size	2	2
Minutes per Day	480	480
Haul Distance	280	280
Out Haul (sec)	82	38
Position butt rigging (sec)	90	90
Hook-on (sec)	120	120
In Haul (sec)	82	60
Dropload (sec)	5	5
Un-hook (sec)	2.5	2.5
Lift Ropes (sec)	2.5	2.5
Cycle Time (min)	6.41	5.29
Contingincy 10% (min)	0.64	0.53
Time Per Cycle (min)	7.05	5.82
Reposition Hauler (min/day)	10	10
Rig up (min per day)	40	60
Rig down (min per day)	30	45
Mechanical Delay (min per day)	5	15
Operational Delay (min per day)	10	10
Cycles per day	55	58
Tonnes per cycle (tonne)	4.0	4.0
Trees per cycle	2	2
Production per day (tonne)	218	234
Day Cost of Operation	$ 7,359	$ 8,180
Unit Rate	**$ 33.70**	**$ 35.00**

Conclusion

The Valentini V1500 has good application for cable harvesting in New Zealand in a standing skyline configuration with a slackpulling carriage with or without intermediate supports depending on deflection.

If the Valentini 1500 were to be used in poor deflection conditions where the butts of trees were digging into the ground, the productivity would be disappointing given the lower main and tailrope winch power compared to a North American hauler.

The Valentini V1500 is remote controlled and many of the functions are automated, which means at least two fewer workers are required in the crew. Automation means the working tensions in the system are controlled and therefore expensive

downtime through rope breakage would be minimised, as shown in the reduced mechanical delays in Table 6.

The Valentini V1500 is capable of operating a 32-mm skyline or larger which would address the payload restrictions of a pre-tensioned skyline in a multispan configuration. Multispan systems help reduce the soil disturbance of cable harvesting operations, but this depends on the number of supports used.

The necessity for pre-rigging, log quality control and truck loading results in more staff required in New Zealand logging crews compared to that of Italian operations. The ability to work on small landings or even roadside in New Zealand is also restricted by the number of log grades cut at an operation at any one time. A solution to minimise the number of log stacks required at the hauler landing will create opportunities for more efficient extraction systems to be adopted.

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