



HARVESTING TECHNICAL NOTE

HTN05-09
2013

Innovative Yarding Systems – Concept Generation

Summary

The objective of this FFR project is to design an alternative new extraction system which can reduce extraction costs and achieve productivity gains of 30% over current steep country extraction systems. In order to generate innovative steep country harvesting concepts for this system, a series of workshops was held throughout New Zealand in October-November 2012. Approximately 45 forestry company staff, contractors, consultants and researchers attended these workshops. Collectively the participants generated 72 new ideas. A panel of harvesting experts then discussed all 72 ideas which were collated and categorised into either innovative yarding systems (18 ideas) or ideas to improve current operations (54 ideas). The panel then discussed in detail the merits of the 18 innovative yarding concepts. This report details the 72 ideas generated and the expert panel ranking and shortlisting of the innovative yarding concepts to a final selection of eight innovative yarding concepts for further analysis. A subsequent report will detail the analysis of these eight concepts for economic viability in terms of productivity and cost.

Spencer Hill and Richard Parker, Scion.

Introduction

The FFR Primary Growth Partnership Harvesting programme includes a project on Innovative Yarding Systems for steep country. The objective of this project is to investigate an alternative new extraction system which can reduce extraction costs and achieve productivity gains of 30% over current steep country extraction systems.

The project plan spans four years and culminates in the field testing of an alpha prototype of the system that can best deliver the desired results by 2016.

In the year ending 30 June 2013 the project milestones are:

1. Run a series of four workshops in conjunction with the University of Canterbury to develop concepts for an innovative yarding system (31st December 2012).
2. To undertake broad level technical and economic feasibility analysis, and shortlist technically feasible and economically viable options (31st March 2013).
3. To complete a paper evaluating the “best” new concept that demonstrates the benefits

in terms of reduced cycle times and increased payload and productivity (30th June 2013).

4. To deliver an Alpha prototype development plan that specifies operational parameters and performance standards for the chosen innovative yarding system 30th June 2013).

This Technical Note summarises the process undertaken to achieve Milestone 1 of the project, and the results of those workshops.

Workshops

Four workshops were held around the country and were well supported by key harvesting management staff from the member companies and some of their contractors. The workshops and respective participants were;

- **Rotorua 10th October, 2012:**
 Brian Tuor – Logging Consultant USA
 Dzhamal Amishev – Scion
 Paul Milliken – Scion
 Andrew Clarke – Interpine
 Duncan Mills – Wood Marketing Services
 Dave Little – Crown Forestry
 Rob Prebble – LFITB
 Tony Evanson – Scion
 Raymond McDougall – Mangoihe Logging



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- **Dunedin 24th October:**

Neil Thomas – Blakeley Pacific
Joseph Graham – City Forests
Guy Bonner – City Forests
Tony Gamble – Gamble Forest Harvesting
Shane Greer – Greer Logging
Richard Parker – Scion
Grant Stewart – Stewart Logging
Hunter Harrill – Univ of Canterbury
Alec Cassie – Wenita Forestry
James McEwan – Wenita Forestry
Bruce McDowell – Wenita Forestry

- **Masterton 31st October:**

Noel Meads – Ernslaw One
Shayne Harvey – Ernslaw One
Bert Hughes – Forest Enterprises
John Schrider – Forme Group
Chris Carlaw – Forme Group
Chris Gibbons – Wngton Regional Council
Tom Ward – Wngton Regional Council
Steve McCabe – Juken NZ
Sean McBride – Juken NZ
Tim Futter – Juken NZ
Nick Cusak – Montana Logging
Tony Smith – Min for Primary Industries
Rob Coulson – PF Olsen
Mike Hodgson – PF Olsen

- **Gisborne 16th November:**

Dan Fraser – Hikurangi Forest Farms
Ian McInnes – Ernslaw One
Tim Petro – Ernslaw One
Nick Bunting – PF Olsen
Marty Watson – PF Olsen
Chris Hurring – Hurring Logging
Robert Stubbs – Stubbs Contractors
Steve Dewes – Dewes Contracting
Peter Sainsbury – Juken NZ
Doug Kinney – Grapple Yarding Systems

The workshops comprised half-day “brain storming” sessions. After a brief overview of the objectives of the project by Keith Raymond of FFR, Spencer Hill facilitated the workshop sessions. Ground rules for the workshops were agreed; that no idea is a bad idea; that the workshop was not to solve obvious issues; that no futuristic or “space age” ideas would be

considered; and that all ideas would be considered no matter how trivial the idea may seem.

The workshop commenced with each participant spending 15 to 20 minutes documenting their ideas individually and describing each idea with a drawing, and if possible a broad costing and productivity estimate. The aim was for each participant to generate three ideas each.

The workshop participants were then split into groups where each individual described their ideas to the group for discussion. The ideas were recorded on large posters. After discussion on the merits of each idea, each group used a modified De Bono “Six Thinking Hats” method for group discussion and individual thinking to describe and rank each idea. The headings for discussion were:

- Emotions (“Red Hat”) - intuitive or instinctive “gut feel” reactions or statements of emotional feeling (but not any justification)
- Optimistic response (“Yellow Hat”) - logic applied to positive aspects, identifying benefits, seeking harmony
- Discernment (“Black Hat”) - logic applied to identifying negative aspects, reasons to be cautious and conservative

All the concepts documented on posters were displayed around the room and each group leader then gave a verbal summary of each idea to all participants, describing each idea in detail and expressing the group’s ranking to the rest of the workshop.

At the end of the presentations each member of the workshop was asked to vote for the best three or four ideas (applying voting stickers to the posters for their preferred ideas).



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Results

From the four workshops, 72 ideas were generated, refer Appendix 1.

An expert panel was formed after the initial workshops to narrow the ideas down to six or seven. The expert panel comprised;

- Dan Fraser – Hikurangi Forest Farms Ltd
- Brian Tuor – Logging Consultant USA
- Brett Vincent – Tramroad Limited
- Keith Raymond – FFR
- Spencer Hill – Scion
- Dzhamal Amishev – Scion

The panel's first job was to agree on the definition of what comprised an "innovative idea" or "improving current practice". To be deemed "innovative" the concept had to be a yarding system (that is, not any other type of harvesting system), achievable, and new to New Zealand. Of the 72 ideas, 18 were deemed to meet these criteria.

The panel then discussed each of the 18 ideas and shortlisted this list down to eight ideas on the basis that the concept was not:

- already part of another research project
- of limited application, or
- thought to be unachievable due to cost or time frame.

Further discussion on the remaining eight ideas followed to agree how each concept might work in reality, and to agree whether the idea would deliver the goal of at least 30% increase in productivity or similar reduction in cost.

On completion of the discussion each member of the group ranked the ideas in order of priority, 1 being top priority and 8 being the lowest. Table 1 shows the final eight ideas. Table 2 shows the results of the panel's ranking and subsequent final score.

Table 1: Final selection of eight ideas

1	"Spider" camera-type setup for hauling trees. Four independent drums anchored at corner points of a setting joined to a carriage that can move over any part of the setting depending on which combination of winch drums was activated.
2	Automation of hauler controls whereby the breaker-out has full control of the hauler from the break-out site, with the objective of making operation safer. Possibly hydraulic to allow better information on rope tensions etc. Includes the automation of return function (UBC 044 automated Swinger)
3	Continuous loop cable system similar to chair lift setup (horizontal large sheaves) with four grapples positioned evenly around the continuous loop mounted on a setup similar to the connection used on the chair. A rope tensioning device either with a Dutchman type block or a third mobile back tower. A rope storage (rewind) mechanism would need careful design.
4	Lowering a clambunk skidder (Highlander) which is capable of felling down the hill. Fell trees and place in clambunk and when clambunk is full the clambunk is pulled back up the hill with 10 trees (20 tonne).
5	Turn a swing yarder into a Harvestline type machine by taking off the boom and gantry and replacing it with a digger boom and arm with tower addition, so converting a swing yarder into a guyless swing yarder but maintaining the line speed.
6	"Draw Well" cable system where two carriages/grapple carriages run on two skylines. One carriage is coming in while the other is returning. Excavators feed the grapples. Yarder has four drums, two skylines and main and tail.
7	Ground arch system. Single main and haul back High lead type system. Two grapple arches run over the ground. When one grapple arch is coming in the other is returning. This system would operate like the draw well system without the need for skyline support. The system has two mobile back anchors with the possibility of the back anchors running Dutchman sheaves to tension rope.
8	Cable ways to access difficult blocks rather than roading. Logs removed from block along cable way to where trucks can access. Intermediate supports could be mobile tractor units.



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Table 2: Ranking of the final eight ideas

Idea	Dan Fraser	Keith Raymond	Brian Tuor	Brett Vincent	Spencer Hill	Dzhamal Amishev	Total	Rank
1	5	8	6	1	1	3	24	4
2	1	2	1	2	4	2	12	1
3	8	7	7	8	5	8	43	8
4	2	3	4	5	2	1	17	2
5	3	4	3	3	3	6	22	3
6	6	1	8	4	6	7	32	6
7	7	6	5	6	8	4	36	7
8	4	5	2	7	7	5	30	5

Conclusion

The process of developing ideas through workshops resulted in a large number of ideas. The development of 18 innovative yarding concepts was a good result. The generation of the other 54 ideas that were categorised as “improving current practice” was also a good result. These will be worked into current projects where possible, developed into new projects where funding allows, and researched further as part of the “Harvesting Technology Watch” programme (Task 3.2).

The final eight ideas will be taken further to analysis stage to test whether in theory they will deliver a 30% increase in production.

A subsequent report will detail the analysis of these eight concepts for economic viability in terms of productivity and cost.

Acknowledgements

A special thanks to all the participants of the four workshops and the expert panel members who gave up their time to support this project.



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Appendix 1. All Innovative Yarding Systems and Continuous Improvement Ideas for Cable Harvesting - from Rotorua, Dunedin, Masterton and Gisborne Innovative Yarding System Workshops

Idea Number	Idea	Gut Feel Ranking	Votes	Category
1	A light weight felling wedge that has a hydraulic or mechanical mechanism to split the wedge. The wedge to be possibly powered by the chainsaw. The objective is to fell trees accurately to reduce breakage at felling and during breakout.	2.5	0	Improving current practice (proposal to TST)
2 and 44	A spider camera type set up for hauling trees. Four independent drums anchored at corner points of a setting joined to a carriage that can move over any part of the setting depending on which winch drum was activated.	2.8	9	Innovative Yarding (Question on Achievability)
3	Mobile intermediate support. Rig a spar on a tractor or other platform to improve lift over difficult areas of a setting i.e., roman nose. Intermediate support possibly to be positioned using hauler ropes such as the tractors used for laying gas pipe lines for the oil industry.	2.7	0	Improving current practice (not innovative)
4	Business mentors. Utilise the skills of capable loggers who have retired to help young loggers with planning logging operations.	1.6	14	Improving current practice (Another Project)
5	Continuous loop cable system similar to chair lift setup (horizontal large sheaves) with four grapples positioned evenly around the continuous loop mounted on a setup similar to the connection used on the chair. A rope tensioning device either with a Dutchman type block or a third mobile back tower. A rope storage (rewind) mechanism would need careful design.	3.6	1	Innovative Yarding (Question on Achievability)
6	Develop a logging grapple that is designed for stream cleaning on the completion of cable harvesting to be operated on a separate low cost machine.	2.7	3	Improving current practice (Tech Watch)
7	Extended hauler and processor shifts to produce more logs for a comparatively small increase in cost. System must be grapple and able to be run without a spotter in the dark (with powerful lights). As soon as line is complete operation stops.	1.5	0	Improving current operation (Tech Watch)
8 link 13	Rubber-tyred harvesters to operate between multiple hauler crews. Rubber-tyred machines can travel between operations without wrecking the roads as track-based harvesters do.	1.8	3	Improving current operations (TST)



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9	In line with the new rules regarding safe distance for breaker-outs the hauler operator is to have a screen in cab of hauler that identifies the distance the breaker-outs have retreated from the rigging before inhaul begins. Each breaker-out to wear a GPS locator. Use the data over time of breaker out habits.	2.1	11	Improving current operations (extension to Hauler Vision – TST)
10	Automation of hauler controls whereby the breaker-out has full control of the hauler from the break-out site with the objective of making operation safer. Possibly hydraulic to allow better information on rope tensions etc. Includes the automation of return function.	1.45	31	Innovative Yarding (project in plan - Grapple Control systems)
11	Processing heads to also debark radiata pine logs to reduce the debarking cost, with the objective of reducing the need for fumigation.	2.5	7	Improving current operations (include in OPALS)
12	Instead of chokers on the end of strops, use small light weight grapples (tongs). This would help reduce the need to dig under trees to get the strop around the tree.	2.25	10	Improving current operations (Tech Watch)
13	Lowering a clambunk skidder (e.g. Highlander) which is capable of felling down the hill. Fell trees and place in clambunk and when clambunk is full the clambunk is pulled back up the hill with 10 trees (20 tonne).	1.7	19	Innovative Yarding (Analysis)
14	A carriage with a hydraulic arm and grapple to be lowered down a skyline for bunching trees for later extraction either with same hauler or a secondary hauler.	2.6	8	Improving current operations (off)
15	Turn a swing yarder into a guy-less swing yarder (e.g. Harvestline-type machine) by taking off the boom and gantry and replacing it with an excavator boom and arm with tower addition, but retaining the fast line speeds of a swing yarder.	2	19	Innovative Yarding (Analysis)
16	Develop a scanner/sensor to run with a grapple so the grapple can recognise pieces needing to be extracted.	4.6	0	Improve current operations (project in plan - Grapple Control systems)
17	Develop a magnetic connection between strop and butt rigging so hook up is semi-automated. Strop could be applied to tree prior to felling.	4.2	0	Improving current operations (off)
18	Develop a retractable bungy-type cord to assist breaker-outs retreating			Improving current operations (off)
19	Use a helium balloon to either lift the tail hold position or to provide lift during in-haul (attached to the butt rigging) to help improve deflection.	2.8	3	Innovative Yarding (off)
20	Put a man in an exoskeleton for felling trees and then manually bunching trees together on terrain inaccessible to machines.			Innovative Yarding (off)
21	Develop a separate excavator type machine to run off hauler power source for clearing chute.			Improve current operations (Tech Watch)



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22	Develop a tree monkey device that can de-limb trees while scaling and assess tree characteristics and make logs on the way down or set up intermediate supports.	2.75	3	Innovative Yarding (off)
23	Remote controlled helicopter to fly logs from cutover to landing, no cockpit, possibly electric-powered. Trees processed in the cutover.	2.9	4	Innovative Yarding (off)
24	A feller buncher mobile tail hold. A feller buncher with short integral pole to fell and present logs to a grapple. The integral spar providing lift at all times.			Innovative Yarding (off)
25	A steam powered hauler (possibly electric) to runoff logging waste	3.1	3	Improving current operation (Tech Watch)
26	Instead of self-levelling machines, make only the seat/cab self-levelling to ensure operator comfort.			Improving current operation (off)
27	A clamp system for steep country feller buncher. A clamp that extends from both ends of the excavator which can hold onto tree stumps which could do away with a cable attachment. The excavator base could be altered to have drive motors in both ends of track to provide additional power.	2.5	2	Improving current operation (include in Awdon project)
28	A grapple carriage that has an extendable telescoping grapple which has the capability of operating laterally.			Improving current operation (Tech Watch)
29	A movable self-anchoring barge for whole tree extraction when working areas of forest either on lake edge or sea edge.	2.4	0	Innovative yarding (off)
30	Mobile low cost system for small scale logging such as Ecologger yarder, excavator-based yarders or multipurpose European-type yarders with built in processors.	2	15	Improve current operations (another project)
31	Downhill extraction using Wyssen-type winch setup. Trees felled and cut to length and extracted straight to waiting truck.			Improve current operation (off)
32	Mobile mini system yarder that can be used for pre-bunching ahead of time for the bigger grapple machines.	2.6	0	Improving current operation (Tech Watch)
33	Develop a lateral yarding system that allows essentially logging around corners (similar to bridling) that allows grapples to log to the side. This idea was a variation of using a Dutchman block on skyline to gain lateral yarding. The skyline bent at a machine.			Improving current systems (off)
34	Reduce number of log grades to increase through-put and reduce landing size; i.e., export sold from 20cm to 90cm in one stack. Maybe logs transferred to a sort deck to segregate somewhere other than the bush.			Improving current operation (OPALS)
35	Better scheduled maintenance programmes for loggers to concentrate more on preventative maintenance rather than reactive breakdowns.	2.9	0	Improving current operations (off)



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36	Fit data recorder to carriage butt rigging to record parameters associated with extraction.	2.6	2	Improving current operations (off)
37	Synthetic ropes rather than heavy duty steel ropes. Aim for more light weight more cycles. Less stress on breaker-outs etc. Could involve light weight straw line (e.g. Bill Winmill using synthetic guys.)	1.5	19	Improving current operation (off)
38	The use of reusable mats for road construction for short shunt roads or weak sub-base roads. Mats could be laid by machine and picked up by machine. Mat to spread load of truck wheels over bigger area.	3.1	5	Improve current operations (off)
39	A finite plan is provided to faller through a tablet or smart phone so faller knows exactly which way to fell tree. In conjunction with tree felling wedge idea.	2.5	0	Improve current operations (off)
40	Trees made into logs using a concept similar to the Logmaister merchandiser, where trees are delivered to the scanner/processor perhaps using conveyors rather than ropes.	4.6	0	Innovative Yarding (off)
41 and 12	Replace chokers with light weight grapples similar to tong thrower grapples. This will speed up choker setting.			Improve current operations (same as 12)
42 and 16	Laser guided grapple similar to guided missiles. Spotter aims laser beam at log and grapple picks up signal and automatically is guided to site.	2.9	1	Innovative Yarding (include in grapple control project)
43	Attracting better people. Analyse the benefit of better people and therefore how much more is a better man worth, can you pay a team of good people \$40 per hour for instance?	2.1	3	Improve current operations (off)
45	Felling machine on legs rather than tracks similar or the same as the Awdon concept	2.2	0	Innovative Yarding (Already)
46	Purpose built light weight low centre of gravity remote controlled winch incorporated backline machine anchored by guying back to stumps or incorporating screw mechanisms to penetrate dirt, rock or stumps.			Improving current operation (Tech Watch)
47	Hauler operator glasses that display an image from a grapple camera so there are no screens in the cab.			Improving current operation (Hauler Vision project)
48	Steep slope feller buncher with long boom to reach more trees from one location. The felling head to be supported by a wheel or sphere on the ground.			Improving current operation (add to Awdon project)
49	An accumulating grapple that can feed a clambunk-type grapple for achieving two stems per cycle when grappling.			Improving current operation (off)
50 and 28	A grapple carriage that has a knuckle boom arm attached for reaching further to side of the ropes.			Improving current operation (Tech Watch)



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51 and 21	A knuckle boom or excavator retrofitted to hauler to clear the chute. If grappling, this would allow the hauler (tower) to sit right on the lip of the landing, also helping to improve deflection.			Improving current operation (Tech Watch)
52	Guy rope sheave/rollers system at the top of pole similar to swing yarders to make turning hauler much quicker. Only need to move two guys instead of five.	1.8	9	Improving current operation (TST)
53	Grapple designed for North Bend system so limits the need to lift and lower skyline all the time.			Innovative Yarding (Grapple project)
54	Job rotation of breaker-outs so breaker-outs are always fresh, reducing fatigue and poor decision making that comes with fatigue.	3	2	Improving current operation (off)
55 and 24	Remote controlled platform for feller buncher.	2.6	2	Improving current operation (Awdon)
56	Develop a telescoping tail spar that can be sent to the backline on the cables and erected on the backline easily.	2.8	7	Improving current system (off)
57	A strop system whereby strops do not tangle and are readily available and free when butt rigging returns to breaker-outs.			Improving current systems (TST)
58	"Draw Well" cable system where two carriages/grapple carriages run on two skylines. One carriage is coming in while the other is returning. Excavators feed the grapples. Yarder has four drums, two skylines and main and tail.	2.4	4	Innovative Yarding (Analysis)
59	Ground arch system. Single main and haul back Highlead type system. Two grapple arches run over the ground. When one grapple arch is coming in the other is returning. This system would operate like the draw well system without the need for skyline support. The system has two mobile back anchors with the possibility of the back anchors running Dutchman sheaves to tension rope.			Innovative Yarding (Analysis)
60	Remote controlled tail hold system for towers yarders and grapples. Tail hold running on a cable between two anchor points.	2.6	0	Improving current operation (Tech Watch)
61	Gravity downhill slide/chute system. A steep slope feller buncher/processor to make logs and to feed logs into chute. Chute possibly stored underneath feller buncher/processor and fed out as FB/P moves uphill.	2.8	0	Innovative Yarding (off)
62	Separate powerful portable mobile winch strong enough to pull skyline from stump to stump and strong enough to pull the tail rope from block to block without the need to use straw line.			Improving current operation (Tech Watch)



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63	A system where the faller or breakerout pre-sets strops around trees so that if grapple gets on one log it automatically gets two logs. Another variation is that the strop automatically connects to butt rigging through powerful magnets.	2.2	4	Improving current operation (Tech Watch)
64	Cable ways to access difficult blocks rather than roading. Logs removed from block along cable way to where trucks can access. Intermediate supports could be mobile tractor units.			Innovative Yarding (Analysis)
65	8x8 Man/Scania trucks to shift log lengths away from hauler landings allowing the yarder to be placed in a position for maximum yarder production (shorter haul distance). Already being done in Northland, refer November Logger magazine.		2	Improving current operation (OPALS)
66	Snake robotic strop which can hook up itself without the need for breaker outs.	4	0	Improving current operation (off)
67	All towers to have tension monitoring, OSH and ACC to provide funding.		2	Improving current operations (off)
68 and 59	Passive winch system for assisting feller buncher or grapple feeding machinery up and down hill (retractor like winch).	2.4	1	Improving current operation (Part of 59)
69	Siting logging crews closer to job in makeshift camps.	4.3	0	Improving current operation (off)
70	Motivated boots. The heel has a spring system built in so when heel is lifted the spring system is actuated to help spring the boot upwards and therefore help a step to be taken.	2.8	0	Improving current operation (off)
71	Camera system to improve hauler operator vision. Could be located on cutover or on hauler somewhere.	1.3	12	Improving current operation (Hauler Vision project)
72	2D scaling. Move away from JAS.	4.5	0	Improving current operation (OPALS)