LogPlus: Added Value through Automation   DRAFT

SUMMARY

The co-investor organisation involved in this proposal is Future Forests Research Ltd (FFR). FFR is a research company established in late 2007 as a partnership between the forest industry and the forestry Crown Research Institute, Scion, to coordinate forest research and development strategy, funding and organisation of research delivery for the New Zealand forest growing and harvesting sector.

In 2009, FFR formed an alliance of forest owners, research providers, and tree harvest engineering and machinery companies with Ministry for Primary Industries, under the Primary Growth Partnership (PGP) to co-invest in innovative harvesting technologies to improve productivity and worker safety in steep land harvesting in New Zealand (PGP Steep Land Harvesting Programme). The programme, due for completion on 30 June 2016 has delivered a number of harvesting solutions to the forest industry, including the ClimbMAX harvester, CutoverCam, Alpine Grapple Carriage and the Twin Winch Tail Hold Carriage, and has catalysed a new wave of innovation in steep terrain harvesting in New Zealand.

The forestry industry believes development of technology is a fundamental driver to international competitiveness which in turn catalyses economic growth. FFR is proposing a new Primary Growth Partnership (PGP) programme which aims to boost the profitability of the forest growing sector through extending forestry mechanisation into the field of automation and robotics in order to further reduce costs, add value and improve worker safety in forestry operations in New Zealand.

Manual jobs in a changing natural environment such as mining, fishing and forestry are among the most dangerous in New Zealand. The opportunity to further expand harvest levels over the next seven years, with demands on skilled labour, may put industry safety performance at risk. Even with increased mechanisation of tree felling and processing there is still the potential for accidents. This programme will reduce worker risk, workload and fatigue-related hazards by automating processes and developing teleoperated and robotic logging systems.

The vision of this programme is "Automate to the Forest Gate". This will deliver additional benefits for the same cost (adding value to the customer), while removing many manual tasks from the supply chain (reducing operating costs). Other benefits include enabling industry expansion towards its full potential, through solving labour shortages and attracting a new generation of technicians and technologists into the industry.

We are aiming to improve the efficiency of forest harvesting supply chains and safety of forest operations by increasing the degree of mechanisation, remote control, teleoperation, and semi-automation to full robotics. The scope of the programme is wider than the earlier PGP programme which focussed on steep land tree felling and extraction in that it covers forest operations, harvesting, log manufacturing, and in-forest logistics for both large-scale commercial and small forests in New Zealand. Although some results may impact on road transport and port operations, this research focuses primarily on operations inside the forest.

The goals of the programme are: (1) reducing average harvesting costs of ground-based and hauler operations; (2) eliminating all manual tasks in tree felling, extraction and log measurement and

processing; (3) realising more value from the forest resource; and (4) increasing the efficiency of forestry supply chains through implementing remote control, teleoperation and semi-automation in production processes.

There are three research and development themes: New Technology to Automate Manual Tasks; Adding Value through Information Management and Product Traceability; and Human Factors of Automation and Robotics. Programme outcomes will see the profitability of the forest growing sector boosted by reduced operational harvesting cost, improved efficiencies and added value from the forest resource, harvesting jobs made safer and more attractive through automation and reduced manual workload, and growth in the forest technology sector through sales of new products.

VISION

Worldwide there is a significant move towards robotics and automation and this programme envisages bridging these rapidly growing technologies with conventional forest operations. The opportunity we are targeting is to improve efficiency and safety of forest operations and supply chains through an increasing degree of mechanisation, remote control, teleoperation, and semi-automation to full robotics. "Automate to the Forest Gate" is the vision for the new programme. It is envisaged that by 2025 all harvesting, pruning and thinning operations will be fully mechanised and 50% of all forest operations will be automated; repetitive manual tasks will be removed from the supply chain (reducing production costs); and logs from harvested trees will be fully traceable and segregated for their best use and highest value in the appropriate supply chain (adding value to the customer). The programme will provide added benefits of enabling the industry expansion towards its potential, solving workforce shortages and attracting a new generation of technicians/technologists into the industry.

PROGRAMME SCOPE

Figure 1 depicts a forestry value chain from the standing tree to the delivery of a high value product to the customer, which could be a domestic wood processor or an export port. All the activities are interlinked in an overall integrated stump to market value chain with each activity impacting on subsequent activities in terms of volume, value, cost and time.

The scope of the programme is forest operations, harvesting and logistics within the forest industry in New Zealand. For the intended outcomes described above to be achieved changes will need to take place in the forestry operations of harvest planning, tree felling (thinning to waste, production thinning and clearfelling), log extraction (both ground-based and cable logging), log manufacturing, truck loading and log transport inside the forest gate or to loading point for high productivity motor vehicles (HPMVs). The boundaries of each project will be well established at the outset of the programme.

This investment will be undertaken across a part of the forest and forest products value chain and includes research and development, product development, commercialisation, technology transfer and impacts on training and skills development on the forest growing sector. No changes are planned in the log transportation and port operations parts of the value chain as these areas are being addressed by other parts of the NZ Forestry Science and Innovation Plan and the Wood Processing and Manufacturing Science and Innovation Plan. The research will however consider the impact on the total forestry value chain from felling to log delivery to domestic mill or export port.
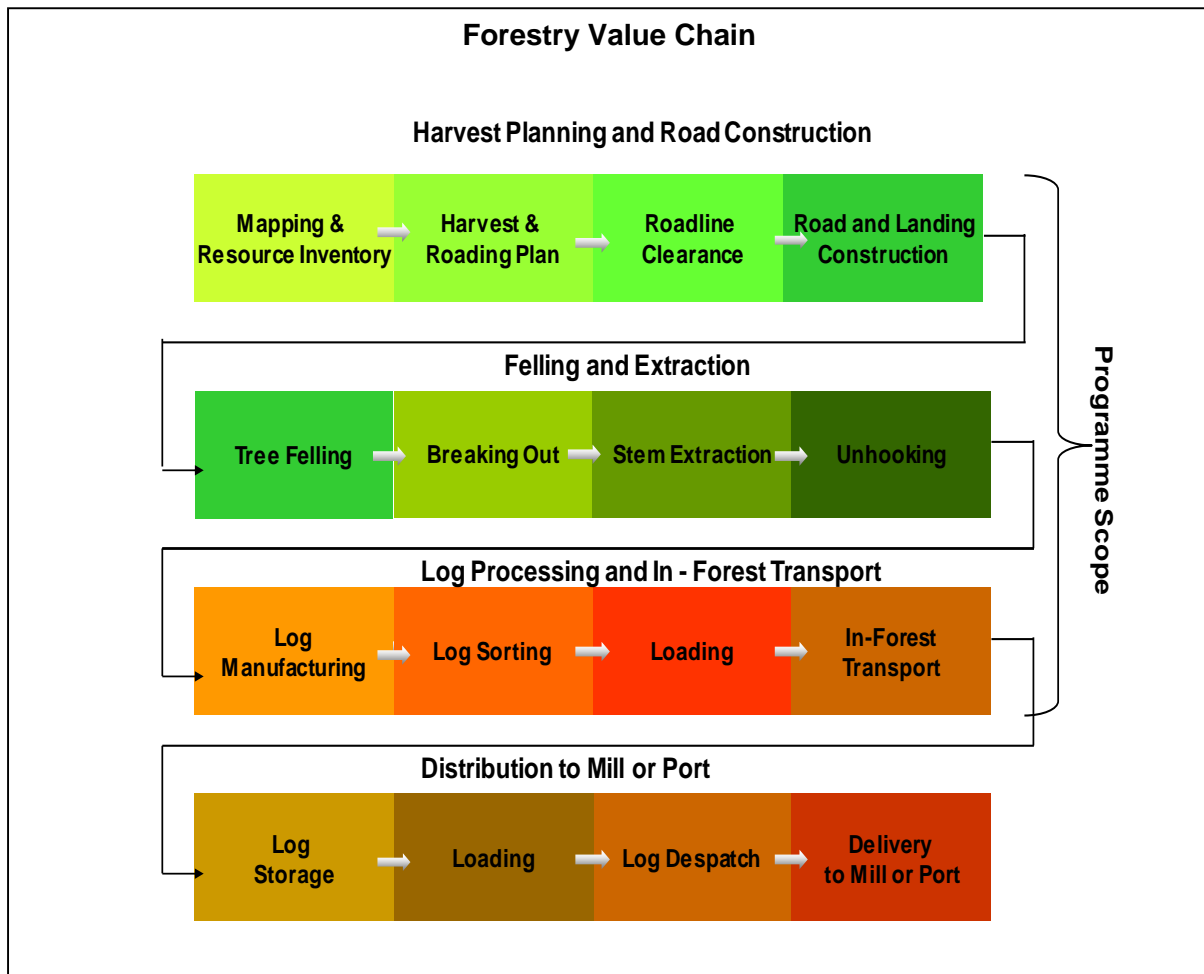
Forestry Value Chain

Harvest Planning and Road Construction

Mapping & Resource Inventory	→	Harvest & Roading Plan	→	Roadline Clearance	→	Road and Landing Construction

Felling and Extraction

Tree Felling	→	Breaking Out	→	Stem Extraction	→	Unhooking

Log Processing and In - Forest Transport

Log Manufacturing	→	Log Sorting	→	Loading	→	In-Forest Transport

Distribution to Mill or Port

Log Storage	→	Loading	→	Log Despatch	→	Delivery to Mill or Port

Programme Scope

Figure 1: The components of a forestry value chain

GOALS

The Programme will:

- Reduce average harvesting costs (ground-based and hauler) by 15% by a combination of :
  - Improving machine utilisation (from 70% to 85%) through multi-shift operation and more autonomous operations?
  - Reducing diesel fuel costs by 25% (from $4/m^3 to $3/m^3)
  - Doubling labour productivity from 25 tonnes/day per worker to 50 tonnes/day per worker.
  - Reducing capital requirement in harvesting through reduced number of machines, integrating functionality and adopting semi-automation.
- Reduce manual chainsaw tree felling through continued development of an alternative mechanised felling system (doubling New Zealand's level of mechanised felling from 38% to 75%)
- Improve working conditions, safety and work load related to the human factors of harvesting through implementing automated log extraction and processing systems that eliminate hazardous manual roles (taking workers off the ground).

- Add value – Realising more value from the forest resource, through assuring maximum log value and greater utilisation of resource (reducing log wastage and finding markets for residues).
- Increase the efficiency of forestry supply chains – halving the number of times a log is handled during manufacturing (delimb, debark, measure, optimise, cut to length, tag, sort, load), measuring logs once only along the supply chain, creating a more consistent flow of logs, and reducing log stockpiles.

PROGRAMME OUTCOMES

The overall outcomes from the programme will be:

1. The profitability of the forest growing sector will be boosted through reduced costs, improved supply chain efficiencies and added value from the forest resource.
2. Improved worker safety in harvesting operations – zero serious harm incidents and lost time through increased levels of forest mechanisation, remote control, teleoperation and semi-automation in tree felling, extraction and log processing.
3. New prototype products developed that will create commercial opportunities and ultimately contribute to New Zealand's domestic and export earnings from development and sales of a harvesting system that incorporates state-of-the-art technology and degrees of automation to produce delimbed, debarked, cut-to-length log products with attendant data that can be delivered directly to customer.
4. Internal and external customers provided with "LogPlus" solutions – log products plus information (source, tracking, and on time delivery)
5. Capacity built and workers trained for new technology expansion in the industry.
6. Industry environment created that is more conducive to innovation (continued "wave of technology innovation" in the forest industry).

There are also a number of other benefits that will flow out of the PGP, such as transferring information, knowledge and technology across the primary industries, fostering partnerships, creating jobs and keeping skilled people in New Zealand.

WORK PROGRAMME THEMES

The three research and development themes are:

- New Technology to Automate Manual Tasks (products)
- Adding Value through Information Management and Product Traceability (information)
- Human Factors of Automation and Robotics (people)

Theme One: New Technology to Automate Manual Tasks

The two highest priority projects in the survey of industry investors were in the new harvesting technology area:

Project 1.1 Totally new felling technologies

Objective: Develop automation and robotics further to remove worker from danger in high risk forest operations

Timeframe: Year 1 – 7

Method:
1. Generating new ideas for felling technology to enable harvesting phase to be either remote-controlled or teleoperated (all operators off-site.
2. Brainstorm new ideas for automation of operations.
3. Develop alternatives to the chainsaw to reduce downtime and increase safety.
4. Look in new places and engage people not traditionally used (both inside and outside industry).
5. Rethink / redesign / modify tree felling technologies.

Outcomes:
1. Recognition of great new ideas
2. Stimulate communications.
3. Develop disruptive technologies.
4. Innovative culture that fosters continuous improvement towards safer and more productive forest operations.

Project 1.2 Continue development of remote controlled tree-to-tree harvesting machine

Objective: Continue momentum in projects to eliminate manual tree felling on steep slopes ("No worker on the slope").

Timeframe: Year 1 – 7

Method:
1. Complete development of remote controlled steep slope harvesting machine ("Stick Insect") & felling wedge to commercial stage
2. Lab and field testing
3. Commercial partner identified

Outcomes:
1. Commercial products available
2. Reduced safety risk with operators isolated from harm
3. Reduced manual tree felling workload
4. Minimise travel to site
5. Improve productivity (24-hour, 7-day week operation)

Project 1.3 Log measurement and identification during processing

Objective: To develop individual log measurement and ID system to eliminate manual scaling and log weighing.

Timeframe: Year 1 – 3

Method:
1. Improve log measurement method during processing using sensing technology
2. Design and development of processing head debarking, measuring and log ID system.
3. Develop system to transfer and manage production data.

Outcomes:
1. Improve efficiencies of log processing and downstream log handling.

2. Optimised truck loads (known volume) and reduced docket delays.
3. Sales of new processor head incorporating debarking, measuring and log ID system

Theme Two: Adding Value through Information Management and Product Traceability

The second area of priority stated by industry investors was in the Supply Chain Logistics area (log measurement/data flow and efficiency/process simplification):

Project 2.1 Automate log scaling method

Objective: Implement an automated log measurement method for calculating log volume that best fits the current NZ resource and is acceptable to both seller and buyer.

Timeframe: Year 4 – 7

Method:
1. Investigate alternative log scaling methods
2. Automate log scaling method.
3. Develop sales and payment system based on cubic volume measured and graded by processing head.

Outcomes:
1. Reduced cost with better precision of log volume calculation
2. A good fit of volume estimate to the current NZ resource.
3. Move to cubic volume measure for sale and payment.
4. Eliminate log weighing/ scaling.

Project 2.2 Reducing log grade complexity

Objective: Quantify cost/benefit of reducing number of log sorts from stump to customer.

Timeframe: Year 1 – 3

Method:
1. Evaluate current number of log sorts and associated supply chain costs.
2. Benchmark against world best practice.
3. Evaluate scenarios of fewer log sorts and assess market implications / costs.
4. Standardise log grade specifications within the log supply chain.

Outcomes:
1. Information on supply chain costs so that forest owners can make decisions on improved harvesting supply chains.
2. Reduced number of log sorts produced in-forest
3. New Standard NZ Log Grades.
4. Improved understanding of log grades within the industry

Project 2.2 Value chain optimisation

Objective: Optimise supply chain from stump to cut-to-length customer to reduce delivered log costs by 15%.

Timeframe: Year 1 – 7

Method:
1. Build value chain model to test and quantify financial impact of changes.
2. Identify bottlenecks and inefficiencies
3. Understand cost implications of changes in one part of supply chain on other parts.
4. Determine benefits/optimal conditions by region (similar to meat and dairy processing model).
5. Propose more efficient system / improvements for scaling/grading to meet customer needs.

Outcomes:
1. Builds on collaboration between industry contractors and other stakeholders.
2. Understanding impacts of process change.
3. Reduce delivered log costs by 15%.
4. Platform to drive supply chain efficiencies and innovations.

Theme Three: Human Factors of Automation and Robotics

Project 3.1 Determine industry needs for workforce of the future

Objective: Clarify career pathways and determine skills required

Timeframe: Year 1 – 4

Method:
1. Labour market research
2. Survey skill level of existing workforce
3. Define future skills requirements
4. Define skills gap
5. Investigate monetary incentives (parity with comparable industries)
6. Benchmark exemplar sectors e.g. Scandinavia and set benchmark for industry needs
7. Develop career pathways
8. Investigate training options (possibly using outside assistance to diagnose problem and propose solutions.

Outcomes:
1. Industry benchmark to establish gaps of skills to provide framework for future training and certification standards.
2. Career path development
3. Industry has continued supply of motivated well-trained workers.

Project 3.2 Safe high productivity workplaces

Objective: Managing fatigue to improve safety

Timeframe: Year 5 – 7

Method:
1. Undertake human factors workplace studies (on-site monitoring and evaluations).
2. Design "Guidelines" to manage fatigue.
3. Develop "early warning" sensor technologies for identifying onset of fatigue that could impact safety, productivity and value recovery.

Outcomes:
1. Tools/guidelines to manage fatigue and other hazards.
2. Improved industry image regarding workload of tasks.

INVESTMENT

Funding from the Forest Grower Levy Trust for a proposed new programme "Automation to Improve Efficiency and Safety of Forest Operations and Supply Chain" has been recommended by the Forest Research Committee for approval, and has been included in the 2016 Forest Growers Levy Trust Annual Work Programme (www.fglt.org.nz/2016_work_programme).

A funding bid to the Primary Growth Partnership will be submitted to Ministry for Primary Industries as soon as possible.

NEXT STEPS

The stages of the programme development are:

1. Prepare Programme Summary with input from working group of forest industry stakeholders (22 Dec 2015 - 20 Jan 2016)
2. Discuss Programme Summary with PGP Programme advisers (21 Jan 2016)
3. Proposal Development: Further develop the research programme summary according to feedback received through the Primary Growth Partnership (22 Jan 2016 – 16 Feb 2016)
4. Present to FFR TST Meeting (17 Feb 2016) for approval of FFR funding
5. Present to FGLT Forest Research Committee for approval of funding from the Forest Grower Levy Trust (March 2016).
6. Proposal Submission: Submit PGP Proposal to Investment Advisory Panel
7. Proposal Assessment (within 10 weeks of submission of proposal)
8. Gain approval of IAP to proceed to Business Case Development
9. Business Case Development: Develop detailed Business Plan (including benefits case, project resources, research providers, costs etc.).
10. Submit Business Case to Investment Advisory Panel
11. Presentation of Business Case: Present to Investment Advisory Panel
12. IAP Recommendation to MPI
13. MPI Approval of Funding
14. Contract Negotiation

APPENDIX 1: BUSINESS PLAN DEVELOPMENT GROUP

The forest industry working group to establish and develop the new harvesting and logistics research programme represents a cross-section of the forestry sector made up of forest management companies, smaller forest company investors (consultants and FFR associate members), harvesting contractors, forest industry organisations and machinery manufacturers.

In addition to members of the forest industry, the Business Case Development Group will have MPI representation. The list of potential members of the Business Case Development Group is given in Table 1 below (to be confirmed).

Table 1: Potential Members of the Business Case Development Group

Representing	Name	Organisation
Forest Owners / Management Companies	Hamish Macpherson Mike Soper Tim Petro Dan Fraser	PF Olsen Ltd Rayonier/Matariki Forests Ernslaw One Ltd Hikurangi Forest Farms Ltd
Consultants/Research Providers	Keith Raymond Dr Carel Bezuidenhout Dr Hamish Marshall Dr Glen Murphy Spencer Hill	Future Forests Research Ltd Scion Interpine Group Ltd GE Murphy and Associates Ltd Scion
Contractors	Steve Dewes	Dewes Contractors Ltd
Industry Association / Training and Education	John Stulen	Forest Industry Contractors Association (FICA)
Machinery Manufacturers	Beau Candy	Yarding Solutions Ltd
Crown	To be advised	Ministry for Primary Industries