

Progress Review of Primary Growth Partnership Steep Land Harvesting Programme: Summary Report



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1. EXECUTIVE SUMMARY

The Steep Land Harvesting PGP programme is a partnership between Future Forests Research Ltd (FFR) and the Ministry for Primary Industries (MPI) to develop new harvesting technologies for forest harvesting in steep terrain forests in New Zealand. This is a six year programme which started in 2010 and finishes in June 2016. Total project funding is \$6.52 million of which MPI will fund up to \$3.26 million.

The objectives of the programme are to improve harvesting productivity and worker safety by developing and commercialising a range of new harvesting technologies in the tree felling and extraction phase of steep country harvesting operations.

The outcomes expected from the programme include:

- A 25% reduction in steep terrain harvesting costs
- Zero lost time injuries during felling and breaking out on steep country
- A 10% reduction in fuel costs
- Development of new harvesting machinery for domestic and export sale.

To achieve these outcomes, the programme is investing in the following research and development activities:

- Mechanisation on steep terrain
- Increased productivity of cable extraction
- Development of operational efficiencies

This progress review is intended to provide the co-investors in the Steep Land Harvesting PGP programme with an independent assessment of how the programme is tracking towards its goals as set out in the original business plan. The key objectives of the review were to:

1. review progress made to date in each of the programme work streams;
2. assess progress made against the intended programme outcomes set out in the programme's contracted business plan;
3. check progress and direction of the programme against international science/technology/industry trends.
4. review internal and external factors affecting the programme including management and governance.
5. make recommendations for improvements to the programme (if any).

This independent progress review of the programme found that:

1. Stakeholders that contributed to this review engaged positively in this process.
2. The programme has strong support from most industry members who were generally pleased with programme management, programme reporting, progress against project plans and achievements from the programme to date.
3. Programme governance and management, including financial governance, management and reporting, is of a high standard.
4. The programme has been a catalyst for increased innovation in harvesting in New Zealand with new technology being developed and deployed, both from the programme and outside of the programme.

5. It is clear that the programme is making progress towards delivering against the expected outcomes but the extent and timing of that delivery is still to be determined.
6. There was no need for reviewers to comment on programme personnel.
7. The outputs and ultimately desired outcomes from the programme relating to safety are very relevant to the current high level of focus and enquiry on worker safety in the forestry industry, primarily in harvesting activities.
8. The outputs from the programme will not present specific new challenges to the forest harvesting industry in the area of skills and training.

Specific recommendations from the review, each of which have supporting rationale and commentary detailed in the body of the report, are:

1. Initiate a project to establish transparent measures to track and report on achievement against the expected outcomes of the project. (Note – since completing the field work for this review the reviewers have been made aware that MPI have a project underway that is consistent with this recommendation).
2. Introduce international technology scan and awareness into each of the current projects rather than maintain Technology Watch as a stand-alone project.
3. Review management across existing work programmes to enhance structured and formal collaboration between research providers.
4. Initiate a concerted campaign to enrol more direct contractor participation for the balance of the programme with the purpose of achieving greater engagement from this group to facilitate commercialisation and uptake.
5. Review all current work programmes with a view to prioritisation of outputs such that as many as possible are moved along the development path towards being able to be commercialised, or at least have enough momentum to continue in some form, by the end of this programme.
6. Review all current commercialisation plans and results and enlist external expertise to assist with learning from the experience to date within the programme, and to inject knowledge and learning from outside the programme to ensure the commercialisation aspect of the current work programmes is better understood, and appropriately resourced and managed for the balance of the programme.
7. Continue promotion of outputs and delivery of outcomes from the programme through workshops and field days.
8. Increase the emphasis on operational trials for outputs at or near commercialisation for the balance of the programme.
9. Have the Programme Steering Group, Programme Leader, and Technical Steering Committee produce a clean sheet plan for the last 12 months of the programme in March 2015 for approval and implementation in June 2015.
10. Canvas programme stakeholders and stakeholders outside of the current programme with the view to developing a plan for what might come next in the space of Harvesting Research in New Zealand, which could include transitioning some work from the existing FFR Steep Land Harvesting Programme.

2. INTRODUCTION

The Steep Land Harvesting PGP programme is a partnership between Future Forests Research Ltd (FFR) and the Ministry for Primary Industries (MPI) to develop new harvesting technologies for forest harvesting in steep country forests in New Zealand. This is a six year programme which started in 2010 and finishes in June 2016. Total project funding is \$6.52 million of which MPI will fund up to \$3.26 million.

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To achieve these outcomes, the programme is investing in the following research and development activities:

- Mechanisation on steep terrain
- Increased productivity of cable extraction
- Development of operational efficiencies

3. TERMS OF REFERENCE

Objectives of the Review:	This progress review is intended to provide the co-investors in the Steep Land Harvesting PGP programme with an independent assessment of how the programme is tracking towards its goals as set out in the original business plan (as modified from time to time). The key objectives of the review are to: 1. review progress made to date in each of the programme work streams; 2. assess progress made against the intended programme outcomes set out in the programme's contracted business plan; 3. check progress and direction of the programme against international science/technology/industry trends; 4. review internal and external factors affecting the programme including management and governance; 5. make recommendations for improvements to the programme (if any).
Scope of the Review:	The progress review is intended to be wide ranging and include: 1. all projects within the Steep Land Harvesting programme; 2. management, governance and reporting; 3. project resources – contractors, staff and research providers; 4. programme funding; 5. programme outcome monitoring; 6. other internal and external factors affecting the programme.
Outcomes:	As a result of this progress review: 1. the co-investors will have an independent assessment of the progress made in the programme, and the expected outputs and outcomes from it with which to make informed business decisions about the future of the programme; 2. recommendations will be provided on any improvements (if required) to any aspect of the programme including technical aspects, funding priorities, resourcing, management, governance and reporting.

4. REVIEW METHODOLOGY

The review was planned and carried out in the following manner:

- A review of contracts, business plans, annual plans, progress reports, technical reports and publications, and other various documents associated with the programme
- Face to face meetings or telephone meetings with industry members (12 organisations), research providers (five organisations), representatives of programme management, MPI and the PGP Investment Advisory Panel, and one independent expert
- Preparation of report addressing the Terms of Reference
- An initial findings face to face meeting with the Programme Steering Group (PSG)
- Submission of a draft report for review and feedback from the PSG
- Submission of a final report and summary report

5. PROGRAMME PROGRESS

Table 1: Programme Description

Programme	Project No.	Project Name
1. Mechanisation on Steep Terrain	1.1	Cable Secured Excavator System
	1.2	Teleoperated Felling Machine
2. Increased Productivity of Cable Extraction	2.1	Advanced Hauler Vision Systems
	2.2	Improved Grapple Carriage Control
	2.3	Innovative Yarding System
3. Development of Operational Efficiencies	3.1	Delimbing/Cut to Length on Slopes
	3.2	New Yarding Technologies and International Monitoring

The projects in each programme are listed in Table 1. Programme progress documents and feedback from programme stakeholders show good progress has been made in the Steep Land Harvesting Programme. Most objectives are showing good progress against the defined milestones. The few milestones that are behind schedule have been identified by the programme management processes and are being given special attention, though it is not clear that strategies to address the issues are understood in the same way by all stakeholders involved. Overall funding for the programme has effectively remained unchanged from the original Business Plan though there has been some redistribution of the resources to reflect the priority and potential for some activities identified through the programme governance process.

For those research objectives that have been achieved, generally they have been delivered to a level appropriate for transition to commercialisation and application, with a number of examples making that transition. The reviewers are concerned that the effort, resources and communication required to make the transition from research output to industry application have been underestimated; good technology with great potential is not enough on its own. There is concern that the potential impact of the programme may not be realised, not due to lack of performance of the programme but because the outputs are not effectively translated into practice; i.e. not taken up by industry. In the first instance the key issue is not who pays for the extra commercialisation efforts, but rather that the full effort is properly recognised in the planning and execution. Each case is likely to present different areas of emphasis that will dictate who should make the investment.

It was noted that the programme has achieved a level of recognition internationally and that New Zealand has taken a leadership role in the development of mechanised forest operations on steep slopes. While there are examples of strong industry collaboration within New Zealand to deliver technology solutions, there seems to be limited inclusion and partnering internationally to leverage existing international best technology to meet particular New Zealand operating needs with new components or adaptations. This approach of building full systems from scratch is potentially stretching the limited programme resources too far and not allowing enough focus on the innovative components and ideas that could deliver the most value to New Zealand forest operations and the manufacturing industry. Specifically the reviewers see significant opportunities in international partners that have already advanced components of desired systems in different operating conditions that can be adapted to the New Zealand conditions at a lower investment of the limited resources. This partnering would then allow the programme resources to be targeted at particular novel components of the system that deliver the biggest impact for New Zealand operations and most likely have the greatest potential for international export. This theme is further developed in Section 7 – Direction against International Trends in Science and Technology.

5.1 Programme Resource Allocation

As part of this review budgets from the original business plan have been compared to the current budget situation that includes actual expenditure to the end of the 2013/14 financial year plus the projected budget to the end of the programme. This comparison is set out in Table 2 below.

Table 2: Comparison of Original Programme Budget to Current Programme Budget

Original Budget				
Project	% of total	Total \$	Inkind (\$)	Direct Research (\$)
1.1	7.0%	\$456,750	\$44,623	\$412,127
1.2	30.0%	\$1,957,500	\$179,011	\$1,778,489
2.1	5.5%	\$358,875	\$36,462	\$322,413
2.2	4.5%	\$293,625	\$30,016	\$263,609
2.3	35.0%	\$2,283,750	\$203,905	\$2,079,845
3.1	4.5%	\$293,625	\$26,370	\$267,255
3.2	7.0%	\$456,750	\$42,112	\$414,638
Sub-Total	93.5%	\$6,100,875	\$562,499	\$5,538,376
FFR Overhead	6.5%	\$424,125		
Total	100.0%	\$6,525,000		

Actuals to date plus Budget to Programme End				
Project	% of total	Total \$	Inkind (\$)	Direct Research (\$)
1.1	13.1%	\$852,454	\$60,185	\$792,269
1.2	27.7%	\$1,808,935	\$147,130	\$1,661,805
2.1	6.6%	\$428,497	\$30,757	\$397,740
2.2	9.5%	\$621,072	\$49,585	\$571,486
2.3	22.6%	\$1,474,553	\$119,136	\$1,355,417
3.1	4.0%	\$263,803	\$22,319	\$241,484
3.2	10.8%	\$707,224	\$58,770	\$648,453
Sub-Total	94.4%	\$6,156,538	\$487,882	\$5,668,654
FFR Overhead	5.6%	\$368,463		
Total	100.0%	\$6,525,001		

Absolute Difference (\$)				
Project	% of original	Total \$	Inkind (\$)	Direct Research (\$)
1.1	87%	\$395,704	\$15,562	\$380,142
1.2	-8%	-\$148,565	-\$31,881	-\$116,684
2.1	19%	\$69,622	-\$5,705	\$75,327
2.2	112%	\$327,447	\$19,569	\$307,877
2.3	-35%	-\$809,197	-\$84,769	-\$724,428
3.1	-10%	-\$29,822	-\$4,051	-\$25,771
3.2	55%	\$250,474	\$16,658	\$233,815
Sub-Total	1%	\$55,663	-\$74,617	\$130,278
FFR Overhead	-13%	-\$55,662		
Total	0%	\$1		

Note: Direct Research includes research time plus research materials (capex) plus project management

Overall the budget has been stable which indicates the programme has been successful in attracting and maintaining industry contributions at expected levels.

While, generally speaking, any programme would benefit from access to increased resources, the Steep Land Harvesting Programme would appear to be well resourced to meet the defined objectives. Sensible reallocation of resources seems to have been made to projects with significant leveraging opportunities (i.e. Projects 1.1 and 2.2) where private developers were progressing technology in line with programme plans and objectives. In projects where external development was leveraged (i.e. ClimbMAX harvester and grapple carriages) private investment in the concept was captured as an in-kind contribution to further support the shift of programme resources to the activity.

Project 2.3 stands out both for having a high level of programme resource budgeted to it at the beginning of the programme and for having had a significant reduction in the budget allocated to it in the current budget. This review has noted a need in this particular activity to review the intended objectives and ensure planned activity is well targeted to those objectives so that the most impact possible can be achieved within the limited remaining time and resources of this programme. These budget trends further support the need to effectively target the resources where impact can be realised.

5.2 Mechanisation on Steep Terrain

5.2.1 Project 1.1: Mechanisation on Steep Terrain – Cable Secured Excavator System

The inclusion of the cable secured excavator was an opportunistic partnership with a manufacturer that provided leverage with a commercial development investment, which allowed accelerated progress. This early progress was valuable in creating a strong profile for the programme and generally promoted a spirit of innovation across industry stakeholders. Many of the stakeholders interviewed noted this seemed to play a catalyst role in getting momentum in other projects. A strong set of outcomes has been achieved relative to the project resources invested.

The commercialised result of this project is the ClimbMAX feller buncher. Outside of the programme there have been a number of operators who have been working to develop lower cost versions of the ClimbMAX machine. While this can be seen as an innovative entrepreneurial spirit, if minimum standards are not met when attempting low cost variations there is significant risk of catastrophic failures that could jeopardise the entire concept. If the risk associated with this “copycat” outcome can be managed effectively it is generally accepted that the outcome of these other designs would be seen as an outcome to which the programme contributed.

This area of research has seen the investment by the programme nearly double from the original planned budgets. Having targeted the investment to collaborative industry investment seems to have been a good approach to achieve a significant output. While it is only 13% of the total programme investment, it is a significant project and converting the outputs into outcomes providing an impact on the industry will be critical to meeting the programme objectives.

5.2.2 Project 1.2: Mechanisation on Steep Terrain – Teleoperated Felling Machine

Of all projects in the programme the work in this area is pushing the boundaries of forest operations the most with the exploration of modern engineering technology. The teleoperation control system represents an important first step in having machines operating on steep slopes without exposing a person to potential risks. In addition it is opening the door to new machine designs that can be better adapted to operating on slopes without the need to accommodate an operator on the machine. The tree-to-tree robot or mobile platform design is very innovative engineering research capturing strong interest from engineering research experts while still being well aligned to addressing real forest industry issues. This programme is seen as delivering good value for the investment, currently projected to be 8% under the original budget, and shows the greatest collaboration between research providers.

While the teleoperation control system is closer to completion than the tree-to-tree machine this overall area of research is generally the farthest from operational application. It is not likely to realise its potential impacts in the forest industry within the life of the current programme and therefore is very reliant on a future beyond the current programme. The research team leading the work on the tree-to-tree machine largely does not have a history of working with the forest industry and while there is a milestone to identify a machinery manufacturing partner, the team are, in the opinion of the reviewers, potentially underestimating what will be required to secure the future for this research beyond the programme. Efforts will need to be made to make sure key industry partners are engaged and recognise the practical value of this research. Given the strong engineering community interest, parallel futures could be explored in the current collaborative forest industry format, with a major equipment manufacturing partner, or in a more academic robotics research funding environment.

5.3 Increased Productivity of Cable Extraction

5.3.1 Project 2.1: Increased Productivity of Cable Extraction – Advanced Hauler Vision Systems

The advanced hauler vision research has been completed and has now moved on to commercialisation, and has stayed close to planned budgets. Effectively two camera solutions were delivered from the project: a grapple-mounted camera to provide a point of view from the grapple and the cutover camera system providing a broader view of the operations.

The grapple camera version has taken on a commercial life of its own with the system designed through the project being overtaken by a lower cost, equivalent solution coming to the market. While potentially this could be considered as not being a commercial success, the programme played an important role in getting this technology out to industry and the delivery of the potential improvement in operational productivity and safety. The reviewers consider the fact that the output of the grapple camera was ultimately overtaken commercially as an indicator of the importance of having the right commercial partners involved as early as possible in technology development projects.

The cutover camera has only just started its commercialisation. It is clear that with the recent safety performance of steep slope operations and the current safety review in New Zealand there is and will be increased interest in safety. While there is certainly potential for productivity gains offered through the use of the visioning systems they can also deliver on improved safety. Clearly understanding the impact these visioning systems can have on both productivity and safety is the key to them finding their place in operations.

5.3.2 Project 2.2: Increased Productivity of Cable Extraction – Improved Grapple Carriage Control

Improved grapple carriage control systems are another area of activity that benefited from partnering with manufacturers who were already investing or were prepared to invest in new grapple carriage technology. In one case a grapple was studied that was developed by a large contractor. In another case a grapple was developed in conjunction with a machinery manufacturer. This linkage provided an in-built operational environment for prototypes and pre-commercial units to be applied. Some feedback through the review indicated that the ability to claim and show up to 10 units in different operations played a significant role in building market confidence in the technology for commercialisation. As noted around the ClimbMAX technology, and probably more prevalent with the grapple carriages, the programme has played a real catalyst role in triggering development and innovation beyond the programme, which should help enhance programme outcomes and industry impact.

5.3.3 Project 2.3: Increased Productivity of Cable Extraction – Innovative Yarding System

The innovative yarding system shows great promise to innovate current cable yarding systems. While it is presented as a total system, comprising five components, it is the reviewers' view that one component, the mobile tail hold carriage, offers most of the innovative change and impact to cable extraction systems. This project is clearly behind schedule and the reviewers question whether the whole system can be brought to a complete pre-commercial design before the end of the programme.

This project seems to be one that has not taken full account of international state of the art in cable yarding systems and would likely benefit greatly from stronger collaboration across existing research providers in the project and more broadly internationally. The greatest innovation for the project is, in the reviewers view, attached to one component in the system. This potentially provides a strong foundation for international collaboration where research focus can be given to that one component with the balance of the system development being leveraged off current international technology and development.

5.4 Development of Operational Efficiencies

5.4.1 Project 3.1: Operational Efficiencies – Delimbing/Cut to Length on Slopes

Very little information was seen in the review for this particular activity, which has been formally deferred in the programme. It appears to be a natural progression that can be leveraged off the current ClimbMAX technology developed in the programme. The reviewers believe the programme should still explore and understand the value proposition of conducting these operations on the slope. As the activity was mentioned little through the review we have inferred there is limited industry push for this particular progression of mechanisation on the slope. The reviewers note that this activity has been deferred rather than terminated.

5.4.2 Project 3.2: Operational Efficiencies – New Yarding Technologies and International Monitoring

There are two key activities in this project comprising operational benchmarking and an international technology watch.

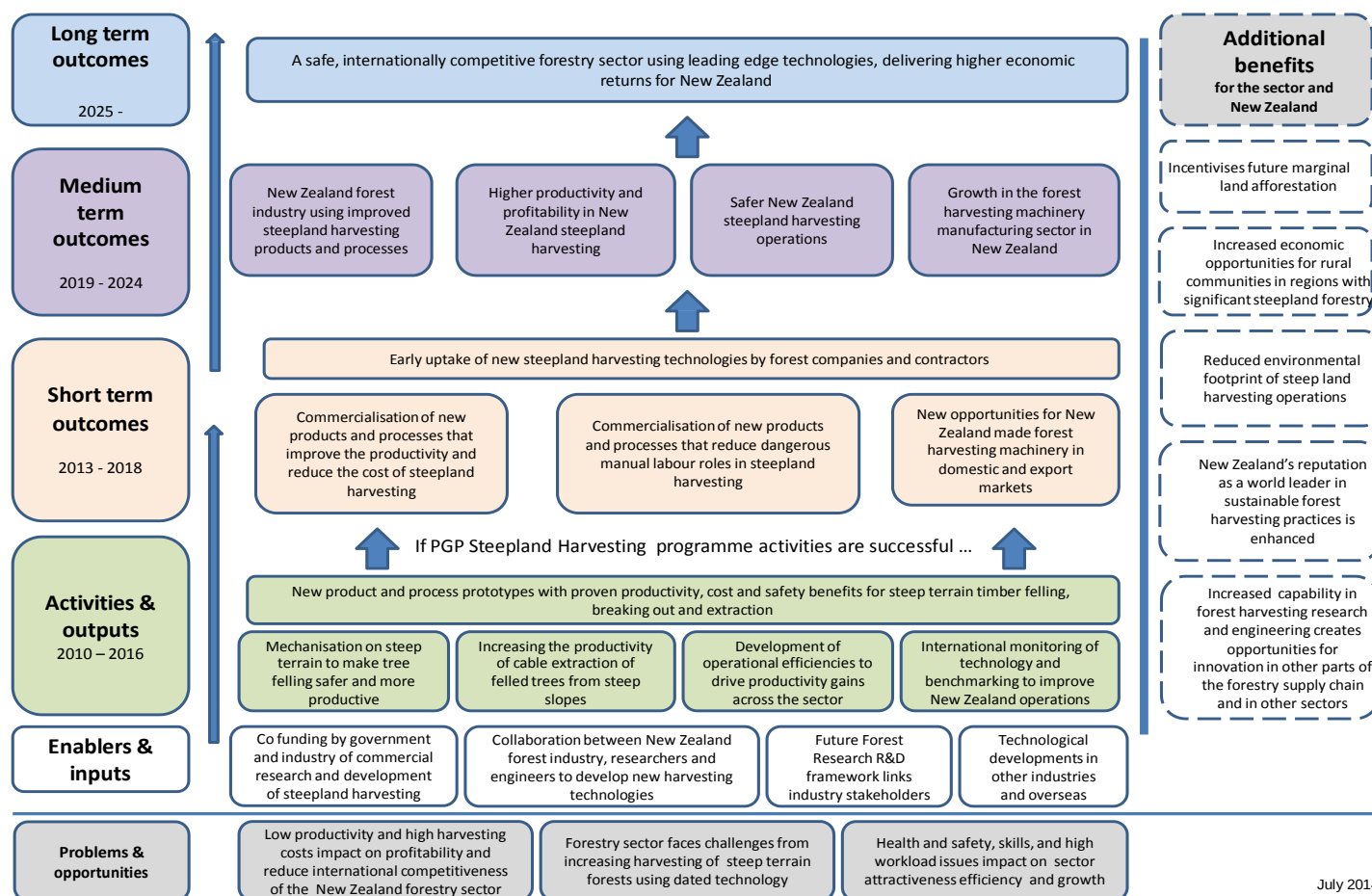
The benchmark activity is a very successful project in the eyes of the industry partners and adds practical value in the management of their operations. The availability of this database should prove valuable in properly exploring the impacts of the programme between now and the end of the funding. This was one of the original milestones in the Business Plan. The level of detail collected in the database does not allow the exploration of specific technology (where users can compare different operation types but not different technologies within an operation type). At this

level of detail long term trends can be tracked. Where a technology from the programme was to dominate a particular operation type with significant positive impacts the benchmarking could capture it. To capture impacts within the life of the programme or shortly after its conclusion will require finer details to be captured in the database and different analysis. With this potential added value in mind the data captured in the database should be reviewed to make additional inclusions that will help address particular impact questions. Given the potential role in understanding the entire programme impact further efforts and support to get data from all of industry may be worthwhile.

The greatest value of the international technology watch should have been realised early in the programme, in using that knowledge to shape the research plan. It would appear that the scope and impact of the international watch has been quite limited, particularly early in the programme. In the reviewers' view, given the current state of the programme, this international watch would be better integrated as a key deliverable within each of the other research activities. Each research activity could include a deliverable from a current international technology watch related to that project, driving the research to be more aware of international developments and collaboration opportunities. The most successful international watch activity identified by some of the programme partners was not directly linked to the programme. There have been two industry exploration tours to Europe organised by University of Canterbury Department of Forest Engineering, and a number of FFR members have been involved in these tours. It is noted that FFR had provided some financial support to the second of these two tours.

6. DELIVERY AGAINST OUTCOMES FROM THE PROGRAMME

The Outcome Logic Model for the programme (Figure 1 below) sets out short term outcomes (2013 – 2018), medium term outcomes (2019 – 2024), and long term outcomes (beyond 2025).



July 2014

Figure 1: Outcome Logic for Steepland Harvesting PGP Programme 2010 – 2016

The short term outcomes from the programme as set out in the Outcome Logic Model are around commercialisation of new products and processes that improve productivity, reduce cost and improve safety in steep land harvesting, and providing new opportunities for New Zealand made forest harvesting machinery in domestic and export markets. This review was timed early in the period 2013-2018 during which it is expected these short-term outcomes will be delivered. Progress against these short term outcomes is dealt with specifically in Section 5 – Programme Progress. It is clear that there has been and is traction in a number of projects towards commercialisation of products that improve productivity, reduce cost, and improve safety. Amongst these are commercial sales of the ClimbMAX machine, both domestically and export, sales of grapple carriages fitted with cameras, and one sale of a cutover vision camera system.

The medium term outcomes expected from the programme as set out in the Outcome Logic Model are:

- A 25% reduction in steep terrain harvesting costs
- Zero lost time injuries during felling and breaking out on steep country
- A 10% reduction in fuel costs
- Development of new harvesting machinery for domestic and export sale

It is not evident that there has been a strong focus in the programme to date on putting in place specific measures to track delivery against these outcomes during the programme, on completion of the programme, or beyond the programme.

None of the industry members expressed an expectation that an emphasis on metrics against the outcomes expected from the programme was an important priority or that measured success against these outcomes would be an important determinant of their overall assessment of the programme. Several went further to state that they saw these outcomes as aspirational targets only.

In contrast to industry participants, the expectations of MPI and the Investment Advisory Panel of the PGP (IAP) around being able to provide metrics to measure delivery from the programme against the stated outcomes are much more specific. MPI and the IAP acknowledge the inherent difficulty in measuring performance against what is a moving target with many parts outside of the influence of the programme. An IAP member noted that the “sound bites” on achievements have been very well done and that it was also very important to provide metrics on the economic and safety outcomes.

7. DIRECTION AGAINST INTERNATIONAL TRENDS IN SCIENCE AND TECHNOLOGY

Overall the Steep Land Harvesting Programme can be classified as a world class research and development programme with most of the programme contributing to world class development in forest operations and a few components leading the way in research. As an industry collaborative programme it is heavily focused on applied outcomes which tend to favour very applied research and, even more so, development activities. This is consistent with the design intent of the PGP. The work in steep terrain mechanisation, innovative yarding systems and remote control systems would fall into world-class development projects for the forest industry and these areas would have the most to gain from improved international engagement.

The development of tethered machine technology and machine design with low centre of gravity has been an area of focus in Europe over the past decade with significant programmes being run in Austria, Germany and Norway. While not directly applicable to the New Zealand conditions, having been developed on smaller machines, the basic principles of design and application are similar. While the programme has played a leading role in pushing this technology into large, track based machines suitable for New Zealand operating conditions, it would benefit by having stronger connections with the European programmes and leveraging off the commercially available solutions.

In the area of remote controls, taking a scope beyond the forest industry, there are a number of industries currently applying remote control systems to heavy equipment. In particular the mining industry makes extensive use of remote control systems with their focus on site extraction and short distance transportation. Even within the forest industry there is a pre-production remote control harvester in Sweden that has been used in trials to explore how best to apply the technology in harvesting systems to achieve increased productivity. In the case of the Swedish programme they have designed the remote control machine without an operator cabin, extracting greater advantage from remote control systems in reduced machine design cost/requirements and providing a lighter, lower centre of gravity machine. The New Zealand programme is in a position to advance this work to address particular steep slope challenges and like the tethered machine could maximize its impact by leveraging off the heavy equipment remote control applications in Sweden and within the mining industry.

Added to these world-class development activities, the programme can claim leadership with its activity in harvest visioning systems, the mobile tail hold carriage, and the robotic tree-to-tree harvester. The harvest visioning systems have taken leading camera and networking technology to develop a new robust forestry application not yet widely explored in forestry operations. The lateral moving tail hold carriage and the robotic tree harvester go a step further in world leading forestry technology research and development. In this case new ideas are being explored and developed that, to the reviewers' knowledge, are unique and have the potential to create a step change in steep terrain harvesting. The robotics is still likely to be at a conceptual/model level when the programme concludes providing a platform for future development. The lateral tail hold carriage has the potential to create real operational impact in clearfell operations within the life of the programme if given appropriate resources and focus.

The programme clearly is respected internationally as a quality programme pushing key new developments for the New Zealand industry and helping set new benchmarks globally.

8. GOVERNANCE, MANAGEMENT AND MEMBERSHIP

8.1 Governance

The governance structure of the FFR Steep Land Harvesting Programme comprises:

- The FFR Board whose primary role is governing FFR Ltd and representing the interests of its membership.
- The Programme Steering Group (PSG) provides programme oversight, ensures the programme delivers against outcomes, approves annual plans and payments, recommends contract variations and meets all the reporting, planning and communication requirements of the Primary Growth Partnership. The PSG comprises two MPI staff, and two FFR representatives (the FFR Manager - now R&D Manager, New Zealand Forest Owners Association, and a member of the FFR Board). The PSG is advised on all aspects of the programme by the Technical Steering Team (TST).

The PGP Investment Advisory Panel (IAP) advises MPI on decisions about the allocation of PGP co-investments and monitors programme progress. It is clear that MPI has clear expectations around the level and quality of reporting back to them on programme management and progress and it was evident that these expectations are being met. Likewise the IAP has clear expectations about reporting requirements and is provided with copies of annual plans and quarterly reports for comment. The IAP has been quite satisfied with the quality, clarity and frequency of reporting.

MPI was concerned about potential changes to industry co-funding of the programme over the last 12 months, as a result of changes in industry funding of forestry research with the implementation of the Forest Levy. Industry co-funding for the Steep Land Harvesting Programme continues to come direct from member organisations. The FFR Ltd entity was retained as the contracting entity for the Steep Land Harvesting Programme. The PSG has been retained and a smaller FFR Board has been put in place to meet the statutory requirements of FFR Ltd, the legal entity. MPI is satisfied with the arrangements that have been put in place and with overall programme governance.

The reviewers formed the view that governance of the programme has been to a high standard and that changes to FFR as a result of the introduction of the Forest Levy have been well managed to not impact on this programme.

8.2 Management

The management structure of the FFR Steep Land Harvesting Programme comprises:

- FFR Harvesting Programme Leader
- The TST comprising representatives of industry member companies and MPI. This group has the role of reviewing and tracking the progress of each of the projects within the programme and providing technical direction and operational level input to the research and development projects. It is a vehicle for industry end user input and engagement in the programme. It also recommends payments to research providers to be approved by the PSG.
- R&D Manager, New Zealand Forest Owners Association (under a management agreement with FFR)

There was an overall consistent message from industry members that this programme is very well managed. Specifically almost all members singled out the organisation and running of TST Meetings, the quality and frequency of project reports, updates and newsletters and access to programme management and research providers as all being very positive. The TST has a strong level of partner participation and plays a significant role in guiding the research activity and allocation of budget.

An Assurance and Evaluation Review of Management of Funding by the Office of the Director General, Ministry for Primary Industries carried out in 2012 concluded the FFR has:

- effective financial management systems in place to manage funding and co-funding
- an effective framework and processes for developing annual budgets and planning research activities for the life of the programme
- effective processes for contracting with research providers to deliver goods and services for the programme
- an effective framework for financial management reporting and general ledger processing
- effective processes for making payments to research providers
- supporting evidence for amounts being claimed as in-kind contributions and an adequate process to value in-kind contributions

The reviewers formed the view that the programme has good management and financial management and reporting processes in place.

8.3 Membership

The reviewers note that FFR Harvesting programme members have easy access to all published information through the FFR Harvesting website which has access restricted to members. It is clear that there is a structured process for maintaining and making information available to members. Members appreciate this access and it is clear that at least some have accessed the information extensively.

Members were, for the most part, very positive about the profile of the programme in the wider industry and beyond and felt that FFR had done a good job communicating progress in the programme to various industry publications and forums. Based on this review it was seen by the reviewers as a risk to programme outcomes to isolate the programme outputs from being available to non-contributing industry members. This only results in information not being made broadly available to the industry as a whole and limits programme success. Finding the right balance in managing its external communications and publications may be an explanation for the perception by some members that communication was limited in the earlier part of the programme. This appears to have hit the right balance over the last 12 to 18 months.

There is limited direct contractor membership in the programme. One member who joined the programme in 2013 provided feedback that prior to joining the programme he felt that there had been poor contact and communication with contractors about the programme and the merits of becoming part of the programme. This member had a negative view of the programme prior to getting involved but expressed a very positive and enthusiastic view after having become actively involved in parts of the programme.

Overall, the reviewers are of the opinion that there is strong support for the programme and its progress to date by industry members.

9. SUMMARY FINDINGS AND RECOMMENDATIONS

9.1 Summary Findings

1. The reviewers found that stakeholders that contributed to this review engaged positively with this process.
2. The reviewers found the programme has strong support from most industry members who were generally pleased with programme management, programme reporting, progress against project plans, and achievements from the programme to date.
3. The reviewers found programme governance and management, including financial governance, management and reporting, to be of a high standard.
4. The reviewers believe the programme has been a catalyst for increased innovation in harvesting in New Zealand with new technology being developed and deployed, both from the programme and outside of the programme.
5. The reviewers felt it is clear that the programme is making progress towards delivering against the expected outcomes but the extent and timing of that delivery is still to be determined.
6. The reviewers found no need to comment on programme personnel.
7. The reviewers believe outputs and ultimately desired outcomes from the programme relating to safety are very relevant to the current high level of focus and enquiry on worker safety in the forestry industry, primarily in harvesting activities.
8. The reviewers are of the view that outputs from the programme will not present specific new challenges to the forest harvesting industry in the area of skills and training.

9.2 Recommendations

Recommendation	Link to section(s) in report
1. <i>Initiate a project to establish transparent measures to track and report on achievement against the expected outcomes of the project. Such a project would seek to measure and document programme impacts in industry and act as an input to existing modelling of programme impacts while providing a stronger foundation to demonstrate to industry the following outcomes have been realised:</i> • <i>A 25% reduction in steep terrain harvesting costs</i> • <i>Zero lost time injuries during felling and breaking out on steep country</i> • <i>A 10% reduction in fuel costs</i> • <i>Development of new harvesting machinery for domestic and export sale</i> <u>Note</u> - It was brought to the reviewers' attention late in the review that MPI had earlier initiated a project that will address this recommendation. The reviewers endorse this project. This recommendation is specifically targeted at obtaining real measures in industry that will objectively assess and document the real impacts of the programme outputs and outcomes. This will require robust methods that recognise their limitations, have credibility with industry and that can contribute to existing high-level economic impact modelling. The Benchmarking Project could provide a basis for measuring gains in productivity associated with the introduction of new technology and systems and from this impact on costs. This goes beyond the current benchmarking project and it is recommended that resourcing/funding for extension of this project is allowed for. Safety data would need to be collected on a configuration specific basis. A methodology would need to be developed for measuring impact of new technology on fuel consumption. The reviewers were made aware of a study conducted by a School of Forestry post-graduate student that should be examined. Measures adopted should be transparent, objective, and used consistently with the understanding that they may have limitations. Particular priority should be given to assessments where existing baseline data from past operational work studies can be used to help baseline the impacts. The reviewers were provided with a NZIER Evaluation of PGP benefits at a much broader level. The reviewers considered the NZIER work was at too high a level to be of specific use to track achievement against the expected outcomes of this particular programme.	Section 5.4.2 and Section 6.

2.	<i>Introduce international technology scan and awareness into each of the current projects rather than maintain Technology Watch as a stand-alone project.</i>	Section 5, 5.3.3, 5.4.2 and Section 7.
	The reviewers and a number of industry members felt that there has not been enough consideration of what technology exists or is in development in other parts of the world that is relevant to all the projects within this programme. The reviewers sensed that the desire to develop a home grown solution has been quite prevalent and that there have been assumptions made that our conditions and harvest piece size considerations preclude technology that exists in other parts of the world, particularly Europe. It was evident that the perspectives of some industry members have changed as a result of their participation in trips to Europe to view harvesting technology. These trips are outside of the FFR programme but there has been some financial support from the programme. The reviewers note that consideration is being given to accommodate trialling European hauler systems in NZ. The reviewers would like to see this go further, asking the following questions: How can overseas technology be adapted to the NZ situation? Are there currently unexplored opportunities to collaborate with overseas companies to incorporate technology and ideas from NZ and overseas into systems? Should we take a more modular approach rather than trying to develop home-grown systems? While initiated for research and development interests any international partnership should be established with a view to commercialising specific innovative components from the research in partnership internationally. This recommendation would seek to provide incentive to all activity leaders to reach out to international technology researchers and developers in their area of interest. Part of their programme responsibility should be to both germinate collaboration opportunities in their research activity as well as feed the existing international technology watch.	
3.	<i>Review management across existing work programmes to enhance structured and formal collaboration between research providers.</i> The reviewers formed the view that more direct interaction between the research providers, even where projects do not overlap, could benefit the overall programme. Individuals provide some of the coordination across programmes and this should continue, with more opportunities for direct contact between research providers providing more opportunities for peer review and idea generation. This increased interaction should be done to drive a greater team feeling across the whole programme and likely could be a combination of some regular group meetings (e.g. all research providers to meet twice a year to discuss progress and project challenges) and virtual collaboration environments (e.g. Google, SharePoint etc.). This should be structured as a safe environment to share information, data, success and failures that extend the wider experience of the programme team to the benefit of the programme outputs.	
4.	<i>Initiate a concerted campaign to enrol more direct contractor participation for the balance of programme with the purpose of enhancing greater engagement from this group to facilitate commercialisation and uptake.</i> This needs to be considered to maximise engagement and adoption of	Section 8.3.

	technology developed in the programme. The contractor community should be viewed as separate from the forest owners to whom they contract. Existing members and Forest Industry Contractors Association (FICA) are obvious links to the contractor community, recognising that FICA does not count all contractors as members. Given the challenges to date in enrolling direct contractor participation it is thought that a targeted approach to selected contractors, with a contractor specific engagement model, and using the assistance of industry members is likely to be the best approach. Contractors have a perspective to add to the programme development and progress and play a particularly important role in the uptake of programme outputs; they will be the industry stakeholders who will convert outputs to outcomes for most of the programme. The process to formally engage them in the programme needs to recognise this important role and effectively value their in-kind contribution as a real contribution to the programme.	
5.	<i>Review all current work programmes with a view to prioritisation of outputs such that as many as possible are moved along the development path towards being able to be commercialised, or at least have enough momentum to continue in some form, by the end of this programme.</i> This may entail taking a serial versus parallel approach (that is working on one component of the activity at a time) in some work streams looking for the component(s) of a system that will have the greatest impact. That is not to say other parts of the work stream should be deferred but rather ensuring that resources are prioritised to give the best chance of maximising programme outcomes vs. maximising work stream outputs. The project can then progressively work through the different components of the system, based on their potential to deliver impact, as time allows. This serial approach is seen to mitigate risk for the programme and maximise the potential impacts delivered.	Section 5.1 and 5.3.3.
6.	<i>Review all current commercialisation plans and results and enlist external expertise to assist with learning from experience to date within the programme and to inject knowledge and learning from outside of the programme to ensure the commercialisation aspect of current work programmes is better understood and appropriately resourced and managed for the balance of the programme.</i> The original Business Plan states that “Management recognises that the development of many of the machines or even prototypes will require a level of investment well beyond that of the current budget...” Notwithstanding that point, this recommendation applies whether or not commercialisation is regarded as part of the programme or outside of the programme. It is important that commercialisation is properly managed to avoid viable technology improvement failing to move into adoption in operations due to poor execution of the commercialisation phase and as a result not delivering the potential impact of the research and development the programme has generated. The intent is to better understand the current commercialisation challenges, ideally through the perspective of a technology commercialisation expert. The knowledge gained in combination with the targeted expertise should allow the development of stronger commercialisation plans going forward	Section 5, 5.2.1 & 5.3.1.

	(and potentially reinforce current programme commercial outcomes if required). Given the importance to the programme of achieving outcomes and impact with industry, gaining this improved knowledge on transitioning of research outputs to commercialised outcomes is seen as a good investment of some programme resources. Identifying which party is required to invest in aspects of commercialisation can be explored and defined once they are known and as they relate to a given project or technology.	
7.	<i>Continue the promotion of programme outputs and delivery of outcomes through workshops and field days.</i>	
	It is evident that field days to date have been successful – well run and well attended by contractors and operations staff. Workshops and field days provide a good forum for understanding, examination, and adoption of outputs from the programme.	
8.	<i>Increase the emphasis on operational trials for outputs at or near commercialisation for the balance of the programme.</i>	Section 5.3.1
	Understanding the performance and limitations of equipment in a range of operating conditions is a key determinant in the uptake of new technology. Conversely unanticipated negative operational outcomes from utilising new technology, whether these are manifested in terms of safety, environmental impact, productivity or cost, have the potential to derail adoption of new technology, even if these issues could be fixed or managed. Industry needs to be equipped with good and reliable knowledge of where the new technology fits, how it will perform in different conditions and what the impacts will be to have the confidence to implement it in their business.	
9.	<i>Have the Programme Steering Group, Programme Leader and Technical Steering Committee produce a clean sheet plan for the last 12 months of the programme in March 2015 for approval and implementation in June 2015.</i>	Section 5.1.
	Six to nine months from the date of this review there will have been consideration of the recommendations of this review and implementation as seen fit by MPI/FFR. The stock take of progress in the various work streams/outputs will have changed. There will be twelve months of funding and resources left to maximise the potential for delivery against the expected outcomes of the programme. Without being bound by the existing project plans the balance of the programme should be critically reviewed with the view to allocating funding and resources to ensure the best chance of continued delivery against the expected outcomes of the programme as well as beyond the end of the programme.	
10.	<i>Canvas programme stakeholders and stakeholders outside of the current programme with the view to developing a plan for what might come next in the space of Harvesting Research in New Zealand, which could include transitioning some work from the existing FFR Steep Land Harvesting Programme.</i>	Section 5.2.2.
	This recommendation does not imply or assume continued PGP funding for harvesting research. At June 30 th 2016 the FFR Steep Land Harvesting Programme will have outputs in various stages of development, ranging from those commercialised and adopted in operations to those still at alpha prototype stage. Not all outputs can be expected to continue through to being	

	adopted in operations; that is the nature of research. However without some structure to support the progress of outputs that show promise along a path towards commercialisation and adoption there is a risk that potential value from investment in the FFR Steep Land Harvesting Programme could be lost. Momentum beyond the programme is important to delivery of the expected outcomes of the programme and ultimately the success of the programme. Further, the existence of the FFR programme has developed research and technology capacity and innovation momentum in the industry that had been lacking for a period prior to the advent of this programme. The outcomes of the current Independent Forestry Safety Review and the priorities identified in the recently revised New Zealand Forest Growers Science and Innovation Plan may provide direction for and identification of the need for harvesting research capacity. It would be of particular interest to actively engage international networks in this forward planning to ensure future direction is internationally relevant and plans can leverage off the best international research investments and development. Identifying the priorities, how they are funded and how a programme might be managed are all core to determining the way forward if harvesting research capability is to be maintained and further developed. A hiatus in activity after the end of the FFR Steep Land Harvesting programme would likely be detrimental to maintaining and developing harvesting research capability.	
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