



Case Studies & Trial Results of Biomass Harvesting in Australia

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CRC Biomass Trials

- Slash-bundler: Northern Tasmania
- Bruks chipper: Green Triangle Vic./SA
- Whole tree chipping: South-west WA
- 'FibrePlus': South-west Slopes NSW

Slash-bundler (TAS)



Scattered slash



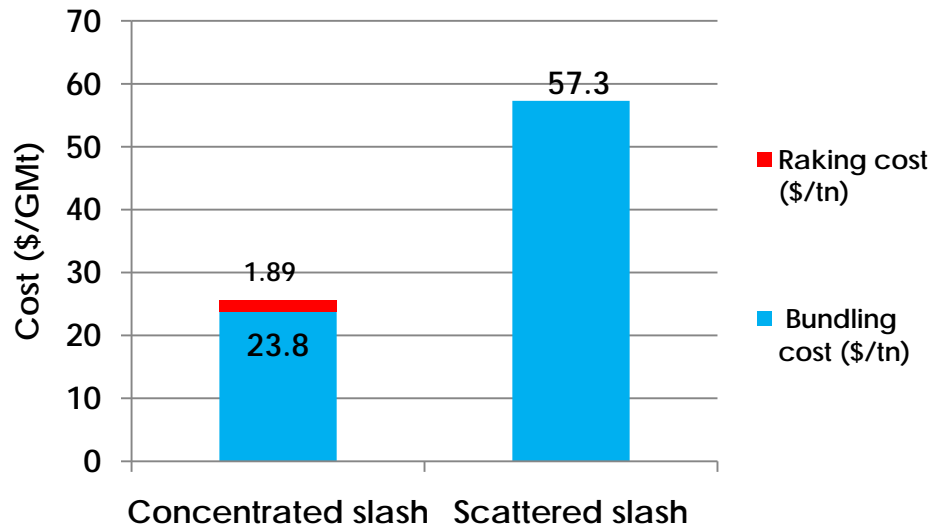
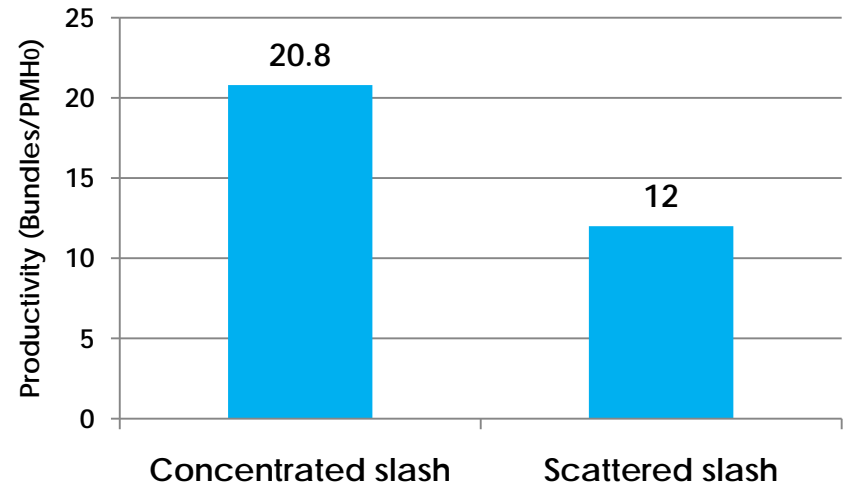
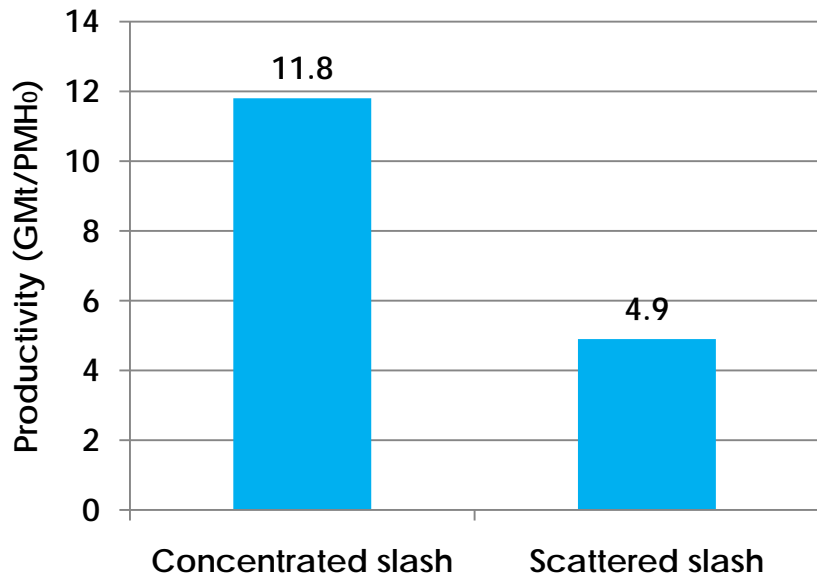
Raking



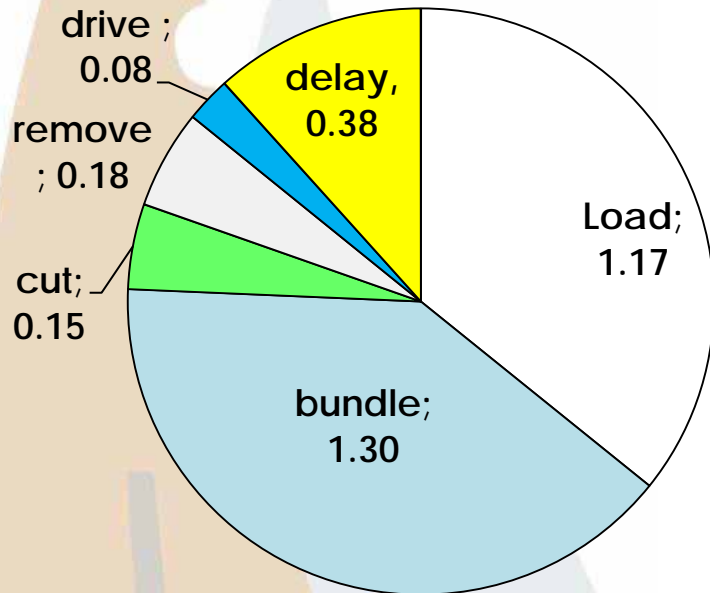
Cultivation



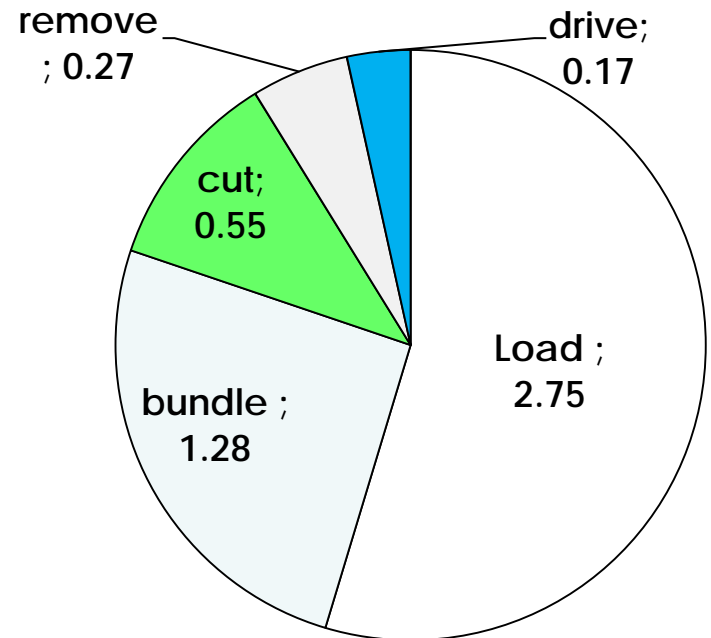
Concentrated slash



Time elements



min./bunle in concentrated slash



min./bundle in scattered slash



Left-slash (GMt/ha)	70.4
Collected slash (%)	64.2
Left-slash (%)	35.8
Total slash (GMt/ha)	197



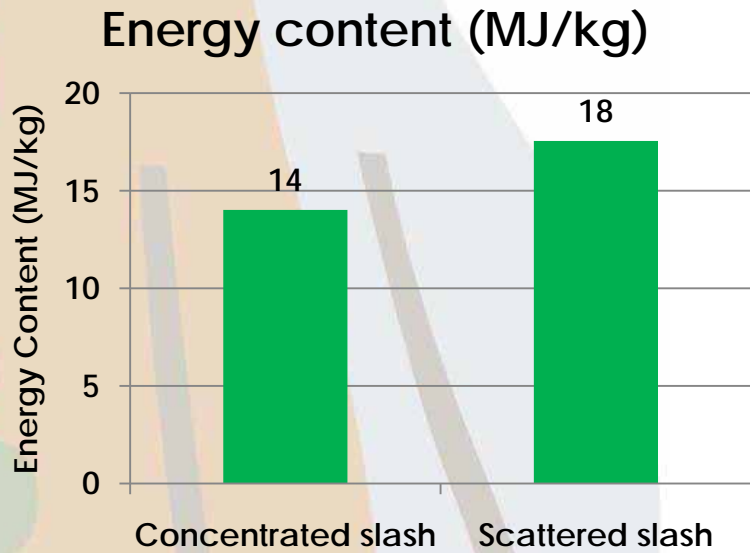


Scattered slash

Contaminant= 1.2%

Concentrated slash

Contaminant= 8.9%



570 kg

Raking and cultivation



Work type	Productivity (ha/hr)	cost (\$/ha)
Raking	0.325	368.8
Cultivation	0.4	300

Bruks chipper (Green Triangle)



Stem wood



Raking with excavator



Stem wood with minimum branches



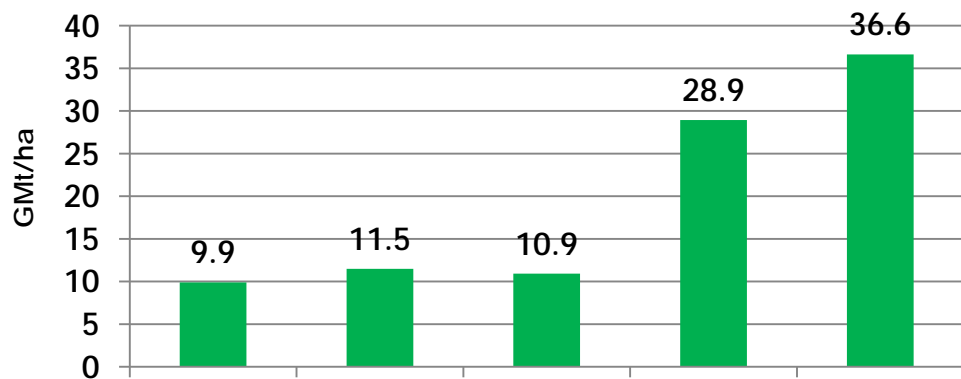
All residues



Road side

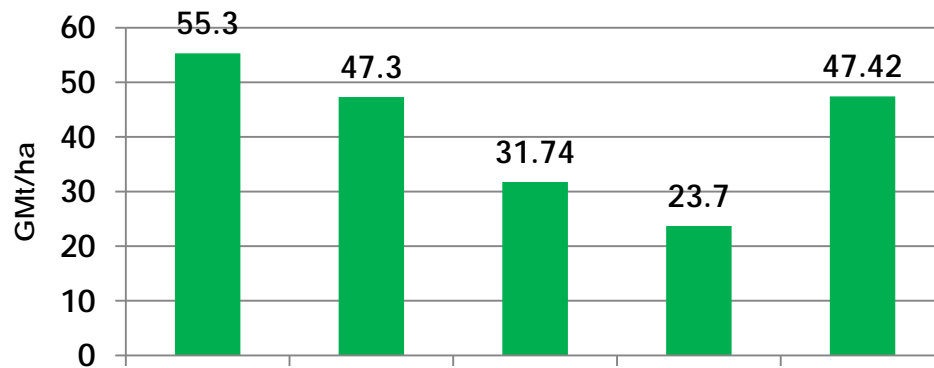


Biomass Yield (GMt/ha)



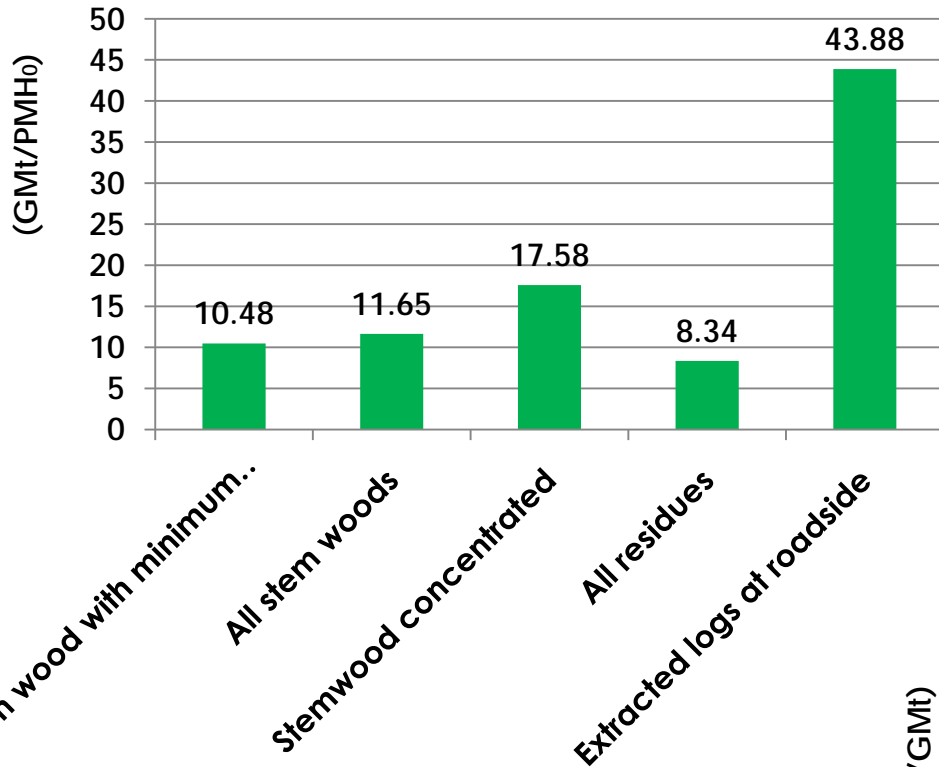
Stem wood with minimum.. 15%
 All stem woods 20%
 Stemwood concentrated 26%
 All residues 55%
 Extracted logs at roadside 43%

Retained Biomass (GMt/ha)

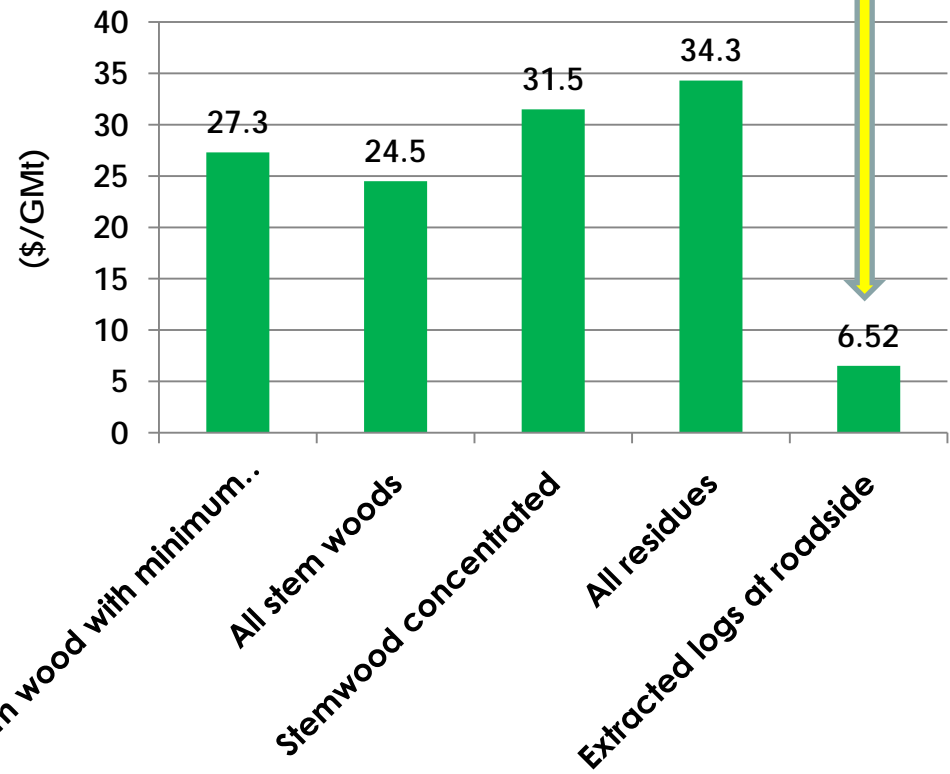


Stem wood with... 15%
 All stem woods 20%
 Stemwood concentrated 26%
 All residues 55%
 Extracted logs at... 43%

Productivity (GMt/PMH₀)

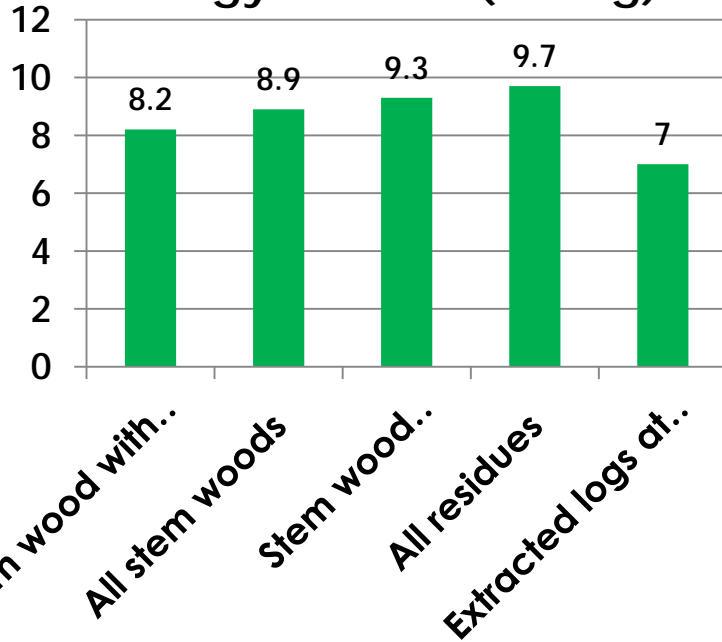


Cost (\$/GMt)



Energy content- Energy used = Net energy output

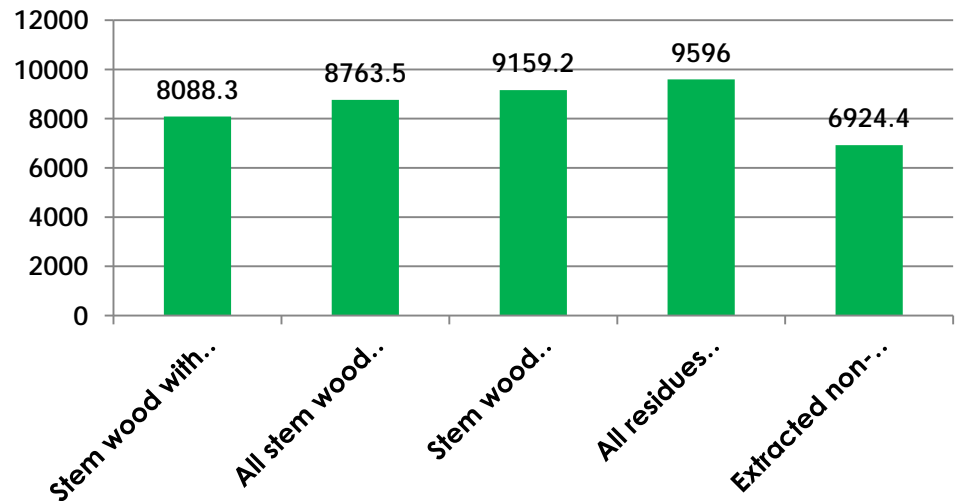
Energy content (MJ/kg)

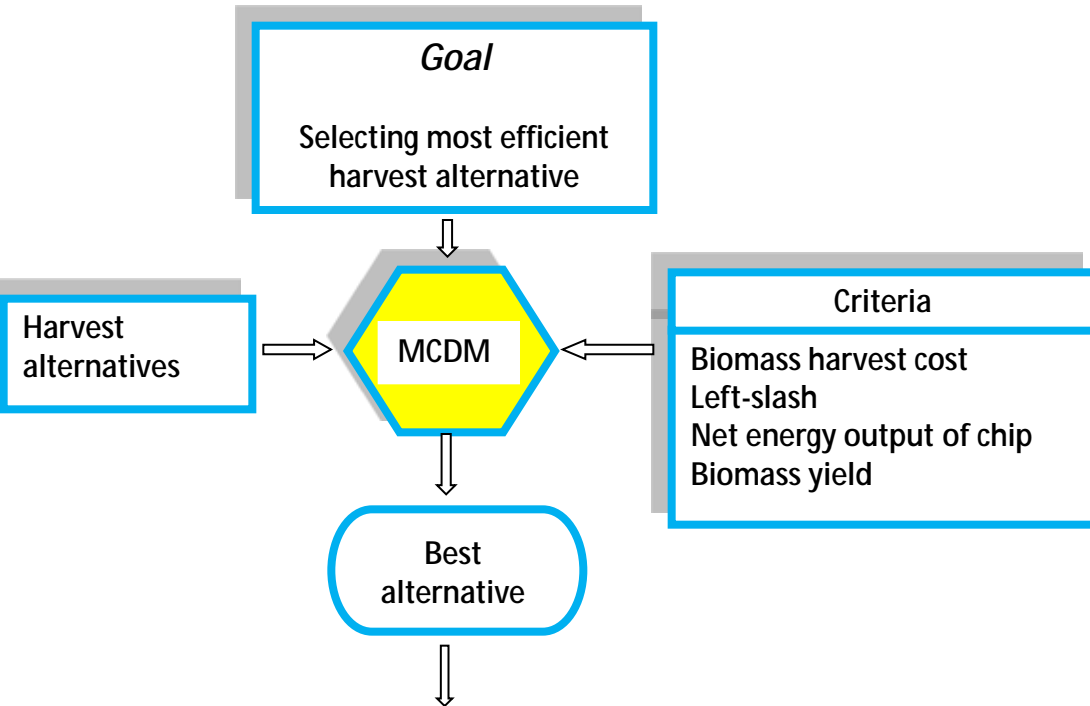


Energy input (MJ/tn)



Energy output (MJ/tn)

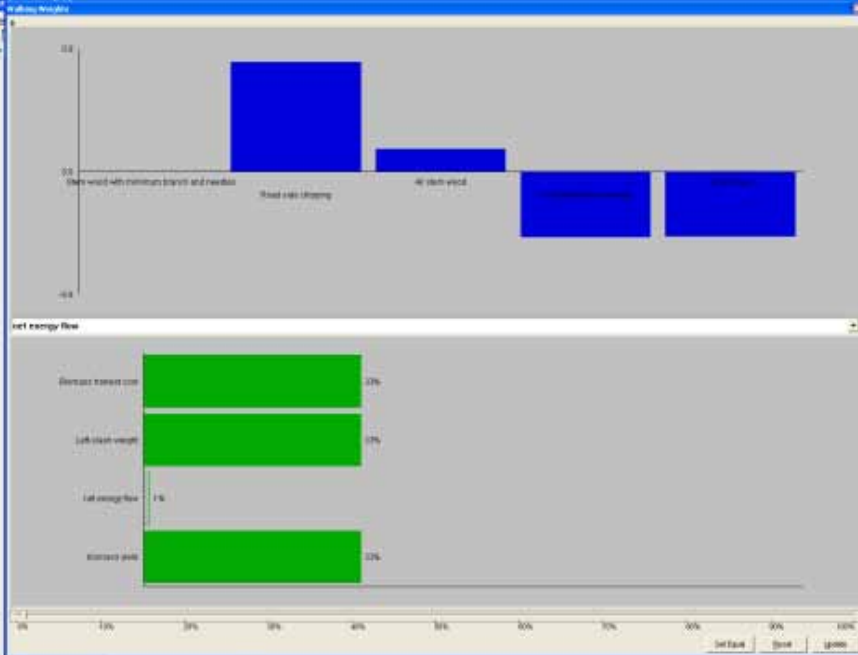




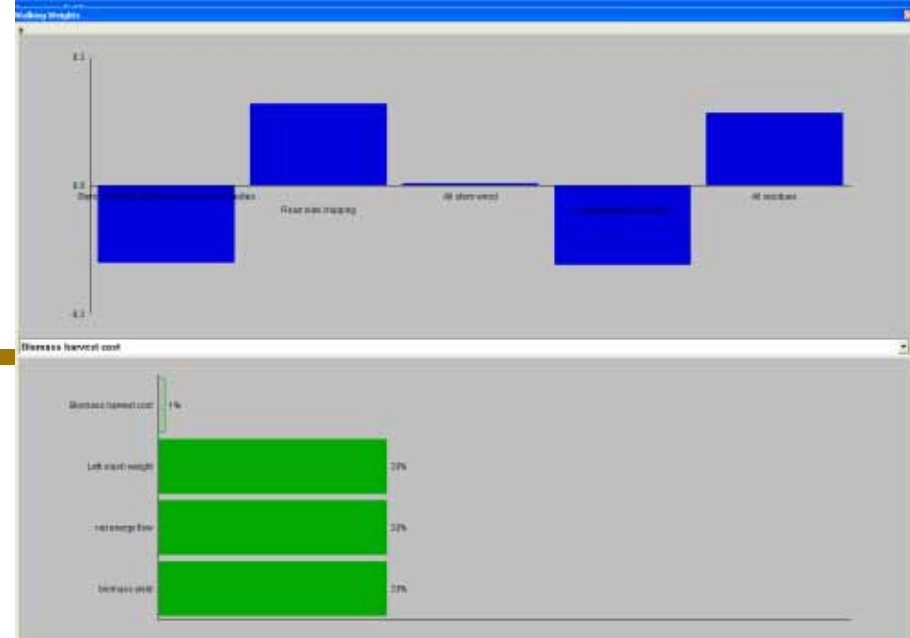
1. Extracted logs at road side

- 2. All stem wood**
- 3. All residue and stem wood with min. branch**
- 4. Stem wood concentrated by excavator**





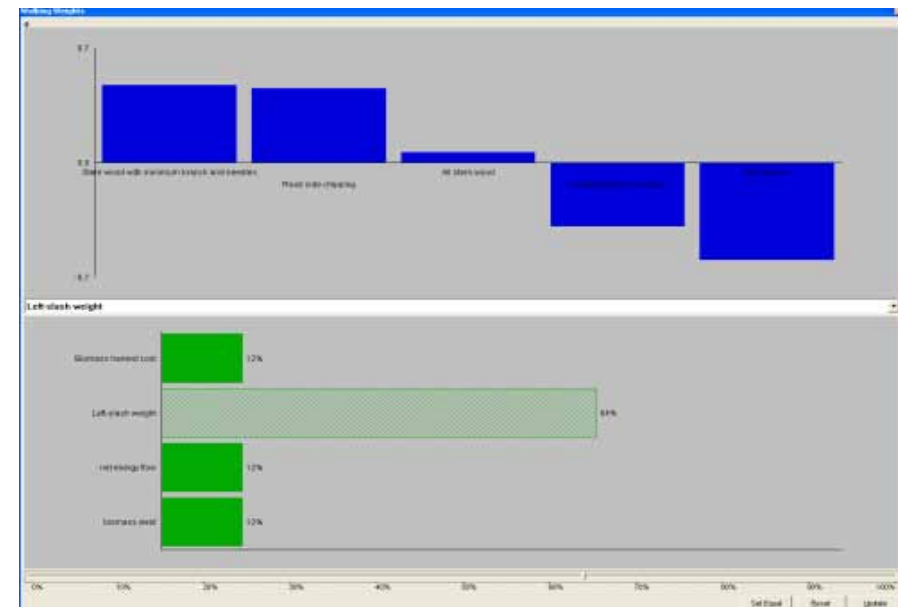
Net energy >41%: All residues



Cost: road-side chipping



Biomass yield: road-side chipping



Left-slash >63%: stem wood-minimum

Whole tree chipping (WA)



Tigercat 845C



Poor quality stand, 5.2 ha

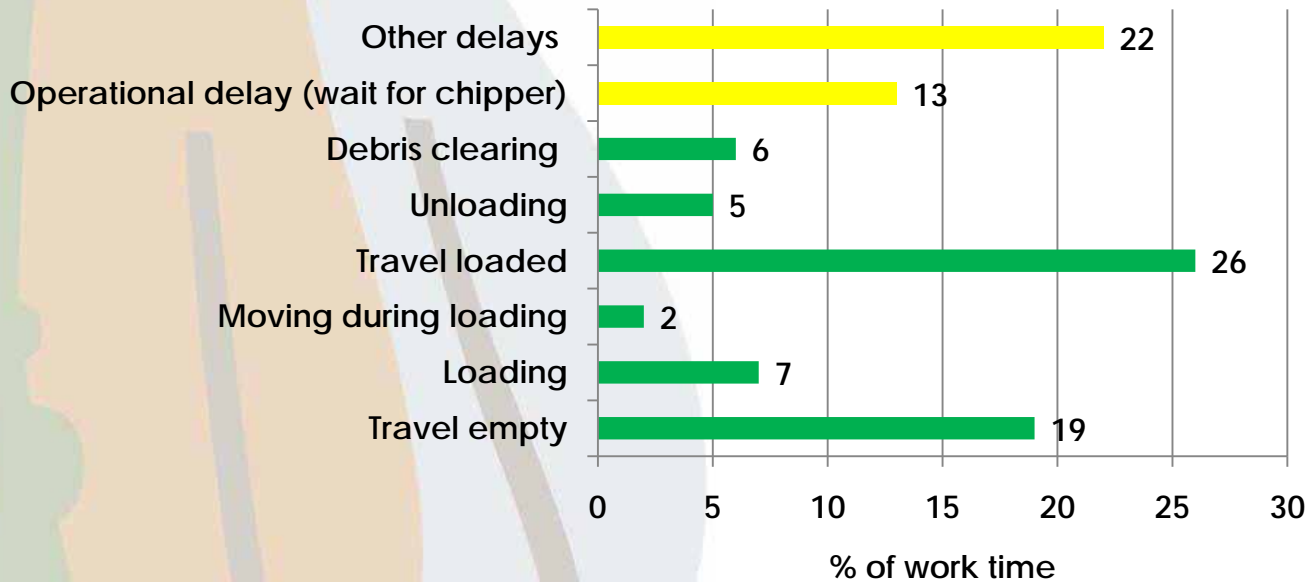
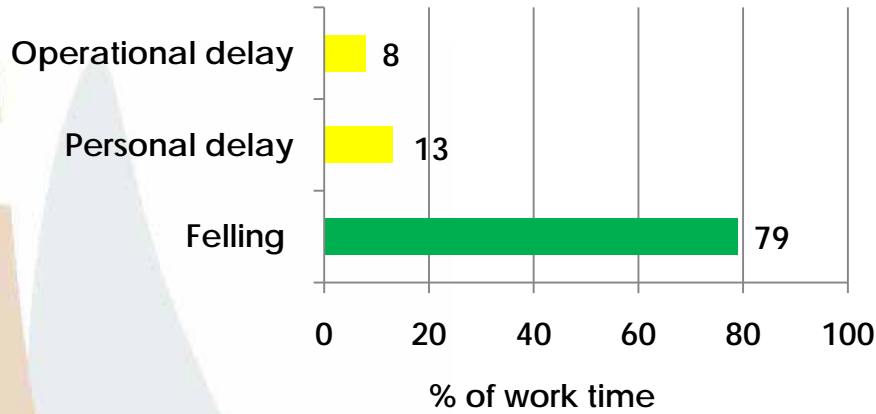


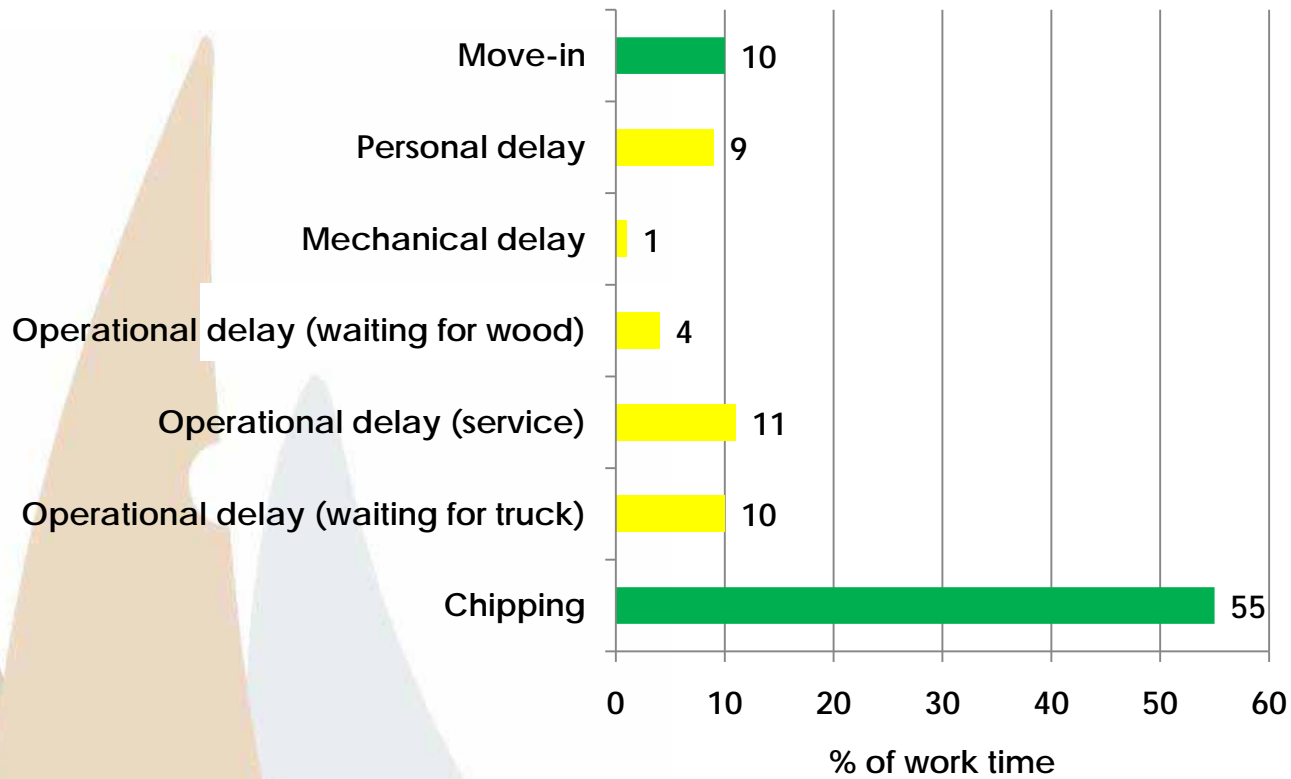
Tigercat 730C

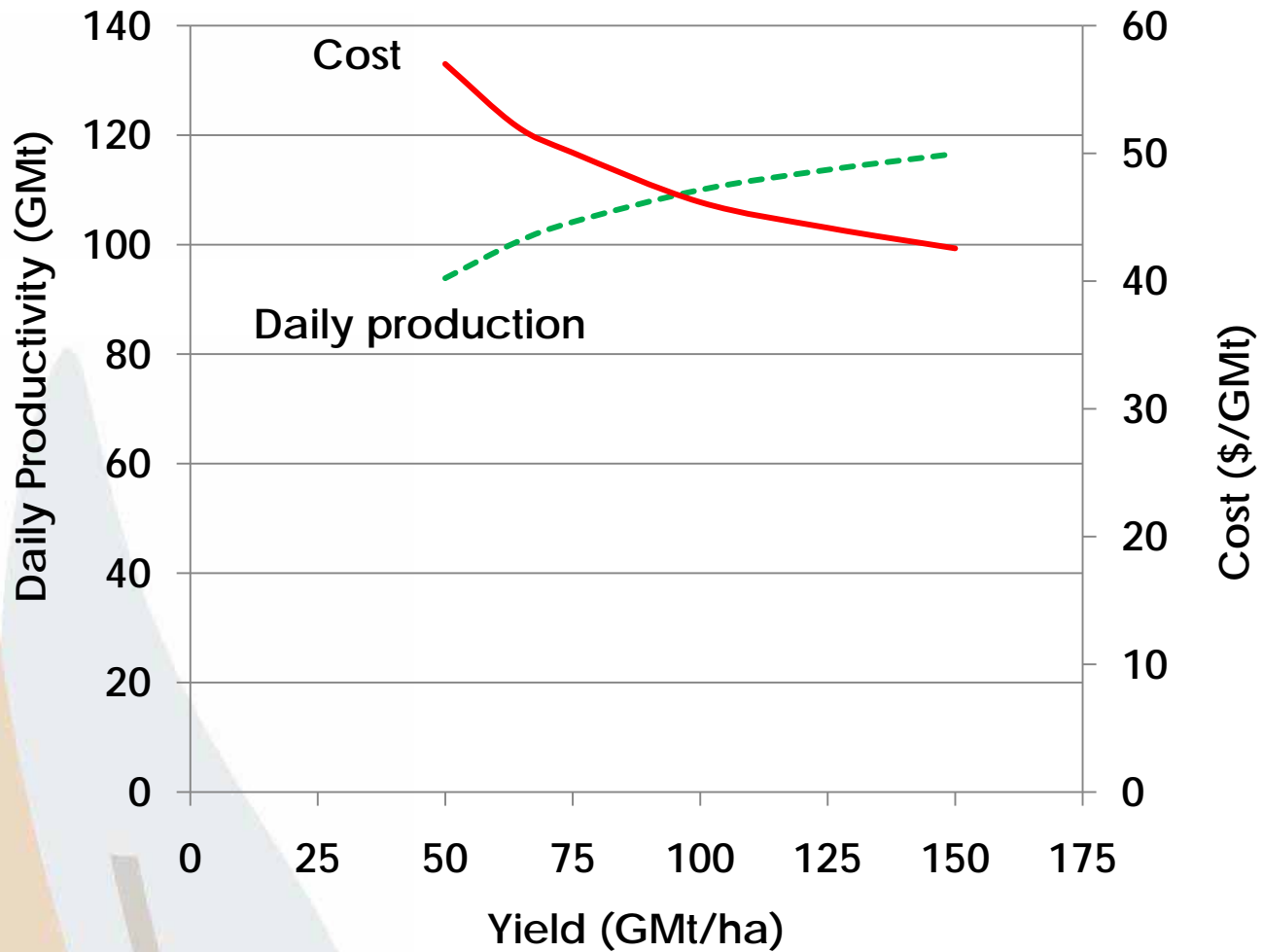


Husky Precision 2366

Machine	Production (GMt/PMH ₀)
Feller-buncher	50.1
Skidder	44.6
Chipper	51.7

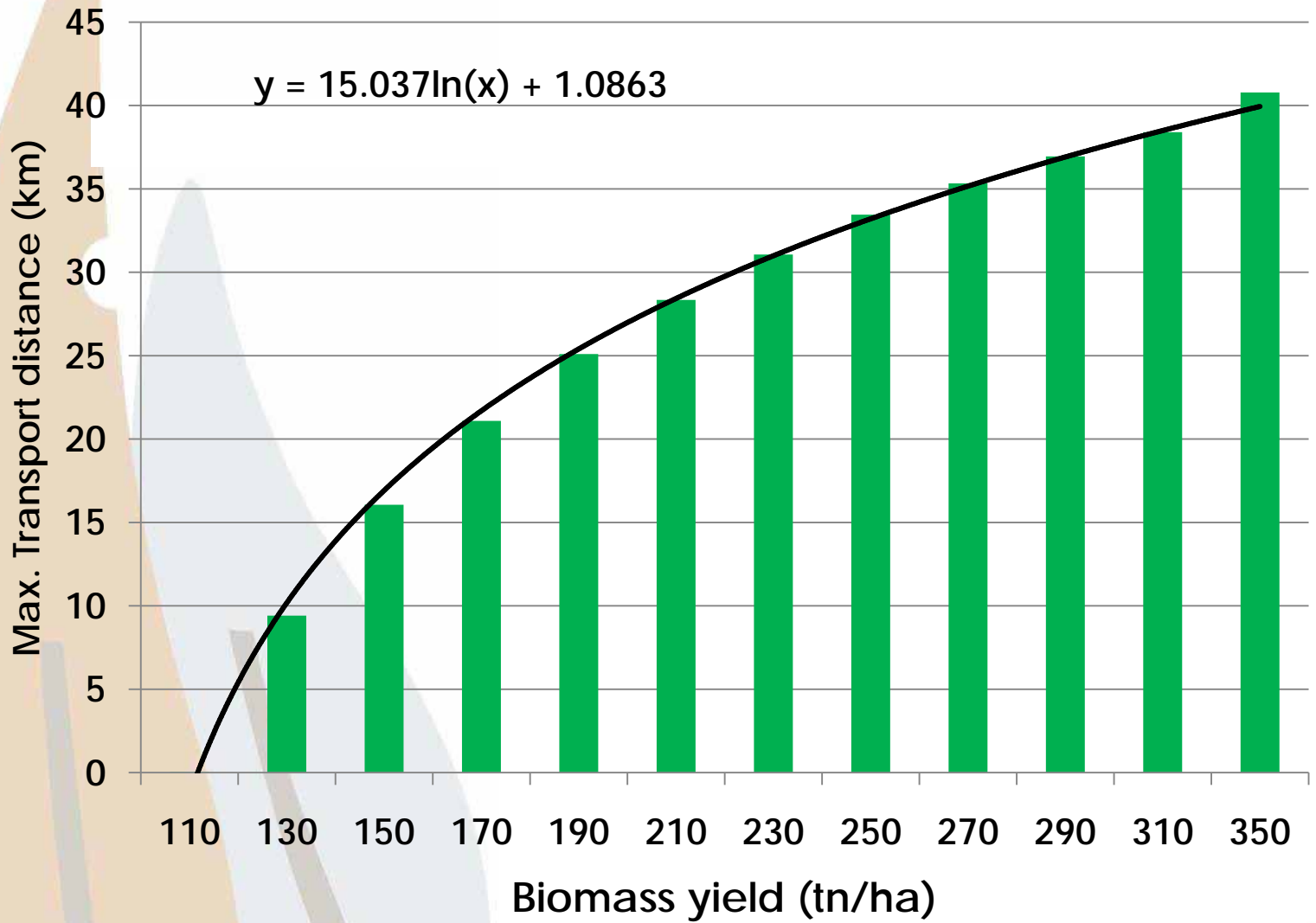






Production-costs for different yields of biomass

Maximum distance (Km)



Next steps....

- Slash-bundler for road side harvest residues
- Training driver for biomass High-Tech. harvesters
- Bruks mobile chipper in thinning
- Bruks mobile chipper vs in-field chipper
- Biomass supply chain in Australia: supplies-demands

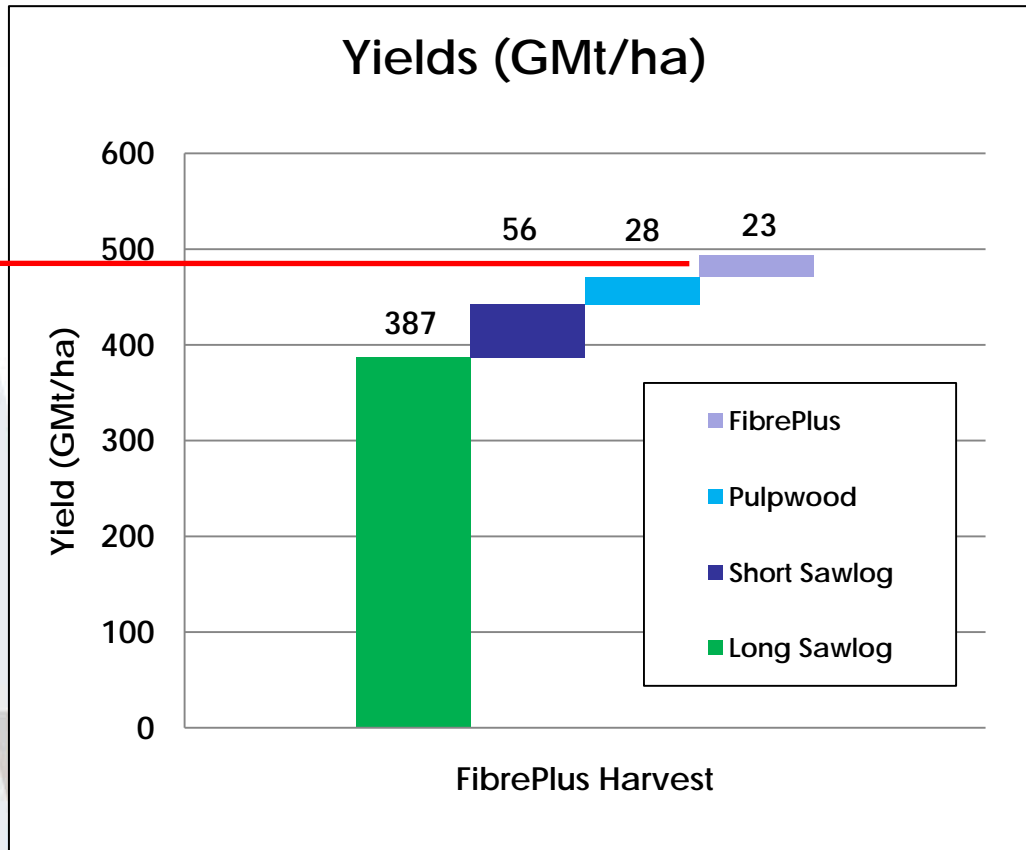
'FibrePlus' Study (Tumut, NSW)

- What is FibrePlus?
 - Tops and large 'waste' pieces of the stem.
 - Outside the existing sawlog and pulp specification.
 - <3.7 m in length and/or <8cm SEDOB.



'FibrePlus' Study Results

493 GMt/ha ←

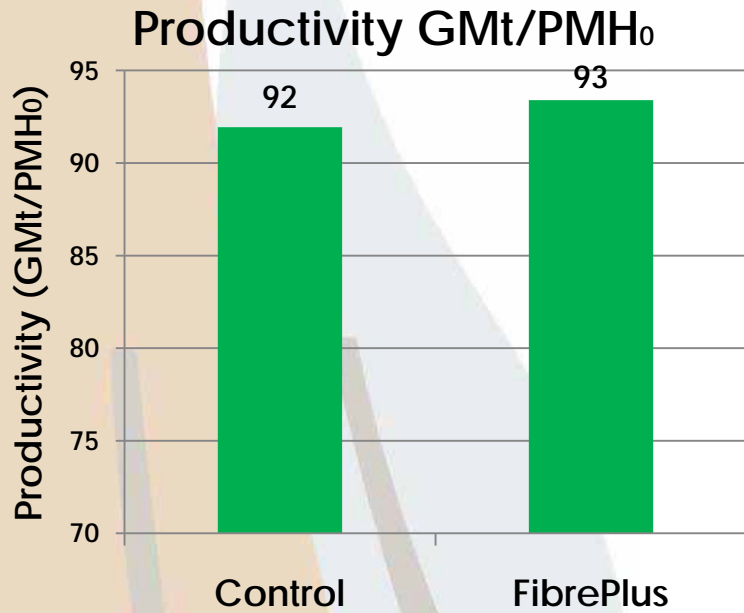




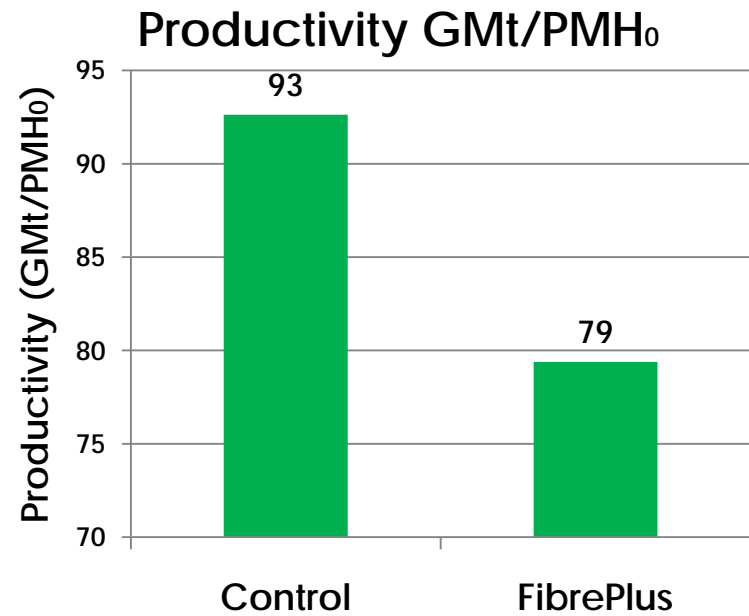
Valmet 475



Timbco 820



No difference!



~14% reduction!

'FibrePlus' Study Results

- Why Forwarding Productivity Reduced?
 - Time element comparison doesn't explain.
- Check productivity by log product?

Log Product Extracted	Control	FibrePlus
6.1m sawlogs	114.4 (35)	110.1 (36)
4.9/3.7m sawlogs	56.5 (8)	58.4 (6)
Pulp	41.6 (4)	N/A
Pulp/FibrePlus	N/A	30.8 (9)

- Significant difference in forwarder productivity between Pulp only loads (Control) and combined Pulp/FibrePlus loads (FibrePlus).

'FibrePlus' Study Results

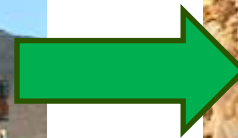
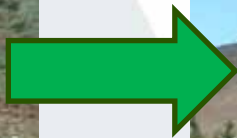
- Check mean load weights and mean total cycle times?

Log Product Extracted	Control		FibrePlus	
	Mean Load Weight (GMt)	Mean TCT (mins)	Mean Load Weight (GMt)	Mean TCT (mins)
6.1m Sawlogs	27.7	14.66	25.8	14.15
4.9/3.7m Sawlogs	17.7	18.81	19.0	19.57
Pulp	18.0	25.94	N/A	
Pulp/FibrePlus	N/A		12.7	24.88

- Significant difference in forwarder mean load weight between Pulp only loads (Control) and combined Pulp/FibrePlus loads (FibrePlus).

'FibrePlus' Study - Results

- FibrePlus Chip Quality
 - Chipped at roadside bark-on.
 - Bark content ~3%.
 - Suitable for papermaking mixed with debarked roundwood chip, or as biomass fuel.

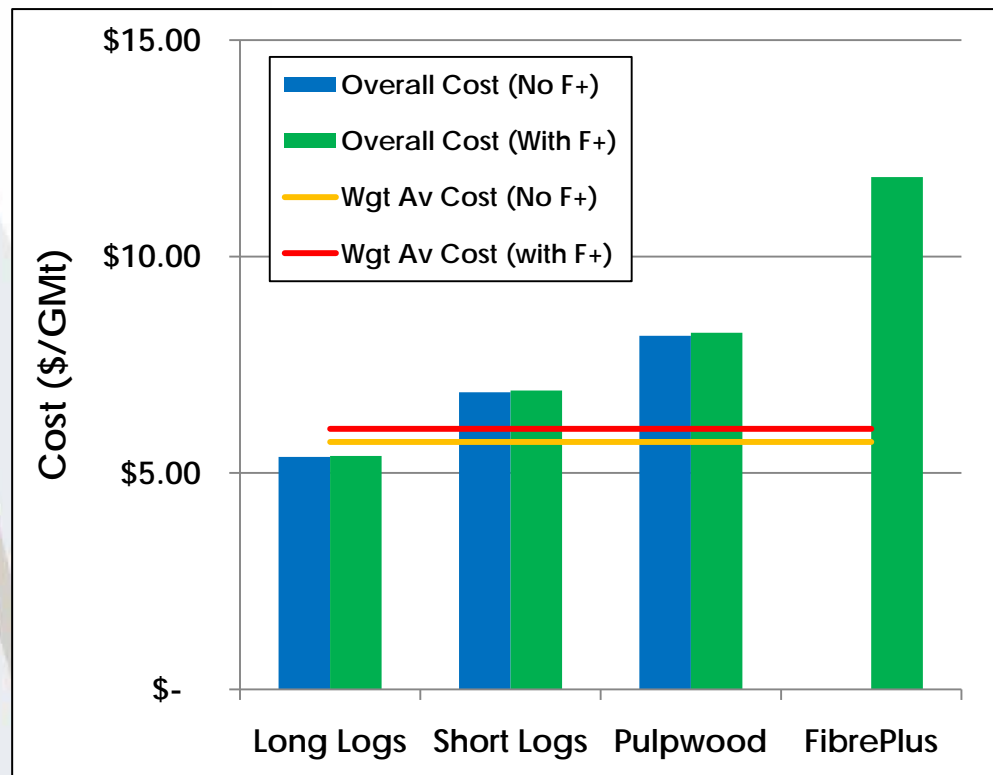


'FibrePlus' Study - Results

- Cost Impact
 - Existing hot-deck operation – increased overall harvest, extraction & loading cost of 12.1%!
 - Increased cost due to harvester slowing to balance the decreased productivity of forwarder.
- Alternative Scenarios
 - Cold-deck operation with alternative means of loading trucks.
 - Modified hot-deck operation where forwarder works extended shift.
 - Cost increase falls to 2.7 – 6.0%.

'FibrePlus' Study - Results

- What does it cost?



- Increase overall costs and prices paid by ~4%.

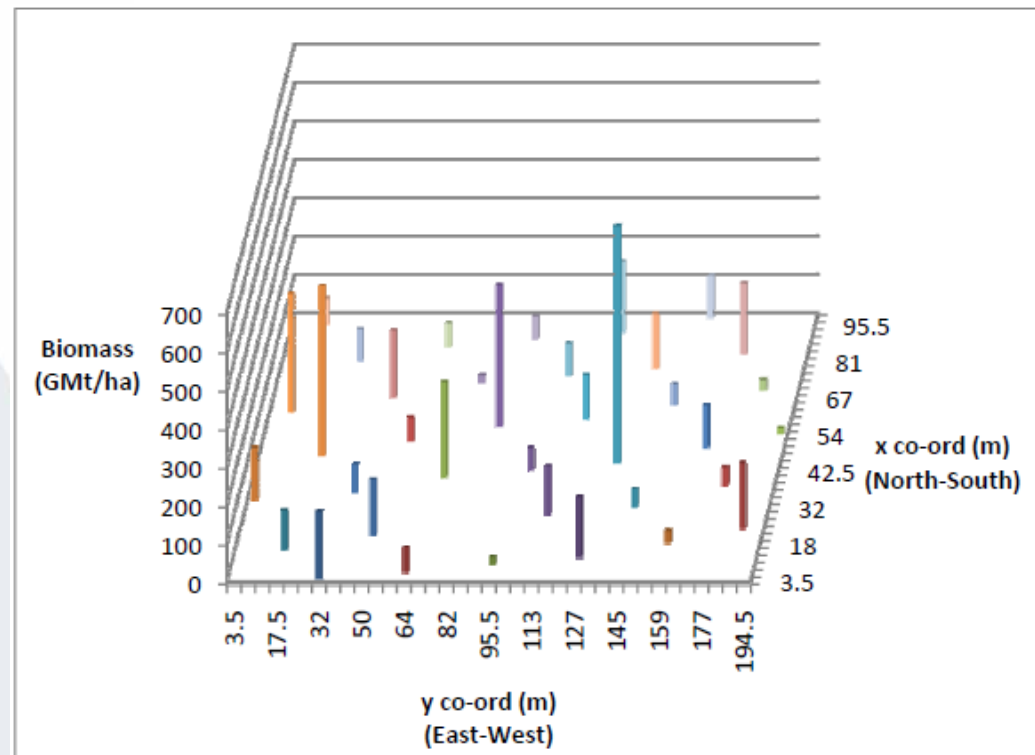
Retained Biomass Sampling

- Stratified random sampling based on pre-assessment of area.
- Use 1x1 m plots.
- Sample fractions – needles, stemwood, branches, bark, etc.

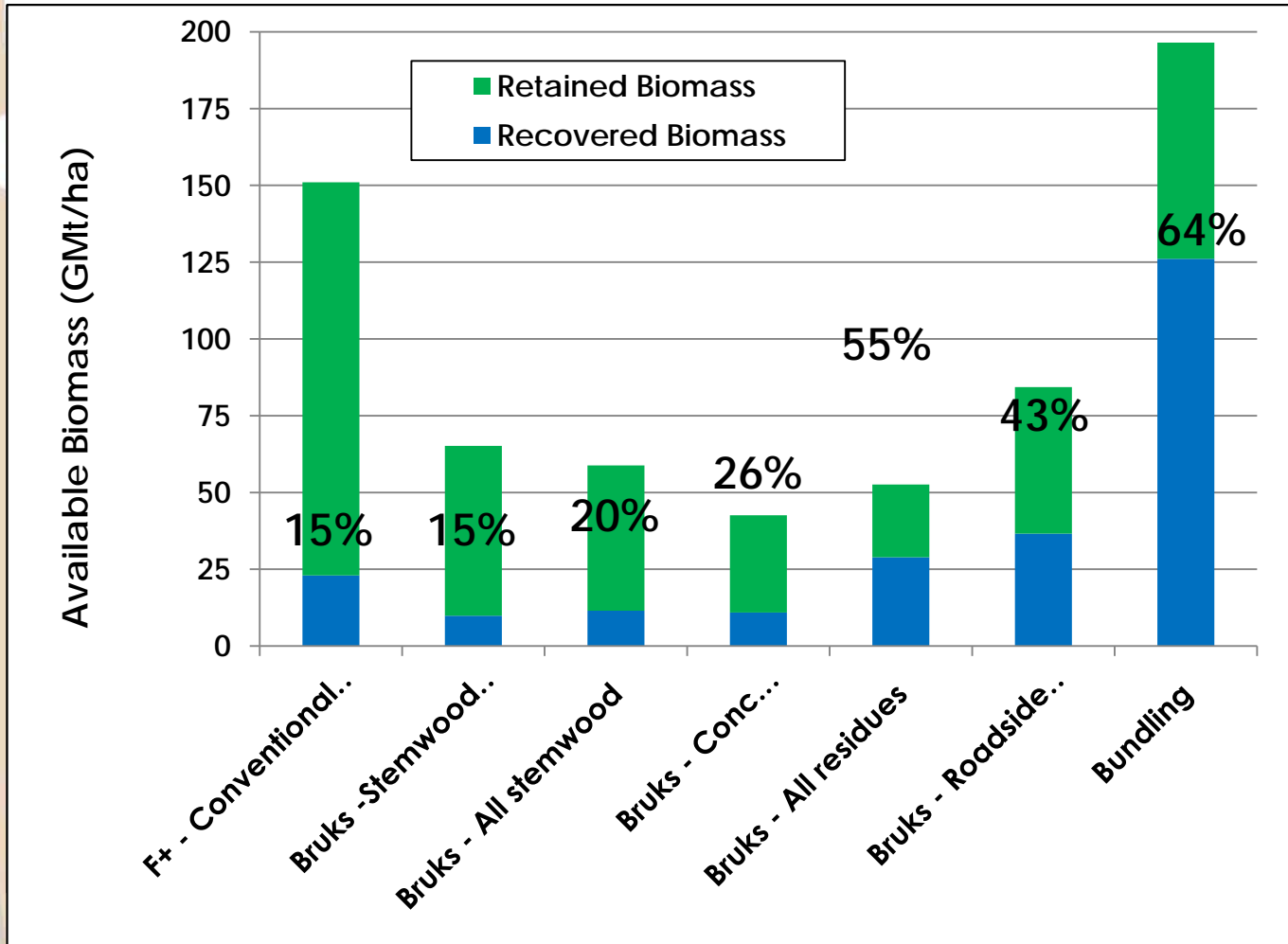


'FibrePlus' Study - Results

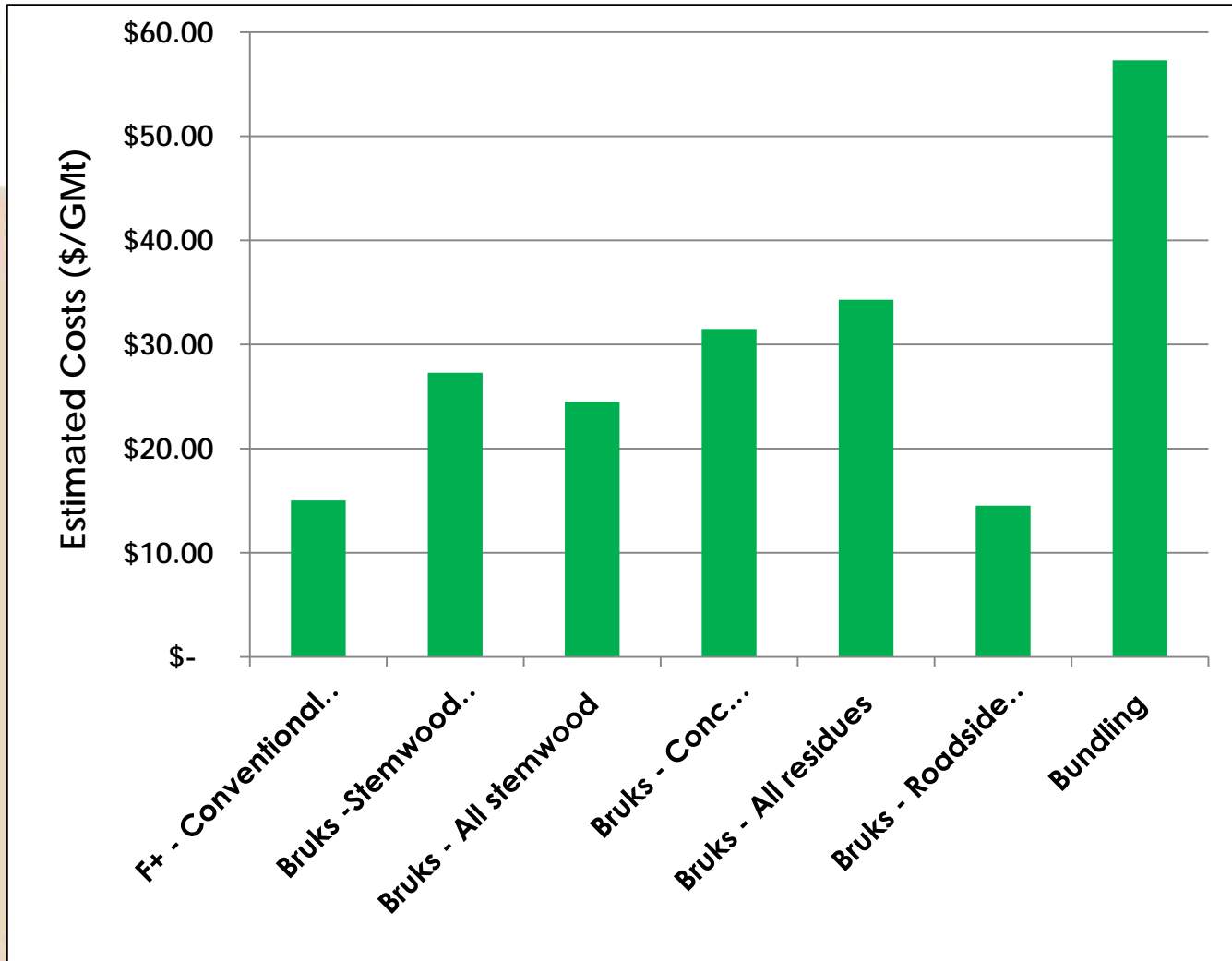
- ~130 GMt/ha of pine biomass left on site.
- Highly variable distribution 14 – 616 GMt/ha.



Trial Comparisons



Trial Comparisons



System	Advantage	Disadvantage
Slash-bundling	<ul style="list-style-type: none"> •Uniform product •Flexible logistics •Less storage needed •High biomass recovery 	<ul style="list-style-type: none"> •Expensive •Contamination •Medium to high nutrient removal
Bruks Mobile Chipper (in-forest)	<ul style="list-style-type: none"> •Effective extraction and transport of residue to roadside Flexible work options •Low nutrient removal 	<ul style="list-style-type: none"> •Difficult and expensive in steep or rough terrain •Expensive in thinning operations
Roadside Chipping – CTL Forwarder ('FibrePlus') with mobile chipper (eg. Bruks)	<ul style="list-style-type: none"> •Integrated into existing harvest operations •Relatively low cost when combined with mobile chipper •Higher productivity of mobile chipper – less movement of chipper. •Collects stemwood only, biomass left on site – low nutrient removal 	<ul style="list-style-type: none"> •Slows forwarder production – incurring extra costs •Potential problems balancing /matching machine outputs
Whole-tree Chipping	<ul style="list-style-type: none"> •High productivity for chipper and loader •No additional cost to extract residues •Biomass potentially available to be left on site if integrated operation 	<ul style="list-style-type: none"> •High nutrient removal •Site specific •Not integrated with other products •If integrated operation some biomass left on site as 'beehives' - uneven dispersal of retained biomass on site

Conclusions

- Possible biomass collection from harvest residues: Economy-Ecology
- Reduction of biomass harvest costs
- Increase product quality
- Finding best work method for each biomass harvester



Thank you!

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