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# The impact of mechanical log surface damage on fibre loss and chip quality when processing *Eucalyptus* pulpwood using a single-grip harvester

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**MSc. Project**

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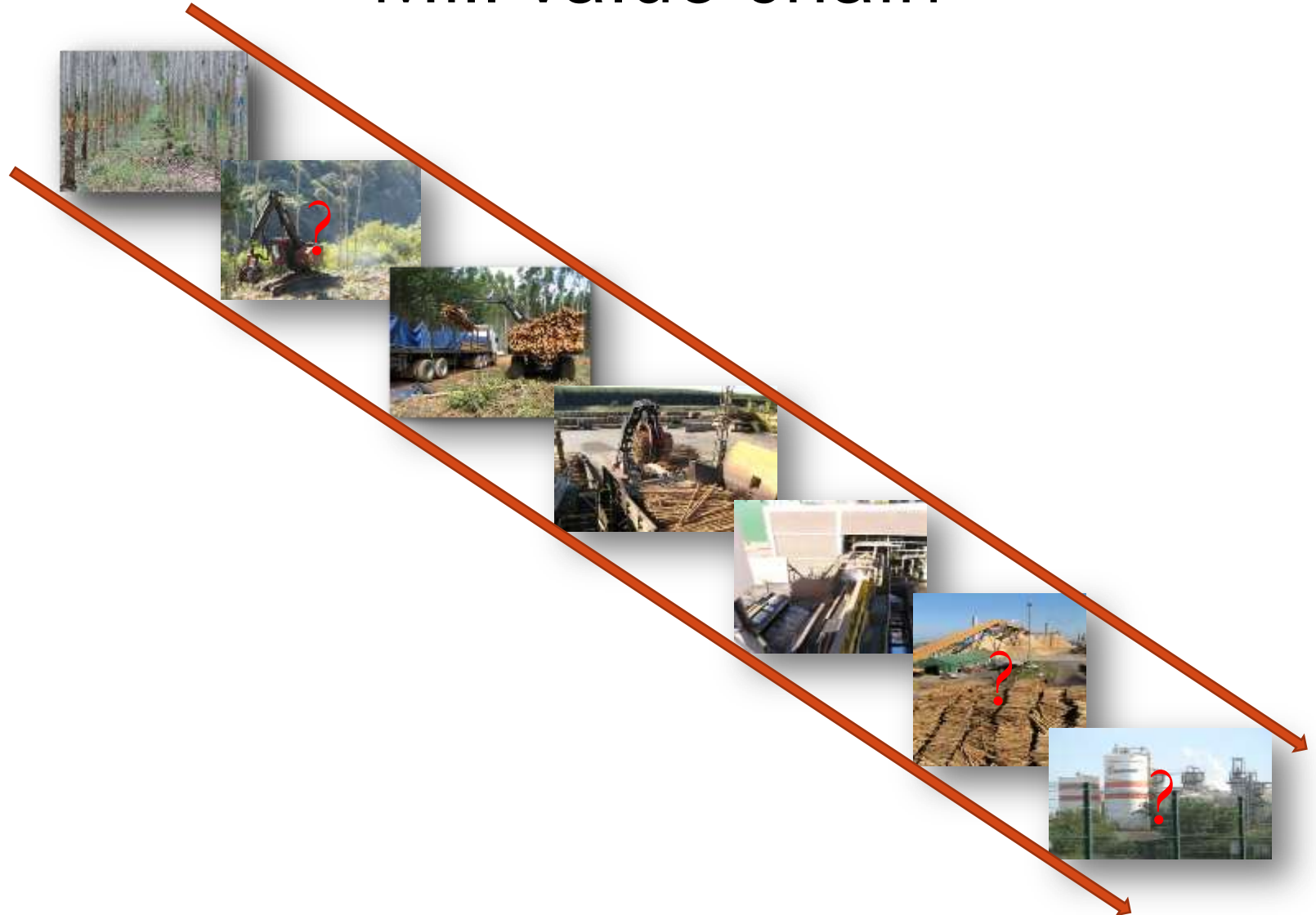
# Research problem & Question

- Influence of mechanized debarking, log dryness class and log size on:
  - Wood chip size distribution
  - Wood chip bark content values
  - Fibre loss

How does mechanised debarking of *eucalyptus* roundwood logs influence wood chip quality and fibre loss in pulp and paper manufacturing?



# Mill value chain





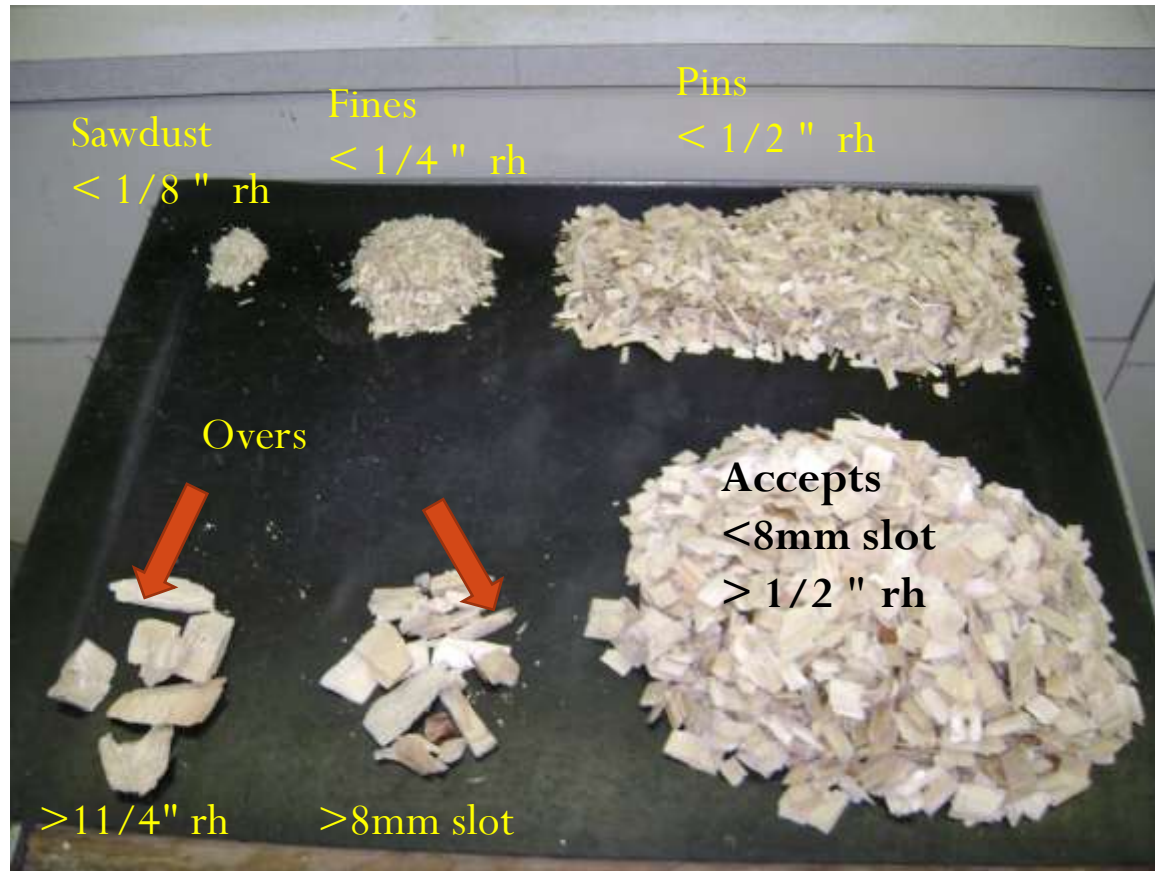
# Log surface damage







# Typical wood chip size specifications



	Fines	Pins	Accepts	Over-thick	Oversize
Relative pulp yield values	0.25	0.50	1.00	0.94	0.92
Pulp Yield % for <i>E. grandis</i> × <i>urophylla</i> (9 years)	12.85	25.70	51.40	48.32	47.29

(True, 2006; McEwan, 2004)



# Site information





# Experimental design

- **180 Trees harvested (540 logs)**
- **Harvesting treatments (18 with 30 logs per treatment)**
- **Three debarking treatments**
  - **Mech 1 (3 processor head passes)**
  - **Mech 2 (5 processor head passes)**
  - **Motor-manual (control)**
- **Two drying periods**
  - **One week**
  - **Two weeks**
- **Three log section classes**
  - **Base section**
  - **Middle section**
  - **Top section**
- **3 × 2 × 3 Factorial design**
- **Degree of confidence 95%**

R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15
A3	A3	A3	A3	A3	A2	A2	A2	A2	A2	A1	A1	A1	A1	A1
A3	A3	A3	A3	A3	A2	A2	A2	A2	A2	A1	A1	A1	A1	A1
A2	A2	A2	A2	A2	A3	A3	A3	A3	A3	A1	A1	A1	A1	A1
A2	A2	A2	A2	A2	A3	A3	A3	A3	A3	A1	A1	A1	A1	A1
A3	A3	A3	A3	A3	A2	A2	A2	A2	A2	A1	A1	A1	A1	A1
A3	A3	A3	A3	A3	A2	A2	A2	A2	A2	A1	A1	A1	A1	A1
A2	A2	A2	A2	A2	A3	A3	A3	A3	A3	A1	A1	A1	A1	A1
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A2	A2	A2	A2	A2	A2	A2	A2	A2	A2	A1	A1	A1	A1	A1
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A3	A3	A3	A3	A3	A2	A2	A2	A2	A2	A1	A1	A1	A1	A1
A3	A3	A3	A3	A3	A2	A2	A2	A2	A2	A1	A1	A1	A1	A1
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A2	A2	A2	A2	A2	A3	A3	A3	A3	A3	A1	A1	A1	A1	A1
A2	A2	A2	A2	A2	A3	A3	A3	A3	A3	A1	A1	A1	A1	A1





# Harvesting





# Marking & Fibre collection – log level

- Logs marked after felling (5.5m logs)
  - Use of timber tags
  - Numerically sequenced
- Complementary data
  - Tree –DBH, height
  - Log position – Base, middle, top
  - Debarking treatment







# Fibre collection





# Secondary transport







# Chipping



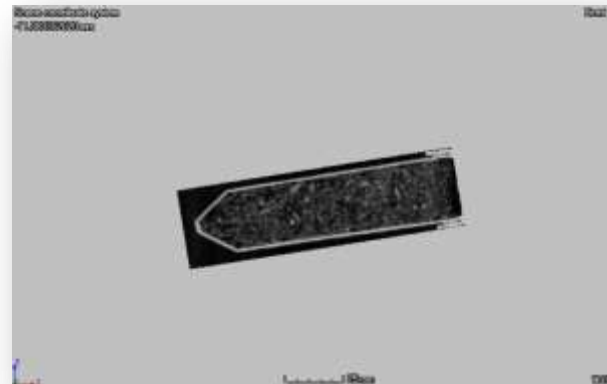
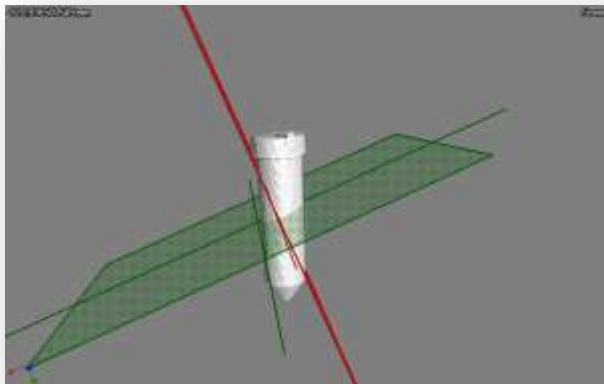
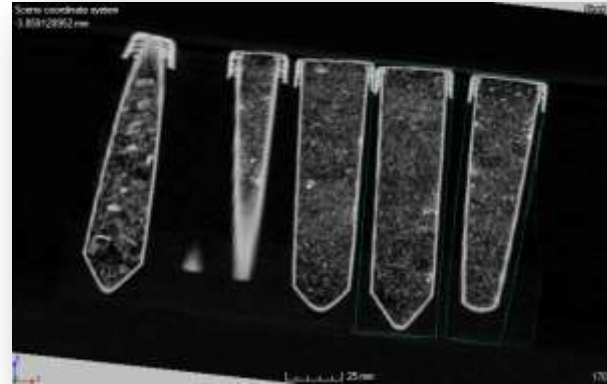
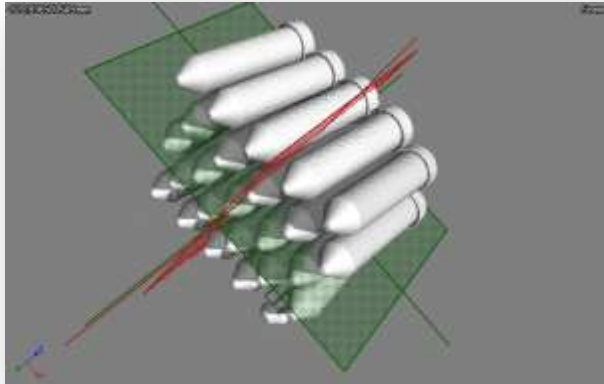


# Wood chip sampling

- Wood chip samples
  - Non bias (12 litres) per log – thoroughly mixed wood chips
    - Chip screening and classification
      - Oversize chips
      - Over-thick chips
      - Accept chips
      - Pins
      - Fines
  - Wood chip moisture content calculated
  - Wood chip purity
    - Bark and knots removed
    - Expressed as a weight fraction of sampled chips



# Harvesting residues: Micro CT scanning



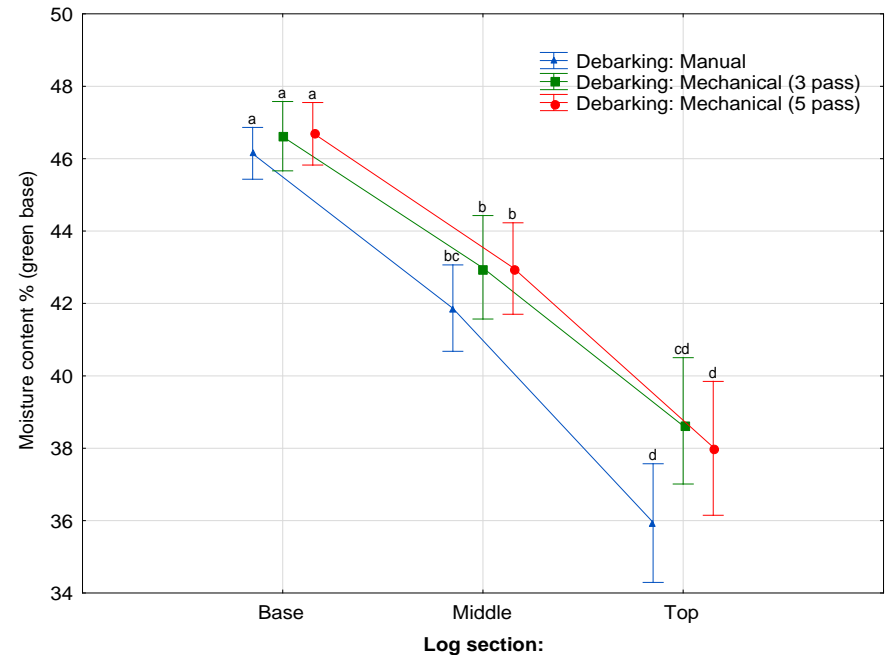
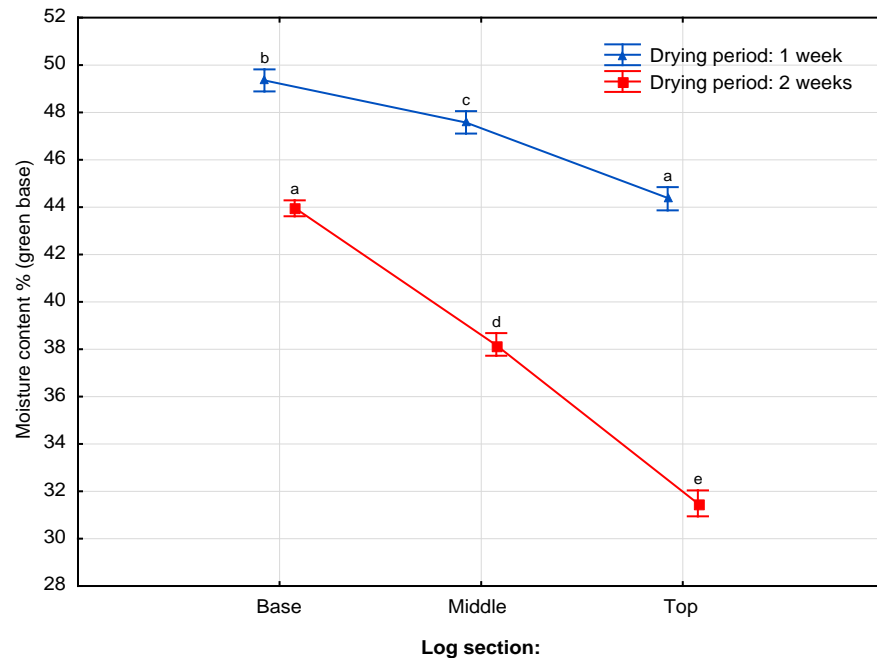


# Physical log properties





# Wood chip moisture Content %



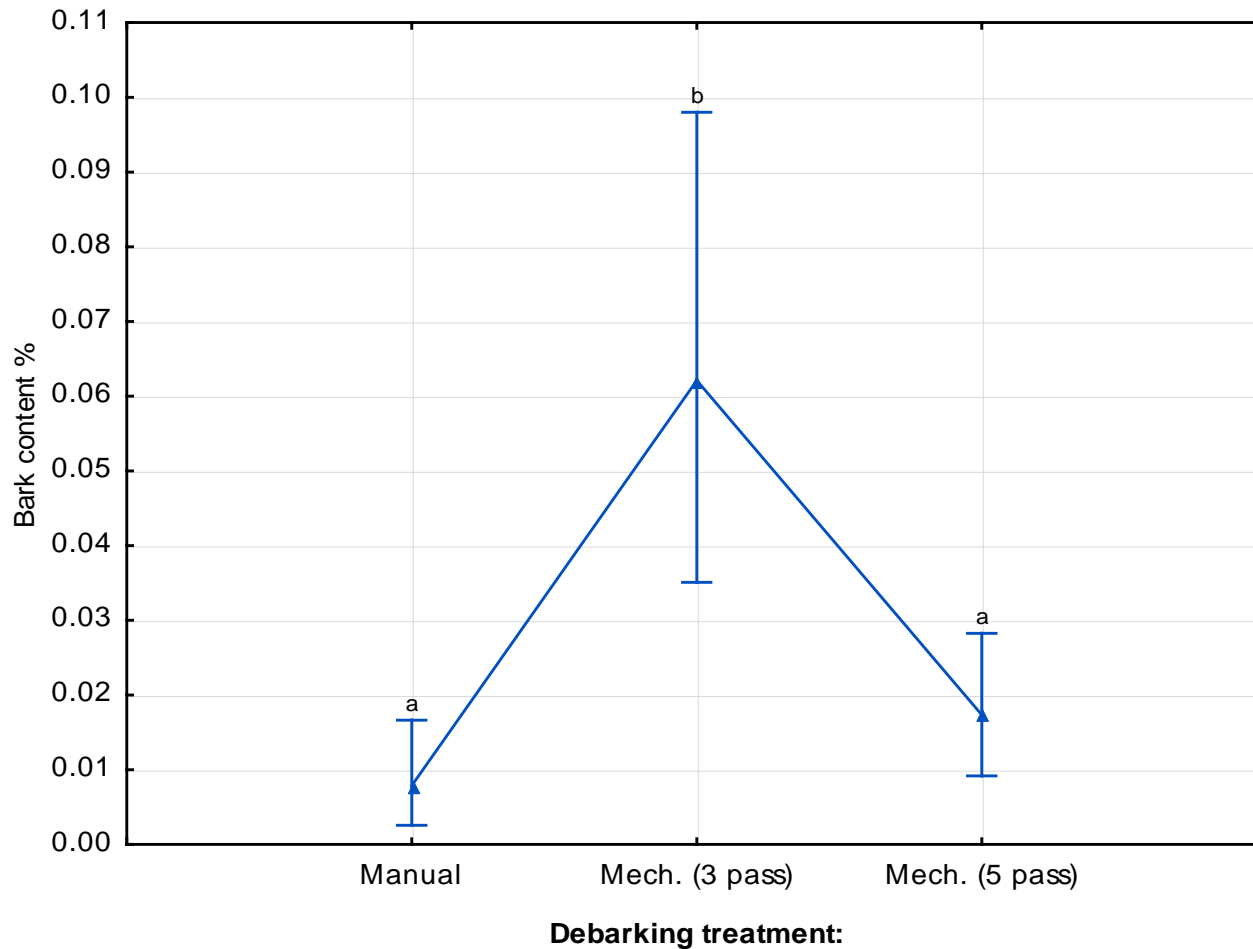
- Log drying rates higher with decreasing log size
- No significant difference in log MC across debarking treatments



# Wood Chip Purity



# Bark content %: Treatment



- Manually and Five pass mechanically debarked logs produced wood chips with a significantly lower bark content.
- Wood chip bark contents of 0.3% - 0.5 % allowed (Biermann, 1996)

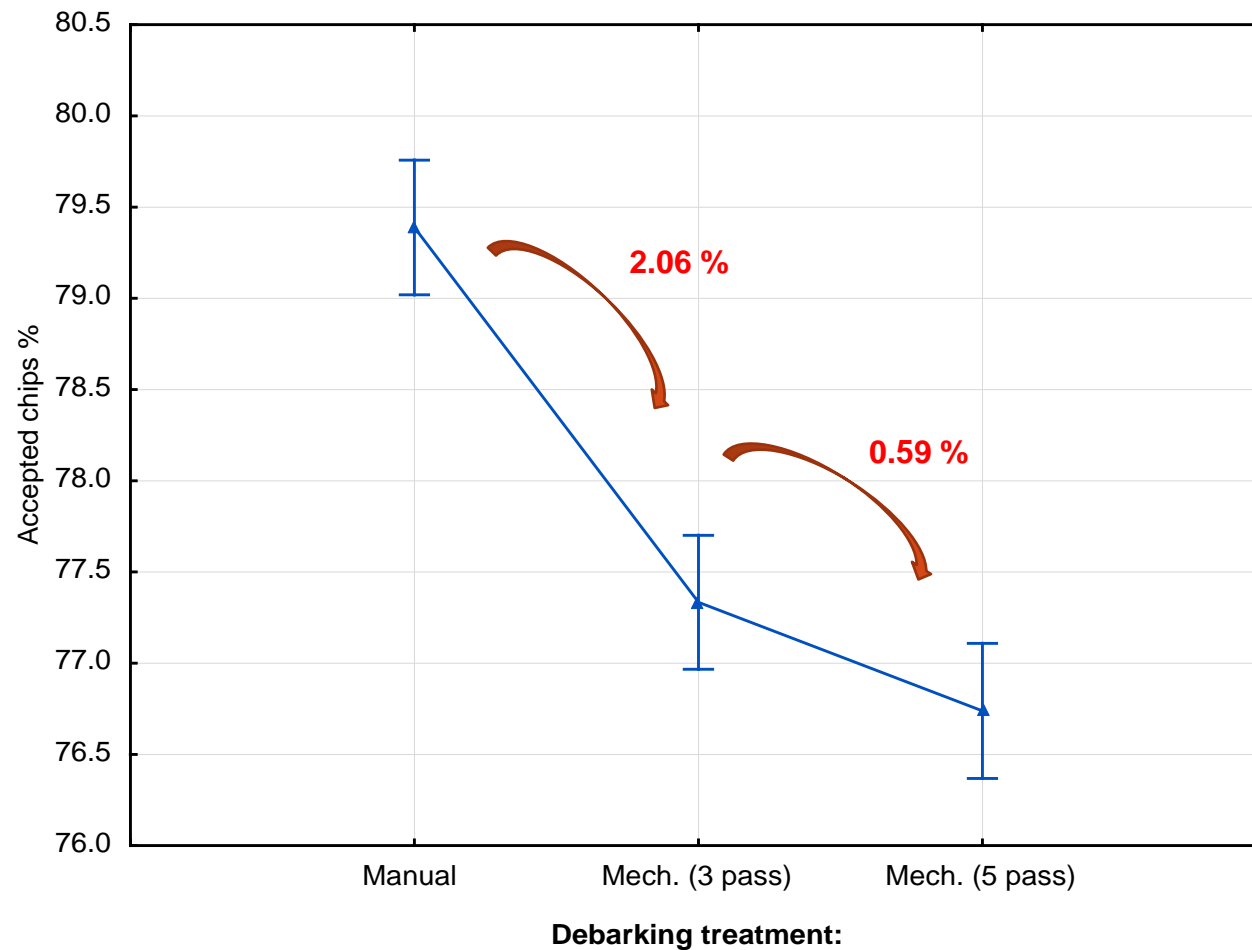


# Wood Chip Uniformity



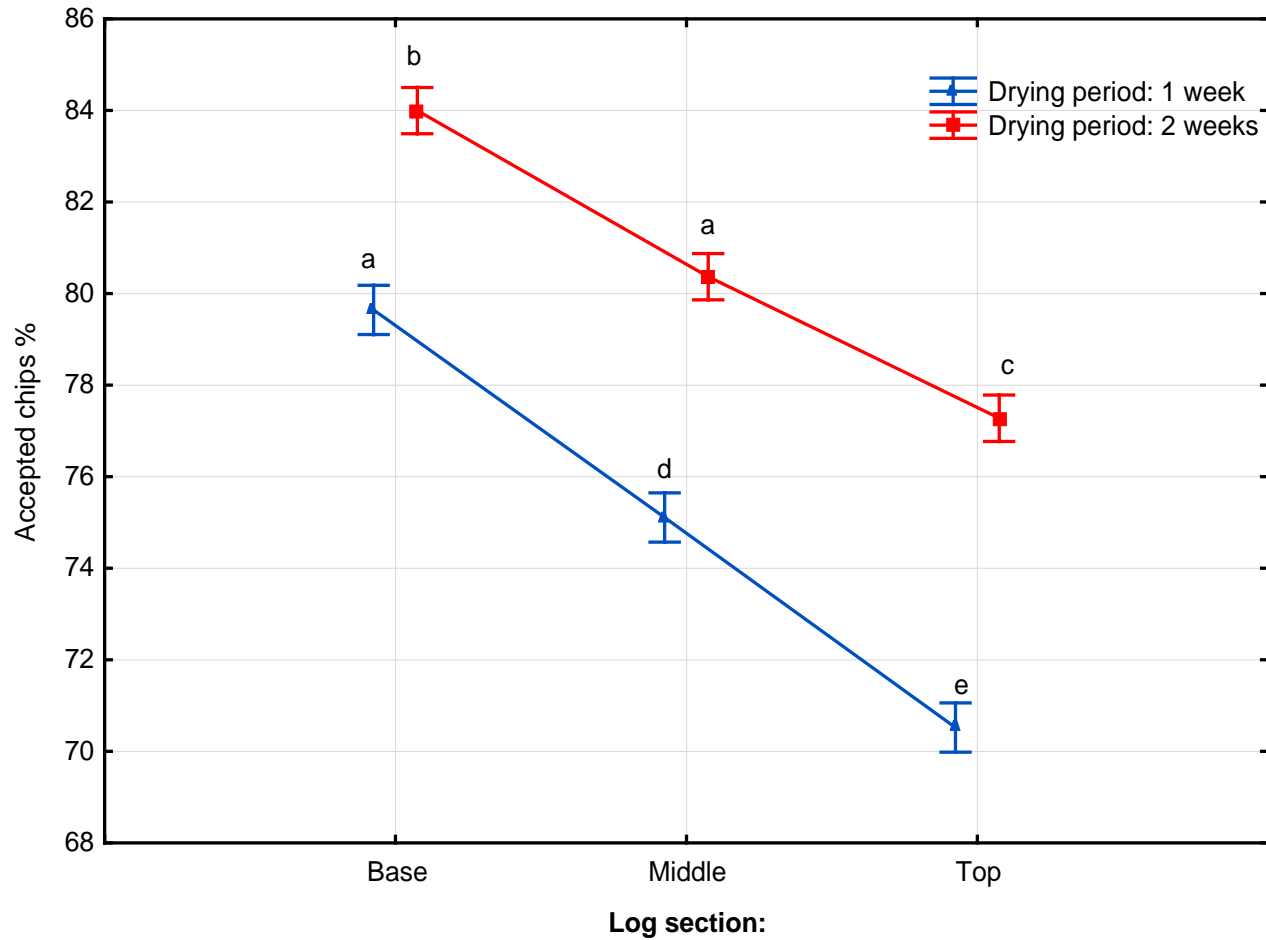


# Accepted chips %





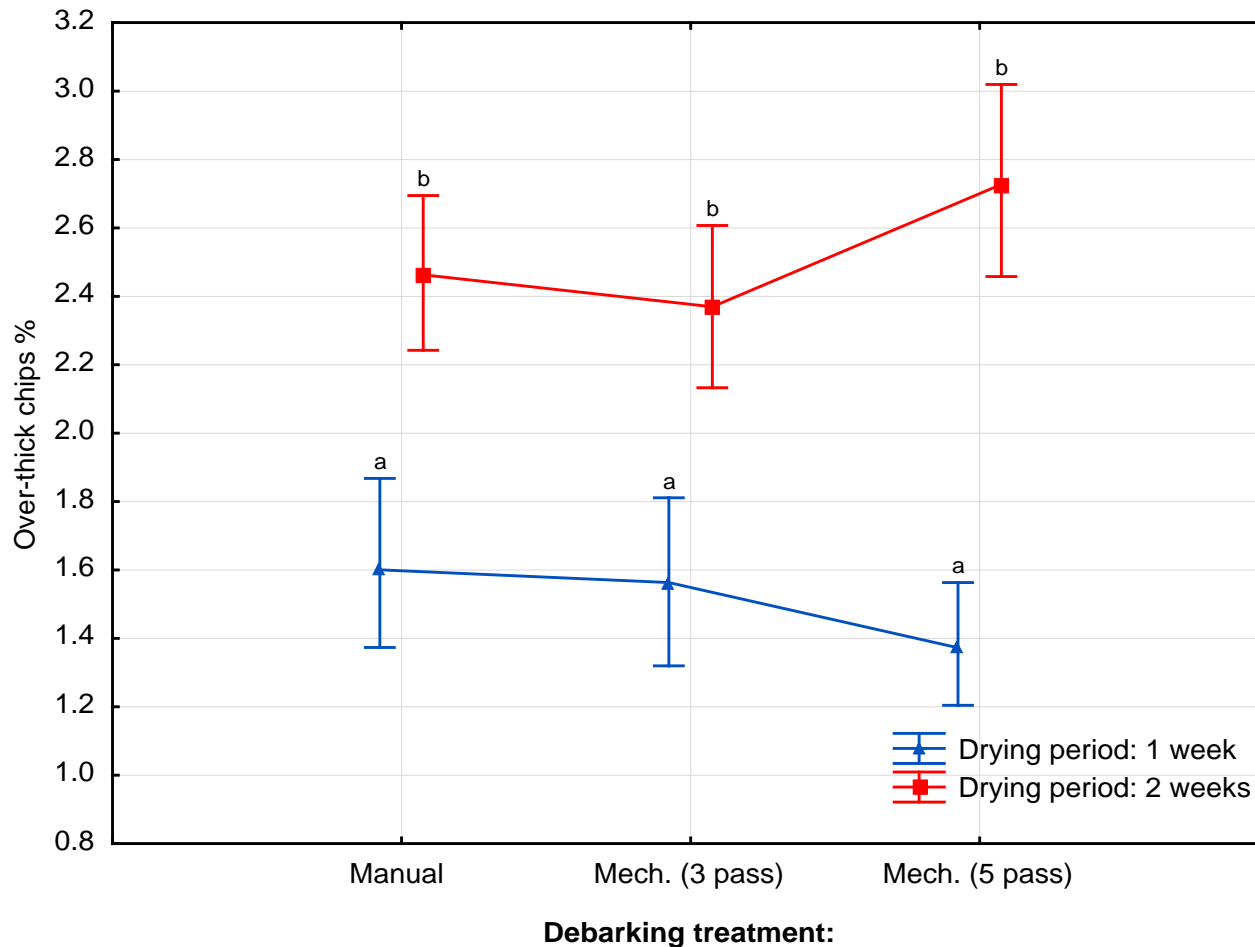
# Accepted chips %



- Logs dried for a one week period produced significantly less accept chips
- Accept chip content decreased with decreasing log size



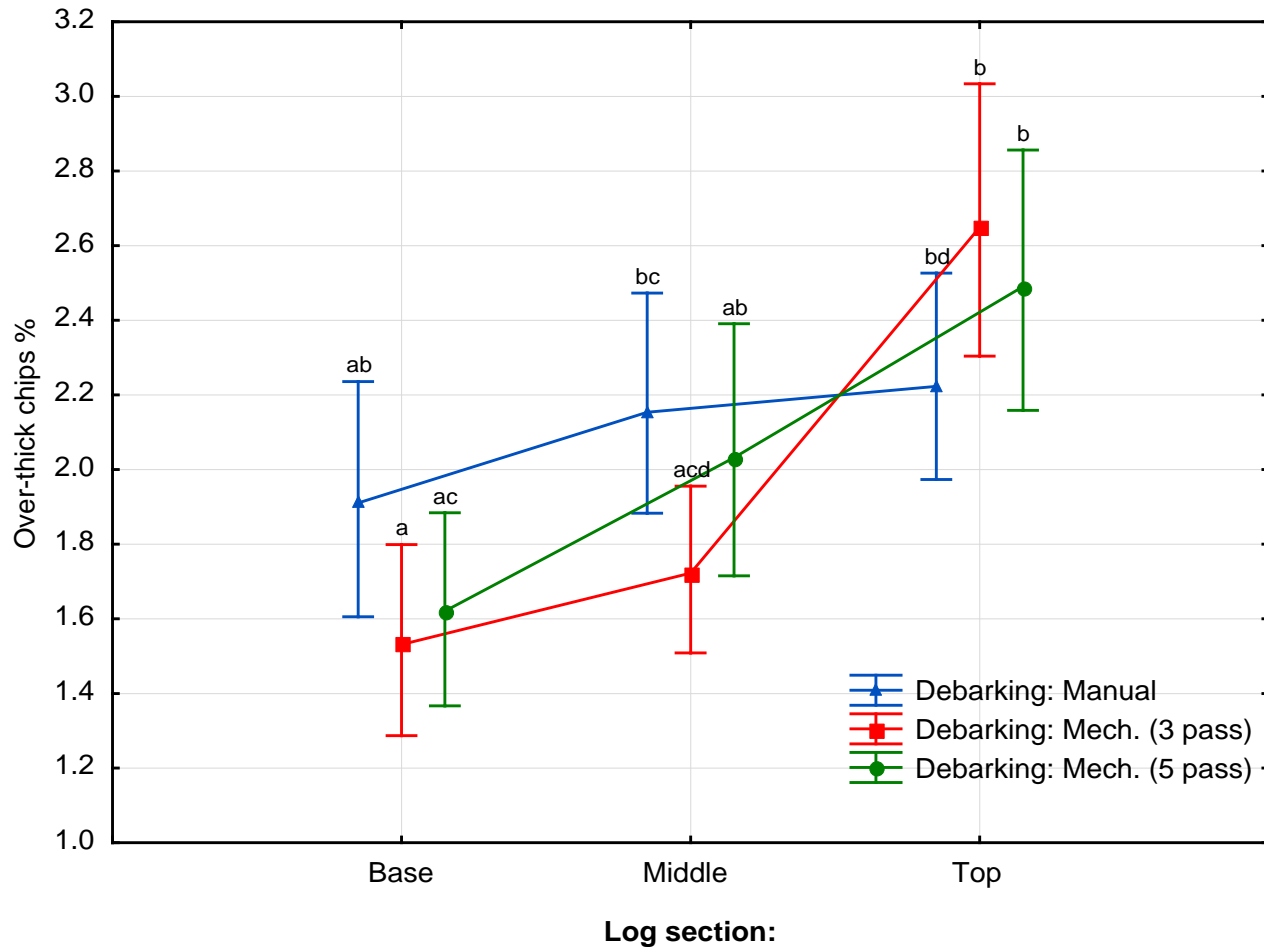
# Over-thick chips: Treatment × Drying period



- Logs dried for a one week period produced significantly less over-thick wood chips



# Over-thick chips: Treatment × Log section



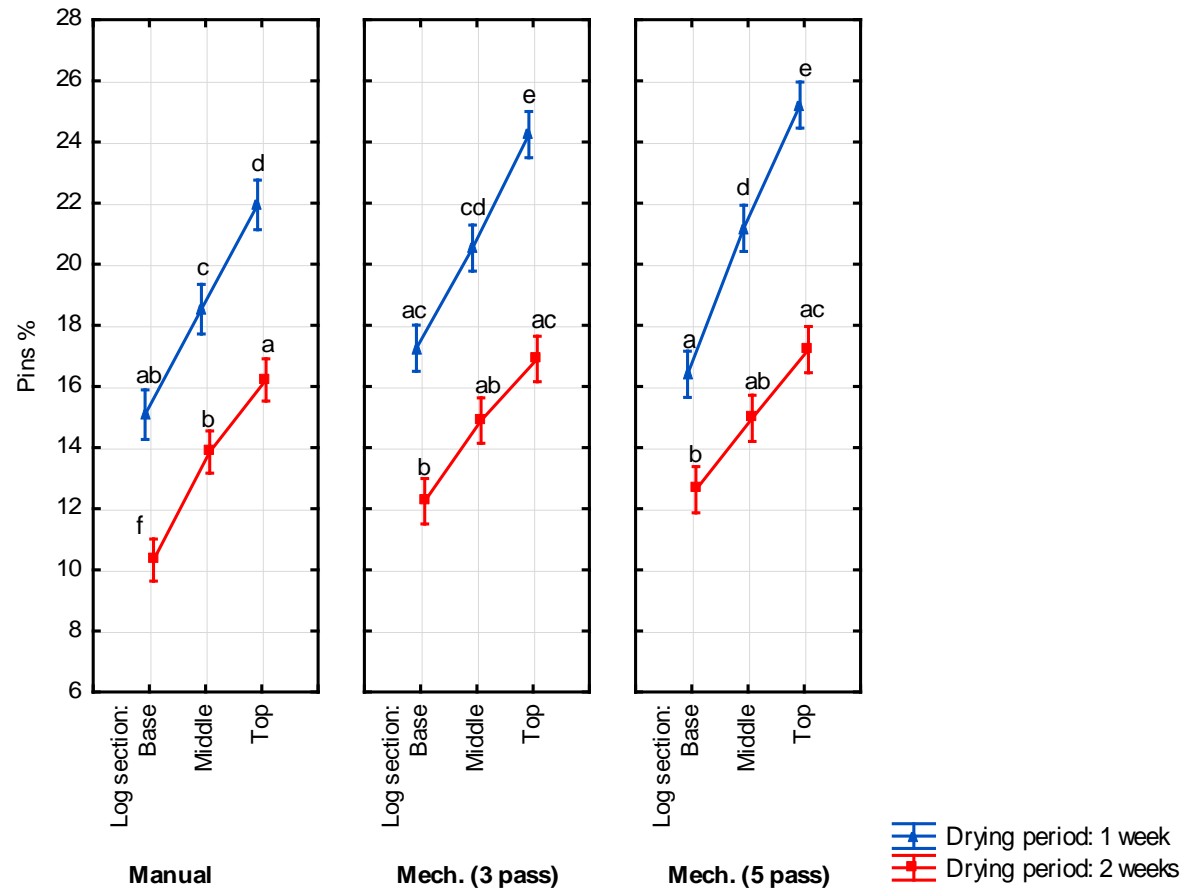
- Feed roller induced log surface damage had a significant effect on over-thick chip production





# Pins:

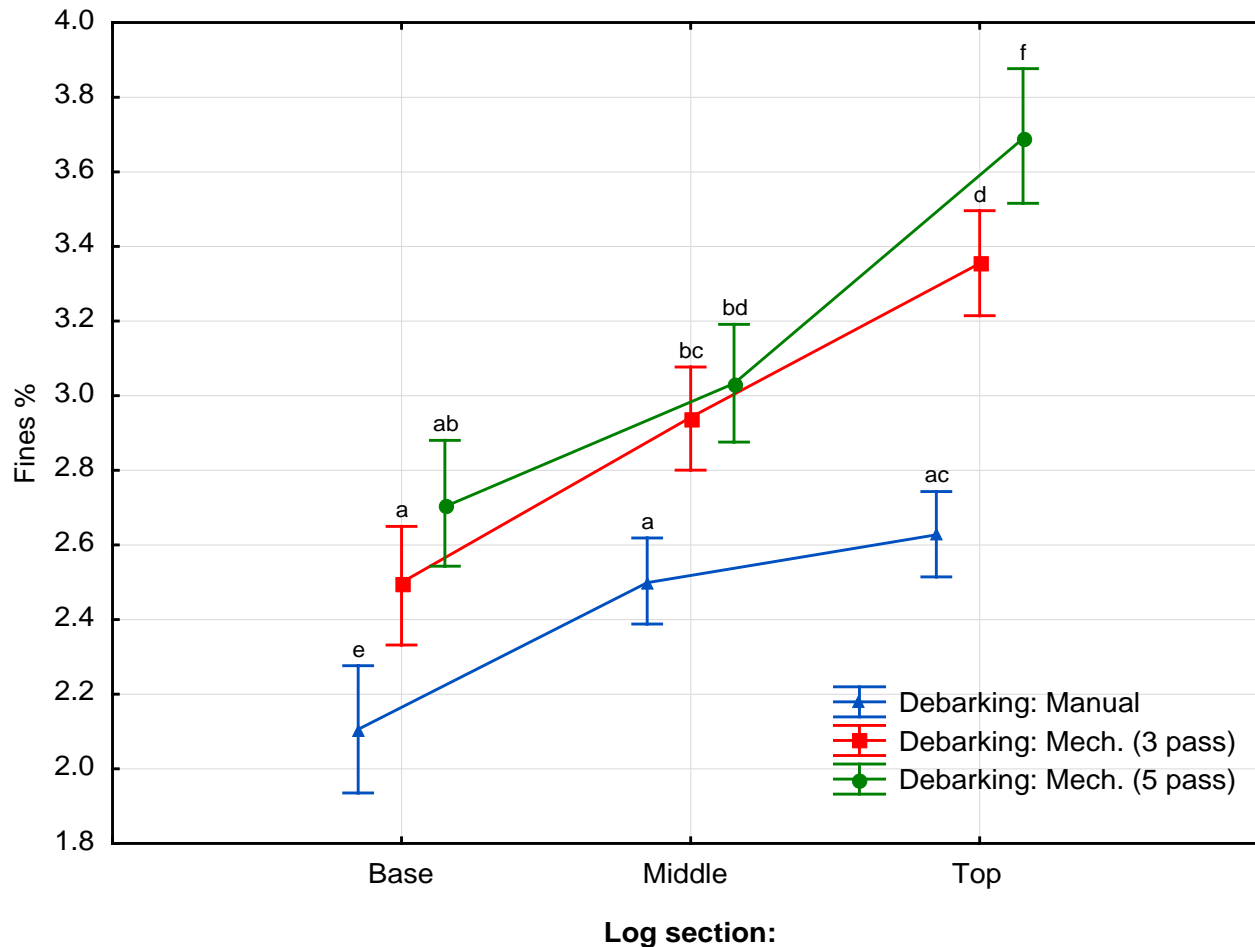
## Treatment×Drying period×Log section



- Logs dried for a one week period produced wood chips with significantly more pins
- Wood chip pin content increased with decreasing log size
- Log surface damage caused greater increases in pin chip production after a one week drying period



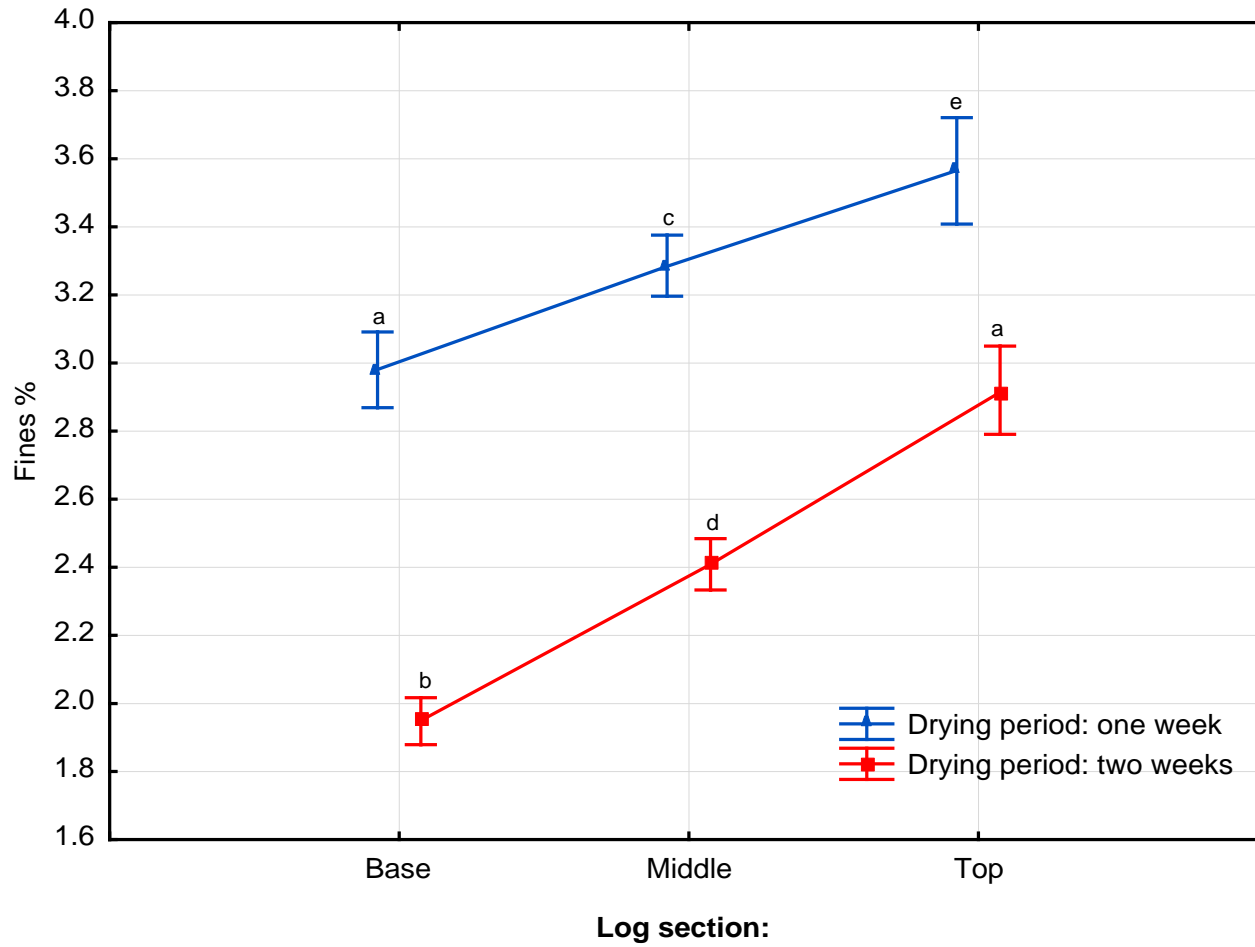
# Fines: Treatment × Log section



- Manually debarked logs produced wood chips with significantly less fines
- Wood chip fines content increased with decreasing log size



# Fines: Drying period × Log section



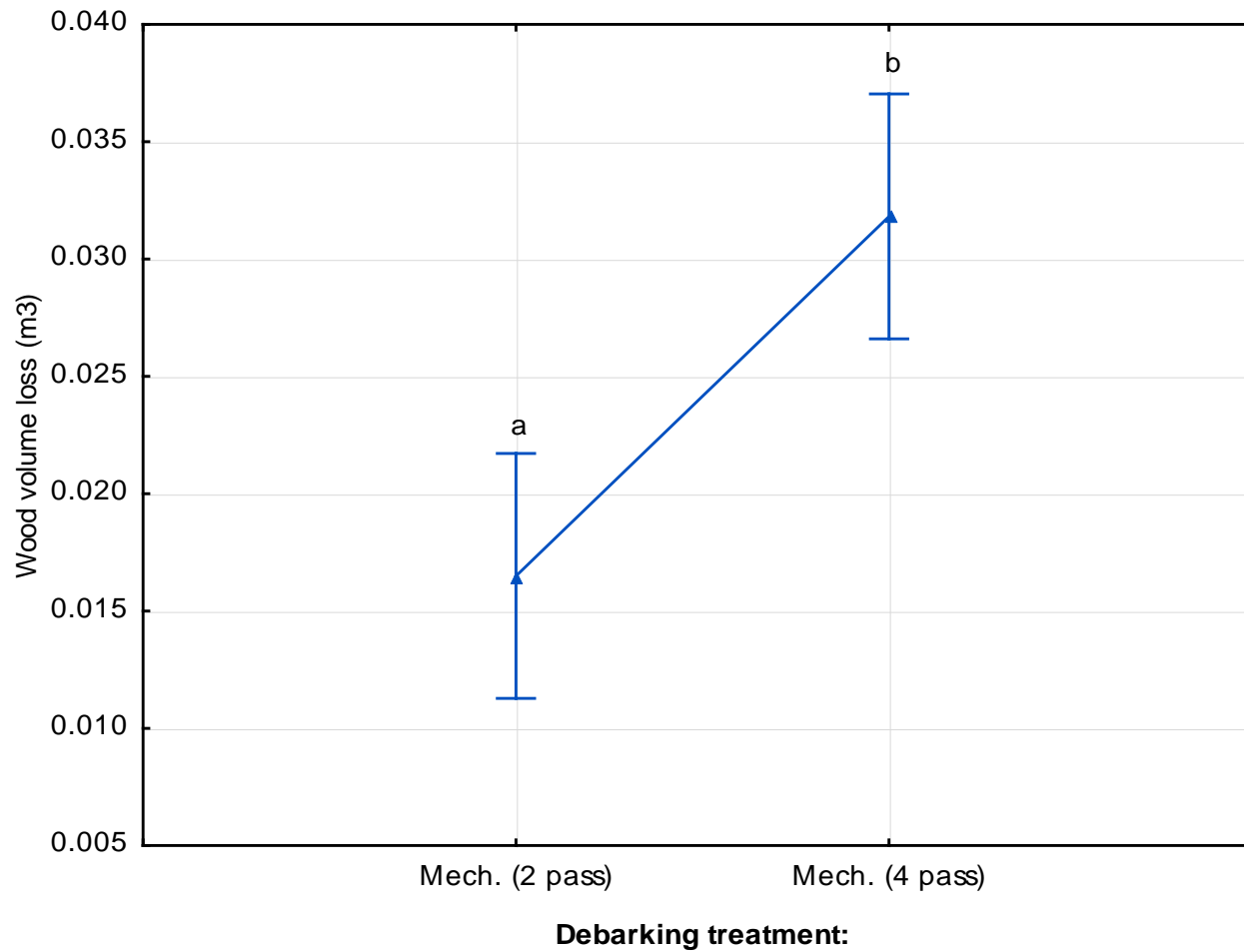
- Logs dried for a one week period produced significantly more wood chip fines
- Wood chip fines content increased with decreasing log size



# Feed roller induced fibre loss



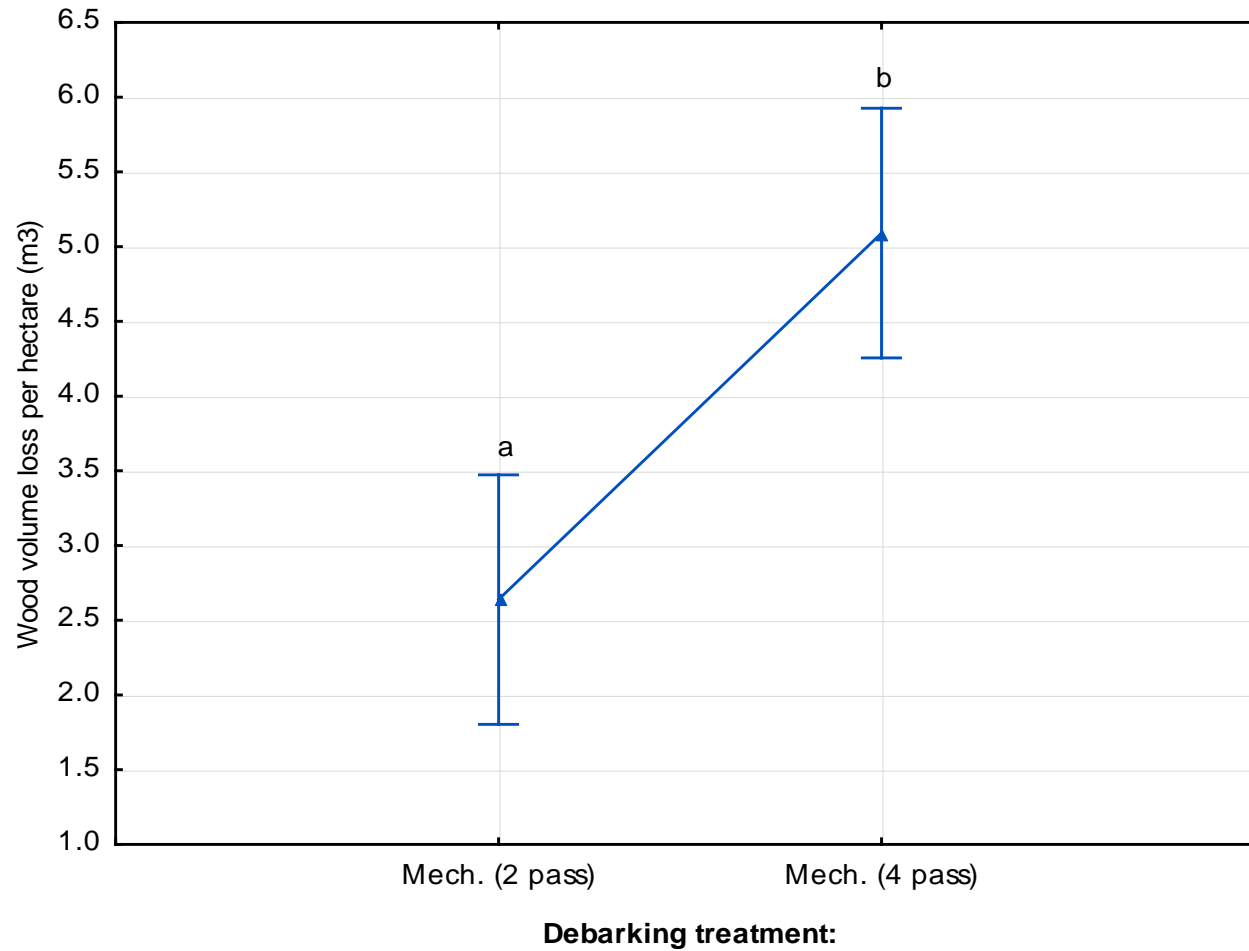
# Wood fibre loss volume: Per setting (10 trees)



Treatment	%	Treatment	%	Diff.
Mech. debarked (two pass)	0.83	Mech. debarked (four pass)	1.58	0.75



# Wood fibre loss volume: Per ha



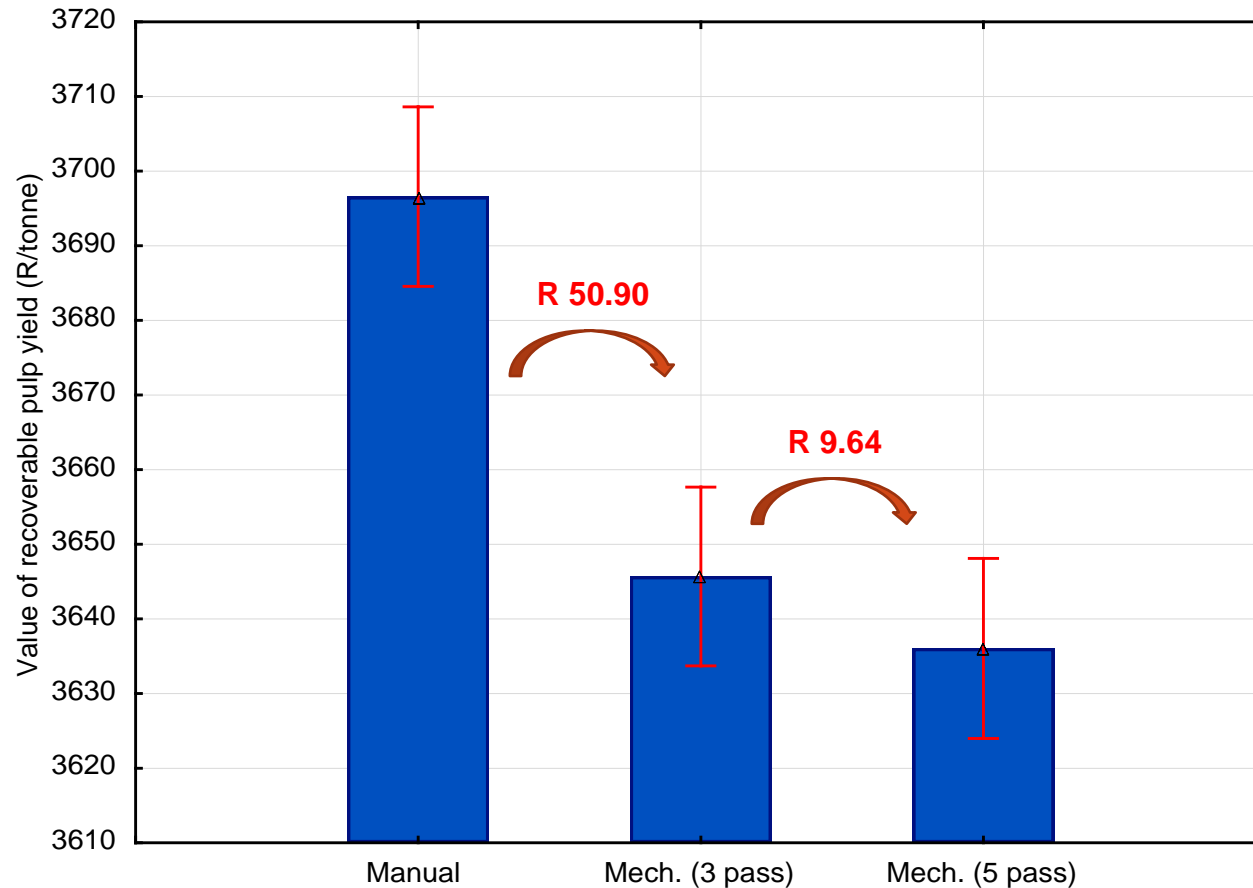




# Economic Evaluation



# Value of recoverable pulp: Debarking Treatment



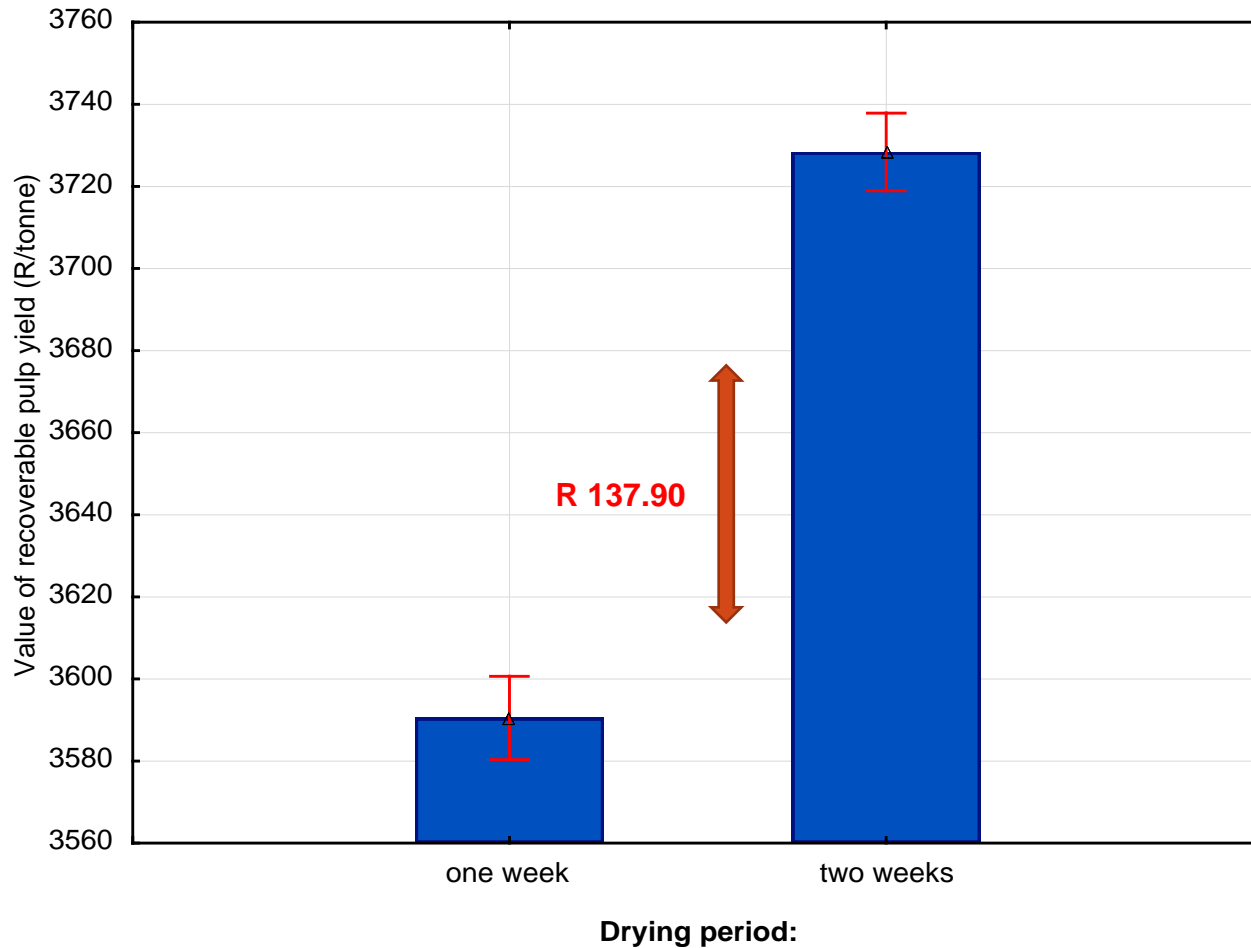
Debarking treatment:

Product	Pulp price (August 2013)	
	US Dollar/tonne	Rand/tonne
Bleached Eucalyptus Kraft pulp (BEKP)	\$ 792.00	R 7 989.21

(KSH Consulting, 2013)



# Value of recoverable pulp: Drying Period

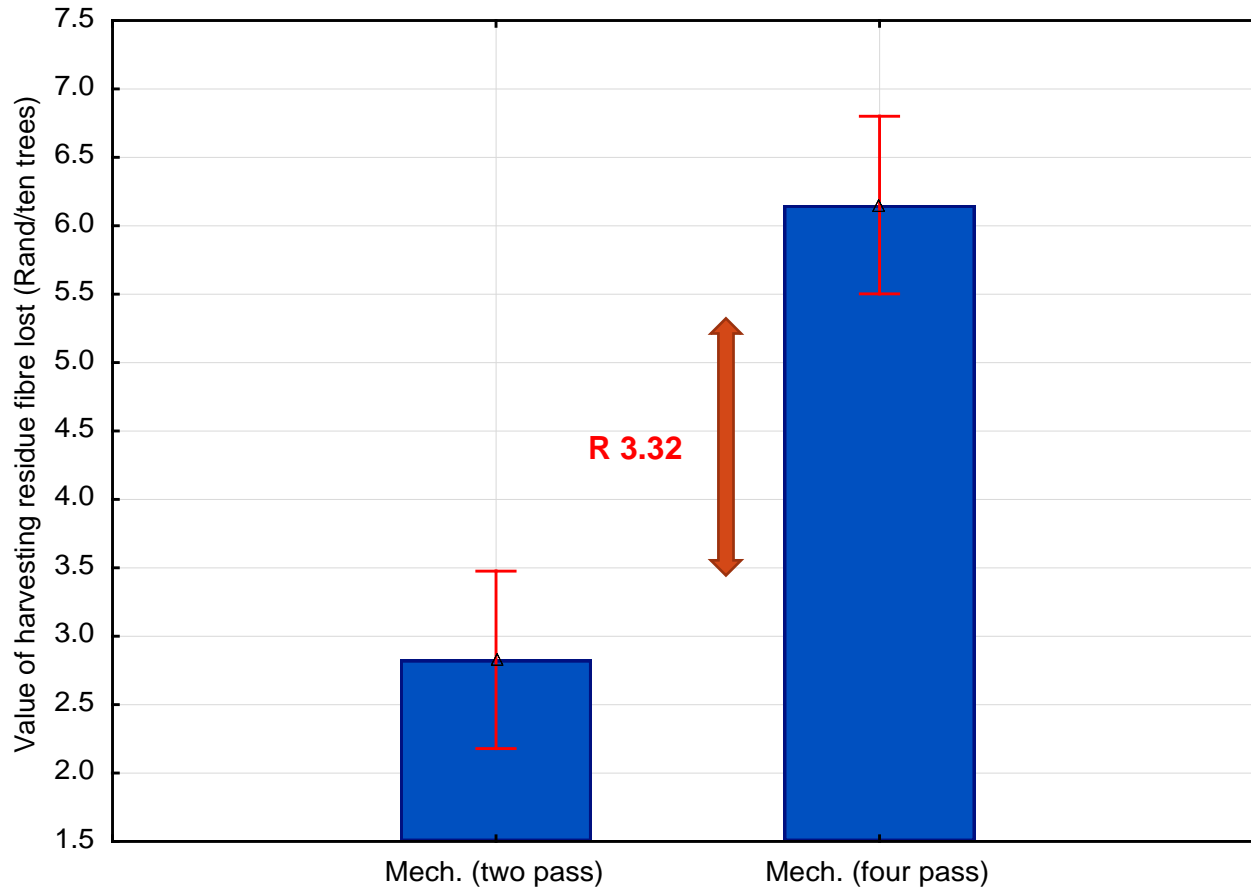


Product	Pulp price (August 2013)	
	US Dollar/tonne	Rand/tonne
Bleached Eucalyptus Kraft pulp (BEKP)	\$ 792.00	R 7 989.21

(KSH Consulting, 2013)



# Value of wood fibre lost: Debarking Treatment (10 trees)

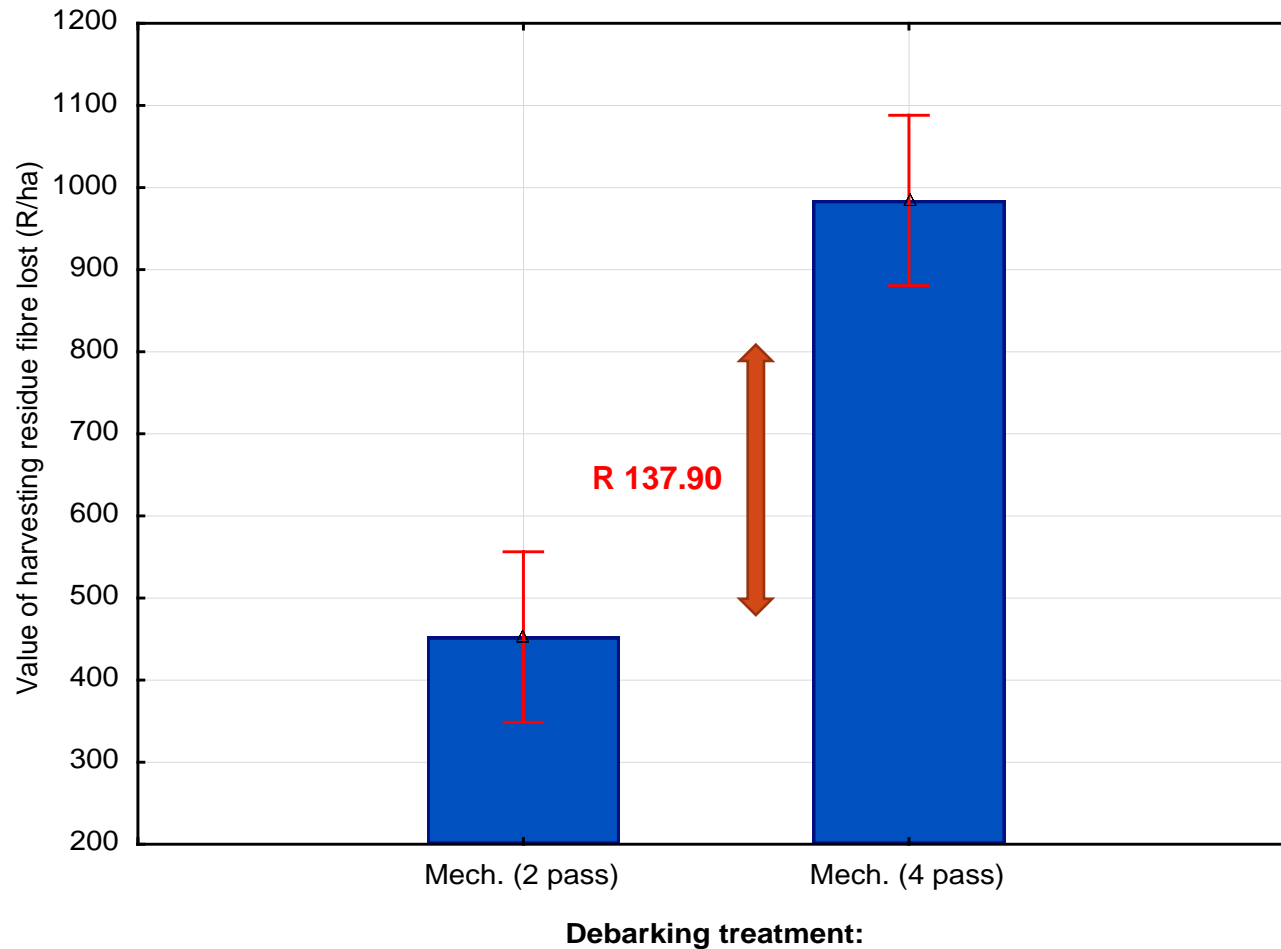


Debarking treatment:

Product	Rand/tonne	Reference
<i>Eucalyptus</i> pulpwood (green state)	R 299.28	FES, 2012



# Value of wood fibre lost: Debarking treatment (1600 trees)



Product	Rand/tonne	Reference
<i>Eucalyptus</i> pulpwood (green state)	R 299.28	FES, 2012





# Results summary

- Wood chip uniformity and fibre loss is related to feed roller induced log surface damage
- Log drying period influence wood chip uniformity and pulp recovery
- Wood chip uniformity and pulp recovery decreases with decreasing log/tree size



# Discussion and Conclusion

- Fewer feed roller passes
- Residual bark
- Harvesting head calibration
- Research into optimum log moisture content
- Optimum debarking break point



# References

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