Unlocking the potential of harvester on-board-computer data in the South African forestry value chain

Marius Terblanche[1], Pierre Ackerman, Simon Ackerman[2]
Department of Forestry and Wood Science, Stellenbosch University, South Africa
17621194@sun.ac.za[1], ackerman@sun.ac.za[2]

1. Introduction

South Africa is experiencing a rapid shift from semi-mechanized to fully mechanized cut-to-length harvesting operations. As a result, there is a marked increase of harvesters in the country, most of which are StanForD protocol compliant. This facilitates the collection of detailed tree and operational data. For various reasons, this data output is not being fully utilized by machine owners. A key issue is the calibration of the on-board computing systems (OBC) with regards to bark deduction methods and under bark volume estimation, however this process is currently not fully understood and utilized in the South African plantation forestry context.

The study objective was to develop and apply a suitable bark deduction method for *Pinus patula* for South African conditions on the Ponsse Opti control system running on purpose built Ponsse harvesters for more accurate harvester under bark volume calculation.

2. Materials and Methods

Change in *P. patula* bark thickness up the stem was modelled using historical bark thickness data.

- Developed bark thickness equations by plotting bark thickness on the y-axis and relative height on the x-axis

Two applicable bark deduction methods available on the harvester`s OBC were parameterised.

- The models developed were used to populate the two respective bark deduction methods –length-based bark deduction method and diameter-class length-based bark deduction.

The two bark deduction methods were field tested and compared with a third control trial.

- Three trials – T1 (control – no bark deduction), T2 (Length-based bark deduction method) and T3 (Diameter-class length-based bark deduction.)

Harvester log measurements were compared with physical log measurements for length, diameter and volume.

- Harvester log measurements were obtained from the StanForD stem files.
- Log length was manually measured, and the log small end diameter was calculated through the use of photogrammetry.

The performance of the two bark deduction methods were analysed and compared with each other and the control sample

- Over and under bark volume differences were compared between the three trials for the first three plywood logs cut from the stem and the total stem volume.

3. Results

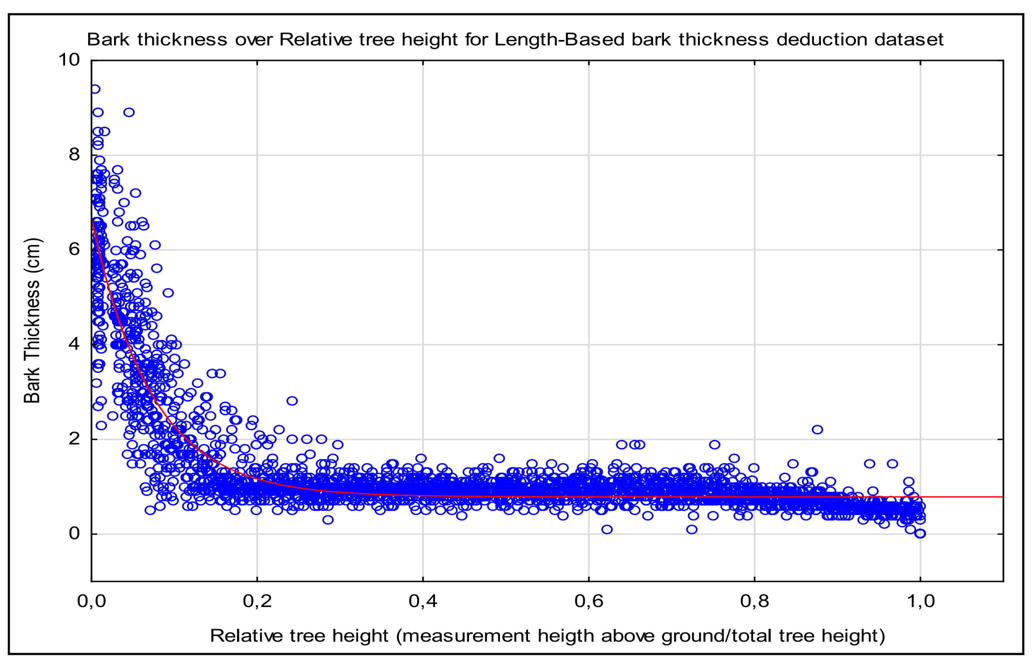

Figure 1: Change in *P. patula* bark thickness with change in relative tree height for length-based bark deduction dataset.

Bark thickness model - $BT = \ a + exp(b + c * RHt)$

Where:

BT = Bark thickness (cm),

a, b & c = coefficients, and

RHt = Relative tree height

Table 1 summarizes the harvesters total under bark and over bark volume estimations per trial.

Table 1: Differences between total harvester over and under bark volume calculations (Positive difference is a underestimation of volume by the harvester while a negative difference is a overestimation.)

Parameters	Treatment		
	T1 (Control – no bark deduction)	T2 (LB bark deduction)	T3 (DL based bark deduction)
Total harvested volume UB (m^3)	39.98	32.19	39.97
Total harvested volume OB (m^3)	39.98	36.60	45.80
Volume difference (m^3)	0.00	4.40	5.83
Total number of stems	40	40	40
Percentage difference between harvester`s UB and OB volumes as percentage of UB volume	0.00%	-13.68%	-14.59%

Table 2 summarizes the manual and harvester under bark volume calculations for the first three plywood logs cut from each stem for each of the three trials.

Table 2: Comparison of the mean manual and harvester volumes for the first three plywood logs cut from the stem (Positive difference is a underestimation of volume by the harvester while a negative difference is a overestimation.)

Treatment	Log Position	Mean Manual Log Volume	Mean Harvester Log Volume	Difference between Manual and Harvester Log Volume as % of Manual Log Volume
T1	1st	0.22	0.29	-30.97%
	2nd	0.18	0.20	-9.71%
	3rd	0.17	0.19	-9.75%
	Total	0.58	0.68	-17.94%
T2	1st	0.21	0.21	-0.06%
	2nd	0.17	0.18	-6.34%
	3rd	0.16	0.17	-6.55%
	Total	0.53	0.56	-3.92%
T3	1st	0.27	0.26	3.20%
	2nd	0.21	0.20	4.96%
	3rd	0.21	0.21	-1.69%
	Total	0.69	0.67	2.28%

4 Discussion

I. *P. Patula* bark thickness

P. patula bark is generally thick at the base of the tree and becomes thinner as tree height increases. *P. patula* bark thickness decreases rapidly between 0.2 and 0.3 of relative tree height from where it stays relatively constant towards the top of the tree (Figure 1).

II. Over and under bark stem volume comparison

The percentage change between the harvester`s mean over bark and under bark volumes show that by not implementing a bark thickness deduction method, the total stem volume for T2 will be overestimated by 13.68%, while T3 is overestimated by 14.59% (Table 1).

III. Plywood over and under bark log volume comparison

- By extracting the dimensions of the first three plywood logs cut for each treatment it was possible to build the mean stem for each of these groups of measurements. This provided a detailed analysis on the impact and improved accuracy of the bark deduction methods on this section of the stem.
- Through the comparison of the OB and UB log volumes for the extracted plywood measurements, we see that when not using a bark thickness deduction method (T1), plywood log volume is grossly overestimated.
- When no bark deduction method is implemented as with T1 harvester volume for the first three plywood logs cut from the stem was overestimated by 17.94% (Table 2).
- Through the implementation of the length-based bark deduction method (T2) this was reduced to a volume overestimation of 3.92%, while for the diameter-class length based bark deduction method (T3) this was reduced to a volume underestimation of 2.28% (Table 2).

5. Conclusion

- With the increasing prevalence of modern CTL harvesters operating in South Africa collecting and recording detailed tree and production data, it is important to ensure the accuracy of this information for use in value chain management and planning.
- The results clearly show the importance of using correctly calibrated harvesters and implementing bark deduction methods applicable to local conditions and species.
- If this not done, the power of automatically recorded tree data from harvester on-board computing systems is potentially lost.