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Fibre losses





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Fibre losses along the South African roundwood softwood sawtimber supply chain

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Introduction



What is fibre or volume loss?

- Volume losses occur when available merchantable tree volume does not reach a predetermined processing installation, or is damaged along the supply chain
- Global problem
 - Literature varying and conflicting
 - Focus on individual operations/events and do not consider the value chain



Fibre and value losses



- Fibre losses from timber harvesting operations are generally attributed to (from literature):
 - High felled stumps (felling techniques and systems)
 - Wide saw kerfs (felling and crosscutting)
 - Merchantable wood left behind in the stand
 - Damage/breakage
 - Sub-optimal log-scaling
 - Inaccurate cross-cutting
 - Non-utilisation of sound wood
 - Inefficient mill processing



Study objective and scope



Quantify type and magnitude of fibre and value losses in typical saw timber semi-mechanised tree-length harvesting operations from felling through merchandising

Study parameters:

- Semi-mechanised softwood saw timber harvesting operations
- Felling either motor-manual (MM) or FB equipped with continuous disk saws
- Extraction by grapple or cable skidder
- Manual log scaling using scaling rod or logging tapes
- MM cross-cutting
- The study ended at roadside or merchandising yard
- No log value optimisation was done



Materials and methods



Tracking fibre and value loss over eight individual treatments:

1. Two merchandising locations (roadside landing/merchandising yard)
2. Two average compartment tree volumes ($<1 \text{ m}^3 \text{ stem}^{-1}$ and $>1 \text{ m}^3 \text{ stem}^{-1}$)
3. Two felling methods (MM for cable skidder, or mechanised for grapple skidder)





Materials and methods



Volume loss categories recorded in this study:

- Stump volume loss
- Felling saw kerf volume loss
- Cross-cut saw kerf volume loss
- Log trimming allowance volume loss
- Incorrect log allowance allocation volume loss
- Excessive trimming and removal of good wood volume loss
- Top volume loss



Materials and methods



- Data collection (fibre volume recovery) process
 - Sample of felled trees selected per treatment
 - Each stump, butt end and top (and utilisable pieces) numbered for control and identification
 - Logs scaled or extracted and subsequently scaled
 - Each cause and dimension of each fibre loss was categorized and subsequently recorded (stump & stem)
 - Subsequent breakages if not extracted traced and linked to specific stem
 - Timber < 10 cm ignored
 - Stump volume – “frustrum of a neiloid” (Ride, 1999)
 - Log/tree volume standard volume equation (Bredenkamp, 2000)



Materials and methods



- Fibre Value Recovery
 - Simsaw6 simulation model (Wessels *et al*, 2002)
 - Total log volume sawn
 - Dry and wet volume recovery percentage
 - Board value recovery ($\text{R}\cdot\text{m}^{-3}$)
 - Net board value recovery ($\text{R}\cdot\text{m}^{-3}$)



Results

Volume loss categories	Treatment							
	Roadside Merchandising				Centralised Merchandising Yard			
	Compartment <1m ³		Compartment >1m ³		Compartment <1m ³		Compartment >1m ³	
	M/M felling	Mech felling	M/M felling	Mech felling	M/M felling	Mech felling	M/M felling	Mech felling
	RS<1MM	RS<1MEC	RS>1MM	RS>1MEC	MY<1MM	MY<1MEC	MY>1MM	MY>1MEC
Average merchantable tree vol. (m ³ ·stem ⁻¹)	0.499	0.766	1.010	1.041	0.770	0.766	1.096	1.453
Average stems·ha ⁻¹	452	398	315	320	386	415	350	315
Number of trees tracked (N)	40	40	60	40	40	42	40	40
Utilisable vol. (m ³ ·ha ⁻¹)	226.00	306.00	347.00	333.00	298.00	315.00	354.00	457.00

Summary statistics: 0.934 m³·stem⁻¹, 330.0 m³·ha⁻¹, and 4.9 m m³·a⁻¹



Results – volume and area loss

* difference between disc (5.5 cm) and chain (0.8 cm)

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Loss categories	Min (%)	Max (%)	Mean (%)	Vol (m ³)	Area (ha)
Crosscut saw kerf	0.17 ± 0.00 (MY<1MM)	0.24 ± 0.01 (RS<1MM)	0.20	~ 9 800	~ 30.0
Log trimming allowance	1.26 ± 0.08 (MY>1Mech)	1.84 ± 0.06 (RS<1Mech)	1.62	~ 80 500	~ 245.0
Excessive removal of merchantable wood	0.48 ± 0.36 (RS)	2.47 ± 0.52 (MY)	2.02	~101 000	~ 305 .0
Stumps	0.07 ± 0.14 (MECH)	1.26 ± 0.14 (MM)	0.778	~ 38 000	~ 100.0
Felling saw kerf	0.15 ± 0.00 (MM)	1.0 ± 0.02 (MECH)	-*	~ 45 000	~ 110.0
Top	2.09 ± 0.49 (<1MECH)	3.70 ± 0.46 (<1MM)	2.57	~130 000	~390.0
Incorrect log allowance allocation	0.24 ± 0.05 (RS)	1.29 ± 0.05 (MY)	0.60	~ 30 000	~ 90.0
Total volume loss	6.49 ± 0.12	10.09 ± 0.13	7.93 ± 0.04	~ 421 700	~ 1 280.0



Results – log scaling



Logs under or over scaled

Location Activity	Roadside scaling		Merchandising yard scaling	
Over scaled %	2.73 ^a		2.37 ^a	
Under scaled %	2.07 ^a		6.87 ^b	
	Compt. vol. <1m ³	Compt. vol. >1m ³	Compt. vol. <1m ³	Compt. vol. >1m ³
Over scaled %	2.41 ^a	2.80 ^a	3.00 ^b	1.56 ^c
Under scaled %	2.09 ^a	2.12 ^a	11.78 ^d	0.58 ^c



Results – fibre value loss

Simsaw6 simulation result

Merchandising location	Log volume (m ³)	No. of logs (sawlogs)	Product value (R)	Gross value recovery (R·m ⁻³)	Net value recovery (R·m ⁻³)	Average log cost (R·m ⁻³)
Merchandising yard	59.391	285	79 108.50	1 332.00	936.10	395.90
Roadside	61.515	300	80 994.00	1 317.00	927.20	389.40

Lost opportunity costs: additional volume and area felled to replace losses, lumber value and log value not recovered

Category	Wood utilisation (%)	Additional Volume (m ³ ·a ⁻¹)	additional area (ha·a ⁻¹)	Net lumber value (R million·a ⁻¹)	Log value (R million·a ⁻¹)
Overall total volume loss	92.068	421 722	1 278	392.8	165.5



Conclusions



Total volume recovery – 92.07%

- Range 6.49% (<1Mech) and 10.09% (<1 MM)
 - 421 700 m³ - additional volume (4.9 mm³, 7.93%) required
 - 1 277 ha - additional area (Compt. Vol. 0.934 m³, 330 m³ ha⁻¹) required
- Smaller trees resulted in greater % loss for:
 - Crosscut saw kerf (0.24% RS<1MM)
 - Stump volume loss (1.26% <1MM)
 - Top volume loss (3.7% <1MM)
- Not tree volume related:
 - Incorrect trimming allowance allocation (1.26% - RSMech)
- Across all treatments, stump heights were 7.0 cm above acceptable felling height
- Mechanised felling – benefits:
 - Improved safety, production/productivity, quality



Conclusions



- Merchandising location had no bearing on the final outcome of lost volume
- Roadside operations, in trees $<1\text{m}^3$, provided the greatest loss of useful fibre
- MM felling across the board caused greater volume losses when compared to mechanised felling
- Current log trimming allowance consumes approximately $80\,604\text{m}^3$ of wood annually
- The human element had a greater impact on fibre and value losses than actual system choice decision
- As long as supervisors, log scalers and chain saw operators continue to produce sub-standard work, fibre losses will continue



Conclusion



For additional information:

- Ackerman P, Pulkki R. 2012. Fibre volume losses of eight softwood clearfell harvesting systems in South Africa. Southern Forest. 74(2). 133 - 149



Log Traceability in Pine Sawtimber Operations

**Forest Engineering Southern Africa (FESA)
Mechanised Harvesting Working Group**

**G. Hogg, D. Scheepers
7 November 2012**

Thanks to Pierre Ackerman



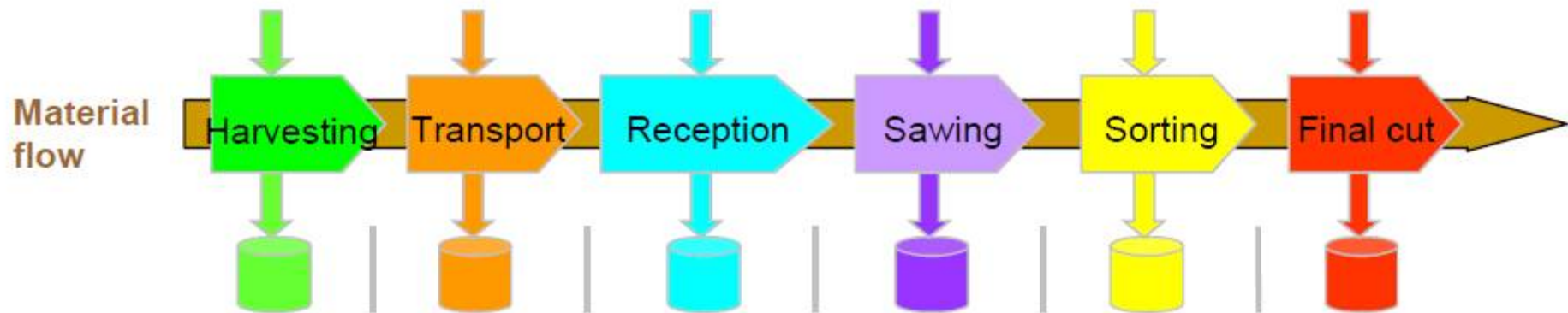
Introduction

- Anticipated volumes of sawtimber moving through the SA Forestry Industry in 2012:
 - 3,259,889m³ softwood
 - 288,325m³ hardwood
- Timber must be measured/tracked and accounted for

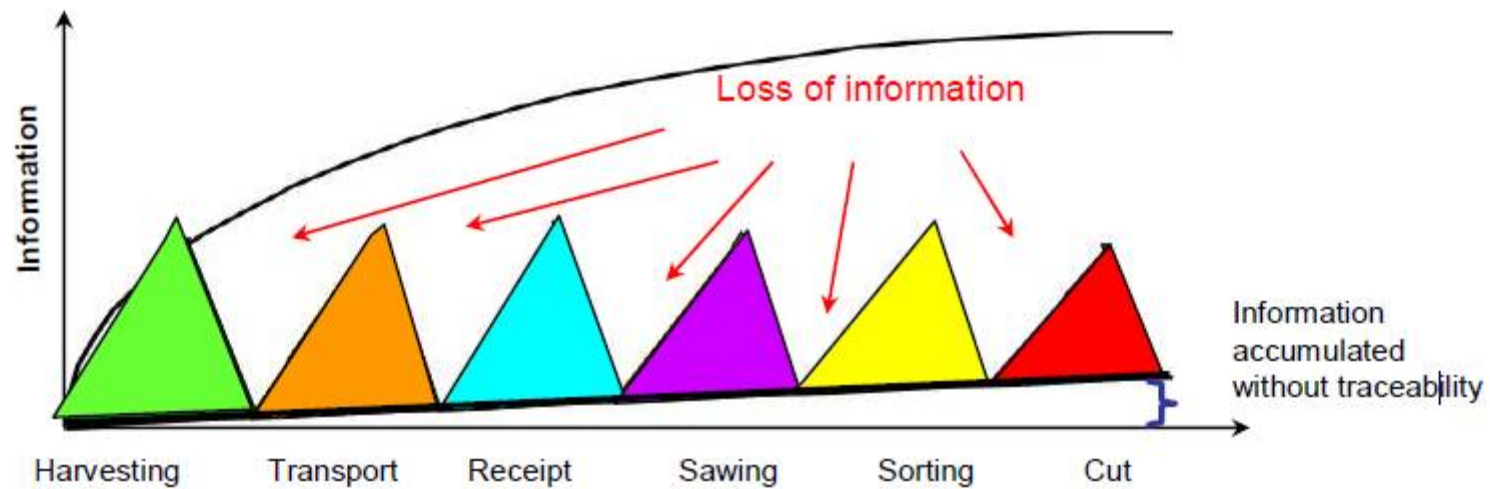
Timber tracking systems are systems which collect data on different products and link this data to a database used to manage the flow of timber through the system.



Introduction



Information accumulated with traceability



Some methods of measuring/tracking timber through the supply chain

- Paint (dye) markings
- Crayon markings
- Weatherproof labels
- Plastic tags
- Barcode labels

Manual log measurement

- RFID tagging
- Bulk calibration
- Harvester measurements

(adjusted with volume calibration @ mill)

- Barcode paint (dye)
- Aroma tagging
- Lazer tagging

Automated log measurement

Some reasons for tracking

- Product must be identified
 - Quality (class)
 - Dimensions
 - Origin
 - Destination
- Theft to be managed



Stand alone tracking systems do not always make sense. It is more useful to consider these systems within the broader context of related areas of forest and timber operations such as forest inventories and forest management systems, sales, payment and accounting systems.

Obstacles Regarding Tracking in Forestry in SA

- Forests lie in remote areas with weak infrastructure
- Forests are spread over large areas
- Delays in current systems (data not captured into database in real-time)
- Lack of skilled employees
- Often several parties must be paid for work in different sectors of the same supply chain
- Mud covers barcodes, paint, tags, crayon markings, etc. and makes them difficult to read
- Rough handling of raw material
- High-volume, relatively low value raw product
- Tree size is decreasing in SA (meaning more logs per m3 timber)
- Constantly changing weather, markets, dimension requirements, etc., etc.
- Different companies employ different systems (often leads to more than 1 tracking system being used)



1) Paint (Dye) / Crayon Markings

- Most commonly used identification technique
- Low cost, easy application and durability.
- Different colours used based on different markets
- Paint = by harvester or manual application
- Crayon = only manual only application
- Crayon = labour intensive and prone to inaccuracy, misreading and forgery.
- Crayon not always easily legible
- Usually used in collaboration with other systems.



2) Weatherproof Labels

- Each tag has a unique number which is captured, along with the log dimensions onto a paper data sheet
- Individual products or commodities can be differentiated within one system and be sold accordingly
- Different coloured labels usually used to differentiate markets
- Higher running costs associated with these systems
- Inaccuracies are extrapolated through the system if it has many links in the chain



Example of Weatherproof Label Physical Tracking System



Infield Manual Length Measuring (1 person)



Example of Weatherproof Label Physical Tracking System



Infield Crayon Length Marking (same person)



Example of Weatherproof Label Physical Tracking System



Infield Tag Application (1 person)



Example of Weatherproof Label Physical Tracking System



Infield Manual Diameter Measuring (1 person)



Example of Weatherproof Label Physical Tracking System



Infield Crayon Diameter Marking (same person)



Example of Weatherproof Label Physical Tracking System



**Roadside Tally Sheet Production Recording
and Painting (2 people)**



Example of Weatherproof Label Physical Tracking System



Roadside Transport Tallying (2 people)



Example of Weatherproof Label Physical Tracking System

- Human component = 7 people + supervisor + admin data capture person + data capture team at mill
- Transport requirement for people
- Production = 500m³ per day
- Safety concerns
- Human error extrapolated through system
- Labels being damaged or lost in the process
- Truck standing time
- Impact of about 12 people in system with equipment on delivered cost of timber



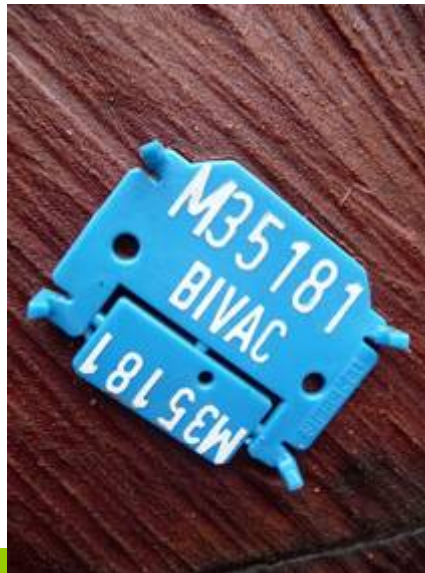
Semi-electronic data capture can be carried out

- Used instead of data sheets
- Unique tag number and log dimensions matched when recording
- Curbs need for admin data capture person
- Electronic transfer to the timber tracking database (GPRS upload or plug in)
- Faster data upload in electronic database
- Requires skilled personnel



3) Plastic Tags

- Different colours (based on markets/suppliers/mills)
- Each tag is printed with a unique identification number
- Applied by hammer to log
- Lack the durability of paint or crayon markings (can become damaged or detached from the logs during transport and loading process)
- Tab removed at mill for recon



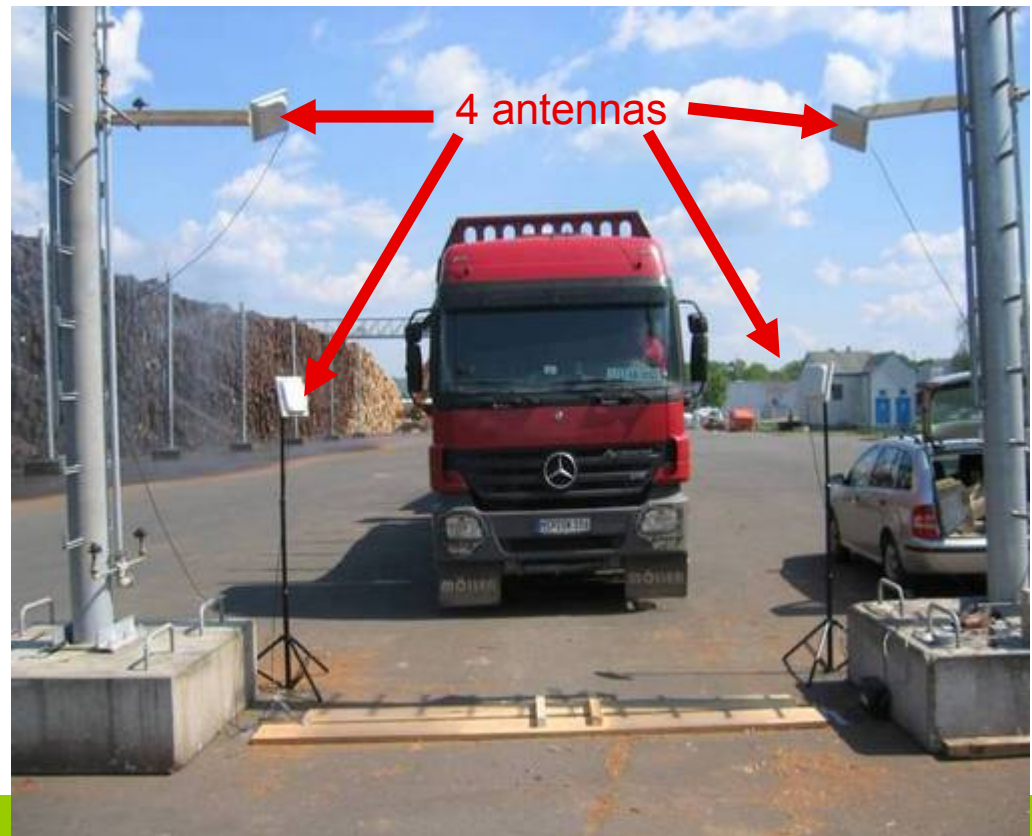
4) Barcode Labels

- Barcodes are fixed to the logs and provide a readable ID number
- Barcodes are scanned into a handheld unit rather than writing down a weatherproof label number, then log dimensions are manually entered.
- Requires skilled staff to operate barcode readers.
- Barcode system is difficult to forge
- Barcodes can become detached or damaged to the extent that they are unreadable



5) RFID Tagging

- RFID stands for **RADIO FREQUENCY IDENTIFICATION**
- RFID uses a tag (a microchip with an antenna) instead of a barcode either stuck to or embedded in an object and instead of a barcode scanner, it has an RFID reader (interrogator)
- RFID uses radio-frequency waves to convey data from a tag to the reader



5) RFID Tagging

- Unique number on each tag individualises each tag (1 per log)
- Device does not need to be positioned in line with the scanning device (unlike barcode)
- Multiple reads at once possible (less standing time for trucks)
- Tracking system runs right through to mill



5) RFID Tagging

- Manual RFID tagging
 - Manual log measuring and tag application
 - Tags can be stapled, nailed, inserted, etc. – depends on tag type
 - Some tags can be processed (e.g. cellulose housed chips in pictures below can be pulped)



5) RFID Tagging

- Embedded vs External RFID tags
 - Embedded RFID tags are designed to penetrate fresh timber
 - Tags should be inserted soon after the log is cut, and as close to the centre of the log as possible



Damaged external tag



External tag



Embedded tag

5) RFID Tagging

- Mechanical tag application – research done by University of Munich in mounting RFID applicator to harvesting head
- Makes use of harvester data
- No human requirement
- Harvester head, forwarder, trucks and mill all have RFID interrogators
- 100% tagging not yet achieved (5% of tags lost in trial research)



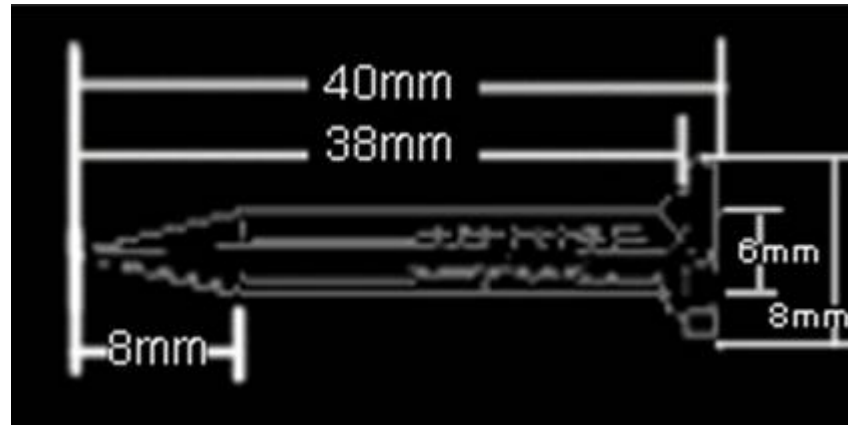
5) RFID Technology

- RFID technology has been available for more than fifty years
- Only recently have technology managed to produce a semi-affordable throwaway inventory control device.
- An RFID manufacturer sold 500 million throwaway tags to Gillette in 2011



5) RFID Technology

- The cost savings of employing an RFID system come into effect when utilised throughout the whole supply chain
- The technology will become cheaper as it becomes more common in other commercial applications (e.g. luggage in airports)



6) Bulk Calibration

- Common in lower value products
- Tons over weighbridge or m3 through a scanner
- Not affected by small piece size
- Tracking individual products from origin to destination not possible



Volume scanner

7) Harvester measurements adjusted with volume calibration

- Technology already exists in some mechanised harvesting systems for volume calibration
- Volume from harvesting head is balanced with timber measurement entering the mill
- Current experience = within 2%



8) Barcode Paint (dyes)

- Unique paint/dye ID fingerprint pattern on each log
- Mechanised operation



9) Aroma Tagging

- Aroma tagging works by applying a specific scent to logs
- The smell print is made up of a combination of artificial odours
- Using different combinations of 25 odours, over 33million logs could be individually identified
- An electronic device “nose” is employed to smell and distinguish the odours, ultimately determining the smell print given off by a log to reveal its history and origin
- Standing tree through mill to final furniture tracking
- Odours must be able to withstand harsh conditions like extreme temperature and humid environments, transportation over dirty ground or on the back of an open truck, etc



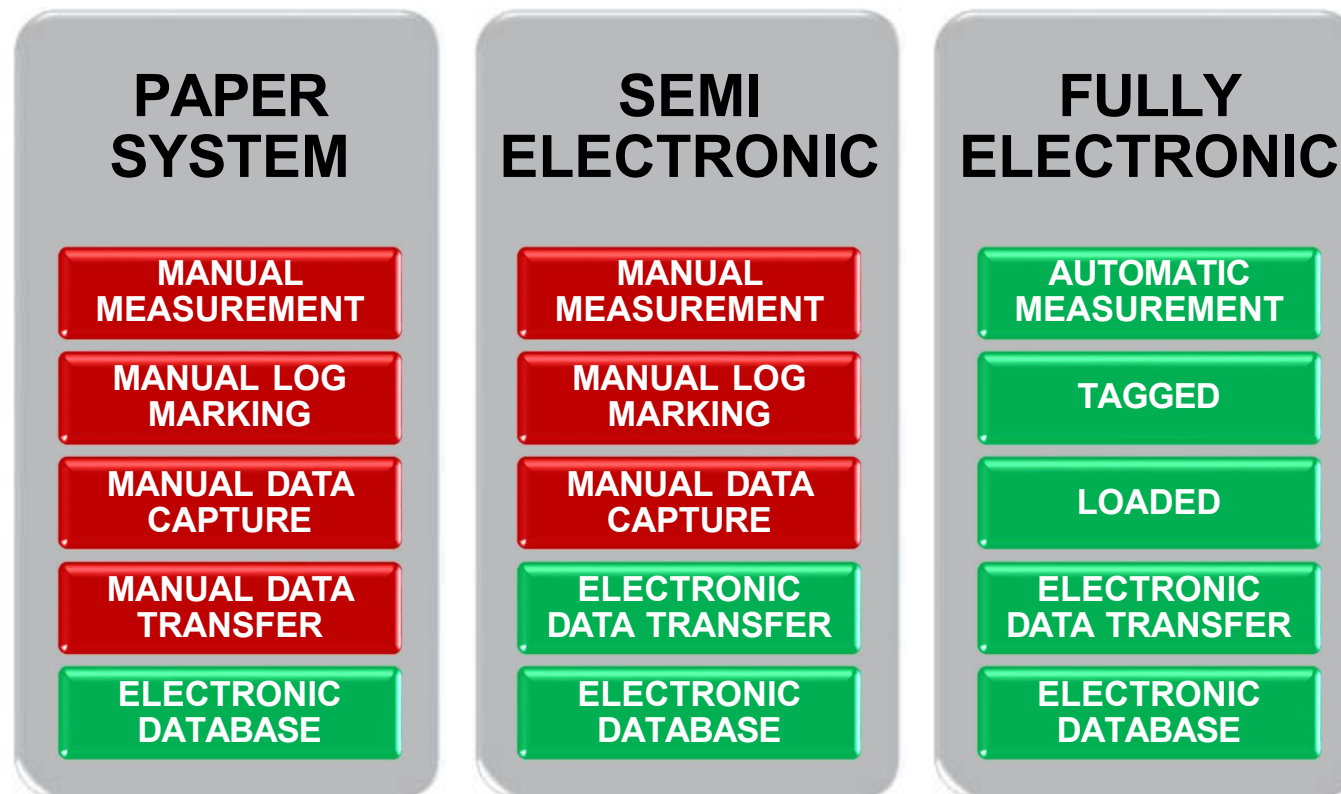
10) Lazer timber marking

- Unique barcode lazered onto each log
- Still in development stages
- Mechanised operation
- Individual scanning of logs required



Comparison of systems

COMPARISON OF CORE ELEMENTS OF DIFFERENT SYSTEMS



Conclusion

- Tracking timber is expensive no matter which of the current systems are employed
- Higher accuracy = bigger price but less undercover costs (errors, lost timber, theft, etc.)
- Technology is developing in all spheres of the forestry supply chain, it is inevitable for timber tracking as well
- Automated systems are becoming practicable
- Greatest benefit only realised if the entire industry adopts one system
- Inaccuracies are extrapolated through the system in most current systems because they have so many links in the chain (all in series)
- Much research still to be done on tracing technologies



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