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Costing the Forest Operations and the Supply of Hardwood in Tennessee

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Abstract

The purpose of this paper is to assess the delivered cost of pulpwood from natural hardwood stands in the State of Tennessee using forest operations supply chain analysis. The study is based on primary production and equipment data collected from logging firms using a statewide in-depth harvesting and transportation survey. Survey results were used to develop estimates for the delivery cost of hardwood pulpwood removed per green tonne unit hour. Findings revealed not only the variability of inputs attached to costing harvesting operations, but also the difficulty in identifying one typical harvest system for the state. This may be explained by the very diverse operating conditions and systems, as well as the low stumpage prices and high cost of harvesting and delivery that are predominantly managed by small scale operations. Results have shown that the cost of harvesting a tonne of wood for a distance of up to 50 km ranges from an average minimum of \$43 per tonne to an average maximum of \$51 per tonne. After this distance, the cost increases exponentially. The fact that this study is the first for the state that looks at the operations logistics indicates the lack of available knowledge of the true cost incurred by operators that may have a lasting impact not only on the continuity of logging operations but also the sustainability and availability of forest products and workforce.

Keywords: cost assessment, survey, production, harvest, trucking, system configurations, operator

1. Introduction

In the southern region of the United States the forest products industry is a significant component of state economies. The majority of the studies have targeted costs associated with harvesting softwood pine stands (Tufts et al. 1988, Carter and Cubbage 1994, Mitchell and Gallagher 2007). While this may be expected, given the predominance of pine species and plantations in the region's forest products industry, more information is needed on the cost of harvesting and transporting hardwood timber, which comprises approximately 30% of all wood harvested in the South, including 27% of the sawtimber and 32% of the pulpwood (USDA Forest Service 2012). It is worth noting that the budget of the hardwood industry in TN is very significant. For example, the state's exports outside the United States in 2011 alone were approximately worth \$1.0 billion (Menard et al. 2013). Accordingly, the key contribution of this study is in assessing for the first time in the state the costs and configurations of forest operations involved in supplying hardwood pulpwood in the State of Tennessee (TN).

The State of Tennessee is located in the middle of the hardwood resource of the southern region, dominated primarily by upland hardwood forests in the eastern and central portions of the state, as well as bottomland hardwood forests in the west. Tennessee forests cover more than 50% of the state's area, with the bulk of the forests (72%) classified as oak-hickory forests in 2013 (Oswalt 2016). Hardwoods comprise more than 80% of the 9.6 million m^3 of wood harvested in TN in 2012 alone, more than 85% of the state's sawtimber and 67% of the pulpwood (USDA Forest Service 2012). Tennessee forestlands are predominantly (81%) owned by private non-industrial landowners (TN Forestry 2013). The objectives of this study are to provide:

⇒ better understanding of different harvesting systems in the state

⇒ calculate the cost of operations starting with the move-in of machines to the site exit and delivery

⇒ explain why assessing forest operations in Tennessee is not a straightforward exercise because of the several nonuniform small scale operations that run the multi-million-dollar industry of the state.

This study is structured to first explain the process of data collection, then explain the cost assessment methods used and discuss the results. The study, methods, and findings are intended to guide operators, practitioners, and scientists interested in this type of information and methods used to assess the cost of logging operations not only in Tennessee but also in other cases.

2. Background

This study is based on the analysis of an in-depth 14-pages logging and transportation survey in Tennessee developed to help explain the forest operations, state of the technology and logistics and the work force capacity of the state. The Tennessee survey disseminated was a replica of a state-wide survey disseminated in the State of Michigan (Abbas et al. 2013, Abbas et al. 2014). The TN survey was piloted with logging operators in Tennessee Master Loggers Workshops, that offer loggers educational setups, to make it more relevant. Data from the TN survey helped offer, for the very first time, a comprehensive survey-based logging operations data, production volume per most common system configuration, products removed and delivered, equipment types and utilization and fuel use in TN forest operations. The survey results were then used to calculate the production cost of the supply chain on a metric green tonne basis. The results of the study explained the difficulty in attempting to explain a typical logging configuration for the state. Assessing the cost of the supply chain required an explanation of the logging operations and unique system configurations of the state (Abbas and Clatterbuck 2015). This was due to the very many configurations and small sized operations that were almost unique to every respondent as the harvesting system they used as a whole. However, after detailing each individual response against survey questions, these responses were juxtaposed with other questions that reported equipment data, configuration, production volume and number of units owned by operators. The most commonly used reported systems were identified based on the most occurrences of these systems in the responses, and were analysed by the reported productivity. The systems identified were run by operators in the state to clarify their relevance to what they perceived to be the more »typical« system. The cost of these systems is analysed in this study using standard machine costing methods (Miyata 1980).

The importance of this study is not only in identifying the cost of harvesting operations, but also in recognizing the voices of the logging community in TN. During the survey stage, operators were asked about where they would like to see improvements in the field of forest operations. Their recommendations targeted improvements in the areas of forest products markets of the state and travelled roads. They further indicated their interest in more sales contracts and to see more support to small numbered operators on the smaller jobs. The survey results confirmed this, by showing that on average there were only 4 employees per firm (Abbas and Clatterbuck 2015). Operators also voiced a concern about the importance of improving the public's perception of logging and loggers.

Operators also noted the importance of improving loggers' education in negotiating payments with mills, cutting costs along the supply chain, and gaining a better understanding of both the soft and hardwood markets in the state. Considering the low stumpage price over the past years, as presented in this study, these recommendations are crucial. Respondents also have expressed an interest in more training that explains how to better cruise timber, improve and pay for insurance, getting trained in cash flow management and how to keep safe on the job. Despite the difficult hardwood markets in TN, machine and logging operators under non-regulatory forest best management practices have demonstrated high compliance rates of 82% (Kinney 2011). This is a credit statement to the hardworking, yet under-recognized, workforce responsible for the supply chain of forest products for the state.

3. Material and methods

Calculations of the harvesting cost estimates of the forest operations involved in this study were based on standard costing methods (Miyata 1980) and the model used to calculate these costs was based on the updated Microsoft Excel MSO® spreadsheet of the Fuel Reduction Cost Simulator Model (FRCS) developed by the United States Department of Agriculture, Forest Service (Dykstra 2012). The machine cost model used required input of equipment purchase price; machine life expectancy; salvage value; repair and maintenance as a percent of depreciation; insurance; interest and tax rates; fuel use and cost; lube and oil (as a % of fuel cost); and operator wage, fringe and benefits; and utilization rates. Data required and collected to assess the cost of the forest operations included:

⇒ published average stumpage values for two years (2013–2014) based on Timbermart-South quarterly stumpage reports for the State of Tennessee for 2013–2014 (TMS 2013–2014)

⇒ equipment haul rates to the harvest site collected from local dealers

⇒ harvesting cost using most typical system configurations identified for Tennessee from the survey

⇒ the cost of pulpwood delivery using trucks at different distances collected from local industries and truckers.

3.1 System configuration and production volume

The process of determining the average production per typical harvest system was based on configuring the most commonly used equipment types in the supply chain and reported volumes from the survey results (Abbas and Clatterbuck 2015). Results were configured for the two systems primarily used and reported. Those came out to be: System Configuration A (SCA): 1.2 feller bunchers, 3.6 chainsaws, 2 skidders, 1.5 knuckleboom loaders; and System Configuration B (SCB): 3.3 chainsaws, 1.6 skidders, 1.1 knuckleboom loaders. Tables 1 and 2 below describe the average production volume in tonnes calculated from the reported system configuration types in the survey.

3.2 Costing the system configuration

The purchase price of equipment was collected from local dealers based on the most common machine brands in Tennessee reported in the survey. Utilization rates were assumed to be 75%, even though such utilization values are much higher than the actual reported survey results. However, since the costing method applies a potential five-year machine life for assumed new machinery, the use of utilization

Table 1 Average Production for SCA* (tonnes removed per Scheduled Machine Hour (SMH)): 1.2 Fellerbuncher, 3.6 Chainsaws, 2.0 skidders, 1.5 Knuckleboom Loader

Tonnes per Hour	30–50% removal			50–70% removal			Clearcutting		
	Hardwood	Softwood	Mixed wood	Hardwood	Softwood	Mixed wood	Hardwood	Softwood	Mixed wood
Average	16	17	15	18	19	16	21	23	21
Maximum	36	36	36	36	41	36	45	54	51
Minimum	3	4	4	4	5	5	5	5	5
Std. dev.	9	10	9	10	11	9	12	15	13
No. of responses	19	16	17	14	11	13	21	17	16
Total no. of equipment	162	137	143	111	100	111	181	153	140

*SCA: System Configuration A using fellerbuncher for primary cutting machines

Table 2 Average production for SCB* (tonnes removed per Scheduled Machine Hour (SMH)): 3.3 Chainsaws, 1.6 skidders, 1.1 Knuckleboom Loader

	30–50% removal			50–70% removal			Clearcutting		
	Hardwood	Softwood	Mixed wood	Hardwood	Softwood	Mixed wood	Hardwood	Softwood	Mixed wood
Average	10	10	13	12	10	11	13	13	14
Maximum	27	18	45	27	18	23	27	23	54
Minimum	2	2	2	2	2	2	2	2	2
Std. dev.	7	5	13	7	6	7	7	8	15
No. of responses	14	9	10	13	8	9	11	8	11
Total no. of equipment	89	55	59	74	46	50	55	49	69

*SCB: System Configuration B using chainsaws for primary cutting machines

Table 3 Average individual components linked to calculate the full supply chain cost (the cost of system configuration values was rounded to the nearest 10th)

	Stumpage	Equipment site haul		Harvest		25 km	50 km	100 km	150 km	200 km	250 km	300 km
		FBS	CS	FBS	CS	FBS/CS	FBS/CS	FBS/CS	FBS/CS	FBS/CS	FBS/CS	FBS/CS
30% removal	$9.3	$2.4	$2.1	$26.8	$25.1	$6.1	$6.1	$9.5	$14.3	$19.0	$23.8	$28.5
50–70% removal	$9.3	$2.1	$2.0	$24.0	$24.5	$6.1	$6.1	$9.5	$14.3	$19.0	$23.8	$28.5
Clearcut	$9.3	$1.8	$1.7	$19.7	$20.6	$6.1	$6.1	$9.5	$14.3	$19.0	$23.8	$28.5

* Stumpage values were averaged from Timber Mart South 5 quarters data for Tennessee for hardwood stumpage prices (4th quarter 2013–4th quarter 2014)

rates of the older equipment would not have been reasonable. Very often the cost of used equipment is not well represented in the literature (Bilek 2008). However, these existing methods based on new machinery costing methods offer a means to help explain the cost of harvesting based on summing up the fixed and variable costs of typical forest harvesting machines, when no other machine-specific expenses are available. There are several reasons for this limitation and why the more conventional new equipment costing method is used. Those reasons include the lack of knowledge of:

- ⇒ the precise repair and maintenance attached to survey reported utilization rates of used equipment
- ⇒ downtime cost
- ⇒ used machine purchase price
- ⇒ the revenue the operator lost while the machine was down.

Transportation rates are based on actual delivery costs based on talks with procurement agents in Tennessee. Labor cost estimates were developed based on the Bureau of Labor Statistics data (BLS 2016). Hourly labor cost estimates used for Tennessee were $16.67 per SMH, which is the hourly mean wage of neighboring states (Georgia, Mississippi and Alabama) (BLS 2016). Identifying the actual harvest systems most commonly used in Tennessee was based on analyzing survey responses for the most commonly reported systems used and the reported production per hour of these systems. Transportation and truck delivery rates were based on average market delivery costs collected from practitioners in Tennessee at a fixed rate of $150 per the first 64 km travelled, then increased exponentially at a rate of $3.4 per km added. Volumes reported in the survey were based on production per Scheduled Machine Hour (SMH) and not Productive Machine Hour (PMH). This is because the survey specifically asked about production volume per hour and not productive machine hour. As a result, scheduled machines hours were used to calculate the cost of the green tonne removal. According to the TN logging and transportation survey results, on average all the equipment used was depreciated beyond the assumed 5-year expected machine life (Abbas and Clatterbuck 2015).

4. Results and Discussion

The results of average stumpage price, equipment hauls, harvesting and delivery costs per system configurations A and B and treatment types were calculated on a per metric green tonne basis, and based on the equipment supply chain expression (1).

$$TSC = St + Eh + H + D \tag{1}$$

Where:

TSC total supply cost
St stumpage value
Eh equipment haul to site (one way, with the assumption it is going to a different site after this job is completed)
H harvesting (felling, skidding, loading and chipping)
D delivery.

Based on the results of the cost assessment methods, the supply chain cost of the hardwood pulpwood was identified. Table 3 identifies the $/tonne of the fellerbuncher (FBS) (SCA) and chainsaw (CS) (SCB) systems in the most harvesting treatment types in Tennessee. These were identified as 30%, 50–70% and clearcut removals. Values are presented per metric green tonne hour supply cost at different distances from site.

Based on Table 3, fellerbunched sites per tonne removed within 50 km from site were at a minimum total cost of harvesting and delivery of $43 per tonne removed from clearcuts and at a maximum of $51 per tonne for fellerbunched selective cuts. Chainsaw systems have seen a lesser variation between harvesting types, at a minimum of $44 per tonne clearcut to a maximum of $49 per tonne selective cut. Since any transportation up to 50 km is fixed at $6.1 per tonne, based on discussions with the industry, this means that these minimum and maximum values would be in the range of the cost of removed material to the market regardless of distance to market up to 50 km. This was based on the industry assumptions that up to 64 km all wood hauling costs are at $150 per truckload. After this »distance«, transportation costs are going to increase exponentially at a rate of $3.4 per km travelled. In other words, if harvested materials are going to be trucked for larger distances, say 200 km, the cost increase is expected to be an additional $15 per tonne hauled. Transportation values are critical and accounting for the distance harvested by the operators is a key pricing factor. However, fortunately, based on survey results most of the supplies products were found to be within this 50 km range (Abbas and Clatterbuck 2015).

Furthermore, the predominance of hardwood species in TN adds another complexity to costing factors that are not accounted for in the stumpage and market values of supplied pulpwood. Operators were asked on two occasions to what extent they found that the cost of harvesting hardwoods increased over the cost of harvesting softwoods. Respondents reported an increase of an average of 29% in the state of Michigan (Abbas et al. 2014) and 31% in the State of Tennessee (Abbas and Clatterbuck 2015). Accordingly, hardwood forest operations – the most prevalent in TN – are typically more expensive to operate than softwood operation considering the impact of these stands types on equipment and the entire cost of removal.

Based on standard equipment costing methods and low stumpage values, forest products markets likely do not account for the actual cost of the forest operations supply chains. Price of tonne removed and delivered paid to operators is typically a proprietary value. However, the conventional understanding is that loggers are typically not under long term contracts (Becker et al. 2009, Dructor et al. 2012). Recent 2016 stumpage values have further indicated that the price of hardwoods in TN has seen a 30% price reduction (Timber mart South 2016 4th Q) from the survey average stumpage values in 2013 and 2014. It is unclear how this is going to impact the operator's pay per load, since it turned out that on average 51% of the operations involved stumpage purchase (Abbas and Clatterbuck 2015).

5. Conclusion

This study provided details of the cost of the supply chain operations in Tennessee. The methods detailed in this study could be used to help operators calculate the most recent values of their supply chain and production using customized cost data to their operations.

The significance of this study lies in the complexity of the data collected that helped develop first time results for hardwood pulpwood forest operations costs in Tennessee. It helped explain study design details that may aid in collecting complex machinery harvesting estimates and methods when no other benchmark data for forest operations are available to compare results to.

Several factors emerged that need to be accounted for to more accurately price products delivered in the market. The key message this study hopes to convey is that if site material type, operators and equipment considerations are not key to informing market pricing methods of products, the entire supply chain and operations of forest products could be impacted.

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