Fuel Consumption Rates of Southern Timber Harvesting Equipment

W. Dale Greene¹, Erik Biang², and Shawn A. Baker³

Abstract

Fuel represents 15-20% of current cut and haul rates in southern harvesting operations, yet little objectively obtained information exists in the literature about fuel consumption rates for modern timber harvesting and delivery operations. Working with an industrial partner, we gathered weekly production and machine-level fuel consumption data for seven logging crews in the coastal plain of Georgia. Our data collection began in September of 2012 and will end in June 2014. The study will end with over 6,000 operating hours of data on wheeled feller-bunchers, skidders, and loaders associated with producing over 130,000 tons of wood. Feller-bunchers consumed 6.56 (± 1.57) gal/hour and 0.15 (± 0.047) gal/ton, skidders consumed 5.09 (± 1.02) gal/hour and 0.14 (± 0.052), and loaders consumed 3.71 (± 0.742) gal/hour and 0.09 (± 0.024) gal/ton. Further study is needed to explore best practices regarding fuel conservation among operators.

Keywords: Fuel consumption, wheeled feller-buncher, grapple skidder, knuckleboom loader

Introduction

Timber harvesting and delivery costs are significantly affected by the cost of fuel which accounts for 15-20% of cut and haul costs depending upon haul distances, type of logging conditions, and market fuel prices. In recent years, the market price of oil and the fuels produced from it have been quite volatile, often increasing 50% or more over a few months. This volatility strains market relationships as suppliers often request fuel cost adjustments to their contract rates and where possible, buyers attempt to determine what an appropriate rate adjustment should be.

Despite the importance of fuel to the overall cost of supplying wood, little objectively obtained information exists in the published trade or scientific literature about fuel consumption rates for timber harvesting and delivery operations. One might think that such information would be readily available, but it is not. Marchman et al. (2013) reported that only 40% of Georgia and South Carolina contractors tracked fuel consumption and half of these did not monitor it on a machine level but only on a crew basis. The majority of loggers (60%) did not maintain any records on fuel usage. Even forward-thinking operations that do monitor fuel consumption lack a benchmark to compare their consumption against to determine how efficiently they use fuel. Tracking fuel use is not complex, but it does require people to understand the importance of

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record-keeping to their business’s success, to have a method that takes a minimum of time, and to have equipment and supplies to do so.

**Objectives**

This study sought to obtain long-term operational data on fuel consumption per operating hour and per ton produced for a typical mechanized timber harvesting crew working in pine plantations (clearcut and thinning) in the southeastern coastal plain.

**Methods**

The project took place in cooperation with a wood consuming facility in the lower coastal plain of Georgia that purchases approximately two million tons annually of pine roundwood. UGA consulted with the mill procurement staff to identify logging businesses that provided significant deliveries on a consistent basis. In Fall 2012, each selected logging firm was contacted by mailed letter to seek their voluntary participation in the project. In return, they were offered a fuel meter for each of their in-woods fuel tanks and a fuel data recording system. We also provided periodic reports during the year to the cooperators to allow them to compare their fuel consumption to their peers in the study. Our goal was a minimum of 10 cooperators for the project or approximately 100 road vehicles and/or woods machines recording fuel usage. No cooperators opted to include any highway vehicles in the study, thus we only describe method associated with woods equipment.

We initially planned a short training session to be attended by all in the study. When this proved impractical, we instead visited each logging business and trained the employees of each cooperator individually. These included logging foremen in the woods and clerical staff at the office. This also helped develop a working relationship with each so that we could monitor the progress of the study by phone or email to reduce travel time and costs. In the weeks immediately after the initial training, UGA staff visited each cooperator at their office and/or woods operation to confirm that the recording of fuel use was following the protocols outlined during the training sessions and to answer any questions. In addition, we reviewed the general information recorded for each machine to ensure its accuracy.

Data were recorded on three forms – a machine information form, a weekly fuel log for each machine, and a weekly production report for the crew. The machine information form was collected at the beginning of the study or when a new machine was added to the crew lineup. Data included machine name or code number (for anonymous identification), type (feller-buncher, grapple skidder, knuckleboom loader), year of manufacture, manufacturer, model number, engine size (hp), type of transmission (direct, powershift, hydrostatic), fuel tank capacity, tire size, and hill or swamp crew use. The weekly production records included week ending date, loads delivered, tons delivered, hours worked in the woods, days worked in the woods, total wood order for the week (loads or tons), and any comments about working conditions. The weekly fuel consumption form recorded by machine the following entries each
time the machine was fueled: machine/vehicle name or code number, date, time of day, hour meter reading, gallons of fuel added, and tank status after fueling (full or partial). Cooperators used regular mail or fax to send their completed forms to us.

**Results**

During the first year of the project, we recruited 10 participants to join the study. Seven of these actually shared data with us and three of those did not maintain their data reporting for more than a few weeks. However, we did have four contactors who consistently reported data to us for 19 months (November 2012 – March 2014). For some weeks, we were unable to obtain production data from the cooperators, but did have the fuel use and the number of operating hours available from machine clocks. Through April 2014, the consumption data included fuel use associated with 136,017 tons of wood produced by feller-bunchers, 160,873 tons produced by grapple skidders, and 164,972 tons of wood handled by knuckleboom loaders (Table 1). In total, the machines consumed nearly 107,000 gallons of diesel. Each machine type was monitored for approximately 6,000 operating hours.

Table 1. Tons of wood produced, machine hours involved, and diesel fuel use during a 19-month study of fuel consumption in southeast Georgia.

<table>
<thead>
<tr>
<th></th>
<th>Feller-Bunchers</th>
<th>Grapple Skidders</th>
<th>Knuckleboom Loaders</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tons Produced</td>
<td>136,017</td>
<td>160,873</td>
<td>164,972</td>
</tr>
<tr>
<td>Machine Hours</td>
<td>5,880</td>
<td>6,599</td>
<td>6,640</td>
</tr>
<tr>
<td>Gallons Consumed</td>
<td>38,877</td>
<td>41,156</td>
<td>26,923</td>
</tr>
</tbody>
</table>

Fuel consumption per operating hour was highest for feller-bunchers (6.46 gal/hr) followed by grapple skidders (5.05 gal/hr) and knuckleboom loaders (3.65 gal/hr) (Figure 1). All feller-bunchers in our study used hydrostatic transmissions (the industry norm today) where most grapple skidders use a powershift transmission. As expected, loaders used the least fuel per hour since all loaders in our study were trailer-mounted (stationary) hydraulic loaders.

When fuel consumption was measured on a per ton basis, feller-bunchers and grapple skidders had very similar fuel consumption at 0.15 and 0.14 gallons per ton respectively (Figure 1). Loader consumption was much less at 0.09 gallons per ton produced. Skidder fuel consumption per ton would be reduced as payload and skidding distance increase. The separation between felling and skidding consumption on an hourly basis does not exist on a per ton basis due to these factors in our opinion. We also feel that the slightly higher variability of the fuel consumption per ton for skidding is likely explained by the effects of distance and payload. The coefficient of variation (CV) values for fuel use per ton ranged from 27% for loaders to 31% for feller-bunchers to 37% for skidders.
Figure 1. Mean fuel consumption measured in gallons per operating hour (top) and gallons per green ton produced (bottom). Error bars represent one standard deviation and the corresponding coefficient of variation is also given.
Conclusions

Using the data we observed during our study through 19 months, it appears that mechanized systems in the coastal plain using feller-bunchers, grapple skidders, and knuckleboom loaders consume about 0.38 gallons of diesel per green ton of wood as loaded onto a trailer. Applying the variability associated with one standard deviation would suggest that this consumption ranges from 0.25 to 0.50 gallons per ton depending on operating conditions.

The systems using these machines primarily performed thinnings of pine plantations although they also conducted clearcuts as well. We did not have a large enough sample size nor detailed enough data from our cooperators to evaluate how different system operating strategies could impact fuel consumption per ton. Most knuckleboom loaders used a pull-through delimer to perform final delimming and topping of stems. Others used a chain-flail delimer (Chambers Delimbinator) to remove limbs. Systems that did not use a chain-flail delimer typically performed their initial delimming with a grapple skidder backing stems into a delimming gate. The impact of tree size, skidding payload and distance, ground conditions, the number of product sorts, and other operating factors were not examined. The variability of fuel consumption as measured with the coefficient of variation (CV) would be one measure of how these factors might impact fuel use.

Literature Cited