FPInnovations®
INFO NOTE
January 2018 - no. 2
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Dangle head processors: Effect of different operator-selectable power modes on energy intensity

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Introduction

With fuel costs ranging from one-quarter to two-thirds of an off-road machine's operating cost, getting the most from this expensive commodity is critical for every fleet manager. This report will help operators of dangle head processors better understand each power mode's effect on productivity and fuel consumption, and describe situations where these modes can best be applied. A previous study with a log loader demonstrated that lowering the engine's operating speed or power level saved fuel without significantly reducing productivity.[1] It was upon this premise that power mode selection (as shown in Figure 1) was to be investigated for the processing of logs.

Figure 1. Operator-selectable power modes in this John Deere machine: ECO (economy), PWR (power), and H/P (high performance).

Methodology and site conditions

A diagnostic data logging tool compatible with the equipment's J1939 CAN bus port was used to access the electronic control module (ECM) data to determine the fuel consumption over the three test conditions. It was later calibrated using tank fill data. Productivity was determined by counting the stems produced and scaling the logs. Energy intensity was defined as the liters of fuel required to produce one cubic meter of pulp log.

[1] Rittich, C. & Nishio, G. (2016). *Reduced engine RPM and energy intensity for log loaders in Northern Alberta* (Technical Report No. 17). Vancouver, B.C.: FPInnovations.

The study was conducted in northern Alberta in July 2017. The daily temperatures reached a high of 20°C and testing was conducted using a fully warmed-up machine. The tests were performed in one forest stand of contiguous tree cover composed of 100% hardwood on flat topography.

The test machine, shown in Figure 2, was a model year 2017 John Deere 2154G equipped with a Southstar QS505 processing head. It was powered by a 122 kW Tier 3 emissions engine with 791 operating hours. The tests were conducted for the following ascending power levels: economy, power, and high performance, indicated on the operator's instrument panel as ECO, PWR, and H/P, respectively. These power levels control the engine power and response, as well as the hydraulic system response.

Figure 2. 2017 John Deere 2154G.

Results

Table 1 presents the results of the productivity and energy intensity comparisons made between the three performance modes. The stems produced were uniform pulp logs 11.3m in length. The productivity results should not be viewed as indicative of what can be achieved over a shift level of work, as there were no stoppages during the trials to check log length or rest breaks. The results showed a linear increase in volume production as well as increasing energy intensity as power levels are increased. From the lowest to highest power levels, volume production increased 15% and energy intensity increased 12%.

Table 1. Volume production and energy intensity for three operator-selectable power modes

	Power mode			Difference of H/P over ECO (%)
	Economy (ECO)	Power (PWR)	High performance (H/P)	
Volume production (m^3/h)	36.4	40.2	43.1	15
Energy intensity (L/m^3)	1.02	1.04	1.16	12

Implementation

Often, little thought is given to user-selectable power modes. Operators typically select the mode that "feels best" and leave it at that setting. Operators are encouraged to experiment with the three modes as follows:

- Economy mode saves fuel and lowers productivity, which would be ideal for someone learning the functions of a new machine, or where productivity is not a priority.
- Power mode strikes a balance between the economy and high-performance modes, and could be used when productivity is not the highest priority.
- The high-performance mode increases productivity substantially, but results in greater fuel consumption per cubic metre produced. Given that many forest operations feel limited by their processing phase's output, most will choose to maximize production and incur greater fuel costs. Operations with a processing phase that is matching pace with log shipments may benefit by changing to a reduced power mode and realizing a modest fuel savings.