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Diesel Fuel Consumption During Field Operations

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Introduction

Direct energy expenses (diesel, gasoline, propane, electricity) total more than $1 billion annually for Iowa's farmers. Farm management techniques such as adjusting tractor gear and throttle settings, reducing tillage depths, and monitoring tractor tire inflation pressures can reduce diesel fuel consumption for row crop production. This study is being conducted over multiple years to measure the effects of energy management techniques on tractor fuel consumption during spring and fall field operations.

Materials and Methods

A small auxiliary 12-gallon fuel tank was mounted on a John Deere 7420 tractor. Plumbing was added for diesel fuel to be supplied and returned from the engine via either the main or auxiliary fuel tank, depending on the setting of a single flow control valve. A load cell under the auxiliary fuel tank measured the net (supply minus return) weight of fuel used. Most fieldwork on the farm is done in smaller plot areas. One objective was to measure fuel use in areas of 0.7 to 1 acre when possible; the auxiliary tank measures fuel use within 0.1 lb increments. Another objective was to obtain multiple replications if land area and timing of trials allowed. Small plots or farm scheduling frequently conflicted with these objectives, limiting the ability to measure statistical significance beyond overall trends in data.

Fuel consumption was measured as gallons per acre (gal/acre). Although larger equipment consumes fuel at higher rates, fieldwork is also completed at a faster rate (acres/hr). Gallons per acre generally remains consistent and is a common, useful measure for farmers.

Results and Discussion

Initially, single fuel measurements during chisel plowing were made at three different travel speeds (Table 1). A trend toward decreased fuel use at greater travel speed was unexpected. The trend probably was due to single observations and becoming familiar with the instrumentation and equipment. Effects of tandem disking at two tillage depths (Table 2) shows the trend of increased fuel use with depth of tillage. Tandem disking was done at two different transmission gear and engine speed combinations with a common travel speed (Table 2). Greater fuel use at the lower engine speed was unexpected and may have been due to random field conditions or implement loading on the tractor.

Effects of shifting up one transmission gear and throttling back the engine's speed were compared during moldboard plowing (Table 3). As expected, maintaining travel speed but using a slower engine speed in a higher transmission gear showed a trend of reduced fuel use. Overall values were greater than expected and reflect more turning time within small plots. Using a higher gear and slowing engine speed also reduced fuel use during planting (Table 4). Fuel use decreased approximately 20 percent during planting when engine speed was reduced at higher transmission gears.

Conclusions

Results generally indicate reduced diesel fuel consumption when using a 'shift-up/throttle-back' strategy with drawbar loads that are less

than the available maximum tractor horsepower. Similarly, reduced fuel consumption was shown with reduced tillage depth during disking. Results are only from the first year of study. Unexpected results for chisel plowing travel speed or transmission gear/engine speed settings during disking may have been due to single observations, becoming familiar with auxiliary fuel tank readings, field conditions, or other unknown factors. Farm staff plans to continue further fuel consumption comparisons next year.

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Table 1. Chisel plowing at different travel speeds.

Operation	No. of replications	Treatment travel speed, mph	Gal/acre
Chisel plowing	1	3.0	1.06
	1	4.3	0.98
	1	4.7	0.94
LSD $_{\alpha=0.05}$[a]			NS[b]

[a]Least significant difference between treatments at a 95% confidence level.
[b]No significant difference at the 95% confidence level.

Table 2. Tandem disking at different tillage depth and gear/engine speed combinations.

Operation	No. of replications	Disking depth, in. or gear/engine rpm	Gal/acre
Disking, 4.6 mph	4	3	0.35
	4	5	0.38
LSD $_{\alpha=0.05}$[a]			NS[b]
Disking, 4.6 mph	4	B3/2200	0.34
	4	C1/2000	0.39
LSD $_{\alpha=0.05}$[a]			NS[b]

[a]Least significant difference between treatments at a 95% confidence level.
[b]No significant difference at the 95% confidence level.

Table 3. Moldboard plowing with different gear/engine speed combinations.

Operation	No. of replications	Treatment gear/engine rpm	Gal/acre
Moldboard plowing, 4.5 mph	1	B2/2250	4.84
	3	B3/2000	4.57
	4	B4/1700	3.67
LSD $_{\alpha=0.05}$[a]			NS[b]

[a]Least significant difference between treatments at a 95% confidence level.
[b]No significant difference at the 95% confidence level.

Table 4. Planting with different gear/engine speed combinations.

Operation	No. of replications	Treatment gear/engine rpm	Gal/acre
Planting, 4 mph	4	B2/2225	0.46
	5	B3/1850	0.39
	4	B4/1500	0.38
LSD $_{\alpha=0.05}$[a]			NS[b]

[a]Least significant difference between treatments at a 95% confidence level.
[b]No significant difference at the 95% confidence level.