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Diesel Fuel Consumption during Field Operations

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Abstract
Direct energy expenses (diesel, gasoline, propane, electricity) total more than $1 billion annually for Iowa's farmers. Day-to-day 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 field operations.

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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. Day-to-day 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 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–return) weight of fuel consumed.

Most field work on the farm was conducted in small plot areas. One objective was to measure fuel consumption 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 of land area and timing of trials allowed. Small plots, weather, and 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/acre. Although larger equipment consumes fuel at higher rates, field work also is completed at a faster rate (acres/hr). Gallons/acre generally remains consistent and is a common, useful measure for farmers.

Results and Discussion

Effects of shifting up to a higher transmission gear and throttling back the engine's speed were compared during moldboard plowing and planting (Table 1). As expected, maintaining travel speed but using a slower engine speed in a higher transmission gear shows a trend of reduced fuel consumption. Total fuel consumption is greater than expected for moldboard plowing and reflects more turning time within small plots. Fuel consumption decreased approximately 32 percent during plowing and 15 percent during planting when engine speed was reduced at higher transmission gears.

Effects of tandem disking at two tillage depths and two travel speeds (Tables 2 and 3, respectively) show trends of increased fuel consumption with deeper tillage depths (41% greater) and to a lesser extent with faster tillage speeds (15% greater). Trends of slightly decreased fuel consumption with greater tire inflation pressure during disking were unexpected (Table 4) and may have been due to soil conditions.

Conclusions

Results 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 and reduced speed during disking.

Results are from the second year of study. Unexpected results for tire inflation may have been due to field conditions or other unknown factors. Research farm staff plan to continue further fuel consumption comparisons next year.

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Table 1. Fuel use at the Armstrong Research Farm, spring 2014.

Operation	No. of replications	Treatment gear/engine rpm	Gal/acre
Moldboard plowing, 4.3 mi/h	3	B2/2250	3.764
	4	B3/2000	3.508
	3	B4/1700	2.857
LSD $_{\alpha=0.05}$[a]			0.486
Planting, 4.0 mi/h	4	2200	0.432
	4	1900	0.376
	4	1520	0.389
LSD $_{\alpha=0.05}$[a]			NS[b]

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

Table 2. Fuel use at the Armstrong Research Farm with varying tillage depth, spring 2014.

Operation	No. of replications	Tillage depth, in.	Gal/acre
Disking	4	4	0.229
	4	6	0.324
LSD $_{\alpha=0.05}$[a]			NS[b]

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

Table 3. Fuel use at the Armstrong Research Farm with varying travel speed, spring 2014.

Operation	No. of replications	Travel speed, mi/h	Gal/acre
Disking	4	4.5	0.258
	4	5.0	0.296
LSD $_{\alpha=0.05}$[a]			NS[b]

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

Table 4. Fuel use at the Armstrong Research Farm with varying rear tire inflation, spring 2014.

Operation	No. of replications	Tire pressure	Gal/acre
Disking	4	10	0.288
	4	14	0.266
LSD $_{\alpha=0.05}$[a]			NS[b]

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