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FUEL REQUIREMENTS FOR FIELD OPERATIONS

with
Fuel Saving Tips

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INTRODUCTION

Tillage and other field operations consume between 10 and 20% of the total energy expended in crop and livestock production, and an even larger percentage of the **total** liquid fuel used on the farm.

A Michigan Farm Energy Audit Study* was conducted during 1978 and 1979 to determine fuel usage on the farm. This study surveyed over 30 field and other farm operations for fuel consumption. Table 1 reports the results of thousands of observations, in some cases from 40 or more different farms in the two-year period. The values are averages of gallons of diesel fuel used per acre for various operations. Also shown are the high and low values (on an overall farm average) of fuel usage for each operation. Values for these operations as an average from other states data are also given. These can be used for comparisons with the results from the Michigan study.

The fuel consumption values can serve as guidelines to determine whether fuel usage for a particular operation on a farm is above or below average. If fuel usage is above the average, it does not necessarily mean that fuel is being wasted; certain conditions may require high energy inputs to complete the job. For example, plowing a heavy clay soil requires 1 to 3 more gallons of fuel per acre than plowing a sandy soil. Nevertheless, you can use the average values in Table 1 as guidelines to determine if you are using fuel efficiently on the farm. If your values are consistently higher than these averages, you should determine the possible causes for this higher fuel use and decide if savings can be made.

For those who have gasoline-powered equipment, gallons of diesel fuel per acre reported in Table 1 can be converted to gallons of gasoline per acre by multiplying the numbers by 1.45 (or dividing the numbers by 0.70). As suggested by these conversion factors, diesel engines are more fuel efficient than gasoline engines.

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FUEL CONSERVATION METHODS

If you find that you are using excess fuels for field operations, there are many ways you can reduce fuel consumption. The first step is to determine how much fuel is used for a particular field operation. You can do this by measuring fuel consumption on a per acre basis: fill the fuel tank of the tractor before an operation starts, complete the field operation noting the number of acres covered, and then refill the tank to determine the number of gallons used. Compare this estimate of fuel usage per acre to the averages listed in Table 1. If it is higher than the average, reduction of fuel consumption may be possible, resulting in fuel and dollar savings. A discussion of several methods to reduce fuel consumption in field operations follows.

Reducing Number of Operations

Reducing the number of field operations is a simple way of decreasing total fuel usage on the farm. Often, more secondary tillage operations are performed than necessary to establish a good seedbed for planting. For example, one disking may suffice, rather than two, particularly if a spring or spike-tooth harrow is pulled behind the disk in the first operation. Minimum and no-tillage systems reduce tillage operations, thereby lowering fuel consumption, saving time, reducing soil compaction and minimizing machinery inputs. As an illustration, assume you do each of the following separately — plowing, two secondary tillage operations, planting and spraying — the total of these operations requires over 4 gallons of fuel per acre. If you no-till plant, a total of about 1 gallon per acre is needed for planting and spraying, or a savings of 3 gallons of fuel per acre.

Matching Implement to Tractor Size

Matching implement size to tractor size can result in fuel savings. Generally, if implements are matched to tractor size, a tractor should be able to pull the implement in the 3 to 7 mph range. When a tractor can easily pull an implement faster than 7 mph, the tractor is probably too large for the implement. Conversely, if the tractor cannot pull the implement faster than 3 mph, the tractor is probably too small for the implement. (MSU Extension Bulletin E-1152 "Matching Tractor Horsepower and Farm Implement Size" contains a more detailed method of matching tractor size to implement size).

A prime example of matching tractor to implement size is the large fuel usage of spring-tooth harrows as reported from the Energy Audit in Table 1. Based on theoretical calculations, a spring-tooth harrow should require no more than ½ gallon of diesel fuel per acre. However, the average value from the Michigan Farm Energy Audit Study was 0.73 gallon per acre. Upon analyzing the data, it was found that large tractors were being used to pull spring-tooth harrows on these farms, which represented a mismatch of tractor to implement size, and resulted in greater fuel consumption. Several other operations such as spraying and hay raking showed higher fuel usage in the audit than when theoretically calculated. Again, analysis of data revealed that too large a tractor was being used.

When matched properly to implement, larger tractors are often more efficient than smaller tractors, yet small tractors can be more economical and fuel efficient than large tractors when pulling small implements or doing small jobs. In Michigan, the trend has been for farmers to sell their small tractors. Farmers should consider keeping small tractors that are in good condition for doing the smaller jobs around the farm. An alternative to using a smaller tractor is to employ the concept of "gear up/throttle down" with a tractor that is too large for the implement. When pulling light loads for short periods of time, fuel can be saved by pulling the load in a higher gear but at a reduced RPM. Do not reduce RPMs below 20 to 30% of the rated RPM. If black smoke is visible during operation, this may indicate overloading and suggests going to the next lower gear.

Speed

The speed at which a tractor can be operated is related to matching implement size to tractor size. If implements are properly matched to tractor size, then the normal range of operating speeds (3 to 7 mph) will usually produce the most efficient fuel usage. Faster field speeds consume more fuel. Tractors should not, however, be driven slowly just to save fuel, because time required for the operation may be considerably greater.

Combining Field Operations

Combining operations such as disking and dragging (pulling the drag behind the disk in one operation) can reduce fuel consumption by ¼ to ⅓ gallon per acre. A savings in time and labor and a reduction in soil compaction also result. Other examples of combining field operations are attaching or mounting a sprayer on a planter, or pulling a cultipacker behind a grain drill.

Alternative Implements for Similar Operations

Often a lower fuel-requiring implement can be used to perform a similar operation. For example, using a chisel plow instead of a moldboard plow for primary tillage can save ½ gallon or more fuel per acre. A spring or spike-tooth harrow can replace a disk or field cultivator under certain field conditions, saving you ¼ to ½ gallon fuel per acre. You can determine the value of alternative implements for fuel savings in field operations by comparing the fuel consumption of different implements that perform similar operations (See Table 1).

Field Efficiency

Field efficiency affects the total amount of fuel needed to perform an operation. Spending an unnecessary amount of time turning around at the ends of short, wide fields or overlapping tillage operations within a field wastes fuel. To reduce turning time, make fields large, long and narrow by eliminating fence rows, ditches or other barriers. The concept of "tilling off the corners" of the field when tilling diagonally can also save fuel by converting the turning into useful tillage.

Depth of Tillage

Increasing the depth of tillage results in greater fuel use. Every inch increase in plowing depth uses about 0.15 gallons or more diesel fuel per acre. A proportionate fuel increase results for other tillage operations at increased depths. Secondary tillage should seldom be performed deeper than ½ the depth of primary tillage. For example, if a field is plowed 8 inches deep, do not disk deeper than 4 inches. Shallower secondary tillage not only saves fuel, but reduces compaction, and lessens the amount of wet soil and weed seeds brought to the soil surface.

Soil Conditions

Soil texture greatly influences fuel usage. As mentioned earlier, substantially more fuel is needed to till a clay than a sandy soil. Some other common soil conditions which can increase fuel consumption are: (1) compacted soils (2) extremely wet or dry soils (3) sod and residues from previous crops.

The more times a field is secondary tilled, the less fuel is needed for subsequent operations. However, the frequently tilled soil becomes more compact and will require more fuel for future primary tillage operations. The concept of controlled wheel traffic patterns can result in fuel savings and reduce total soil compaction. This means operating the tractor and other machinery in the same tracks for all operations. Tractive efficiency is improved and compaction occurs only in a narrow area. Crop growth in the rest of the field is considerably better than if compaction had occurred all over.

Crop Conditions

Crop conditions can affect the amount of fuel used in harvesting operations. A crop which is too wet, lodged, or harvested under wet soil conditions can cause an increase in fuel consumption. Proper machine adjustment and timing to harvest under optimum crop and field conditions result in fuel efficiency. Harvesting less straw and stalks during grain combining can also save fuel.

Machine Conditions

The condition of tractors and other farm machinery can affect their fuel efficiency. To maintain a tractor in good condition: change oil and air filters regularly; be sure carburetor settings, fuel bowls and other fuel related parts function properly. Adjust plows and other equipment to reduce draft or friction which can increase fuel consumption. Keep knives and other cutting parts sharp. Maintain tractors and tires to optimize wheel slippage at 10 to 15 percent. Too little slippage requires too much fuel energy to move the wheels, whereas too much slippage (greater than 15 percent) can result in excessive tire slip and subsequent energy loss. (More information on optimal wheel slippage can be found in MSU Agricultural Engineering Information Series #364, "Wheel Slip and Proper Tractor Weight for Maximum Efficiency.")

ADDITIONAL INFORMATION

Other farm energy use data and conservation information reported by the Michigan Farm Energy Audit Study are available in a notebook *"Farm Energy Use"* available in each county Cooperative Extension Service office. The notebook can be purchased from the Agricultural Engineering Dept., Michigan State University for $20.

Table 1. Diesel Fuel Consumption (gallons per acre) For Field Operations.

OPERATION	MICHIGAN FARM ENERGY AUDIT			AVERAGE FROM OTHER STATES*
	Average	Range High	Range Low	
Primary Tillage				
Moldboard Plow	1.81	3.50	0.90	1.87
Chisel Plow	1.36	3.50	0.80	1.09
Offset Disk	1.11	1.20	0.90	0.97
Subsoiler	1.54	2.30	1.10	1.56
Secondary Tillage				
Disk	0.93	3.30	0.30	0.65
Field Cultivator	0.78	1.80	0.30	0.68
Spring Tooth Harrow (Drag)	0.73	1.80	0.20	0.48
Fertilizer + Chemical Application				
Pesticide Spraying	0.33	2.90	0.10	0.13
Chemical Incorporation	0.80	1.10	0.50	—
Spread Fertilizer	0.30	0.50	0.10	0.19
Knifed-in Fertilizer	0.58	1.30	0.20	1.05
Planting				
Row Crop Planter	0.51	1.00	0.20	0.54
Grain Drill	0.56	2.31	0.10	0.33
Potato Planter	0.95	1.90	0.90	0.95
Broadcast Seeder	0.28	1.12	0.10	0.15
No-Till Planter	0.68	—	—	0.43
Cultivation				
Cultivator	0.39	1.90	0.10	0.42
Rotary Hoe	0.23	0.70	0.10	0.21
Forage Harvesting				
Mower/ Conditioner	0.72	1.80	0.30	0.66
Rake	0.46	1.26	0.20	0.24
Baler	0.65	2.90	0.10	0.69
Large Round Baler	0.80	—	—	—
Forage Harvester or Green Chop	1.57	2.00	0.20	1.87
Corn Silage Harvester	3.14	6.70	1.70	2.69
Grain & Row Crop Harvesting				
Small Grain or Bean Combine	1.23	1.80	0.70	1.01
Corn Combine	1.51	2.20	0.70	1.37
Corn Picker	1.84	3.00	1.20	1.10
Pull and Window Beans	0.52	1.10	0.30	0.34
Beet Harvester	1.37	1.90	0.90	1.91
Topping Beets	0.83	1.20	0.40	1.47
Potato Harvester	2.69	—	—	1.73
PTO Operated (gal/hr)				
Forage Blower	2.19	6.20	0.90	
Irrigation	3.41	4.40	1.10	
Grinding	3.84	6.90	2.20	

**Average values were calculated from data reported in Extension publications and literature from the following states: Iowa, Pennsylvania, Nebraska, Missouri, Wisconsin, New York, Ontario, Oklahoma, North Dakota.*

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