RUTGERS
New Jersey Agricultural Experiment Station

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Cooperative Extension

Fact Sheet

Fuel Requirements and Energy Savings Tips for Field Operations

*Zane R. Helsel, Extension Specialist**

Fuel Use

Tillage and other field operations consume between 10% and 20% of the total energy expended in US crop and livestock production. These activities represent an even larger percentage of the total liquid fuel usage. Table 1 reports fuel use values for many field operations summarized from various states. Although these data are not from New Jersey, the values may be useful as guidelines to determine whether your fuel usage for a particular operation is reasonable. If your values are consistently higher than the averages in Table 1, then you should investigate the possible causes to determine if savings can be made. For those who have gasoline powered equipment, it takes about 25-30% more gallons of gasoline than diesel fuel to perform the same field operation because diesel engines are more fuel efficient than gasoline engines.

Fuel Conservation Methods

Farmers can consider numerous measures to reduce fuel consumption. The first step is to determine how much fuel is being used for a particular field operation. This can be done by filling the fuel tank of the tractor before an operation starts, then complete the field operation noting the number of acres covered (43,560 square feet in an acre), and finally refill the tank to determine the gallons used. The number of gallons used divided by the number of acres covered gives use in gallons per acre. The resulting estimate of fuel usage can be compared to the values listed in Table 1. If the numbers obtained are higher than the average and particularly if at the top of the range, consider the following tips to reduce fuel consumption.

Reduce Number of Operations

Reducing the number of field operations is a simple way of decreasing total fuel usage on the farm. Minimum and no-tillage systems reduce tillage operations thereby lowering fuel consumption, saving time, reducing soil compaction and erosion, and minimizing machinery inputs. As an illustration, assume a farmer uses a plow followed by two secondary tillage operations prior to planting and spraying, the combination of these operations results in about 4 gal/A of fuel used. If the farmer chooses no-till planting, a total of about 1 gal/A is used for planting and spraying--a savings of 3 gal/A. Often times, more secondary tillage operations are performed than are 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.

Match Implement to Tractor Size

Matching implement size to tractor size can result in fuel savings. In general, if implements are matched to tractor size, a tractor should be able to pull the implement in the 3 to 8 mile per hour range. When a tractor can easily pull an implement faster than about 8 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. Surveys in the past have shown several operations such as spraying, harrowing, and cultivating to consume more fuel than would be suggested by mathematical calculations. Analysis of that survey data often revealed that too large a tractor was used for the particular field operation.

When properly loaded, larger tractors can be more efficient than smaller tractors, yet small tractors used to pull small implements or to do small jobs can be more economical and fuel efficient than using large tractors to pull small implements. 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 an implement. When pulling light loads for short periods of time, a fuel savings can result from pulling that load in a higher gear but at a reduced RPM. The RPMs should not be reduced below 20% to 30% of the rated RPM. If black smoke is visible during the operation this may indicate overloading and would suggest going to the next lowest gear.

Speed

Speed is related to matching implement size to tractor size. In general, the faster the speed of field operation, the more fuel is consumed. Tractors should not, however, be driven slowly just to save fuel, because in saving fuel, time required for the operation may be considerably greater. However, if implements are matched to tractor size, then the normal range of operating speeds (4 to 7 MPH) will often produce the most efficient fuel usage.

Combine Field Operations

Combining an operation such as disking and dragging, that is, pulling the drag behind the disk in one operation, can reduce fuel consumption by 1/4-1/3 gal/A compared to that used by pulling the two tillage implements separately. A savings in time and labor and a reduction in soil compaction can 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. Combining operations has the added benefit of reducing wheel traffic and compaction.

Alternative Implements for Similar Operations

Often a lower fuel-requiring implement can be used to perform a similar operation. For example, a chisel plow may be used in place of a moldboard plow for primary tillage resulting in a 1/2 gal/A or more fuel savings. A spring or spike-tooth harrow may replace a disk or field cultivator under certain field conditions. A savings of 1/4 to 1/2 gal/A could result. You can compare the fuel consumption of different implements that perform similar operations (See Table 1) to determine possible alternative implements for fuel savings in field operations.

Field Efficiency

Field efficiency refers to the time spent doing the operation verses turning and other non-productive time. Spending an inordinate amount of time turning around at the ends of short, wide fields or overlapping tillage operations within a field can result in higher fuel consumption. To reduce turning time, farmers should strive to make fields large, long and narrow by eliminating fence rows, ditches or other barriers. Larger implements, if matched to tractor size, can be more field

efficient due to the fewer number of turns required at the ends of fields because bigger implements cover larger areas. The concept of going "catty corner" or "tilling off the corners" of the field when one is tilling diagonally can also save fuel by having the turning result in a tillage operation. The concept of controlled wheel traffic patterns can result in fuel savings and reduce total soil compaction in a field. This requires the operation of 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 other areas of the major portion of the field is considerably better than if some compaction occurred all over; however, poor drainage or other problems may occur near the compacted zone.

Depth of Tillage

Deeper tillage results in greater fuel use. For every inch increase in moldboard plowing depth, about 0.15 gallons more diesel fuel per acre is consumed. A proportionate increase results for other tillage operations at increased depths. Secondary tillage should seldom be performed deeper than 1/2 the depth of primary tillage. For example, if a field is plowed 8 inches deep, disking should be no deeper than 4 inches. Shallower secondary tillage has the added benefits of not only saving fuel, but reducing compaction, and lessening the amount of wet soil and weed seeds brought to the soil surface. Water loss is also often reduced with shallower tillage resulting in a longer period to first irrigation and/or better overall early growth.

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 harvest, where possible, under optimum crop and field conditions can result in fuel efficiency. Harvesting less straw and stalks during grain combining (increasing height of cut) can reduce fuel consumption as well.

Machine Condition

Conditions of tractors and other farm machinery can affect the fuel efficiency of those machines. A tractor should be maintained in good condition: Oil, fuel and air filters should be changed regularly according to manufacturers' recommendations; carburetor settings, fuel bowls and other fuel related components should function properly. Plows and other equipment should be adjusted (see owners manual) to reduce draft (friction) that can increase fuel consumption. Knives on forage harvesters, mowers, and other equipment should be checked daily under heavy use and kept sharp. Tractors and all equipment should receive lubrication regularly. Tractors and tires should be maintained to optimize wheel slippage at 10% to 15%. Less slippage than this results in the expenditure of too much fuel energy to move the wheels, whereas too much slippage (greater than 15%) can result in excessive tire spin and energy loss through the tire, which is non-productive. To determine percent wheel slip, place a mark on the inside of the tire that you can observe from the tractor seat, and then mark off a distance of 100 feet part way into the field. Then, determine the circumference of the tire by placing a string (or cloth/plastic measuring tape) around the center part of the ribs. Finally drive the 100 feet with the field operation in progress counting the number of revolutions of the tire. Multiply the number of revolutions by the circumference (in feet) of the tire and divide by 100. If excessive slippage occurs (greater than 15%), weights (iron and/or fluid in tires) may need to be added, air pressure changed, duals added, or new tires purchased, if heavily worn. If slippage is less than 10% weights should be removed and tire pressure checked.

Table 1. DIESEL FUEL CONSUMPTION (GALLONS PER ACRE) FOR FIELD OPERATIONS

Operation	Michigan Farm Energy Audit *			Average from other States**
	Average	Range High	Low	
Primary Tillage				
Moldboard Plow	1.81	3.50	0.90	1.87
Chisel Plow	1.36	3.50	0.80	1.09
Offset Disc	1.11	1.20	0.90	0.97
Subsoiler	1.54	2.30	1.10	1.56
Secondary Tillage				
Disc	0.93	3.30	0.30	0.65
Field Cultivator	0.78	1.80	0.30	0.68
Spring Tooth Harrow	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	-----
Spreading Fertilizer	0.30	0.50	0.10	0.19
Knife 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/Green Chop	1.57	2.00	0.20	1.87
Corn Silage Harvester	3.14	6.70	1.70	2.69
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 & 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	

**Adapted from Helsel, Z. and T. Oguntunde.1985.Fuel Requirements for Field Operations with Energy Saving Tips. In: Farm Energy Use: Standards, Worksheets, Conservation C. Myers(ed). Michigan State University, East Lansing, MI*
***Iowa, Pennsylvania, Nebraska, Missouri, New York, Ontario, Oklahoma, North Dakota*

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Rutgers Cooperative Extension
N.J. Agricultural Experiment Station
Rutgers, The State University of New Jersey
New Brunswick

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