FUEL CONSUMPTION AND POWER REQUIREMENTS FOR TILLAGE OPERATIONS

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It is estimated that well over half of the engine horsepower-used on American farms is for tillage operations. Many of the implements used, and much of the need for tillage operations have long been taken for granted. Reducing tillage operations was of considerable. interest before the advent of high priced energy, but interest increased **sharply** when the price per gallon of fuel jumped to three digits.

Diesel tractors are more efficient than gasoline tractors (a diesel uses about 70% as much fuel for a given job than a gasoline tractor). Tractors used to perform tillage operations were some of the first to use diesel engines because they were relatively high horsepower units that offered the greatest opportunity to recapture the diesel's higher initial cost. The transition to diesel is virtually complete today. Diesel engines are found in the large multi-hundred horsepower land preparation tractors down to sub-20 horsepower imported tractors. Many manufacturers of water cooled tractors either do not offer a gasoline engines powered unit or only prepare one on special order. Therefore, fuel consumption figures reported in this paper are considering diesel tractors exclusively.

Most of the published information used for determining farm implement energy rcquirements were derived from data gathered in the Midwest. This data would probably be appropriate for many farm implements, but energy requirements for tillage implements could be appreciably different because of soil type.

Determining Implement Energy Use

Reasonably accurate energy use data can be determined by simply filling the tank to the top, using the machine over a measured area, and determining the fuel used by accurately measuring the fuel needed to restore the leve1 in the tank, if a relatively large area is being worked, the tractor is on level ground, and the tracbbr is shook vigorously to expel air bubbles from the tank.

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In order to increase the accuracy of energy use values when working smaller areas, and,to speed up the operation by eliminating the need for burping air bubbles from the tank, a plexiglass tube was mounted on the fuel tank of a tractor as shown in Figure 1 below. This arrangement makes it possible to get a relatively large fuel level change in the tube when working smaller areas than would be feasible with the "Tank Refill" method.

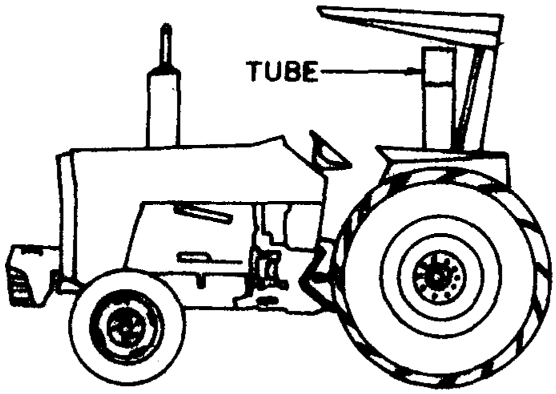

FIGURE 1

The first tube that was mounted on the tractor had a 2 inch inside diameter and would give a large, easily measured fuel level change when the tractor was used for a short time. However, a small change in the temperature of the tractor fuel caused a significant change in the fuel level in the tube. The tube was changed to a 4 inch inside diameter tube in order to reduce the error induced by fuel volume change.

Results of Implement Energy Requirement Trials

Corn-was planted at three different locations in the Gainesville area beginning in February, 1980. The soil preparation and planting treatments were as shown below

1) Disk, moldboard plow, disk, subsoil, plant
2) Disk, moldboard plow, disk, plant
3) Subsoil, plant
4) plant

The energy requirements for these operations were determined using the "Tank Refill" method. Even though the plot areas were only 0.3 acres to 0.9 acres, which is probably small for determining fuel requirements by tank refilling, the results given in Table 1 fall in a rather narrow band. A great amount of credit for this uniformity of results is attributed to the amount of tractor shaking done to expel air bubbles.

Table 1 - Corn Planting Energy Requirements

Location	Plot Number	Energy Used Per Operation (Gallons/Acre)				
		First Disking	Plowing	Second Disking	Subsoil and Plant	Plant
Gainesville	1	0.54	1.63	0.75	1.53	-
	2	-	-	-	-	0.64
	3	0.41	1.40	0.65	-	0.83
	4	-	-	-	1.39	-
	5	0.53	1.43	0.61	-	0.77
	6	0.53	1.50	0.50	1.31	-
	7	-	-	-	1.23	-
	a	-	-	-	-	0.64
Newberry	1	0.56	1.27	0.63	1.19	-
	2	-	-	-	-	0.74
	3	0.51	1.47	0.53	-	0.86
	4	-	-	-	1.24	-
	5	0.51	1.42	0.60	-	0.85
	6	0.51	1.36	0.60	1.31	-
	7	-	-	-	1.27	-
	8	-	-	-	-	0.76
Chiefland	1	0.58	1.40	0.67	1.32	-
	2	-	-	-	-	0.73
	3	0.51	1.35	0.62	-	0.87
	4	-	-	-	1.44	-
	5	0.49	1.34	0.57	-	0.87
	6	0.49	1.33	0.60	1.32	-
	7	-	-	-	1.44	
	8	-	-	-		0.73

The equipment used to perform the soil preparation and planting operations were: an eight foot wide tandem disk, a 3 bottom plow that cut approximately a 4 foot-6 inch slice, a two row Brown-Harden no-till planter with subsoiling shanks, a two row Brown-Harden no-till planter without subsoiling shanks, two sets of unit planters for mounting on the two no-till units, a 52 horsepower tractor, and a 58 horsepower tractor.

The data indicates that at all locations the initial disking required approximately 0.5 gallons per acre. The moldboard plowing required approximately 1.40 gallons per acre. The second disking required approximately 9.6 gallons per acre of 0.1 gallons per acre more than the initial disking because of more slippage. The no-till planter equipped with the subsoiler shanks required about 1.30 gallons per acre. When the no-till planter did not have subsoiling shanks approximately 0.75 gallons per acre was used for planting. Subtracting the no subsoiling from the subsoiling figures indicates that approximately 0.55 gallons per acre were required for the subsoiling operation.

Tests were also conducted at the Agricultural Experiment Station in Quincy, Florida to determine the energy requirements for some tillage operations in heavier soil than those found in the Gainesville area. The results are shown in Table 2.

Table 2 - Tillage Energy Requirements, Quincy

Operation	Depth of Cut (inches)	Gallons/Acre
Tandem disk	5	0.66
Offset disk	6 - 7	0.96
Rolling cultivator	shallow	0.36

The tandem disking operation was performed by a 12 foot wide unit with 20 inch scalloped disks drawn by an 85 horsepower tractor. The offset disk was a 7 foot wide unit with 20 inch scalloped disks drawn by a 52 horsepower tractor. The rolling cultivator was a 4 row unit drawn by a 150 horsepower tractor.

Comparison with Other Published Data

The following is a comparison of the tillage energy requirements published by Iowa State University and those recently determined in Florida.

Field Operation	Gallons/Acre	
	Iowa	Florida
Moldboard plow	1.90	1.40
Offset disk	0.95	0.96
Tandem disk	0.45	0.50
Rolling cultivate	0.40	0.36

How Might Energy Requirements Be Reduced

Farmers cannot use tractor engine efficiency as the sole guide for determing what tractor to buy because of practical considerations like dealer location and dealer's ability to provide parts and service. However, it is felt that more thought should be given to engine efficiency in order to reduce energy requirements. The results of the Nebraska Tractor Tests conducted over the last 10 years reveal that the 24 most efficient tractors delivered 13.91 horsepower hours per gallon while the 24 least efficient tractors delivered 11.16 horsepower hours per gallon. This is a difference of 24.6% and farmers must be made more aware of how to use Nebraska Test Data.