Bulletin 382

TRACTOR FUEL COSTS

Agricultural Extension Service
The Ohio State University

TRACTOR FUEL COSTS

by
B.J. Lamp, Jr., *Agricultural Engineer*
W.E. Gill and S.G. Huber, *Extension Agricultural Engineers*

Farmers welcome ways to cut production costs. One large cost is the fuel bill for the farm tractor. Fuel costs alone generally are greater than the total of all other machinery repair and operational costs. Fuel bills often exceed $400 per tractor per year.

Some farmers using gasoline have expressed interest in other fuels as a possible way to reduce fuel costs and thereby reduce total costs. This bulletin offers information that will help farmers to determine which tractor and tractor fuel will mean the lowest total power costs. It also discusses differences in tractor operation and performance when different fuels are burned.

WHAT ITEMS MAKE UP TOTAL TRACTOR COSTS?

The sum of the overhead, repair and maintenance, and fuel and oil costs make up total tractor costs.

TABLE I
Typical Gasoline Tractor Power Costs
($3000 initial investment and 600 hours of use per year for a 15-year tractor life)

	Cost per Hour	Cost per Year
Overhead	$ .56	$336
Repair and Maintenance	.25	150
Fuel and Oil	.68	408
Total power cost	$1.49	$894

Overhead costs include depreciation, taxes, insurance, interest on investment and housing costs. They are largely determined by the initial investment.

Repair and maintenance costs vary according to maintenance and operational practices. Operators who follow closely the recommendations of instruction manuals will have the lowest repair costs.

Fuel and oil costs depend largely upon the type of fuel and its cost, the size and mechanical condition of the tractor and the manner of operating the tractor.

The repair and maintenance costs are frequently grouped with the fuel and oil costs and are referred to as operating costs.

HOW DO TRACTORS DESIGNED FOR VARIOUS FUELS DIFFER?

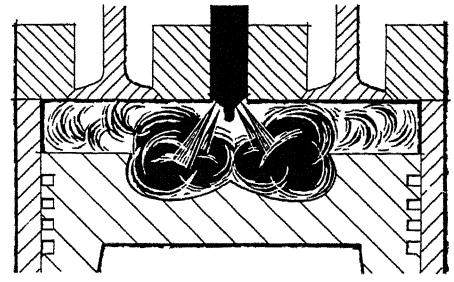
Tractor engines designed for the different fuels must have different engine features for best performance. The major differences occur in (1) method of ignition, (2) method of mixing air and fuel, (3) compression ratio, and (4) starting systems.

Compression ignition is used in a diesel to ignite the fuel. The air temperature must be hot enough that any fuel injected will burn almost immediately. In contrast, tractors designed for the other fuels depend on a spark for ignition.

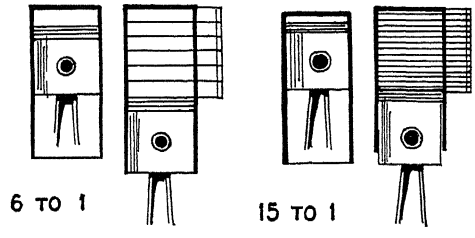
Mixing of air and fuel is done in the carburetor on tractors burning gasoline, propane, and tractor fuel. The mixture is compressed and burned after a spark

is supplied. But in a diesel, air only is compressed; if fuel were present it would be ignited too soon by the heat of compression. The diesel fuel is injected directly into the cylinder at the time burning is desired.

The compression ratio on a diesel is high in order to obtain the high air temperature required for ignition. The compression ratio of engines using fuels requiring a spark for ignition must be much lower and will vary according to the octane rating of the fuel. (See Table II.) In general, higher compression ratios convert the heat of the fuel into power more efficiently.



Diesel fuel is injected directly into the Combustion chamber



Diesels have higher compression ratios than gasoline tractors.

TABLE II *
Typical Compression Ratios of New Farm Tractor, by Fuel Type

	Compression Ratio
Diesel	16.0
Propane	8.3
Gasoline	7.1
Tractor Fuel (Distillate)	4.9

* *Calculated from Nebraska Tractor Tests*

The starting systems vary, particularly in the diesel tractor. Most engines are turned over during starting by a battery-cranking motor system. However, some diesels are started by auxiliary gasoline engines and by integral gasoline-start and diesel-run systems. Almost all diesels have devices for preheating the air, since the high temperatures required for starting a diesel often cannot be obtained during cold weather without adding heat to the air before compression. Tractor initial investments vary because of these design differences.

TABLE III
Initial and per Drawbar Horsepower Investment for a Tractor Model Available to Burn Different Fuels

Fuel	Initial Investment	Cost per Drawbar Horsepower
Gasoline	$3190	$ 79
Propane (L.P.)	3485	89
Diesel	3940	97
Tractor Fuel	3190	101

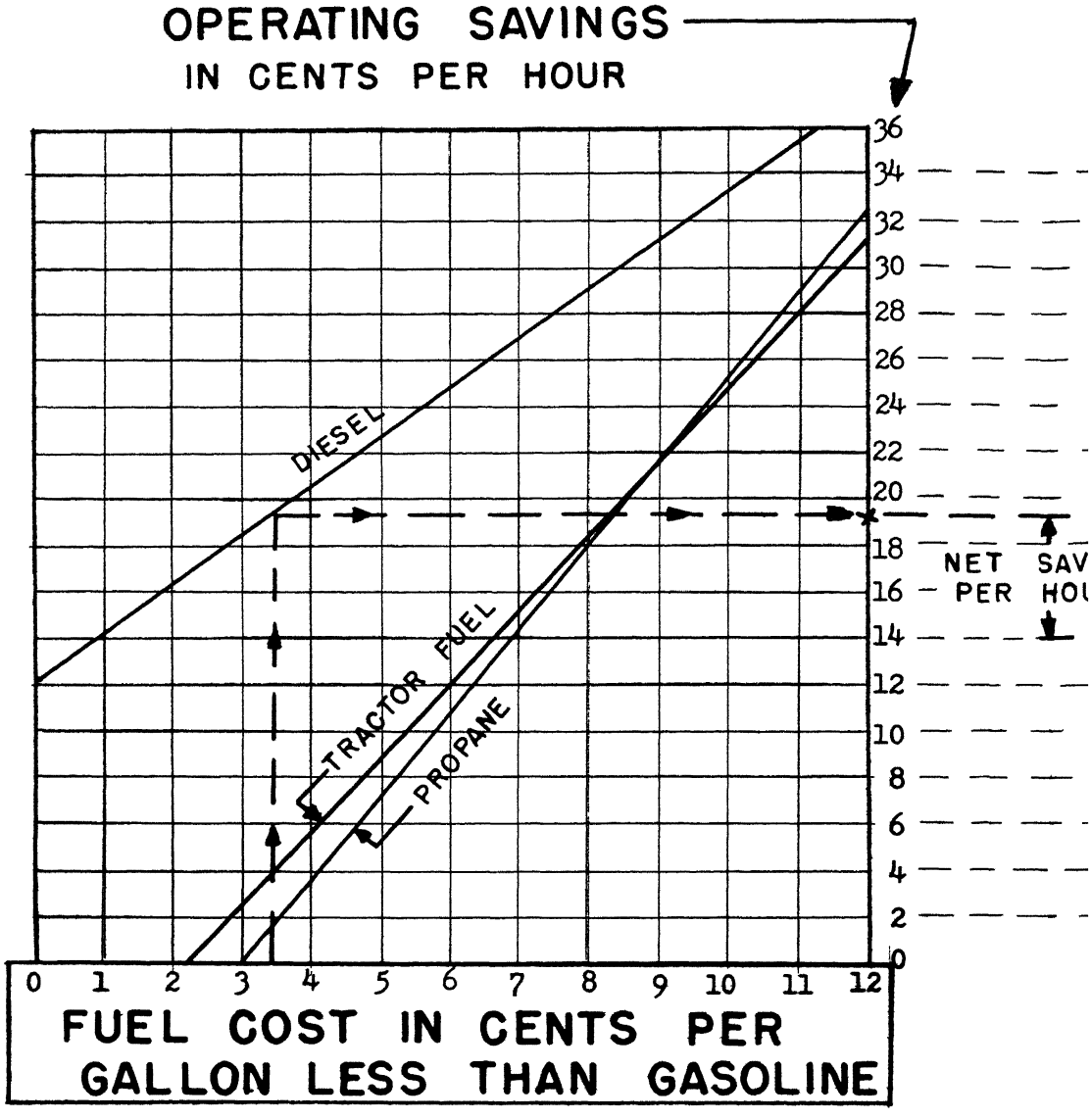
OPERATING DIFFERENCES OF TRACTORS DESIGNED FOR VARIOUS FUELS

Because of the design differences, a tractor model that can be obtained to burn any of the four fuels will have different performance and operating characteristics. A discussion of those of greatest importance to the operator follows.

Horsepower available

Propane, gasoline, and diesel tractors of the same model will have approximately the same horsepower. Tractors burning tractor fuel will have 20 to 30 percent less power because of the much lower compression ratio that must be used. The low compression ratio is used because the octane rating (the measure of a fuel's resistance to knocking) of tractor fuel is very low. (See Table IV.)

GUIDE FOR FINDING MO



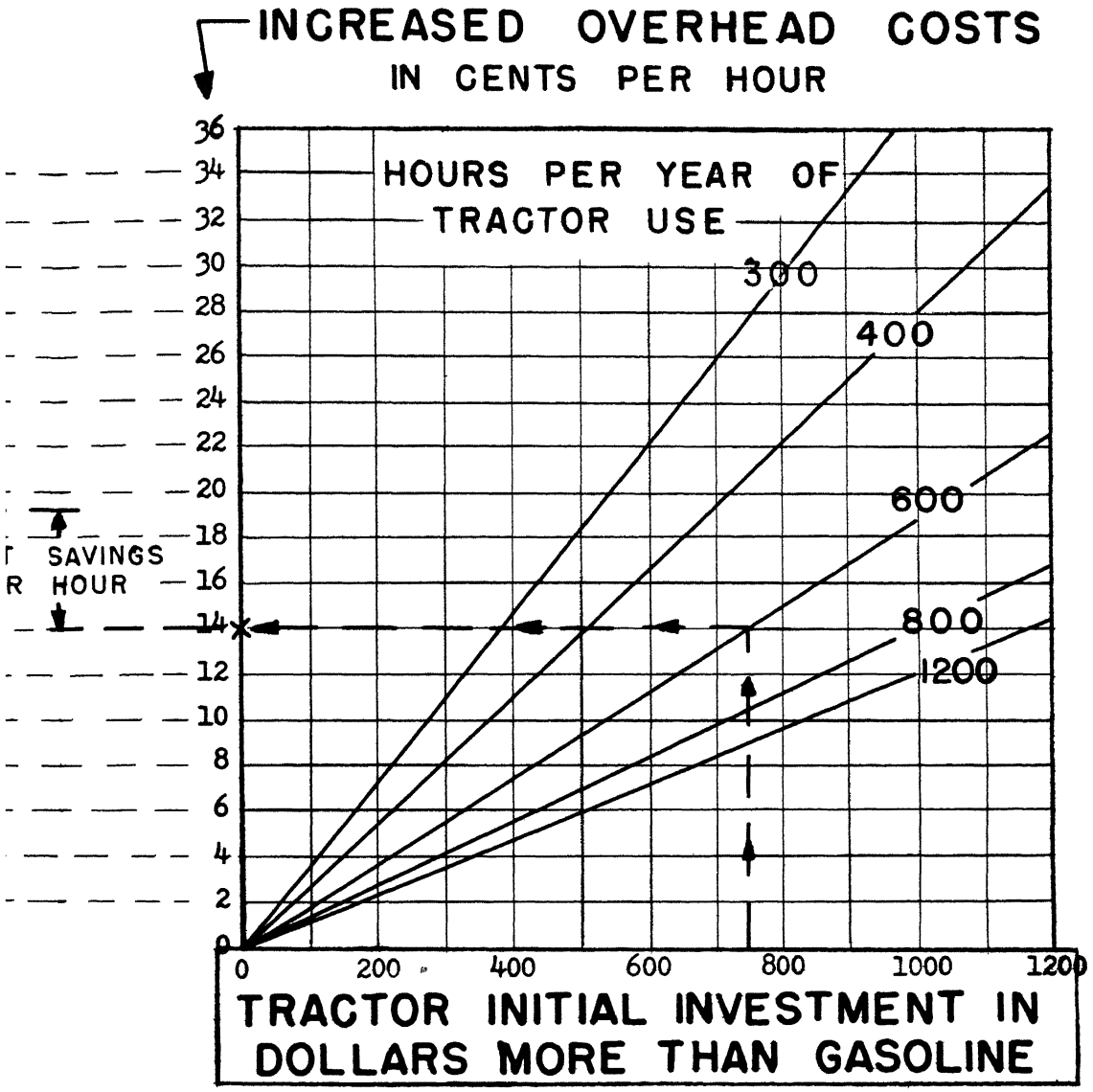
INSTRUCTIONS FOR USING THE CHARTS

(1) Detemine the difference in fuel cost per gallon. Correct difference for tax credits. Enter the chart above at this figure.

(2) Move your pencil straight up until you meet the proper fuel line. Then move straight to the right. Make a pencil mark.

(3) Detemine the initial investment difference. Include fuel storage investments. Enter the chart on the right at this amount.

MOST ECONOMICAL FUEL



(4) Move pencil straight up until you meet the line indicating the total expected hours of use per year. Then move your pencil straight to the left and mark.

(5) Read the cents difference between your two pencil marks. If the mark on the left side is above the mark on the right side you will have a savings in total power costs. The annual savings will be the difference between the two marks times the total hours of use per year. Total annual savings in excess of $30 to $50 are very significant.

TABLE IV
Typical Characteristics of Fuels

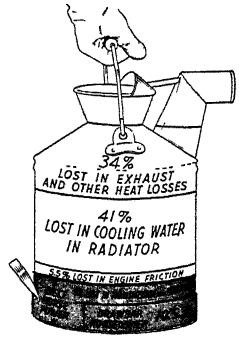
Fuel	Wt. per Gallon in pounds	Heat Units per Gallon (B.T.U.)	Typical Fuel Rating
Propane	4.3	92,300	120 Octane
Regular Gasoline	6.0	122,300	92 Octane
Tractor Fuel (Distillate)	6.6	132,000	36 Octane
Diesel Fuel No.1	6.7	133,600	50 Octane
Diesel Fuel No.2	7.0	138,300	48 Octane

Fuel Consumption

Average fuel consumption rates for several late model tractors developing 30 horsepower are shown in Table V. More gallons of propane are used per hour than the other fuels because it contains fewer pounds and heat units per gallon. The diesel uses the fewest gallons per hour because diesel fuel has more pounds and heat units per gallon than the other fuels. Also, the diesel is generally more efficient.

TABLE V
Average Fuel Consumption Rates at 30 Horsepower

Fuel	Gallons per Hour
Propane	3.6
Tractor Fuel	3.2
Gasoline	3.0
Diesel	2.1



Typical use of fuel in a tractor.

Operating Differences

Tractors designed for tractor fuel require hot-operating engines in order to make sure the fuel vaporizes. If it doesn't vaporize, it dilutes the oil and causes increased fuel consumption and engine wear. For best performance, tractors burning this fuel need to be kept under fairly constant and heavy loads.

Some operators find the odor of a diesel tractor objectionable, particularly during barn and barnyard work.

Repairs and Maintenance

In considering relative repair and maintenance costs, remember that non-engine repair costs, such as rubber tire, transmission and radiator repair costs, will be essentially independent of the type of fuel used. These are generally a large part of total repair costs.

Many hours of diesel operation are proving that diesel repair costs are very similar to those of gasoline tractors. The lack of carburetion and ignition on most diesels does eliminate the most common source of problems on the spark ignition tractors. Repairs on diesel injection equipment, while less frequent than carburetion and ignition repairs, are more expensive when they occur. Most diesel manufacturers have established exchange programs that offer reasonable and prompt service.

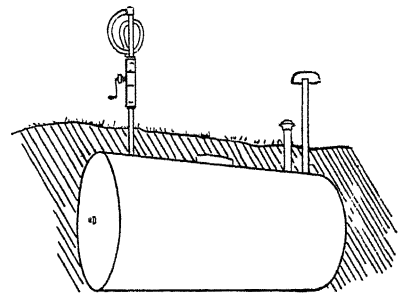
Tractors burning propane have fewer deposits and less oil contamination than other fuel burning tractors. This fact often increases the time interval between valve and ring repairs. Oil life is also extended.

Complete and timely maintenance will reduce repair costs for all tractors. Clean fuel is always important, but it is especially important in diesels. Most diesels have several fuel filters to protect the precision parts of the injection system from dirt and other foreign materials.

Storage and Handling of Fuels

Good storage facilities help to keep the fuel clean and reduce fuel storage losses. The fuel supplier will furnish storage and transfer facilities for all the fuels except propane without extra charge.

Propane, because of its high pressure at normal temperatures, must have special high-pressure storage tanks. These tanks require an investment of $500 to $700. Fuel transfer from storage into the tractor tank normally takes longer than for other fuels and is complicated by the high pressures. Special portable tanks must be adapted for field transfer of propane.



Underground storage facilities are preferred.

WHICH TRACTOR FUEL WILL BE CHEAPEST OVERALL?

The diesel will have the lowest operating costs, but it also has the highest overhead costs. So the answer depends upon the sum of these two costs. These costs vary with fuel prices, tractor investments, and hours of use of the tractor each year. Therefore, a definite answer cannot be given without a knowledge of the conditions of use. On pages 4 and 5, the charts can serve as a guide in determining relative total costs.

The total expected operating savings over gasoline can be found from page 4. This includes fuel, oil, repair and maintenance costs. The total increased overhead costs can be obtained from page 5. When the operating savings are greater than the increased costs, then a yearly savings will result.

Gasoline is used as a base because if other fuels do not give an economic advantage over it there is no overall advantage in using them.

A Farmer Writes:

"FOR MY CONDITIONS WHICH TRACTOR FUEL SHOULD I BE USING?"

"I have always used gasoline for fuel, but I wonder if my total power costs can be reduced by using some of the other fuels.

The tractor initial costs and fuel prices per gallon for my area are: Gasoline $3190 and 26.6 cents per gallon; Propane $3485 and 16 cents per gallon; Diesel $3940 and 15.1 cents per gallon (No. 2 fuel).

I will use this tractor nearly 600 hours per year. I am not interested in tractor fuel because of the loss in power and added inconvenience in its use.

Sincerely,

An Extension Agricultural Engineer Replies:

You indicate gasoline cost to be 26.6 cents per gallon, but you can receive 5 cents Ohio tax and 3 cents federal tax refund per gallon, making the net cost of gasoline only 18.6 cents per gallon. If you're not taking this credit, by all means do so.

	Diesel	Propane
Difference per gallon in fuel cost, cents less than gasoline	3.5	2.6
Operating savings per hour in cents	19	No savings
Increased investment over gasoline	$750	$300
Increased overhead cost, cents per hour	14	6
Total gain or loss per hour	5 cents gain	Lose at least 6 cents per hour
Yearly savings, with tax refund	$30.00	

RECOMMENDATION

Although you can save approximately $30 a year by using the diesel under the conditions you stated, you will want to weigh your situation carefully before changing because the economic advantage isn't great. If your estimate of 600 hours of use per year is high and actual use averages 400 hours, you would lose rather than gain. Most tractors receive less than 600 hours of use per year. Also study the design and operating differences before making a decision.

If you can buy diesel fuel at a lower price, or somehow reduce initial diesel investment and increase the total hours of use per year, you soon can have significant overall saving. Propane cannot be considered economical at the prices you quote.

Sincerely yours, Extension Agricultural Engineer

USE FUEL RECOMMENDED FOR YOUR TRACTOR

There is generally no advantage in using fuel which greatly exceeds the octane requirements of an engine. For example, if a tractor is designed to use a low octane fuel like tractor fuel, using gasoline in it without altering the compression ratio will not increase the power but will increase the cost per hour of operation. Likewise, changing the carburetion on a gasoline tractor to burn high octane propane, without changing the compression ratio and manifold will result in increased fuel costs and a reduction in power.

Tractors originally designed to use low octane tractor fuel can be converted to use gasoline efficiently by increasing the compression ratio and changing the heat to the manifold. Use only factory designed conversion kits. The power will increase, and fuel consumption will decrease.

The diesel operator's manual will generally recommend either No. 1 or No. 2 diesel fuel. When there is a choice, better economy usually results from the number two fuel. Never use other than approved diesel fuel.

CONCLUSIONS

1. Changes in fuel prices, tractor initial investments, and hours of use occur frequently, causing different total costs. In general, however, tractors designed for gasoline should be used unless there is a significant economic advantage to other fueled tractors.

   Gasoline is generally the most economical fuel when the tractor use does not exceed 400 to 500 hours per year.

   The diesel tractor usually gives a significant economic advantage when the annual use exceeds 600 hours.

   The propane tractor does not have an economic advantage under Ohio fuel prices.

   Tractors designed for tractor fuel will seldom be used because of the added inconvenience and the reduced power.
2. All state and federal tax refunds on gasoline should be taken. The refund will usually exceed any savings gained by changing tractor fuels.
3. Selecting the right size of tractor to meet a farm's power need may result in savings greater than those realized by using the more economical fuel.

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