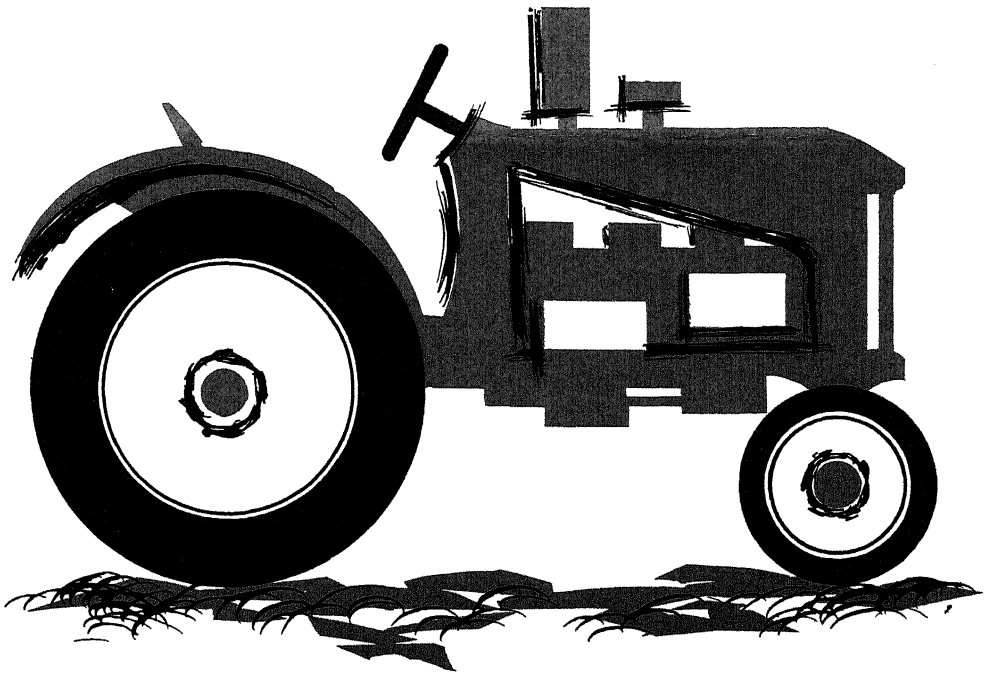
Bulletin 399

WHICH FUEL?



AGRICULTURAL EXTENSION SERVICE
Ohio State University

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 diesel or propane fuel.

"The tractor initial costs and fuel prices per gallon for my area are: Gasoline, $3670 and 29.6 cents a gallon, Propane, $3970 and 16 cents a gallon, Diesel $4470 and 14.8 cents a gallon (No. 2 fuel).

'I use about 2,000 gallons of gasoline a year.'

Sincerely,

AN EXTENSION AGRICULTURAL ENGINEER REPLIES:

"You indicate that gasoline costs 29.6 cents per gallon, but you can receive 7 cents Ohio tax and 4 cents federal tax refund per gallon. If you are not taking this refund, by all means do so.

	Diesel	Propane
Cost of gasoline 18.6 cents		
Difference per gallon in fuel cost, cents less than gasoline	3.8 cents	2.6 cents
Operating savings or loss, dollars per year (From charts - pages 4 through 7)	$120.00 saving	operating loss
Increased overhead cost, dollars per year (assuming you trade at 10 years)	$85.00	
Yearly savings or loss	$35.00 saving	$70.00 over $70.00 loss

'Although you can save about $35.00 a year by using a diesel under the conditions you stated, you will want to weigh your situation carefully before changing because the economic advantage isn t great. Availability of service, operating conditions, and design features of the tractors should be considered.

'The use of propane would increase your power costs rather than reduce them at the fuel prices you quote.'

Sincerely yours,

Extension Agricultural Engineer

Which Fuel?

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.

ITEMS IN TOTAL TRACTOR COSTS

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

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

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

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

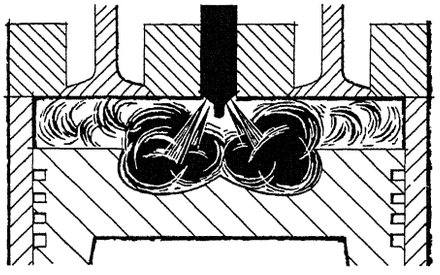
The repair and maintenance costs are frequently grouped with the fuel and oil costs and are referred to as **operating costs.**

HOW DO TRACTORS 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.

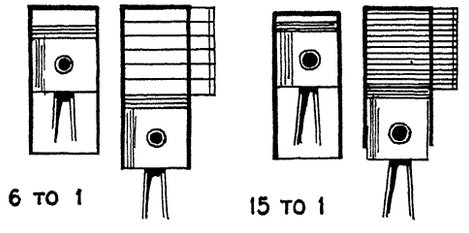
Compression ignition is used in a diesel to ignite the fuel. The air temperature must be hot enough that any fuel injected will burn almost immediately. In contrast, tractors designed for the other fuels depend on a spark for ignition.

Mixing of air and fuel is done in the carburetor on tractors burning gasoline and propane. The mixture is compressed and then 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.



Diesel fuel is injected directly into the Combustion chamber

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.



Diesels have higher compression ratios than gasoline tractors.

FACTS YOU SHOULD KNOW

1. Gasoline is generally the most economical fuel **when the tractor use does not exceed 1500 gallons of gasoline per tractor per year.**
2. **When annual use of gasoline exceeds 2000 gallons per tractor per year, a diesel tractor will give a significant economic advantage.**
3. The propane tractor does not have an economic advantage under present Ohio fuel prices.
4. Tractors designed for tractor fuel are seldom practical because of the added inconvenience and the reduced power.
5. All state and federal tax refunds on gasoline should be taken. The refund will usually exceed any savings gained by changing tractor fuels.
6. Selecting the right size of tractor to meet a farm's power need may result in savings greater than those realized by using the most economical fuel.

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. (see Table III).

OPERATING DIFFERENCES OF TRACTORS

Because of the design differences, a tractor model that can be obtained to burn any of the three 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.

TABLE III

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

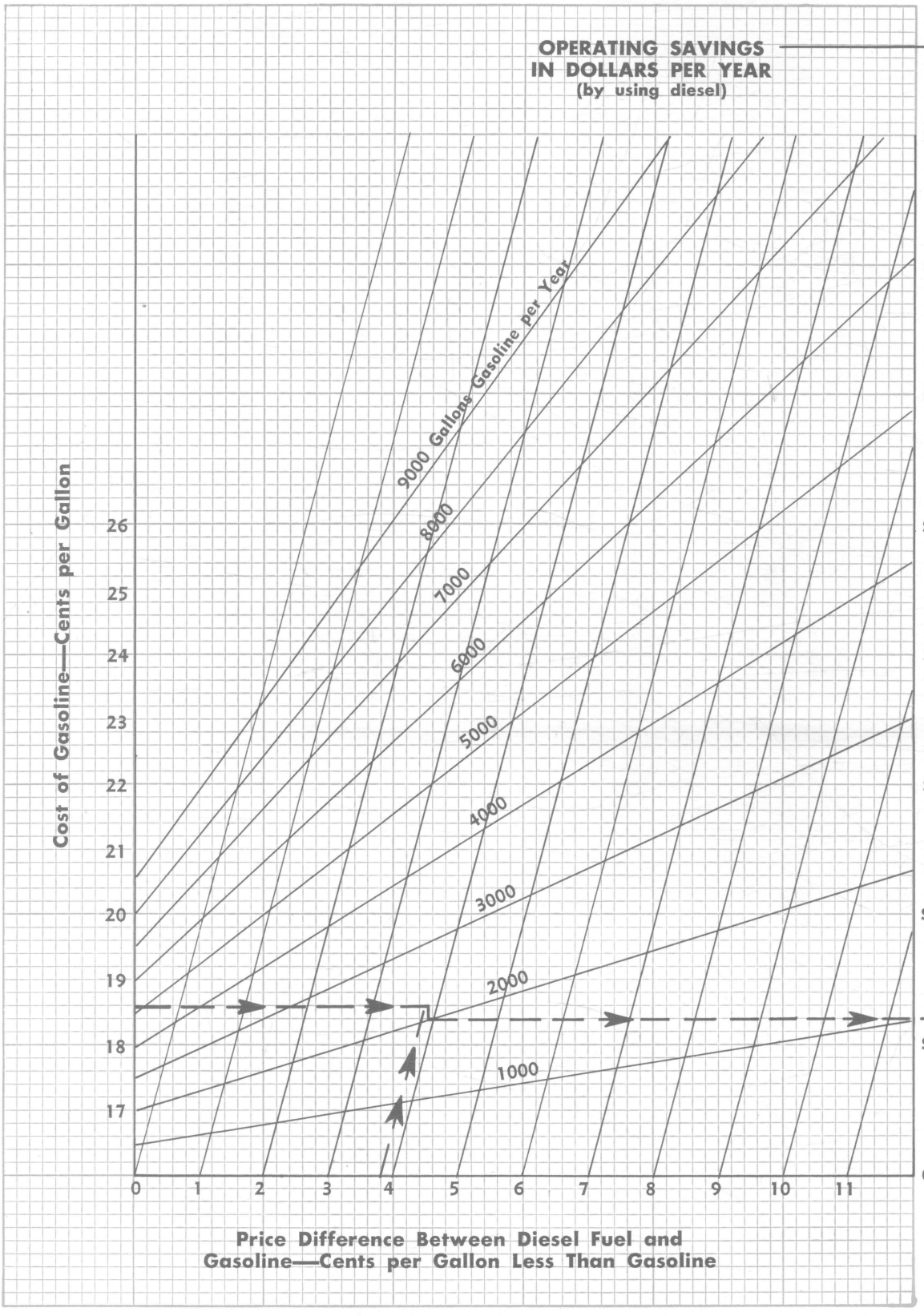
Fuel	Initial Investment	Cost per Drawbar Horsepower
Gasoline	$3190	$79
Propane (L.P.)	3485	89
Diesel	3940	97

TABLE II

Typical Characteristics of Fuels

Fuel	Wt. per Gallon in pounds	Heat Units per Gallon (B.T.U.)	Typical Fuel Rating	Typical Compression Ratios
Propane	4.3	92,300	120 Octane	8.5 to 1
Regular Gasoline	6.0	122,300	92 Octane	7.2 to 1
Diesel Fuel No. 1	6.7	133,600	50 Octane	
Diesel Fuel No. 2	7.0	138,300	48 Octane	16 to 1

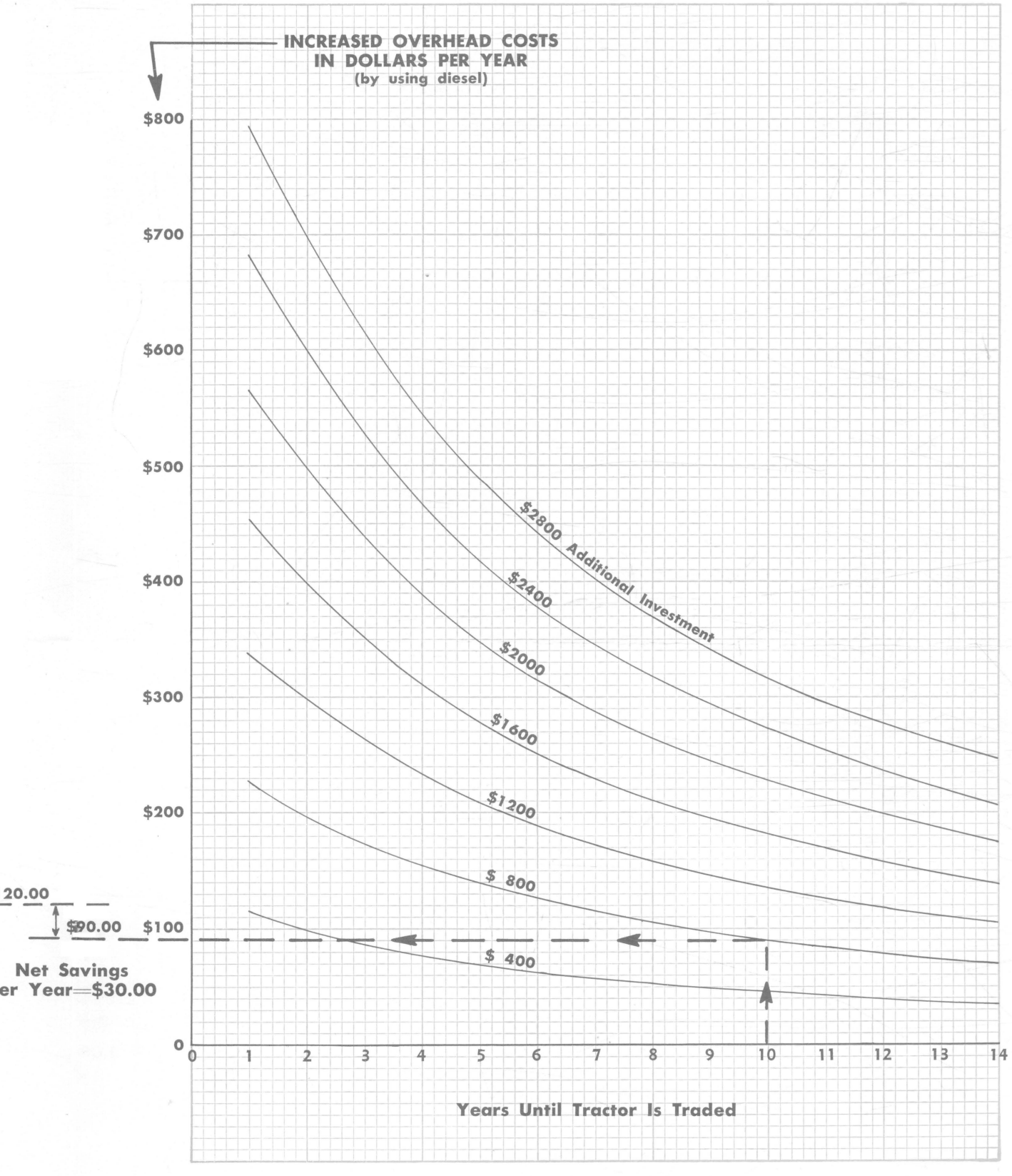
GUIDE FOR FINDING IF GASOLINE OR PROPANE IS



INSTRUCTIONS FOR USING CHARTS

1. Determine the price you pay per gallon for gasoline minus any federal and state tax refunds. Enter left side of chart at this figure and draw a horizontal line.
2. Subtract the cost per gallon of diesel fuel from the net cost per gallon for gasoline. Enter bottom of chart at this figure. From this point—
3. Move pencil up along diagonal line until you meet the horizontal line from cost of gasoline.
4. From the intersection of these lines move either straight up or down until you meet the line giving gallons of gasoline used per year in tractor or tractors.
5. From this point move horizontally to the right and read the yearly operating savings at the right side of the chart.

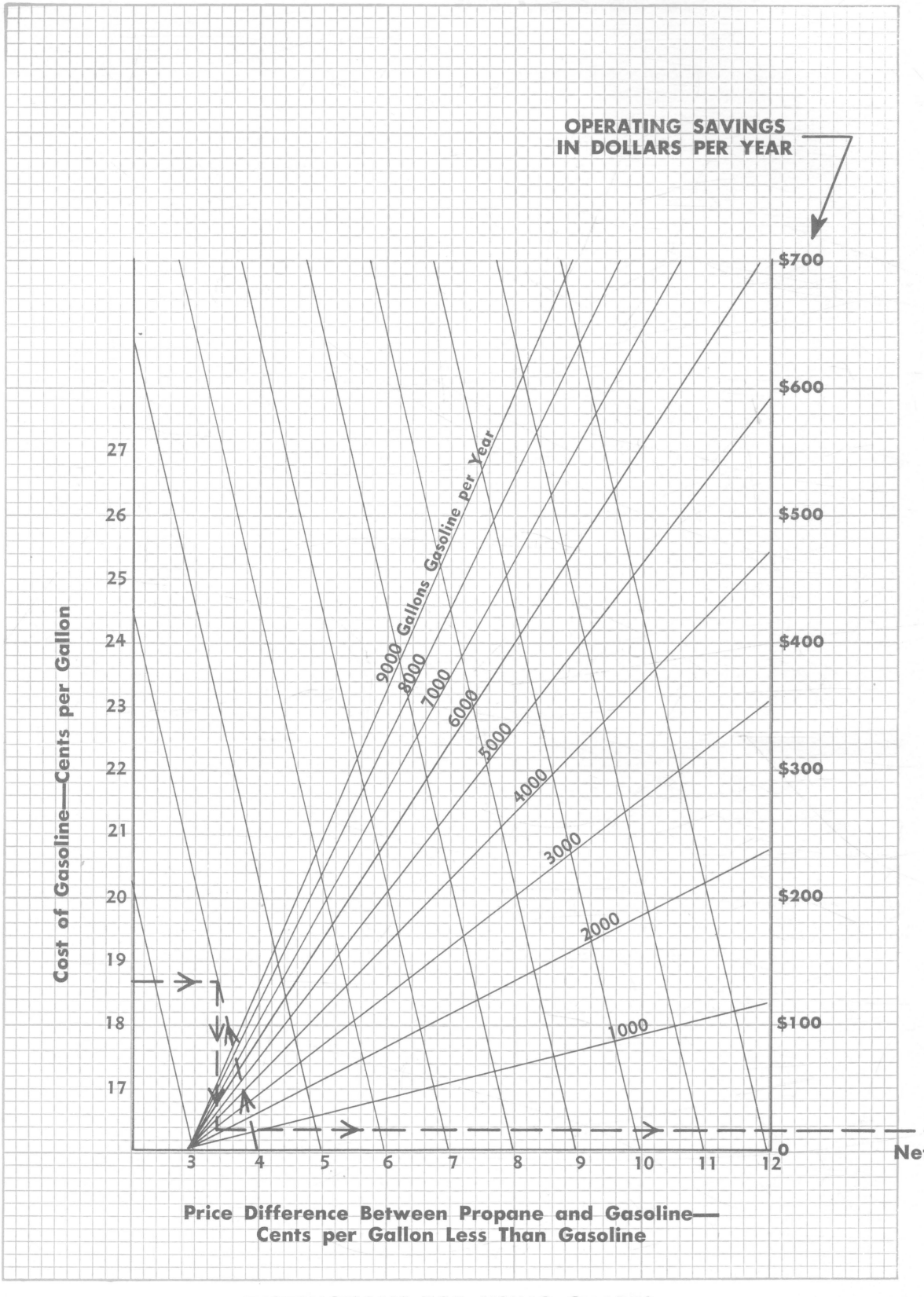
PANE IS THE MORE ECONOMICAL FUEL FOR YOUR FARM



6. Decide the number of years you will keep the tractor. Enter lower scale of right hand chart at this figure and move pencil straight up until—
7. It intersects the curved line showing difference between cost of diesel and gasoline tractor (additional investment).
8. From this point move horizontally to the left and read increased costs at the left side of chart.
9. Determine the difference between the operating savings and the increased overhead costs. This represents the net savings or loss per year.

NOTE—If you are now using diesel and wish to determine net savings per year, over using gasoline, multiply the gallons of diesel fuel used per year by 1.17 and use in chart as gallons of gasoline. Use charts as directed.

GUIDE FOR FINDING IF GASOLINE OR PROPANE IS

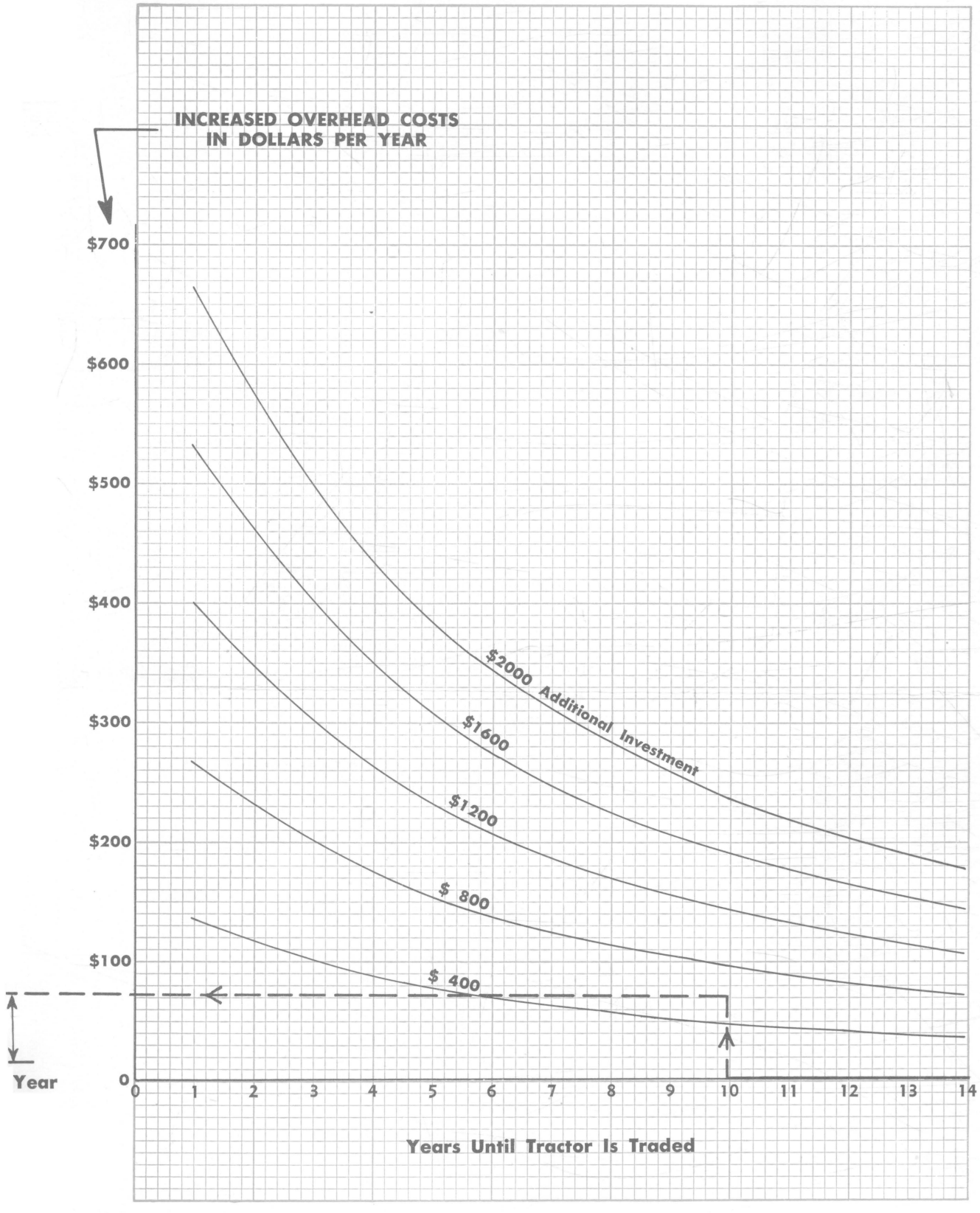


INSTRUCTIONS FOR USING CHARTS

1. Determine the price you pay per gallon for gasoline minus any federal and state gasoline tax refunds. Enter left side of chart at this figure.
2. Subtract the cost per gallon of propane from the net cost per gallon of gasoline. Enter bottom of chart at this figure. From this point—
3. Move pencil up diagonal line until you meet the horizontal line from the cost of gasoline as found in Step 1.
4. From the intersection of these lines move either straight up or down until you meet the line giving the gallons of gasoline you use per year (See Note 1).
5. From this point move horizontally to the right and read the yearly operating savings (See Note 2) at the right side of the chart.

Note 1—If you are checking for most economical fuel for the entire farm operation use total gallons of gasoline used per year in all tractors. If you are checking for one tractor, use estimated gallons of gasoline used for that tractor.

THE MORE ECONOMICAL FUEL FOR YOUR FARM



6. Decide the number of years you will keep the tractor. Enter the lower scale of the right hand chart at this figure and move your pencil straight up until—
7. You meet the curved line showing the additional investment required with propane (cost of propane storage plus additional cost of tractor). The example assumes $600 additional investment.
8. From this point move horizontally to the left and read the increased yearly costs at the left side of the chart.
9. Determine the difference between operating savings and the increased overhead costs. This represents the net savings or loss per year (See Note 2).

Note 2—At present Ohio prices for propane and gasoline there will be an operating loss with propane over gasoline. Adding the increased overhead costs of propane to the operating loss results in considerably higher power costs when using propane.

At present gasoline prices, propane must cost about 4 cents a gallon less than gasoline before any operating savings are obtained.

Fuel Consumption

Average fuel consumption rates for several late model tractors developing 30 horsepower are shown in Table IV. 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 IV

Average Fuel Consumption Rates at 30 Horsepower

Fuel	Gallons per Hour
Propane	3.6
Gasoline	3.0
Diesel	2.1

Operating Differences

There are few operating differences between the various fuels. However, some operators find the odor of a diesel tractor objectionable, particularly when doing 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.

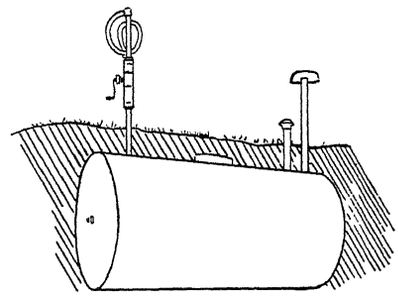
Tractors burning propane have fewer deposits and less oil contamination than other fuel burning tractors. This fact often increases the time interval between valve and ring repairs. Oil life is also extended.

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 FUEL WILL BE CHEAPEST?

The diesel will have the lowest operating costs, but it also has the highest overhead costs. These costs vary with fuel prices, tractor investments, and the amount the tractor is used each year. Therefore, a definite answer cannot be given without this information. The charts on pages 4 through 7 can serve as a guide to determine which tractor fuel will result in the lowest overall power costs under your conditions. The charts on pages 4 and 5 compare diesel and gasoline power costs. Those on pages 6 and 7 compare propane and gasoline. Gasoline is used as a base because this is the most common fuel in use on Ohio farms.

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 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.**

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Agricultural Extension Service, W. B. Wood, director, Columbus 10, Ohio.
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