# Farm Machinery Ideas That Save Energy

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Between 1960 and 1980, production agriculture experienced many changes in farm tractors and other machinery. Most were due to farmers' desires to reduce time and labor requirements for field operations. Wider implements and more powerful tractors became available and were bought by farmers.

The most powerful farm tractor available in the United States in 1960 produced about 85 horsepower—a figure which represents the average farm tractor in 1980. Tractors with 300 horsepower are available today.

Demand for ever more powerful tractors led to the four-wheel drive concept. Four-wheel drive tractors generally have higher tractive efficiencies, allowing them to convert fuel into drawbar horsepower more efficiently than two-wheel drive tractors. They also have greater flotation, which makes earlier working of damp soil possible.

During the rapid rise in engine horsepower, tractor weight did not increase as much. With lower weight-to-horsepower ratios, faster field speeds are needed to use available power. Lighter weight also limits torque loads imposed on the drive train.

In 1960, tractors fueled with gasoline and LP gas were used nearly exclusively. While diesel engines are more expensive than gasoline or LP engines, they are also more efficient converters of petroleum to mechanical energy. Besides, diesel fuel contains more energy per gallon than gasoline or LP gas, and its price has historically been lower. To reduce orerating costs, farmers today have almost completely converted their purchases to diesel powered machinery.

Rapidly rising energy costs have brought major pressures to bear on production agriculture. Farmers have watched diesel fuel prices climb past $1 per gallon, whereas diesel fuel for farm tractors sold at 16 cents a gallon as late as 1970. Of even greater concern are actual and potential shortages of fuel during critical farm seasons. These problems

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326-621 O - 80 - 9 : QL 2

resulted in major efforts to reduce fuel expenses and eliminate fuel availability uncertainties.

Energy factors must be considered in selecting, operating, and maintaining farm machinery. The greatest scope for reducing energy consumption of farm machinery lies with the operation of tractors and tillage implements.

**4 Key Steps in Selecting Equipment**

Selecting implements and tractors involves these steps: 1) what crops are planned and acreages of each to be grown, 2) types of tillage and cultivation tools to be used, 3) implement widths to ensure timely completion of each field operation, and 4) power requirements for tractors established by widths and speeds of the implements and appropriate soil characteristics.

Selecting tillage implements depends on the type of farming desired. A farmer who prefers a clean tilled seedbed will probably select a moldboard plow as the primary tool. If the farmer wishes to leave a certain amount of crop residue on the surface, then a chisel plow or offset disk is more appropriate.

Each tillage operation requires a certain amount of energy. Energy needed for primary tillage operations with three implements are shown in the table.

**Average Energy Consumption, Primary Tillage Operations**

| Implement | Energy Required (HP-HRS. Per Acre) |
|---|---|
| Moldboard plow (7" deep ) | 23.5 |
| Chisel plow | 16.0 |
| Heavy Offset Disk | 13.8 |

Moldboard plowing consumes more energy than disking or chiseling. For minimum energy use, select a tillage system that uses implements with low energy requirements. However, energy is not the only basis for selecting implements. Leaving the desired amount of crop residue on the surface, forming a proper seedbed, and controlling weeds are also important.

A vital step in machinery selection is determining implement widths. Required widths depends on expected field efficiency, length of time available for each field operation (timeliness), and speed of travel through the field.

Field efficiency accounts for time spent in turning, repairing breakdowns, making adjustments, refueling, etc., and for overlap of implement width. It is

expressed as the actual field work rate divided by the theoretical work rate, and normally varies from about 70 to 85 percent for most field operations.

Timeliness is the ability to perform a field operation both at the proper time and during a short period. It is most important during critical planting and harvest seasons. Agronomic research has shown considerable yield benefit from early planting of corn, soybeans and other crops. Timely and rapid harvest will avoid the field losses that can occur with a single storm.

**Farmers Right on Timeliness**

Engineers and economists have generally placed less value on timeliness than farmers, but continuing trends have shown farmers to be more correct.

High speed tillage with contemporary implements requires more fuel per acre than tillage at slower speeds, as illustrated. Therefore, operating costs for fuel rise as field speed increases. At the same time, fixed costs are reduced at higher field speeds since narrower implements can be used to produce the same work rate.

A compromise is needed between high energy costs and reduced fixed costs of higher tillage speeds. Solution to this dilemma is being sought in the design of tools with lower energy requirements.

A final step calls for selecting tractors to provide the power output demanded by the implements previously chosen. Comparative test data is needed to pick a fuel efficient tractor with the required drawbar horsepower output. Tractor fuel economy is expressed as horsepower-hours per gallon of fuel. Tractors with high fuel economies convert fuel to power more efficiently.

**Tractor Test Operation**

The Agricultural Engineering Department at the University of Nebraska has operated a tractor testing facility since 1920. All tractor models offered for sale in Nebraska must be tested at this facility. Test reports of individual tractors and annual summaries can be obtained by writing to the Department of Agricultural Engineering, University of Nebraska, Lincoln, NE 68503. Farmers use Nebraska test results to select tractors in the same way car buyers use EPA mileage ratings.

Nebraska Tractor Tests show tractors vary markedly in ability to convert fuel into power. Of tractors tested during 1979, there was a 23 percent difference between best and worst fuel economies at maximum PTO power.

If Nebraska Test results are graded according to fuel economy and the rankings of the PTO and drawbar tests are compared, considerable differences

between the two rankings are seen. A tractor's performance in the field is affected not only by its engine efficiency, but by its weight-to-power ratio, distribution of its weight, number of drive wheels, and soil characteristics. Each of these factors affects tractor fuel economy. During the 1980's, farmers will become more familiar with all factors affecting fuel economy.

**Fuel Economy Better at High Engine Load**

Tractor engines have better fuel economy at higher engine loads. Fuel economy at full PTO power is about 30 percent higher than at 50 percent PTO power.

When engine loading is not high, fuel economy can be improved by reduced throttle operation using a higher gear, provided care is taken to avoid overloading the engine. This improvement is possible since typical diesel engines give their best fuel economy at about 2/3 rated power and 2/3 rated speed.

The fuel-saving potential of reduced throttle operation is shown in each Nebraska test. Since 1968, several hundred test runs — at about half full load with reduced throttle setting — have shown average fuel savings of 27 percent.

Many farmers are finding that even with relatively heavy loads, substantial fuel savings are available through throttling back. The graph illustrates improvement in fuel economy possible with heavy loading and reduced throttle operation.

Tractor operators are faced with complex decisions in deciding how to operate their equipment for high output with good fuel economy. In the near future they will have electronic assistance in making these decisions.

Performance monitoring is the key to improved tractor/implement operation. Monitors will measure and display important variables that affect operation and performance of the tractor and equipment.

Illustrated is the type of monitor console expected on future tractor models. By referring to information displayed on the console, the operator can immediately see effects of any changes in gears, throttle setting, ballasting, tillage depth, tire changes, etc. The operator then can make the changes that result in best fuel economy or working rate.

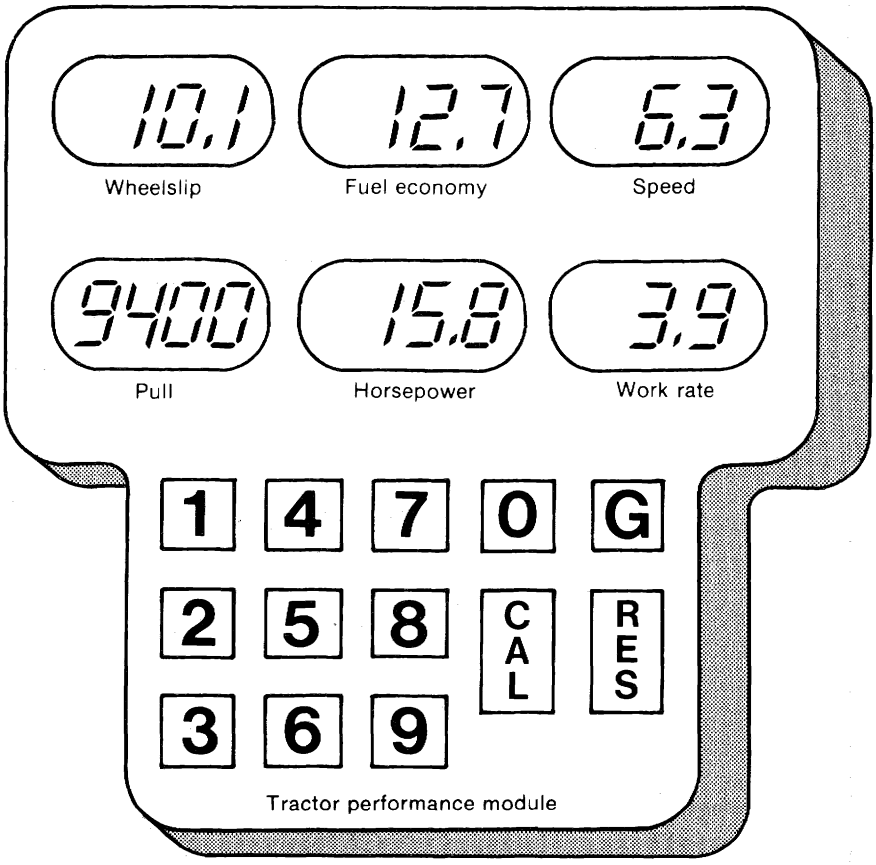
The next step beyond performance monitoring is automatic control feedback. Microcomputers can be used to automatically select gears and set governors for best performance or fuel economy. Microprocessors will also monitor oil pressure, coolant tempera-

ture, exhaust temperature, and other factors important to tractor operation.

Performance-monitoring equipment will also help the farmer make better machinery selection decisions. Farmers will accumulate information unique to their tractors, implements, farming system, and soils. This information will provide the basis for future decisions in selecting tractors and implements.

In terms of saving both energy and money, good maintenance makes good sense. Well maintained equipment runs more efficiently, is less likely to break down at a critical time, and lasts longer.

Thorough maintenance of tractors, especially engines, ensures maximum use of each gallon of fuel consumed. Both internal and external engine components require attention. This means all adjustments and clearances must be kept strictly within their specified range.




**A tractor performance monitor for the future.**

**Fuel System Component Checking**

Fuel system components, including turbochargers, must be checked by qualified mechanics at the first sign of improper operation. Faulty fuel injectors of pumps can dramatically increase the quantity of fuel used by the engine.

Blocked air filters can reduce engine output and increase fuel consumption up to 25 percent. It is vital to change filters at correct time intervals. Air precleaners must also be inspected and cleaned regularly. If precleaners are neglected, the more expensive main filter will quickly become blocked.

In the future, performance-monitoring equipment will indicate the need for maintenance. A drop in power output or a decrease in fuel economy will remind the operator of the need to perform routine inspection and maintenance work.

**Further Reading:**

*Choosing a Tractor Using the Nebraska Tractor Tests*, FS-16, Cooperative Extension Service, Cornell University, Distribution Center, 7 Research Park, Ithaca, NY 14850. 20¢.

*Fundmentals of Machine Operation-Machinery Management*, John Deere and Company, Distribution Service Center, Department SP, 1400 3rd Avenue, Moline, IL 61265. $8.25.

*Tractor Test Data*, MS-418, Cooperative Extension Service, Distribution Center, Umberger Hall, Kansas State University, Manhattan, KS 66506. 35¢.