



# Machinery Replacement Concepts

Department of Agricultural Economics

Manhattan, Kansas

**Guido van der Hoeven**

Extension Agricultural Economist  
Farm Management Association, N.E.

Farm managers and operators make many capital asset decisions throughout a farm firm's life. One such decision that occurs periodically is the replacement of power units, harvesting equipment, and planting and tillage machines. These replacements do not, as a rule, occur on an annual basis. Therefore, major capital asset replacement decisions should be made with care and study as to the long-run economic impacts on the farm firm.

The farm manager has a number of options when considering the replacement of capital assets, namely motorized and tillage equipment. To bring a needed piece of equipment into the operation, the operator may elect to: buy new, buy used, custom hire the work, rent a machine for a short time, or lease the equipment. Typically, lease options are used for motorized equipment such as tractors and combines. In all cases, the farm manager must evaluate the current situation, anticipate for the future, and make a decision.

The purchase of both new and used equipment as well as the comparison of purchases to leasing were considered in this analysis. Custom hiring work and renting machines for short periods of time were not analyzed because these options are viewed as short term solutions in the business life of the farm firm.

Replacement of capital assets is influenced by many factors, such as:

1. Age, efficiency and reliability of present machine.
2. Repair and timeliness of present machine.
3. Depreciation allowance.
4. Technological advancement.
5. Salvage value.
6. Size considerations caused by expansion or contraction.

Incorporating these factors into the decision process involves analysis of the farm firm's present and future economic position. Numerous techniques are available with varying degrees of accuracy. This analysis was limited to those methods that are easiest to use without technical support (i.e., computers).

One simple method of analyzing an asset replacement is the calculation of the payback period. The payback period is that period of time which is required to repay the cost of the machine through future, or increased, earnings directly related to that specific machine. Payback period is calculated by the following equation:

$$P=O/I$$

where P equals the payback period in years, O equals the original investment to acquire the asset, and I equals average annual income after tax. Machinery asset purchases that have lower payback periods are more desirable than those with longer periods. This method is a liquidity measure and not a profitability measure, and does not take into consideration the time value of money. Calculation of the payback period is arbitrary in considering the economic life of an asset or the income earned by the asset following the payback period.

Another method for analyzing machinery asset replacement is calculation of the simple rate of return. This is done by using the formula below:

$$R = \frac{I-D}{O}$$

where R equals the annual rate of return, I is the average annual income after tax before depreciation from the investment, D is the average annual depreciation for the investment, and O is the original purchase price. Rates of return can be calculated for various capital

assets—purchases of both new and used machinery. Those capital assets with the higher rates of return would be more favorable. This method also considers the economic life of the capital purchase investment as well as its life long earnings. Although this method is more accurate than the payback period method, the simple rate of return does not consider money flows and the time value of money.

A third method for analyzing machinery asset replacement is calculation of the cost of ownership per operating hour. A simple worksheet is outlined for this method to compare equipment purchases for four examples. A tractor is used to illustrate the examples. The worksheet does not take into consideration the time value of money; however, an operation cost value in nominal dollars per hour is provided as a basis for evaluating purchases. Capital asset alternatives considered were: (1) purchasing new and keeping the tractor 10,000 hours; (2) trading a new tractor after six seasons of use; (3) purchasing a used tractor; and (4) leasing a tractor.

In example one, the new tractor was delivered for \$65,000 with 10 hours on the meter. After 10,000 hours of operation, the tractor was assumed to have \$5,500 salvage value. Other assumptions were: 650 hours of annual use, fuel efficiency of 7.5 gallons per hour, fuel cost of \$0.71 per gallon, cost of tires after 2,600 hours of \$3,500, oil change and lubrication \$30.00 every 100 hours, annual insurance cost of \$225.00, and annual repairs of \$1,500.

Interest charge for the purchases of the machines in the three purchase examples was assessed using the following assumptions: (1) purchasing new tractor (two examples), financing \$45,500 for three years at 10 percent, and (2) purchasing used tractor, financing \$28,500 for three years at 10 percent. Interest was amortized over three years with a semi-annual payment. Interest was added to the cost of the machine to be depreciated over the hours of use in each example.

The cost of fuel per hour was calculated by multiplying 7.5 gallons per hour of \$0.71 per gallon. Other costs were calculated by dividing total annual hours into the item cost, such as insurance. The cost factors chosen for this example are then added to give a cost of ownership per operating hour. In the case of buying new and keeping the machine for 10,000 hours, the cost would be \$16.41 per hour of use.

To compare the purchase and trade after six seasons, the worksheet example was the same except the trade

value was increased to \$45,000 and the depreciation calculation was slightly higher on a per hour basis. All other costs were assumed to be the same. Cost of ownership per operating hour was \$16.87.

Comparing the purchase of a used tractor with 4,600 hours results in a change in the depreciation calculation. This tractor was assumed to be used to 10,000 hours. Repairs were increased by \$1,000.00 per year while other expenses were the same. The cost of ownership per operating hour was \$17.59.

Comparing the lease of a tractor results in changes in the method by which costs are calculated. In the example, a tractor was leased for three years with an annual lease cost of \$18,135. A penalty for usage of the tractor over the 600 hours allowed per year by the lease was calculated by the formula:

$$\$0.12 * \text{horsepower} * \text{hour}$$

In the example, the horsepower rating of the tractor was 120. The operator is responsible for normal maintenance and repair of the tractor, therefore other costs remain the same as in the purchase examples. Total lease cost per operating hour was \$37.29.

At the termination of the lease the farm manager may elect to buy the tractor. For this example the purchase price was \$40,000. The tractor would have 1,950 hours at the end of the lease.

After-tax consideration of costs will change the value per hour. The relationship of lease costs to ownership costs remains the same. Assuming a marginal tax bracket of 28 percent and self-employment tax of 15.3 percent, the after-tax costs can be calculated. In the case of leasing the tractor, the cost per operating hour was reduced from \$37.29 to \$20.78.

In the case of the purchase of a new tractor, an adjustment in the depreciation cost must be made for tax purposes. Tractors have a depreciable life of seven years following the IRS tax code. In the purchase examples, a management depreciation (purchase price plus interest divided by anticipated hours of use) was used to calculate tractor life to a producer. An increase in depreciation expense is required to match tax regulations for calculation of after-tax costs. The increase in depreciation was \$7.78 per hour. The after-tax costs of ownership per operating hour were reduced from \$24.19 (after depreciation adjustment) to \$13.71 assuming 28 percent income tax bracket and 15.3 percent self employment tax. The cost per operating hour was \$7.07 less in the ownership example than for the lease example.

<b>Tractor Replacement</b>		
<b>Purchase New Tractor and Hold till 10,000 hours</b>		
Price	\$ 65,000.00	
Interest	\$ 8,285.78	
Hours	10	
Repairs	\$ 0.00	
Hours left to 10,000	9,990	
Trade In/Salvage value	\$ 5,500.00	
		Cost/Hr
Insurance annually	\$ 225.00	\$ 0.346
Depreciation (st. line to 10,000 hrs.)		\$ 6.785
Oil and Lube (every 100 hrs.)	\$ 30.00	\$ 0.300
Fuel Economy (gallons per hour)	7.5	
Repairs (per year est.)	\$ 1,500.00	\$ 2.308
Hours used per year	650	
Cost of fuel 0.71 per gal.	\$ 3,461.25	\$ 5.325
Tires (used 4 years 2,600 hrs.)	\$ 3,500.00	\$ 1.346
Cost of Ownership per operating hour		\$ 16.411

<b>Tractor Replacement</b>		
<b>Purchase Used Tractor</b>		
Price	\$ 35,000.00	
Interest	\$ 5,189.99	
Hours	4,600	
Repairs	\$ 0.00	
Hours left to 10,000	5,400	
Trade In/Salvage value	\$ 5,500.00	
		Cost/Hr
Insurance annually	\$ 225.00	\$ 0.346
Depreciation (st. line to 10,000 hrs.)		\$ 6.424
Oil and Lube (every 100 hrs.)	\$ 30.00	\$ 0.300
Fuel Economy (gal. per hr.)	7.5	
Repairs (per year est.)	\$ 2,500.00	\$ 3.846
Hours used per year	650	
Cost of fuel 0.71 per gal.	\$ 3,461.25	\$ 5.325
Tires (used 4 years 2,600 hrs.)	\$ 3,500.00	\$ 1.346
Cost of Ownership per operating hour		\$ 17.588

<b>Tractor Replacement</b>		
<b>Trading New Tractor After Six Seasons</b>		
Price	\$ 65,000.00	
Interest	\$ 8,285.78	
Hours	10	
Repairs	\$ 0.00	
Hours left to 10,000	9,990	
Years Used	6	
Trade In/Salvage value	\$ 45,000.00	
		Cost/Hr
Insurance annually	\$ 225.00	\$ 0.346
Depreciation (st. line to 10,000 hrs.)		\$ 7.253
Oil and Lube (every 100 hrs.)	\$ 30.00	\$ 0.300
Fuel Economy (gal. per hr.)	7.5	
Repairs (per year est.)	\$ 1,500.00	\$ 2.308
Hours used per year	650	
Cost of fuel 0.71 per gal.	\$ 3,461.25	\$ 5.325
Tires (used 4 years, 2,600 hrs.)	\$ 3,500.00	\$ 1.346
Cost of Ownership per operating hour		\$ 16.868

<b>Lease of Tractor</b>		
Lease Cost (\$18,135 * 3 yrs.)	\$ 54,405.00	
Usage over 600 hours/Year Penalty (\$0.12 * HP * Hours)	\$ 2,160.00	
		Cost/Hr
Insurance annually	\$ 225.00	\$ 0.346
Lease cost per hour		\$ 29.008
Oil and Lube (every 100 hrs.)	\$ 30.00	\$ 0.300
Fuel Economy (gal. per hr.)	7.5	
Repairs (per year est.)	\$ 1,500.00	\$ 2.308
Hours used per year	650	
Cost of fuel 0.71 per gal.	\$ 3,461.25	\$ 5.325
Total lease cost per operating hour		\$ 37.287

### Asset Replacement Worksheet

A	Price/Cost of Asset	_____
B	Interest to be Paid	_____
C	Hours on Machine	_____
D	Repairs Before Use	_____
E	Trade In/Salvage Value	_____
F	Intended Hours @ Trade	_____

			Per Hour Cost	
G	Insurance Annually	_____	G/L	_____
H	Depreciation		(A+B+D-E)/ (F-C)	_____
I	Oil and Lube (every 100 hrs.)	_____	I/100	_____
J	Fuel Economy (gal. per hour)	_____		
K	Repairs(per year estimate)	_____	K/L	_____
L	Hours Used per Year	_____		
M	Cost of Fuel per gal.	_____	M * L	_____
N	Tires (hours used)	_____	N/hours used	_____
<b>COST OF OWNERSHIP PER OPERATING HOUR</b>			Sum hour costs	_____

