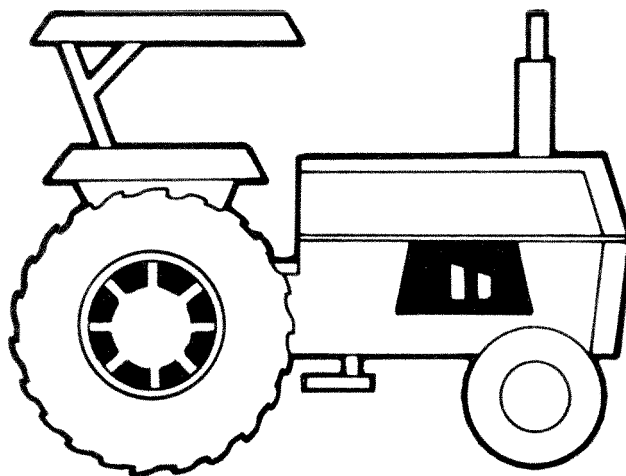


# USING MACHINERY COSTS TO MAKE DECISIONS



COOPERATIVE EXTENSION SERVICE  
THE UNIVERSITY OF GEORGIA  
COLLEGE OF AGRICULTURE/ATHENS  
USING MACHINERY COSTS  
TO MAKE DECISIONS

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## Sources Quoted

Machinery Management, Deere and Company, Moline, Illinois.

Agricultural Engineers Yearbook, Society of Agricultural Engineers, St. Joseph, Michigan.

## USING MACHINERY COSTS FOR BETTER DECISIONS

Farm machinery outlays represent the second largest capital requirement in farming.....second only to land.

The value of machinery on Georgia farms in 1989 was \$1.5 billion. And the expenses for fuel and maintenance of this equipment totaled \$243 million.....about eight percent of total farm operating costs.

Knowing how to accurately estimate costs of owning and operating equipment can help when making farming decisions. Machinery costs are one of the few items that can be minimized.

This guide is designed to help estimate these costs.

### PERFORMANCE RATES

The performance rate of equipment {acres or bales per hour etc.) frequently comes to mind when estimating costs. This can be determined as shown in Table 1.

Three factors determine performance. They are:

1. Implement width,
2. Speed of travel, and
3. Field efficiency.....which is.....

A measure of the percent of time the implement is doing productive work. A field efficiency of 70% means that 30% of the operating time is spent turning at the end of the field, filling tanks with materials, etc.

#### Example: Estimating Performance Of a Field Planter

A 6-row planter.... traveling four miles per hour.... with a field efficiency of 60%.... has a performance rate of:

$$\begin{array}{ccccccc} 216 \text{ inches} & \times & 4 \text{ mph} & \times & .60 & \times & .01 & = & 5.18 \text{ acres per hour.} \\ \text{(width)} & & \text{(speed)} & & \text{(eff.)} & & \text{(factor)} & & \end{array}$$

Increasing field speed from 4 to 5 miles per hour will increase the performance rate to:

$$\begin{array}{ccccccc} 216 \text{ inches} & \times & 5 \text{ mph} & \times & .60 & \times & .01 & = & 6.48 \text{ acres per hour.} \\ \text{(width)} & & \text{(speed)} & & \text{(eff.)} & & \text{(factor)} & & \end{array}$$

**Table 1**

**MACHINERY PERFORMANCE RATES**

---

$$\text{Acres per hour} = \left( \frac{\text{Implement width in inches}}{\text{Speed (mph)}} \right) \times \left( \frac{\text{Field Efficiency}}{100} \right) \times 0.01 = \frac{\text{acres}}{\text{hour}}$$

---

**Coefficients Used to Estimate Machinery  
Performance Rates**

Machine	Speed Range (mph)	Field Efficiency (Percent)
Plow	3.5-6	70-90
Disk, Chisel Plow, Cultivator	3.0-6	70-90
Planter, Drill	3.0-6	50-85
Sprayer	3.0-6	50-80
Mower	5.0-6	75-85
Rake, Conditioner	4.0-6	70-85
Baler, Forage Harvester	1.5-4	60-85
	3.0-10	Tons/Hr
Combine, Corn Head	2.0-4	60-80
Cotton Picker	1.0-3	60-75
Peanut Digger - Shaker	2.0-5	75-85
Peanut Combine	1.0-3	60-80
Rotary Cutter	3.0-8	75-85

Source: Machinery Management, The John Deere Company

## MACHINERY COSTS ARE TWO TYPES

These costs are:

1. Variable Costs, and
2. Fixed Costs.

### Variable Costs Items include:

- \* Fuel and Lubrication, and
- \* Maintenance and Repairs

### Fuel Requirements By Job:

The amount of energy needed per acre to perform most field operations is nearly constant, regardless of the speed and size of the tools and tractor being used. The example below illustrates fuel use.

**Small Tractor**  
3 Gallons / Hour  
@ 2 Acres / Hour  
1.5 Gallons/Acre

**Large Tractor**  
6 Gallons / Hour  
@ 4 Acres / Hour  
1.5 Gallons/Acre

Fuel consumption will vary because of soil type, tune of engine, and machine operator. But, estimates of average diesel consumption for most field jobs are shown in Table 2.

### Fuel Requirements. Total:

An estimate of the average total amount of fuel consumed on a yearly basis for all field jobs (per pto-hp) is shown below. To estimate total annual fuel costs, multiply the average hourly consumption by the price per gallon, and by the hours operation.

---

Engine (Fuel Type)	Average Fuel Consumption (Gallons Per Hour Per Maximum PTO HP)
Gasoline	0.068
Diesel	0.048
LP- Gas	0.080

---

**Lubrication costs** (according to the U. S. Agricultural Census) are 15 percent of the fuel costs of agricultural machinery. These costs can be estimated by multiplying the fuel costs (gallons consumed by the price per gallon), times 15 percent.

Table 2

**AVERAGE ENERGY AND FUEL REQUIREMENTS  
FOR SPECIFIED FIELD OPERATIONS**

Operation	PTO	Gallons Diesel Per Acre	
	HP-Hrs. Per Acre	Average	Southeast
Plow	24.4	1.68	1.40
Heavy Disk	13.8	0.95	1.00
Rip – Hip	24.0	1.65	1.70
Chisel Plow	16.0	1.10	1.30
Light Disk & Apply Herbicide	9.4	0.65	0.70
Plant Row Crops	6.7	0.50	0.50
Grain Drill	4.7	0.35	.040
Cultivate Row Crops	6.0	0.45	0.50
Transplanter	16.0	1.20	1.30
Spray - Tractor Mounted	1.0	0.15	0.20
Mower – Cutterbar	3.5	0.35	0.40
Rotary Mower	9.6	0.80	0.90
High Clearance Sprayer	---	0.20	0.20
Mow - Condition Hay	7.2	0.60	0.75
Combine Soybeans	12.0	1.10	1.30
Dig Peanuts	12.0	1.00	1.00
Combine Peanuts	44.0	3.30	3.30
Combine Corn	17.6	1.60	1.70
Combine Small Grain	11.0	1.00	1.10
Pick Cotton	na	2.80	2.80
Rake Hay	1.5	.15	.20
Bale Hay	6.0	.70	.80
Chop Corn Silage	46.7	3.60	3.60
Chop Green Forge	14.0	1.10	1.10

Source: Machinery Management, The John Deere Company.

Southeast values adjusted for soil conditions

## **Maintenance and Repairs:**

These costs are the most difficult to estimate, as repairs are hard to predict. Usually repairs are related to machine usage. Data in Table 3 indicate the average maximum life to expect from typical farm machinery with average use. Some machinery items will wear out before these life expectancies, and others will last longer than the limits shown.

### **Repair Cost Estimates For a Tractor:**

The expected repairs are shown as a percentage of equipment purchase price. Tractors are expected to incur repair costs of an amount equal to 90% of the purchase price over a 10,000 hour life. An illustration of these estimates is:

**Suppose \$20,000 was paid for a tractor** five years ago, and the machine has been used 5,000 hours. This use is 1/2 the estimated total life of 10,000 hours.

According to Table 3, we would expect to have incurred repair costs of an amount equal to 29.7% of the purchase price at this point of the tractor life (1/2 life), or  $(29.7\% \times \$20,000) = \mathbf{\$5,940}$ .

**Repairs per hour** at 1/2 life are expected to be:  $\$5,940 \div 5,000 \text{ hours}$   
**= \$1.18**

**Total repairs** over the 10,000 hours expected life area  
 $\$20,000 \times 90\% = \$18,000$ , and hourly repairs are:

$\$18,000 \div 10,000 \text{ hours} = \mathbf{\$1.80}$ .

### **Cost Estimates For a Combine:**

You have a combine that cost \$60,000 new. Data in Table 3 indicates the accumulated repair costs over the life of the machine to be 33% of the purchase price. If the machine is expected to be used its' full life of 2,000 hours we would have repair costs of:

Total Repairs Over Life =  $(\$60,000 \times 33\%)$  **\$19,800**

Repairs Per Hour =  $\$19,800 \div 2,000 \text{ hours life} = \$9.90$ .

If the machine has a performance rate of three acres per hour, we have:

Repairs Per Acre (over the life of the machine)  
 $= \$9.90 \div 3 \text{ acres per hour} = \$3.30$ .

Table 3.

**ACCUMULATED REPAIR COSTS FOR EQUIPMENT  
AS A PERCENT OF PURCHASE PRICE <sup>1</sup>**

		1/2 Life		Full Life
Machine	Hours	Accumulated Repair Costs	Hours	Accumulated Repair Costs
Tractor	5,000	29.7%	10,000	90.0%
Crawler (bulldozer)	8,000	26.4%	16,000	80.0%
Plow	1,000	32.5%	2,000	80.0%
Disk, Cultivator & Chisel Plow	1,000	18.7	2,000	65.0%
Planter & Drill	500	24.7%	1,000	75.0%
Mower	500	73.1%	1,000	180.0%
Baler, Bale Wagon & Forage Harvester	1,000	32.5%	2,000	80.0%
Combine	1,000	9.5%	2,000	33.0%
Corn Head	1,000	24.7%	2,000	75.0%
Cotton Picker	1,000	24.7%	2,000	75.0%
Orchard Sprayer	5,000	30%	10,000	60%
Boom Sprayer	5,000	30%	10,000	60%

Source: Machinery Management, The John Deere Company

<sup>1</sup> Repair cost estimates do not include the effect of inflation over the period of ownership.

### Fixed Costs Include:

- \* Depreciation
- \* Interest
- \* Taxes
- \* Insurance
- \* Shelter

**Depreciation** means the machine loses value due to use and age. This is often the largest of all machinery costs.

The most common methods of calculating depreciation are: (a) straight-line method; (b) the declining-balance method; and (c) the sum-of-years digit method. As any of these methods are considered theoretical, the straight-line method is most commonly used, as it is the easiest to calculate.

The Straight-Line-Method is figured as:

$$\text{Annual Depreciation} = \frac{\text{Purchase Price} - \text{Salvage Value}}{\text{Number of Years Use}}$$

A Rule-of-Thumb to estimate annual depreciation over the life of the machine is 8-10% of the new value.

Interest is an expense for borrowing capital, or the opportunity cost of investing available money elsewhere. A convenient method is to use the average value of the investment times the current interest rate.

It is figured as:

$$\text{Annual Interest} = \frac{(\text{Purchase Price} + \text{Salvage Value})}{2} \times \text{Interest Rate}$$

A rule of thumb to estimate annual interest charges over the life of the machine is 6% of the new value.

**Taxes Insurance and Shelter** may not be directly incurred by all operators, but should be charged. Those not carrying insurance assume a loss risk; and those not providing shelter for equipment will likely incur higher repair bills. Annual Costs for Taxes, Insurance, and Housing are estimated to be 3% of the initial investment of the machine.

**Estimated Annual Fixed Costs of Machinery  
As A Percent of Purchase Price  
(based on a ten-year life)**

<u>Cost Item</u>	<u>Annual Costs (Percent of New Value)</u>
Depreciation	8-10%
Interest	6%
Taxes, Insurance, Housing	3%
Total Annual Fixed Cost	17-19%

---

Fixed Costs for a \$35,000 Machine

Using a total annual fixed cost percentage of 18%, a \$35,000 tractor will have annual fixed costs of:

$$(\$35,000 \times 18\%) = \$6,300 \text{ Annual Fixed Costs.}$$

If the machine is used 500 hours annually, its fixed cost per hour is:

$$(\$6,300 / 500 \text{ hours}) = \$12.60 \text{ Per Hour.}$$

The amount of annual use determines the number hours of use the fixed charges are allocated. If the annual use of this machine is doubled, to 1,000 hours, then the hourly fixed cost declines to:

$$(\$6,300 / 1,000 \text{ hours}) \quad \quad \quad \$6.30 \text{ per hour.}$$

## **Estimating Total Costs (for bailing hay)**

**TOTAL COST ESTIMATES** for operating a tractor and hay baler (round bales) is shown on page 10.

To obtain this estimate, we have given:

Tractor purchase price:	\$22,000
Baler purchase price:	\$13,000
Annual fixed costs, % of purchase price	18%
Tractor annual use	600 hours
Baler annual use	150 hours
Fuel price -	\$1.00 per gallon
Performance rate	2.5 acres per hour (5 bales per hour)
Labor cost	\$.00 per hour

### **An estimate of fixed costs are:**

Tractor: \$6.60 per hour, and

Baler: \$15.60 per hour

Fixed costs are higher for the baler due to the relatively small number of hours the machine is used annually.

**Repair costs** over the life of the machine are based on the tractor (10,000 hours) having a cumulative repair cost equal to 90% of the purchase price, and the baler (2,000 hours) having a cost equal to 80% of the purchase price.

Fuel Use is taken from Table 2, and baler twine costs are local dealer estimates.

### **Total Variable Cost estimates are:**

Tractor: \$4.28 per hour, and

Baler: \$7.70 per hour.

**TOTAL COSTS FOR BOTH MACHINES,** including labor are \$40.18 per hour. Using a performance rate of five bales per hour, we have a per unit cost estimate of:

$$\$40.18 \text{ per hour} / 5 \text{ bales per hour} = \$8.04 \text{ per bale,}$$

**MACHINERY COST WORKSHEET**  
(Example 1)

<i>Tractor and Round Baler</i>	<b>Power Unit</b>	<b>Implement</b>
1. Machine	<i>Tractor</i>	<i>Round Baler</i>
2. Purchase Price	\$22,000	\$13,000
3. Annual Use (hours)	600	150
<b>FIXED COSTS</b>		
4. Annual Fixed Costs (Purchase Price x 18%)	\$3,960	\$2,340
5. Fixed Costs Per Hour (Line 4 / Hours Annual Use)	\$6.60	\$15.60
6. Repairs {(Purchase Price x Repair Factor, Table 3) divided by Hours Expected Life}	\$1.98	\$5.20
7. Fuel (Table 3 x fuel price)	\$2.00	---
8. Lubrication (Line 7 x 15%)	\$0.30	---
9. Other (twine)	---	\$2.50
10. Total Variable Costs Per Hour (Lines 6+7+8+9)	\$4.28	\$7.70
<b>TOTAL COSTS</b>		
11. Total Power & Implement <b>Per Hour</b> (Lines 5+10)	\$10.88	\$23.30
(Line 11, Totals)	\$34.18 per hour	
12. Labor Costs per Hour	\$6.00	
13. Total Equipment and Labor (line 11+ line 12)	\$40.18 per hour	
14. Units of Work per Machine Hour (Acres, Tons, Bales)	5 bales	
15. Total Cost per unit Work (Line 13+14)	\$8.04 unit	

## Estimating Total Costs (for a combine)

**TOTAL COSTS FOR OPERATING A RELATIVELY NEW COMBINE** (with a 16 ft. platform) and harvesting small grain or soybeans are shown on page 12.

This estimate is based on:

Combine purchase price	\$90,000
Annual fixed costs	18%
Annual use	200 <i>hours</i>
Fuel price	\$1.00 per gallon
Performance rate	4 acres per hour
Labor cost	\$6.00 per hour

### **Fixed costs estimates are:**

$\$90,000$  (new cost)  $\times$  18% = \$16,200 annual fixed costs.

Fixed costs per hour are:

$\$16,200 / 200$  hrs. annual use = \$81.00 per hour

**Variable costs** (primarily repairs) are figured on a 2,000 hour expected life, and total accumulated repairs equal to 33% of the purchase price. All variable costs are \$16.11 per hour.

### **Total hourly costs** for operating the combine are:

Fixed Costs	\$81.00
Variable costs	\$16.11
Labor	\$6.00
Total	\$103.11

### **PER ACRE COSTS ARE:**

$\$103.11$  (per hour) / 4 acres per hour = \$25.78.

**MACHINERY COST WORKSHEET**  
**(Example 2)**

<i>Combine with 16' Platform</i>	<b>Power Unit</b>	<b>Implement</b>
1. Machine	<i>Combine</i>	
2. Purchase Price	<i>\$90,000</i>	
3. Annual Use (hours)	<i>200</i>	
<b>FIXED COSTS</b>		
4. Annual Fixed Costs (Purchase Price x 18%)	<i>\$16,200</i>	
5. Fixed Costs Per Hour (Line 4 / Hours Annual Use)	<i>\$81.00</i>	
6. Repairs {(Purchase Price x Repair Factor, Table 3) divided by Hours Expected Life}	<i>\$14.85</i>	
7. Fuel (Table 3 x fuel price)	<i>\$1.10</i>	
8. Lubrication (Line 7 x 15%)	<i>\$0.16</i>	
9. Other		
10. Total Variable Costs Per Hour (Lines 6+7+8+9)	<i>\$16.11</i>	
<b>TOTAL COSTS</b>		
11. Total Power & Implement <b>Per Hour</b> (Lines 5+10)	<i>\$97.11</i>	<i>\$</i>
(Line 11, Totals)	<i>\$47.11 per hour</i>	
12. Labor Costs per Hour	<i>\$6.00</i>	
13. Total Equipment and Labor (line 11+ line 12)	<i>\$103.11 per hour</i>	
14. Units of Work per Machine Hour (Acres, Tons, Bales)	<i>4 acres</i>	
15. Total Cost per unit Work (Line 13+14)	<i>\$25.78 unit</i>	

## Using Machinery Cost Estimates For Making Decisions

The most frequent questions that arise when discussing machinery costs are:

**"How much should I charge for doing a specific job?"**

and

**"What should I charge for renting a specific item of equipment (tractor, plow, baler, etc.)?"**

ESTIMATE ALL COSTS WHEN DETERMINING CUSTOM RATES, and decide how much of these costs you want to recover from custom charges.

Consider, for example, the per acre costs of spraying a field with herbicides. These costs are estimated to be:

Fuel & Lubrication	\$0.21
Repairs & Maintenance	\$0.43
Fixed Costs	\$1.50
Labor	<u>\$0.66</u>
Total	\$2.80

Question: **"What custom rate do you charge for spraying?"**

Calculation: Total costs are nearly \$3.00 per acre. A minimum charge would be to cover variable costs. Then decide how much of your fixed costs to cover.

Finally, decide if you want to make a profit. A break-even price to merely cover costs only wears out your machine without making a profit.

Question: **"What rent should I charge for a 75 hp tractor? It is five years old, and cost \$16,000 new!"**

Calculation: You should cover a minimum of two items:.....

a) Repairs, and b) overhead!

Annual overhead would be:  $\$16,000 \times 18\% = \$2,880$ . Hourly overhead costs are  $(\$2,880 / \text{Hours Annual Use})$

Repair costs (average) are estimated to be:

$(\$16,000 \times .90) / 10,000 \text{ hours life} = \$1.44 \text{ per hour.}$

Machinery is probably your second largest capital investment....

Maybe the largest. Use it wisely.

## Machinery Cost Worksheet

	<b>Power Unit</b>	<b>Implement</b>
1. Machine		
2. Purchase Price	\$	\$
3. Annual Use (hours)		
<b>FIXED COSTS</b>		
4. Annual Fixed Costs (Purchase Price x 18%)	\$	\$
5. Fixed Costs Per Hour (Line 4 / Hours Annual Use)	\$	\$
6. Repairs {(Purchase Price x Repair Factor, Table 3) divided by Hours Expected Life}	\$	\$
7. Fuel (Table 3 x fuel price)	\$	\$
8. Lubrication (Line 7 x 15%)	\$	\$
9. Other	\$	\$
10. Total Variable Costs Per Hour (Lines 6+7+8+9)	\$	\$
<b>TOTAL COSTS</b>		
11. Total Power & Implement <b>Per Hour</b> (Lines 5+10)	\$	\$
(Line 11, Totals)	\$	per hour
12. Labor Costs per Hour	\$	
13. Total Equipment and Labor (line 11+ line 12)	\$	per hour
14. Units of Work per Machine Hour (Acres, Tons, Bales)		
15. Total Cost per unit Work (Line 13+14)	\$	unit

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The Cooperative Extension Service, University of Georgia College of Agriculture offers educational programs, assistance and materials to all people without regard to race, color or national origin.

AN EQUAL OPPORTUNITY EMPLOYER

Extension Agricultural Economics 8

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