ESTIMATING AGRICULTURAL FIELD MACHINERY COSTS

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Agricultural engineers and economists use a variety of engineering and economic principles in calculating a machine's use and costs. An effective farm manager must also know these principles and apply them when deciding to buy, lease, rent or share machinery.

The most accurate method of determining machine costs is complete records of the actual costs incurred. **Estimating costs is an alternative**. When estimating costs, methods that require more data specific to your situation, the more accurate will be the estimate. The state custom rate guides provide some indication of machines costs based on what is being charged (Wisconsin Custom Rate Guide, 2004). The guides do not take into account your specific conditions, which may be quite different for you. Data in the guide may be impacted by the supply and demand of custom operators in a geographical area.

Available machine cost tables provide an estimate based assumed input data such as machine list price, recommended acreage, fuel price, and labor. These tables often do not use of information specific to your operation. A frequently used table is the Minnesota Machine Cost Estimates published annually (Lazarus and Selley, 2005). They obtained list prices from machinery dealer surveys and used American Society of Agricultural and Biological Engineers machinery data and formulas (ASABE, 2006).

This article, a revision of an earlier bulletin, is designed to provide farm managers with an additional and more accurate tool for their management decisions permitting input of data specific to your operation (Schuler and Frank, 1991). A series of tables and two worksheets, one for tractors and one for other machines, was developed to help estimate machine costs using the ASABE data and formulas. A computer spreadsheet is also available to make the estimates which are available through the author. Once you can accurately estimate the machine's costs, you can make regarding purchases, leases, rentals and sharing that will meet the needs of your operation.

A discussion of the various components of machinery costs and the procedures for calculating them follows. When you make machinery management decisions, this will help you to estimate machine costs systematically.

TYPES OF COSTS

Costs of agricultural machines fall into two categories.

Fixed (ownership) costs are incurred regardless of the number of acres or hours of use annually. Fixed costs include depreciation, interest, insurance, shelter and, in some cases, taxes.

Variable (operating) costs vary with the hours of machine use. They include fuel, lubricants, repair and maintenance, and labor.

Fixed costs

Machinery loses value due to wear, age and obsolescence. The loss in value due to age and obsolescence is called depreciation. Machines depreciate each year regardless of the hours of use. Therefore, depreciation is considered a fixed cost. The change in a machine's value divided by the number of years of ownership can be considered annual depreciation.

NOTE: Depreciation for tax purposes must be determined differently and is not discussed here.

You can use various methods to determine a machine's value at the end of a specific period of time. This article uses a schedule that considers the value of machinery on the open market.

Interest on money spent on machinery is another fixed cost. This may be a cash cost when you borrow money or an opportunity cost when you buy machinery with money that you've saved. Since interest cost does not vary with machine use, it is a fixed cost. A rate of 8 percent of the remaining machine value is used here for estimating interest cost.

Housing and insurance are also fixed costs. We use a rate of 2 percent of the machine's list price.

Table 1 allows you to estimate fixed machine costs based on a machine's age and category. To determine the fixed costs, multiply the percentage for the appropriate machine age and category from Table 1 times the purchase price. For example, a new $30,000 tractor would have an estimated fixed cost of $13,671 (30,000 times 0.4557, from Table 1) for the first year. During the sixth year of ownership, the fixed cost is $2,367 ($30,000 times 0.0789, from Table 1). The assigned categories for additional machines are found in Table 2.

Table 1. Annual fixed costs in percent of list price by machine category and age. (Interest rate is 8 percent and housing, etc. is 2 percent.) 2006 ASAE Standards

	Equipment Categories			
Age (yrs)	**1 Tractors**	**2 Combines S.P. Windrowers**	**3 Forage Harvester Balers, Blowers**	**4 Other Field Machine**
1	45.57	51.19	57.92	54.61
2	11.01	11.85	10.37	11.15
3	10.13	10.49	9.18	9.86
4	9.32	9.28	8.12	8.71
5	8.57	8.22	7.19	7.70
6	7.89	7.27	6.36	6.81
7	7.26	6.43	5.63	6.02
8	6.68	5.69	4.98	5.32
9	6.14	5.04	4.41	4.70
10	5.65	4.46	3.90	4.16
11	5.20	3.95	3.45	3.68
12	4.78	3.49	3.06	3.25
13	4.40	3.09	2.71	2.87
14	4.05	2.74	2.39	2.54
15	3.72	2.42	2.12	2.24

To determine average fixed costs for a selected machine life, you must average these costs over the machine life. The average fixed costs per year for a machine with a 7-year life is the

sum of the first seven values in Table 1, divided by 7 and multiplied by the machine's value. An example: For a tractor, the sum of the first seven values is 99.75 percent. Dividing by 7, the average annual rate is 14.25 percent

Table 2. Remaining value groups, wear-out life, and total repairs to wear-out life. (Source: 2006 ASAE Standards)

Machinery	**Remaining Value & Fixed Cost Group No.**	**Estimated Wear-out Life** (hrs)	**Total Repairs in Wear-out Life** (% of list price)
Tractor			
Two-wheel dr.	1	12,000	
Four-wheel dr.	1	16,000	100 80
Tillage			
Moldboard pl	4	2,000	100
Offset disk	4	2,000	60
Tandem disk	4	2,000	60
Chisel plow	4	2,000	75
Subsoiler	4	2,000	75
Field culti.	4	2,000	70
Spring tooth	4	2,000	70
Rolling packer	4	2,000	40
Rotary hoe	4	2,000	60
Rolling harrow	4	2,000	40
Row cultivar	4	2,000	80
Planting			
Planter	4	1,500	75
Grain drill	4	1,500	75
Harvesting			
Picker sheller	4	2,000	70
Combine			
Pull type	2	2,000	60
Self prop.	2	3,000	40
Mower cond.			
Sickle	4	2,500	80
Rotary	4	2,500	100
Rake	4	2,500	60
Baler			
Large rect.	3	3,000	75
Large round	3	1,500	90
Forage harv.			
Pull type	3	2,500	65
Self-prop	3	4,000	50
Potato	4	2,500	70
Other			
Fert. spreader	4	1,200	80
Boom sprayer	4	1,500	70
blower	3	1,500	45
wagon	4	3,000	80

Table 1 can also be used to estimate the fixed costs of used machinery. The average fixed costs for the period of ownership can be estimated by using the average percent for the period. For example, if you buy the $30,000 tractor used at 5 years of age and plan to own it for 7 years, then the average annual fixed cost is based on the average for years 6 through 12 from Table 1. In this case, the annual fixed percent is 6.23 percent, and the costs are $1,869 ($30,000 times 0.0623).

Table 3 was developed from Table 1 to provide the cumulative average annual fixed costs, in percent. For the $30,000 tractor, the average fixed cost would be $4,275 per year ($30,000 times 0.1425 from Table 3) for the first 7 years of ownership. You would use this value in the machine's cost calculations.

Since you will use most tractors for several different operations, you must know the fixed costs per hour in order to distribute these costs among all operations. To do this, divide the tractor's fixed costs by the estimated hours the tractor is used for all purposes during the year. Multiply the result by the number of hours the machine requires the tractor each year.

Table 3. Cumulative average annual fixed costs in percent of list price by machine category and age.

	Equipment Categories			
Age (yrs)	**1 Tractors**	**2 Combines S.P. Windrowers**	**3 Forage Harvester Balers, Blowers**	**4 Other Field Machines**
1	45.57	51.19	57.92	54.61
2	28.29	31.52	34.14	32.88
3	22.24	24.51	25.82	25.21
4	19.01	20.70	21.40	21.08
5	16.92	18.21	18.56	18.41
6	15.41	16.38	16.52	16.47
7	14.25	14.96	14.97	14.98
8	13.30	13.80	13.72	13.77
9	12.51	12.83	12.68	12.76
10	11.82	11.99	11.81	11.90
11	11.22	11.26	11.05	11.16
12	10.68	10.61	10.38	10.50
13	10.20	10.04	9.79	9.91
14	9.76	9.51	9.26	9.38
15	9.36	9.04	8.79	8.91

Variable costs

Repair costs

Repair costs depend on hours of annual use and are difficult to predict because operators differ greatly in the levels of repair and maintenance they do. Table 4 estimates repair costs based

on annual use and length of ownership. The values in the table are the percent of the machine's list price to be used to determine the repair for the life of the machine.

For example, consider a $7,500 moldboard plow that is used 100 hours per year. From Table 4, the average repair cost for a 7-year life and an annual use of 100 acres is 15.3 percent of the purchase price. For this plow, the life time repair costs are $1148 (0.153 times $7,500). The annual costs are $1148 divided by seven years, $164. Repair costs beyond the wear-out life are not included in Table 4.

Wear-out life, based on the number of hours of operation listed in Table 2, estimates the useful life of a machine that has had average care and maintenance. Beyond this life, repair and maintenance costs become excessive.

Table 4. Average accumulated costs as a percent of list price for the life of the machine. (Source: 2006 ASAE Standards)

Machine	Annual Hours	7-year Life	10-year Life	15-year Life
Tractor, 2-wheel Drive	200	1.4	2.8	6.3
	400	5.4	11.1	25.2
	600	12.3	25.2	56.7
	800	22.0	44.4	100.8
Tractor, 4-wheel Drive	200	0.6	1.2	2.7
	400	2.4	4.8	10.8
	600	5.3	10.8	24.3
	800	9.4	19.2	43.2
Moldboard Plow	50	4.4	8.3	17.3
	100	15.3	29.0	60.2
	150	31.7	60.2	*
	200	53.1	101.0	****
Chisel Plow and Subsoiler	50	6.4	10.6	18.7
	100	17.0	28.0	49.4
	150	30.0	49.4	*
	200	44.8	73.9	****
Disk	50	3.0	5.5	11.0
	100	9.8	18.0	35.9
	150	19.6	35.9	*
	200	31.9	58.5	****
Field Cultivator and Spring-tooth Harrow	50	6.3	10.2	18.0
	100	16.4	27.0	27.1
	150	28.9	47.6	*
	200	43.2	71.3	****
Roller Packer and Harrow	50	4.1	6.5	11.0
	100	10.1	16.0	27.1
	150	17.0	27.1	*
	200	24.8	39.4	****

Machine	Annual Hours	7-year Life	10-year Life	15-year Life
Row Cultivator	50	1.7	3.7	9.0
	100	7.8	17.0	41.5
	150	18.9	41.5	*
	200	35.6	78.1	*
Rotary Hoe	50	5.3	8.7	15.5
	100	14.0	23.0	40.6
	150	24.6	40.6	*
	200	36.8	60.7	*
Planting Equipment	50	3.5	7.5	17.5
	100	15.1	32.0	74.9
	150	35.5	74.9	*
	200	64.9	*	*
Corn Picker and Sheller	50	1.3	2.8	7.2
	100	6.2	14.0	36.6
	150	15.1	35.6	*
	200	30.4	68.9	*
Combine, Pull-type	50	1.1	2.4	6.2
	100	5.3	12.0	30.5
	150	13.4	30.5	*
	200	26.0	59.1	*
Combine, Self-propelled	50	0.4	0.9	2.2
	100	1.9	4.0	9.4
	150	4.4	9.4	22.0
	200	8.1	17.1	40.2
Mower-cond. sickle	50	3.4	5.9	11.4
	100	10.2	18.0	34.4
	150	19.5	34.4	65.9
	200	30.8	54.6	*
Mower cond. rotary	50	2.0	4.0	9.0
	100	7.8	16.0	36.0
	150	17.6	36.0	81.0
	200	31.4	64.0	*
Pull-type Forage Harvester	50	2.8	4.9	9.5
	100	8.5	15.0	28.7
	150	16.7	28.7	54.9
	200	25.7	45.5	*
Forage Harvester, Self-propelled	50	0.4	0.8	1.7
	100	1.5	3.0	6.8
	150	3.3	6.8	15.2
	200	5.9	12.0	27.0

Machine	Annual Hours	7-year Life	10-year Life	15-year Life
Baler, Large Square	50	1.5	2.9	6.0
	100	5.3	10.0	20.7
	150	10.9	20.7	43.0
	200	18.3	34.8	72.2
Baler, Round	50	6.5	12.3	25.6
	100	22.6	43.0	89.2
	150	46.9	89.2	*
	200	78.8	*	*
Potato Harvester	50	4.4	7.2	12.7
	100	11.5	19.0	33.5
	150	20.3	33.5	59.1
	200	30.4	50.1	*****
Fertilizer Spreader	50	16.1	25.6	43.3
	100	39.6	63.0	*
	150	67.1	*****	*****
Boom Sprayer	50	10.5	16.7	28.2
	100	25.8	41.0	69.5
	150	43.6	69.5	*****
Blower, Forage	50	3.3	6.3	13.1
	100	11.6	22.0	45.6
	150	24.0	45.6	*
	200	40.3	*	*****
Forage Wagon	50	3.0	5.3	10.1
	100	9.0	16.0	30.6
	150	17.3	30.6	58.6
	200	27.4	48.5	92.7

***** Exceeds estimated machine life.

In order to determine repair costs, you must estimate annual hours of use. Divide the total acres for the operation by the effective field capacity of the machine in acres per hour. To estimate field capacity, multiply forward speed in miles per hour by the machine width in feet and by the field efficiency. Then divide by 8.25. Typical forward speeds and field efficiencies are listed in Table 5.

For tractors, the repair cost per hour must be calculated for the entire year and then divided by the total annual use in hours. Then find the tractor repair costs charged to a given machine by multiplying the tractor repair costs per hour by the total time the tractor is used with that machine.

Fuel costs

Fuel costs depend on the hours of operation and the size of the tractor or power unit. To determine hourly fuel consumption, multiply the tractor power-take-off horsepower by a constant that provides a value in gallons per hour. That value is 0.06 for gasoline engines and 0.044 for diesel engines.

For example, a tractor or self-propelled machine with a 120 horsepower diesel engine will use an estimated 5.28 gallons of fuel per hour (120 times 0.044). By knowing the price of fuel and the number of annual hours of operation, you can estimate the annual fuel cost

Table 5. List of field efficiency, suggested forward speed and timeliness constants. (Source: 2005 ASAE Standards)

Machine	**Field Efficiency**	**Suggested Speed** (mph)	**Timeliness Factor**
Moldboard Plow	0.7-0.9	3-6	0.000-0.010*****
Chisel Plow	0.7-0.9	4-6.5	0.000-0.010
Disks	0.7-0.9	3.5-6.5	0.000-0.010
Field Cultivator	0.7-0.9	5-8	0.000-0.100
Roller Packer	0.7-0.9	4.5-7.5	0.000-0.010
Row Cultivator	0.7-0.9	3-7	0.011
Planter	0.5-0.75	4-7	0.005
Grain Drill	0.55-0.8	4-7	0.005
Picker Sheller	0.6-0.75	2-4	0.003
Combine	0.6-0.75	2-5	0.003
Mower-conditioner, Pull	0.75-0.85	3-6	0.010
Mower-conditioner, Rotary, Pull	0.75-0.90	5-12	0.010
Mower-conditioner, Self-propelled	0.7-0.85	3-8	0.010
Baler	0.6-0.9	2.5-8	0.028
Forage Harvester, Pull-type	0.6-0.85	1.5-5	0.028
Forage Harvester, Self-propelled	0.6-0.85	1.5-6	0.028
Boom Sprayer	0.5-0.8	3-7	0.011

***** Tillage timeliness factor is dependent on its effect on planting.

Lubricant costs

To estimate lubricant costs, multiply the fuel costs by 0.15.

Labor costs

To estimate the annual labor cost to run a machine, multiply the hourly wage by the total hours required for the operation. The hourly labor cost may be the hourly wages of hired help or an estimate of the operator's time based on the skill required to operate the machine and perform other tasks, such as management.

Timeliness costs

Every field operation is best done at a certain time. If the operation is not done at that time, the quantity and/or quality of the crop will be reduced. For example, yield may decrease 1 percent per day if the operation is not done on the optimum date. This is called *timeliness*, which can be

calculated as a cost resulting from a decrease in income. The size of the cost depends on factors such as crop value, crop yield, machine operation, weather, and hours available for work per day.

Timeliness costs become very important when you compare machines of different capacities, such as a twelve foot mower conditioner versus a sixteen foot mower conditioner. To estimate these costs, use Table 5 to determine a timeliness factor.

Timeliness cost is calculated using factors and crop information. The formula is:

$$timeliness\ cost\ (\$/hr) = \frac{T_c \times acres \times crop\ value \times yield}{T_x \times hours \times passes}$$

where: T_c = timeliness coefficient from Table 5.

T_x = 4 if operations can be balanced evenly around the optimal time.
Example: cutting or harvesting forages.
= 2 if the operation should either start or end at the optimal time.

Hours = the average hours per day this machine can normally be used.

Crop Value = dollar value of crop in $/bu, $/T.

Yield = crop yield in bu/A, T/A.

Passes = the number of trips over the field or the number of cuttings.

The following worksheets allow you to analyze machine costs using the principles and tables discussed earlier. Worksheet 1 is designed for tractors. This allows you to determine hourly fixed costs and repair costs, which you can then apportion to the various machines used with this tractor.

Worksheet 2 is designed for machines other than tractors. To estimate costs for machines requiring a tractor, you must first calculate hourly fixed costs and repair costs for the tractor. If only tractor costs are evaluated, use Worksheet 2 but disregard items 3, 4d and 7. A completed example of worksheet 2 is also included.

This entire process has been programmed onto spreadsheet software, which allows you to make numerous calculations evaluating a variety of options. The program allows you to select an interest rate that matches your situation.

You will need Excel spreadsheet software to run the program. If you desire the spreadsheet contact Ron Schuler at rschuler@wisc.edu or for to UW-Extension, Cooperative Extension, Team Grain web site. The name of the file is MACHCOST06.

References:

ASABE. 2006. Agricultural Machinery Management. ASABE EP496.2, ASABE, St. Joseph, MI

ASABE. 2006. Agricultural Machinery Management Data. ASABE D497.4, ASABE, St. Joseph, MI

Lazarus, W. and R. Selley. Farm Machinery Cost Estimates for Late 2005. University of Minnesota Extension Service. 11 pp.

Schuler, R.T. and G. G. Frank. 1991. Estimating Agricultural Machinery Costs. UW-Extension, A3510.12 pp.

Wisconsin's 2004 Custom Rate Guide. 2004. Wisconsin Agricultural Statistics Service. 11pp.

WORKSHEET 1
For tractors only.

1. Information needed:
   a. Tractor model - _____
   b. List price - _____
   c. Tractor age - _____
   d. Tractor size, pto hp - _____
   e. Expected years of ownership - _____
   f. Estimate hours of annual use - _____

2. Annual fixed cost:
   List price times fixed factor (Table 3) divided by 100
   _____ × _____ ÷ 100 $ _____

3. Repair cost:
   Cost value from Table 4 times list price = repair cost for life of machine
   _____ × _____ = $ _____
   Repair cost for life of the machine divided by expected years of life = annual repair cost
   _____ / _____ $ _____

4. Total fixed and repair annual costs (sum of 2 and 3) $ _____

5. Hourly tractor fixed and repair costs (divide 4 by 1f) $ _____
   (This cost is used when determining costs of other machines.)

WORKSHEET 2

For machines other than tractors.

1. Information needed:
   a. Type of machine - _____ b. List price - _____
   c. Machine age - _____ d. Machine size - _____
   e. Tractor size, pto hp - _____ f. Acres - _____
   g. Expected years of ownership - _____
   h. Tractor hourly fixed and repair costs (Worksheet 1) - _____
2. Annual fixed cost: List price times fixed factor (Table 3) divided by 100

   _____ × _____ ÷ 100 $ _____
3. Estimated use (for tractors, estimate annual hours):
   a. Effective field capacity, acres per hour (Table 5).
   Forward speed times width times field efficiency divided by 8.25.

   _____ × _____ × _____ ÷ 8.25 = _____ ac/hr
   b. Estimated annual time, hours
   Acres times number of trips divided by effective field capacity.

   _____ × _____ ÷ _____ = _____ hrs
4. Annual variable costs:
   a. Repair cost:
   Cost value from Table 4 times list price/100 = repair cost for life of machine

   _____ × _____ / 100 = $ _____

   Repair cost for life of the machine divided by expected years of life = annual repair cost

   _____ / _____ = $ _____ $ _____
   b. Fuel cost: Fuel factor times pto hp (1e; diesel = 0.044, gasoline = 0.06)

   _____ × _____ = _____ gal/hr

   Gal/hr times hours (3b) times fuel price: _____ × _____ x _____ $ _____
   c. Lubricant cost: Fuel cost (4b) times 0.15: _____ × 0.15 $ _____
   d. Tractor cost : Hours (3b) times hourly tractor costs (1h)

   _____ × _____ $ _____
   e. Labor cost: Hourly wages times hours (3b) = _____ × _____ $ _____
5. Total out-of-pocket cost (sum of 2, 4a, 4b, 4c, 4d and 4e): $ _____
6. Hourly out-of-pocket costs: Total costs (5) divided by hours (3b) $ _____
7. Timeliness cost:
   a. Information needed:
   Crop yield - _____ Crop value - _____
   Timeliness factor - _____ Hours/day - _____
   b. Timeliness cost determination

   Crop value × yield × timeliness factor × acre ÷ (hours/day × 4)

   _____ × _____ × _____ × _____ ÷ (_____ × 4) $ _____

   Hourly cost times hours (3b) = _____ × _____ $ _____
8. Total costs (sum of 5 and 7b) $ _____

WORKSHEET 2 (Sample)

For machines other than tractors.

1. Information needed:
   a. Type of machine – *Rot. Mower-Cond*
   b. List price - *23,5000*
   c. Machine age - *0*
   d. Machine size - *12 ft*
   e. Tractor size, pto hp - *75*
   f. Acres - *200*
   g. Expected years of ownership - *10*
   h. Tractor hourly fixed and repair costs (Worksheet 1) - *16.32*
2. Annual fixed cost: List price times fixed factor (Table 3) divided by 100

   23,500 × *11.99* ÷ 100 $ *2818*
3. Estimated use (for tractors, estimate annual hours):
   a. Effective field capacity, acres per hour (Table 5).
   Forward speed times width times field efficiency divided by 8.25.

   6 × *12* × *0.75* ÷ 8.25 = *6.55* ac/hr
   b. Estimated annual time, hours
   Acres times number of trips divided by effective field capacity.

   200 × *3* ÷ *6.55* = *92* hrs
4. Annual variable costs:
   a. Repair cost:
   Cost value from Table 4 times list price/100 = repair cost for life of machine

   16 × *23,500* / 100 = $ *3750*

   Repair cost for life of the machine divided by expected years of life = annual repair cost

   3750 / *10* = $ *375* $ *375*
   b. Fuel cost: Fuel factor times pto hp (1e; diesel = 0.044, gasoline = 0.06)

   0.044 × *75* = *3.30* gal/hr

   Gal/hr times hours (3b) times fuel price: *3.30* × *92* x *2.50* $ *759*
   c. Lubricant cost: Fuel cost (4b) times 0.15: *759* × 0.15 $ *114*
   d. Tractor cost : Hours (3b) times hourly tractor costs (1h)

   92 × *16.32* $ *1501*
   e. Labor cost: Hourly wages times hours (3b) = *10.00* × *92* $ *920*
5. Total out-of-pocket cost (sum of 2, 4a, 4b, 4c, 4d and 4e): $ *3669*
6. Hourly out-of-pocket costs: Total costs (5) divided by hours (3b) $ *39.90*
7. Timeliness cost:
   a. Information needed:
   Crop yield - *2.0 t* Crop value - *90/t*
   Timeliness factor - *0.010* Hours/day - *8*
   b. Timeliness cost determination

   Crop value × yield × timeliness factor × acre ÷ (hours/day × 4)

   2.0 × *90* × *0.010* × *200* ÷ (*8* × 4) $ *11.25*

   Hourly cost times hours (3b) = *11.2 5* × *92* $ *1035*
8. Total costs (sum of 5 and 7b) $ *4704*