Farm Machinery Cost Calculations

Farm equipment is typically the second-largest investment for a crop farm after land, and it is usually the most complex when determining annual costs. By developing annual costs for equipment, producers have an estimate of farm machinery costs that can be used in enterprise budgeting and whole-farm planning, as well as decisions such as asset replacement. Farm machinery costs are separated into two categories:

1. ownership costs, which include depreciation, interest, taxes, insurance, and housing
2. operating costs, which include repairs, fuel, lubrication, and labor

Annual ownership costs are calculated from financial information, and annual operating costs are calculated using data from detailed equipment records or from engineering factors (if detailed records are not available). This publication demonstrates the process of calculating farm machinery costs using engineering factors when detailed records are not available or when projecting costs for new equipment.

The engineering factors used in the following analysis are from the American Society of Agricultural and Biological Engineers (ASABE) Standards 2011. These factors include salvage value estimates and machine performance rates of field efficiency, field speed, fuel consumption rates, and repair factors. Some well-accepted estimates will also be used from *Farm Management* (Kay, Edwards, & Duffy, 2020) which include taxes, interest, and housing (TIH) costs as a function of average equipment value, lubrication and filter costs as a function of fuel costs, and labor hours as a function of machine hours.

Ownership Costs

Depreciation is an expense that represents the loss in value of equipment due to age, wear, and obsolescence. The annual cost spreads the initial purchase cost across the useful life of the equipment. There are several techniques for calculating depreciation including methods used for income tax preparation. The technique used for this analysis and typically used for budget projections is straight-line depreciation. It is calculated as (initial purchase cost – salvage value) / useful life = annual depreciation expense.

Salvage value is the market value of an asset at the time that it is sold or removed from service. Salvage value can be estimated by various methods; in this publication, we will use factors available in Kay, Edwards, and Duffy (2020), which are based on ASABE Standards. **Table 1** lists the salvage value factors. The salvage value is calculated as the salvage value factor / 100 × the new list price of the equipment.

As an example of depreciation calculations, consider a 130 horsepower (hp) two-wheel-drive tractor with a list price of $120,000; with dealer discounts, the purchase cost was $115,000. If the expected useful life is 10 years, the salvage value factor is 37 as shown in Table 1. Salvage value is estimated to be ($120,000 × 37 / 100) = $44,400. The annual depreciation is then calculated as [($115,000 – $44,400) / 10] = $7,060.

Interest is the cost of using capital invested in farm equipment. With borrowed capital, interest cost is based on the loan interest rate. With owner equity capital, interest cost is based on the interest rate or rate of return

Table 1. Estimated salvage value as a percentage of new list price for a similar machine.

Age of machine in years	Harvesting, crop	Harvesting, forage	Miscellaneous	Planters	Tillage	Tractors 150+ hp	Tractors 80–149 hp
1	69	56	61	65	61	67	68
2	58	50	54	60	54	59	62
3	50	46	49	56	49	54	57
4	44	42	45	53	45	49	53
5	39	39	42	50	42	45	49
6	35	37	39	48	39	42	46
7	31	34	36	46	36	39	44
8	28	32	34	44	34	36	41
9	25	30	31	42	31	34	39
10	22	28	30	40	30	32	37
11	20	27	28	39	28	30	35
12	18	25	26	38	26	28	34

Note: If age of machine exceeds 12 years, the salvage value is assumed to remain constant at the 12-year level.

Source: Kay, Edwards, and Duffy (2020), based on ASABE Standards.

on the next best alternative use of the capital. There are several methods to calculate loan payments depending on conditions of the loan, but interest cost for this analysis will be calculated as the interest cost on the average value of the equipment by multiplying the average value times the interest rate: (initial purchase cost + salvage value) / 2] × interest rate = annual interest expense. This calculation will provide the average annual interest cost over the life of the asset. Using the example above with an interest rate of 5 percent, the annual interest expense is calculated as [($115,000 + $44,400) / 2] × 0.05 = $3,985.

Taxes in Mississippi for farm equipment are sales taxes levied on the purchase of the equipment at the time of sale. As such, these are a one-time cost and should be added to the initial purchase cost. Insurance costs are estimated at 0.5 percent of the average cost, and housing is estimated at 1.0 percent of average cost. **Taxes, insurance, and housing** (TIH) factors are often combined into one factor of 1.5 percent of average value. Continuing with the example above, the annual expense for TIH is calculated as [($115,000 + $44,400) / 2] × 0.015 = $1,195.50 (round to $1,196).

Total annual ownership cost is the sum of depreciation, interest, and TIH. In this example, total annual ownership cost is $7,060 (sum of depreciation) + $3,985 (interest) + $1,196 (TIH) = $12,241.

Operating Costs

Table 2 shows the engineering factors used in the following analysis.

Repair costs are best estimated using detailed history for the individual piece of equipment because of differences in manufacturers, management factors, and working conditions. However, if detailed records are not available, factors have been established by the ASABE that are proportional to the original list price for a type of equipment. For example, a two-wheel-drive tractor up to 150 hp has an average repair cost per 100 hours of use of 0.84 percent of new list price (as shown in Table 2). The average repair cost, then, for a 130 hp two-wheel-drive tractor with a list price of $120,000 and annual use of 400 hours is estimated to be ($120,000 × 0.0084 / 100 hours × 400 hours) = $4,032 per year.

Fuel costs can be estimated using a fuel consumption factor multiplied by the PTO horsepower of the equipment multiplied by the price of fuel. The fuel consumption factors found in ASABE Standards 2013 are 0.060 gallons/horsepower-hour for gasoline, 0.044 gallons/horsepower-hour for diesel, and 0.08 gallons/horsepower-hour for LP gas. For example, the 130 hp diesel tractor from above would have an estimated fuel consumption of (130 hp × 0.044 gallons/hp-hour) = 5.72 gallons per hour. For 400 hours of annual use and diesel price of $1.50 per gallon, the estimated annual fuel cost for the tractor would be (5.72 gallons / hour × 400 hours × $1.50/gallon) = $3,432.

Table 2. Machine performance factors.

Equipment category	Equipment type	Field efficiency – range[1]	Field efficiency – typical[1]	Field speed – range[1]	Field speed – typical[1]	Estimated life (hours)[1]	Average repair factor[2]
Harvesting, crop	Corn picker sheller	60–75	65	2.0–4.0	2.5	2000	1.33
Harvesting, crop	Potato harvester	55–70	60	1.5–4.0	2.5	2500	2.74
Harvesting, crop	PT combine	60–75	65	2.0–5.0	3.0	2000	1.33
Harvesting, crop	Sugar beet harvester	50–70	60	4.0–6.0	5.0	1500	7.77
Harvesting, crop sp	SP combine	65–80	70	2.0–5.0	3.0	3000	1.33
Harvesting, crop sp	SP cotton picker	60–75	70	2.0–4.0	3.0	3000	2.65
Harvesting, forage	Forage harvester	60–85	70	1.5–5.0	3.0	2500	2.60
Harvesting, forage	Large rectangular baler	70–90	80	4.0–8.0	5.0	3000	1.74
Harvesting, forage	Large round baler	55–75	65	3.0–8.0	5.0	1500	5.95
Harvesting, forage	Mower	75–85	80	3.0–6.0	5.0	2000	7.47
Harvesting, forage	Mower (rotary)	75–90	80	5.0–12.0	7.0	2000	8.80
Harvesting, forage	Mower-conditioner	75–85	80	3.0–6.0	5.0	2500	3.12
Harvesting, forage	Mower-conditioner (rotary)	75–90	80	5.0-12.0	7.0	2500	8.80
Harvesting, forage	Rectangular baler	60–85	75	2.5–6.0	4.0	2000	4.00
Harvesting, forage	Side delivery rake	70–90	80	4.0–8.0	6.0	2500	2.45
Harvesting, forage sp	SP forage harvester	60–85	70	1.5–6.0	3.5	4000	1.20
Harvesting, forage sp	SP windrower	70–85	80	3.0–8.0	5.0	3000	1.80
Miscellaneous	Bean puller/windrower	70–90	80	4.0–7.0	5..0	2000	3.12
Miscellaneous	Beet topper/chopper	70–90	80	4.0–7.0	5.0	1200	1.33
Miscellaneous	Boom-type sprayer	50–80	65	3.0–7.0	6.5	1500	4.63
Miscellaneous	Fertilizer spreader	60–80	70	5.0–10.0	7.0	1200	3.09
Planters	Grain drill	55–80	70	4.0–7.0	5.0	1500	5.00
Planters	Roller-packer	70–90	85	4.5–7.5	6.0	2000	2.45
Planters	Row crop planter	50–75	65	4.0–7.0	5.5	1500	5.00
Tillage	(Coulter) chisel plow	70–90	85	4.0–6.5	5.0	2000	3.70
Tillage	Field cultivator	70–90	85	5.0–8.0	7.0	2000	3.56
Tillage	Heavy-duty disk	70–90	85	3.0–6.0	4.5	2000	2.92
Tillage	Moldboard plow	70–90	85	3.0–6.0	4.5	2000	5.05
Tillage	Mulcher-packer	70–90	80	4.0–7.0	5.0	2000	3.12
Tillage	Rotary hoe	70–85	80	8.0–14.0	12.0	2000	3.03
Tillage	Rotary tiller	70–90	85	1.0–4.5	3.0	1500	5.40
Tillage	Row crop cultivator	70–90	80	3.0–7.0	5.0	2000	3.91
Tillage	Spring tooth harrow	70–90	85	5.0–8.0	7.0	2000	3.91
Tillage	Tandem disk harrow	70–90	80	4.0–7.0	6.0	2000	3.91
Tractors 150+ hp	2WD 150+ hp					12000	1.12
Tractors 150+ hp	4WD & crawler 150+ hp					16000	0.48
Tractors 80–149 hp	2WD <150hp					12000	0.84
Tractors 80–149 hp	4WD & crawler <150 hp					16000	0.48

[1]Source: ASABE Standards (2011).

[2]Average repair factor as a percent of new cost per 100 hours of use. Source: Kay, Edwards, and Duffy (2020).

Lubrication and filter costs can be estimated as 15 percent of fuel costs. Using the example above, annual costs for lubrication and filters will be ($3,432 × .015) = $515.

Labor cost for machinery use is estimated by multiplying the annual machinery hours by a factor of 1.2 to estimate labor hours, then multiplying labor hours by the wage rate in dollars per hour. The factor of 1.2 is a rule-of-thumb factor to be used as an estimate of the time spent by workers in pre- and post- operations such as fueling, conducting preventive maintenance, and cleaning. Continuing with the example above with 400 hours of annual use and a wage rate of $15 per hour, the estimated cost of labor is (400 hours × 1.2 × $15/hour) = $7,200.

Total annual operating cost is the sum of repair costs, fuel costs, lubrication and filter costs, and labor costs. In the example above, total annual operating cost is $4,032 (repairs) + $3,432 (fuel) + $515 (lubrication and filters) + $7,200 (labor) = $15,179.

Total annual cost is the sum of total annual ownership costs and total annual operating costs. Total annual cost for the example above is calculated as $12,241 (total annual ownership costs) + $15,179 (total annual operating costs) = $27,420.

This value may be useful for some decisions, such as whole-farm planning, but, more often, calculations are made to determine costs per hour and costs per acre, which are used to compare equipment costs, develop costs of operations, and develop enterprise budgets. **Total cost per hour** is calculated by dividing total annual cost by the estimated annual use in hours. In this case, total cost per hour for the 130 hp tractor is calculated as ($27,420 / 400 hours) = $68.55 per hour.

Combined cost per hour is calculated by adding the cost per hour for the tractor and the cost per hour for an implement. Fuel and lubrication costs are calculated for the tractor and not for the implement. Labor costs are calculated for the tractor and not for the implement in order not to double-count labor costs.

Combined cost per acre is useful when determining the cost of an operation such as the cost of planting or the cost of a tillage operation. The combined cost per acre is calculated by dividing total cost per hour by the field capacity in acres per hour. **Field capacity** is measured in acres per hour and is calculated as [speed (mph) × width (feet) × field efficiency (%) × 5,280 feet/mile] / (43,560 square feet/acre). You can develop speed and field efficiency numbers through farm records or use the ASABE Standards as shown in Table 2, which we will use here. The following example demonstrates the calculations for tractor plus implement, including combined cost per hour and combined cost per acre.

Example Calculation

To illustrate the machinery cost calculations for a tractor plus implement, this example uses a 190 hp four-wheel-drive tractor with a 32-foot field cultivator. **Table 3** shows the initial information. The tractor has a list price of $200,000, purchase cost of $189,000, expected useful life of 20 years, and estimated annual use of 400 hours. The field cultivator has a list price of $45,000, purchase cost of $42,900, expected useful life of 10 years, and estimated annual use of 100 hours. Diesel price is $1.50 per gallon, wage rate is $15 per hour, and interest rate is 5 percent.

Table 4 shows the ASABE factors for the tractor and field cultivator. Factors for the tractor are salvage value factor of 28 and repair factor of 0.48. Factors for the field cultivator are field efficiency of 85 percent, field speed of 7 miles per hour, salvage value factor of 30, repair factor of 3.56, and field capacity of 23.1 acres/hour.

Table 5 shows machinery cost calculation results. Total annual cost for the tractor is $31,421 (total annual ownership cost of $14,613 + total annual operating cost of $16,808). Total annual cost for the field cultivator is $6,375 (total annual ownership cost of $4,773 + total annual operating cost of $1,602). Total combined cost per hour is $142.30 ($78.55/hour for the tractor and $63.75/hour for the field cultivator). The combined cost per acre is $6.17.

Table 3. Example initial information.

	Tractor, 190 hp, 4-wheel drive	Field cultivator
Equipment category	Tractors 150+ hp	Tillage
Equipment type	4WD & crawler 150+ hp	Field cultivator
List price	$200,000	$45,000
Purchase cost	$189,000	$42,900
Expected useful life (years)	20	10
Horsepower rating (tractor only)	190	
Width (feet) (implement only)		32
Annual use (hours)	400	100
Interest rate (%)	5.00	5.00
Fuel price	$1.50 per gallon	
Labor wage rate	$15.00 per hour	

Table 4. Example factors used for calculations.

	Tractor, 190 hp, 4-wheel drive	Field cultivator	Sources of factors
Field efficiency (typical) (%)		85	ASABE (2011)
Field speed (typical) (mph)		7	ASABE (2011)
Salvage value factor	28	30	ASABE (2011)
Repair average factor	0.48	3.56	ASABE (2011)
Field capacity (acres per hour)		23.1	Calculation
Fuel use (diesel)	0.044 gallons/hp-hour		ASABE (2011)
Lubrication and filters	15% of fuel cost		Kay, Edwards, & Duffy (2020)
Labor hours	1.2 times machinery hours		Kay, Edwards, & Duffy (2020)
Taxes, insurance, and housing	1.5% of average value	1.5% of average value	Kay, Edwards, & Duffy (2020)

Table 5. Example cost calculations.

	Tractor, 190 hp, 4-wheel drive	Field cultivator
Basic data		
List price	200,000	45,000
Purchase cost	189,000	42,900
Salvage value	56,000	13,500
Ownership life in years	20	10
Estimated annual use in hours	400	100
Ownership costs		
Depreciation	6,650	2,940
Interest	6,125	1,410
Taxes, insurance, and housing	1,838	423
Total annual ownership costs	14,613	4,773
Operating costs		
Repairs	3,840	1,602
Fuel	5,016	
Lubrication and filters	752	
Labor	7,200	
Total annual operating costs	16,808	1,602
Total annual costs	31,421	6,375
Costs per hour and per acre		
Ownership costs per hour	36.53	47.73
Operating cost per hour	42.02	16.02
Total cost per hour	78.55	63.75
COMBINED COST PER HOUR		$142.30
COMBINED COST PER ACRE		$6.17

Summary

Because farm equipment is such a large capital investment for a farm business, managers should carefully analyze the costs per hour and costs per acre for equipment and for field operations. Actual farm records are the preferred source of data for calculations, but, if records are not available, the ASABE's factors can be used to estimate key items necessary to calculate machinery costs. An accompanying spreadsheet using this method is available at ***https://www.agecon.msstate.edu/whatwedo/budgets.php***.

References

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This material is based upon work supported by USDA/NIFA under Award Number 2018-70027-28585.

Publication 3543 (POD-10-20)

By **Jeff Johnson**, PhD, Extension/Research Professor, Agricultural Economics.

Produced by Agricultural Communications.

Extension Service of Mississippi State University, cooperating with U.S. Department of Agriculture. Published in furtherance of Acts of Congress, May 8 and June 30, 1914. GARY B. JACKSON, Director