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Estimating Rice Combine Harvest Cost:
Performance Rate, Capital Cost, Operating Cost

Michael S. Salassi[1] and Michael A. Deliberto[2]
[1]Professor and [2]Research Associate, Department of Agricultural Economics and Agribusiness
Louisiana State University Agricultural Center, Baton Rouge, Louisiana

Introduction

Harvest equipment represents a major crop production expense on most farming operations. New technology, larger machines and higher energy prices have caused the capital expenditure and operating expense of harvest equipment to increase in recent years. This report presents information on estimating rice combine harvest cost. Procedures for determining combine performance rate, capital cost and operating cost are presented. An example of harvest cost estimation is included as an illustration. In addition, a brief users guide to an Excel spreadsheet decision aid is included which can be used in estimating rice combine harvest performance rates and costs.

Performance Rate

Combine performance rate relates time required to cover a field distance based upon factors including the speed of the machine traveling across the field, the width of the machine or implement being used and the field efficiency of the operation being conducted. Field speed (FS) of grain combines typically range from 2.0 to 5.0 miles per hour, depending upon field conditions (ASABE Standards, 2009). Previous research studies on rice harvesting have found that optimum harvested yield recovery was obtained when combines travelled at 2.0 miles per hour through the field harvesting rice (Hignight and Watkins, and Wilson, et al.). Machine width (MW) relates to the width of the combine header being used to harvest rice. Typical combine header sizes being used to harvest rice include 25 ft. and 30 ft. headers. Field efficiency is a percentage value which specifies, of the total time a combine is running, what percent of that time is being spent actually cutting rice. Reasons for this field efficiency value to be less than 100% include idling time, traveling or waiting to unload harvested rice or time spent traveling to another field. Field efficiency can be quite variable from farm to farm, with typical values in the 65% to 80% range (ASABE).

$$\textit{Acres per Hour} = \frac{\textit{Field Speed x Machine Width x Field Efficiency}}{8.25}$$

$$\textit{Hours per Acre} = 1 / \textit{Acres per Hour}$$

For example, a rice combine with a 30 ft. header, traveling across the field at 2.0 miles per hour, operating at 70% field efficiency would cover 5.09 acres per hour. Harvest time required per acre would be estimated at 0.196 hours per acre of rice harvested. Combine performance rates are used in determining operating or variable costs per harvested acre, influencing primarily fuel and labor harvest expenses.

Capital Cost

Capital costs, also referred to as ownership costs, are related to those expenses associated with the ownership of the combine. Regardless as to the number of hours the combine is actually used during the year, there are costs associated with the ownership of the machine. The primary capital expenses of machinery ownership are depreciation and interest. Other ownership expenses may include taxes, insurance and housing. Calculation of combine depreciation and interest costs are presented here.

Depreciation is a noncash expense that reflects a loss on value of the combine due to age, wear and obsolescence (Kay, Edwards and Duffy, 2004). Depreciation is an economic accounting cost which serves the

purpose of charging for the use of the machine over its entire useful life. Annual depreciation using the straight-line method would be estimated as follows:

$$Depreciation = (Purchase\ Price - Salvage\ Value) / Useful\ Life$$

The amount of machine value which is depreciable (purchase price – salvage value) divided by the estimated years over which the machine will be used (useful life) gives the annual depreciation expense for that machine for each year of use. This value divided by hours of annual use would give an estimate of depreciation cost per hour of machine use.

Capital tied up in investment in a combine cannot be used for other purposes. Therefore, there is an opportunity cost associated with not having that capital available for other uses. The opportunity cost should reflect the expected return from the use of that capital in its next best alternative investment. This opportunity cost is calculated as an annual interest cost on the average value of the investment. Annual interest on investment cost can be calculated as follows (Kay, Edwards, Duffy, 2004):

$$Average\ machine\ value = (Purchase\ Price + Salvage\ Value) / 2$$

$$Interest = Average\ Machine\ Value \times Interest\ Rate$$

An alternative to determining depreciation and interest costs separately is to calculate the capital recovery charge or cost. Capital recovery cost includes both depreciation and interest. The capital recovery factor and annual capital recovery cost for a machine, using the interest rate (i) and years of useful life (n), is estimated as follows:

$$Capital\ Recovery\ (Amortization)\ Factor = [i(1+i)^n / (1+i)^n - 1]$$

$$Capital\ Recovery\ Cost = [Capital\ Recovery\ Factor \times (Purchase\ Price - Salvage\ Value)] + (Interest\ Rate \times Salvage\ Value)$$

Total annual combine capital or ownership cost would be calculated as the sum of depreciation and interest costs, plus any applicable charges such as taxes, insurance and housing. Capital cost estimates in this report only include charges for depreciation and interest.

Operating Cost

Operating or variable costs for a rice combine include charges for fuel, labor and repairs. Diesel fuel consumption of a rice combine is primarily a function of horsepower size. Diesel engines consume, on average, 0.044 gallons of diesel per horsepower-hour (gal/hp-hr) per PTO horsepower. Harvest fuel cost per acre can be calculated by multiplying the fuel consumption rate per hour times the estimated combine performance rate (in hours per acre) times the price of diesel fuel.

$$Fuel\ Consumption\ per\ Hour\ (gal/hr) = 0.044\ gal/hp\text{-}hr \times Machine\ Horsepower$$

$$Fuel\ Cost\ per\ Acre = Diesel\ Price \times Gallons\ per\ Hour \times Hours\ per\ Acre$$

Harvest combine labor cost is a function of the hourly labor rate charged and the harvest performance rate. Actual hours of labor usually exceed the machine hours by 10% to 20%, due to travel time, time required to lubricant and service the machine and other factors. In this report, rice combine harvest labor cost is estimated using a labor multiplier of 1.1 (10%) as shown below:

$$Labor\ Cost\ per\ Acre = Labor\ Rate\ (\$/hr) \times Performance\ Rate\ (hrs/acre) \times 1.1$$

Combine repair and maintenance cost is also an important operating cost to include in the estimation of rice harvest cost. Repair and maintenance costs for agricultural equipment is usually expressed as a percent of the

machine purchase price. The repair and maintenance factor (*RMF*) is defined as the total repair and maintenance expense of a machine over its entire useful life expressed as a percentage of its original purchase price. This cost is then allocated to actual use on a repair cost per hour of operation basis. Repair and maintenance factors for combines are typically in the 40% to 70% range, depending on age and use. Estimated repair cost per hour of operation multiplied by the harvest performance rate of the combine will give an estimate of allocated repair and maintenance cost for the machine on a per harvested acre basis.

Repair Cost per Hour = Purchase Price ($) x RMF (%) / [Est. Life (yrs) x Hrs Annual Use (hrs)]

Repair Cost per Acre = Repair Cost per Hour ($/hr) x Performance Rate (hrs/acre)

Total rice combine harvest cost would be the sum of all capital and operating costs associated with the ownership and use of the machine. Total fixed cost per acre would be equal to the capital recovery cost divided by annual rice acres harvested. Total variable (or direct) harvest costs per acre would be the sum of fuel, labor and repair costs per acre.

Fixed Cost per Acre = Capital Recovery Cost ($/yr) / Acres Harvested Annually

Variable Cost per Acre = Fuel Cost per Acre + Labor Cost per Acre + Repair Cost per Acre

Total Combine Harvest Cost per Acre = Fixed Cost per Acre + Variable Cost per Acre

Rice Combine Cost Estimation Example

The example presented here serves as an illustration of estimating rice combine harvest cost. Data required for cost estimation presented here is also required for use of the rice combine harvest cost spreadsheet-based decision aid presented below. Cost estimates presented in this illustration may differ slightly from example estimates included in the Excel spreadsheet example due to rounding.

Data Required (illustration assumptions):

Acres of rice harvested annually (acres)	=	1,500	Combine purchase price ($)	=	$315,000
Combine harvest field speed (mph)	=	2.0	Repair and maint. factor (%)	=	60%
Combine machine width (ft)	=	30.0	Hours of annual use (hrs / yr)	=	350
Field efficiency (%)	=	65%	Years of useful life (yrs)	=	15
Combine operator labor cost ($/hr)	=	$15.30	Salvage value at end of useful life		
Combine size in horsepower (hp)	=	360	(% of purchase price)	=	20%
Fuel consumption (gal / hp-hour)	=	0.044	Amortization interest rate (%)	=	6.5%
Diesel fuel price ($ / gal)	=	$2.30			

Performance Rate Estimation:

$$\text{Acres per Hour} = \frac{2.0 \text{ mph} \times 30 \text{ ft. width} \times 65\% \text{ field eff.}}{8.25} = \textit{4.73 acres per hour}$$

Hours per Acre = 1 / 4.73 acres per hour = *0.212 hours per acre*

Capital (Fixed) Cost Estimation:

$$\text{Capital Recovery Factor} = [0.065(1+0.065)^{15} / (1+0.065)^{15} - 1] = 0.1064$$

Capital Recovery Cost = [0.1064 x ($315,000 – $63,000)] + (6.5% x $63,000) = *$30,896 per year*

Fixed Cost per Acre = $30,896/yr / 1,500 acres harvested = *$20.60 per acre*

Operating (Variable) Cost Estimation:

Fuel Consumption per Hour (gal/hr) = 0.044 gal/hp-hr x 360 hp = *15.8 gallons per hour*

Fuel Cost per Acre = $2.30/gal x 15.8 gal/hr x 0.212 hrs/acre = *$7.70 per acre*

Labor Cost per Acre = $15.30/hr x 0.212 hrs/acre x 1.1 = *$3.56 per acre*

Repair Cost per Hour = [$315,000 x 60%] / [15 yrs x 350 hrs] = *$36.00 per hour*

Repair Cost per Acre = $36.00/hr x 0.212 hrs/acre = *$7.63 per acre*

Variable Cost per Acre = $7.70/acre + $3.56/acre + $7.63/acre = *$18.89 per acre*

Total Cost Estimation:

Total Combine Harvest Cost per Acre = $20.60/acre + $18.89/acre = *$39.49 per acre*

Factors Influencing Variable Harvest Cost per Acre

Variable harvest cost, which include charges for fuel, labor and repairs, can vary widely due to a variety of factors. Some of the more important factors influencing variable harvest cost include the harvest speed of the combine travelling through the field, the field efficiency of the harvest operation (i.e., of the total time the combine is running, what percent of that time is it actually cutting rice, and the price of diesel fuel. Estimates of the impact of alternative harvest speeds, field efficiency and fuel price on total variable rice harvest costs per acre for the example illustration above are shown below.

Field Speed (MPH)

Fld. Eff.	1.0	2.0	2.5	3.0
55%	$44.63	$22.32	$17.85	$14.88
60%	$40.91	$20.46	$16.36	$13.64
65%	$37.76	$18.88	$15.11	$12.59
70%	$35.07	$17.53	$14.03	$11.69
75%	$32.73	$16.36	$13.09	$10.91

Fuel Price ($/gal)

$2.00	$2.30	$2.60	$3.00	Fld. Eff.
$21.13	$22.32	$23.50	$25.09	**55%**
$19.37	$20.46	$21.54	$23.00	**60%**
$17.88	$18.88	$19.89	$21.23	**65%**
$16.60	$17.53	$18.47	$19.71	**70%**
$15.49	$16.36	$17.24	$18.40	**75%**

Rice Combine Cost Estimation Spreadsheet Model

Data Input

The Excel spreadsheet model which calculates variable and fixed harvest costs for a rice combine has three sections of data entry. The first section allows for entry of total acres of rice harvested annually by the rice combine (cell E8). This acreage value is used to calculate fixed cost per harvested acre.

Data values which are used to estimate variable harvest cost per hour of operation and per acre of rice harvested are entered in the second section. Six data items are required to be entered in this section. Combine harvest speed in miles per hour is the first data entry (cell E11). Harvest speed is typically in the 2.0 to 3.0 miles per hour range. The next data item to be entered is machine width (cell E12). Machine width is the width of the rice combine header in feet. The third data item in combine field efficiency as a percent. Field efficiency represents the amount of time the combine is actually harvesting rice as a percent of the total time the combine is operating. Reasons why this field efficiency value would be less than 100% includes idling time, time spent unloading harvested rice into a grain cart, time spent turning from the end of one pass to the start of the next pass, as well as time spent traveling to another field. The field efficiency value is typically in the 65% to 80% range. The last three data items to be entered in this section include labor cost per hour (cell E19), combine size in horsepower (cell E20), and diesel price per gallon (cell E22). Combine horsepower size is used to estimate fuel consumption per hour, reported in cell E21.

Six data values are required to be entered in the third data entry section and are used to calculate fixed rice combine harvest costs. These data items include the purchase price of the combine (cell E27), total repair and maintenance cost over the life of the machine as a percent of the purchase price (cell E28), hours of annual combine use (cell E29), the years of useful life (cell E30), the salvage value of the combine at the end of its useful life as a percent of the purchase price (cell E31), and the amortization interest rate (cell E32).

(1) Rice Acres Harvested per Farm:

Spreadsheet Cell	*Description*
E8	acres of rice harvested (acres/farm)

(2) Rice Combine Harvest Performance Rate Parameters:

Spreadsheet Cell	*Description*
E12	combine field speed (FS in mph)
E13	machine width (MW in feet)
E14	field efficiency percentage (%)

(3) Rice Combine Harvest Cost Parameters:

Spreadsheet Cell	*Description*
E22	labor cost per hour ($/hour)
E23	combine size in horsepower (hp)
E24	fuel consumption rate in gallons per horsepower-hour (gal/hp-hr)
E26	diesel price ($/gallon)
E27	combine purchase price ($)
E28	repair and maintenance cost as percent of purchase price (%)
E29	hours of annual use (hours/year)
E30	years of useful life (years)
E31	salvage value as percent of purchase price (%)
E32	amortization factor (%)

Rice Combine Harvest Cost Estimation: Performance Rates & Harvests Costs

Estimated Variable and Fixed Costs for a Rice Combine per Harvested Acre

LSU AgCenter Research & Extension

Rice Acres Harvested per Farm

[ENTER] =>	1,500	= acres of rice harvested (total annual acres per farm)

Combine Harvest Performance Rate:

[ENTER] =>	2.0	= combine field speed (FS) in miles per hour
[ENTER] =>	30.0	= machine width (MW in Feet), combine header width
[ENTER] =>	65%	= field efficiency percentage (FE in percent)

4.73 = acres harvested per hour (Performance Rate)

0.212 = hours per harvested acre (Performance Rate)

Rice Combine Variable and Fixed Harvest Cost:

[ENTER] =>	$15.30	= labor cost per hour ($/hour)
[ENTER] =>	360	= combine size (horsepower)
[ENTER] =>	0.044	= fuel consumption per horsepower-hour (gal/hp-hr)
	15.8	= fuel use per hour (gallons)
[ENTER] =>	$2.30	= diesel price ($/gallon)
[ENTER] =>	$315,000	= purchase price ($)
[ENTER] =>	60%	= repair and maint as percent of purchase price (%)
[ENTER] =>	350	= hours of annual use (hrs/year)
[ENTER] =>	15	= years of useful life (years)
[ENTER] =>	20%	= salvage value as percent of purchase price ($)
[ENTER] =>	6.5%	= amortization interest rate (%)
	0.1064	= capital recovery factor

Variable Harvest Cost per Acre

$16.83 = Labor Cost per Hour
$36.43 = Fuel Cost per Hour
$36.00 = Repair Cost per Hour
$89.26 = Total Variable Cost per Hour

Fixed Harvest Cost per Acre

$30,896 = Annual Capital Recovery (Fixed) Cost

$18.88 = Total Variable Harvest Cost per Acre

$20.60 = Annual Capital Recovery Cost per Acre

$39.48 = Total Rice Harvest Cost per Acre

Variable Cost Comparison per Harvested Acre for Alternative Harvest Speeds, Field Efficiencies, and Fuel Prices

Field Speed (MPH)

Fld. Eff.	1.0	2.0	2.5	3.0
55%	$44.63	$22.32	$17.85	$14.88
60%	$40.91	$20.46	$16.36	$13.64
65%	$37.76	$18.88	$15.11	$12.59
70%	$35.07	$17.53	$14.03	$11.69
75%	$32.73	$16.36	$13.09	$10.91

Fuel Price ($/gal)

$2.00	$2.30	$2.60	$3.00	Fld. Eff.
$21.13	$22.32	$23.50	$25.09	55%
$19.37	$20.46	$21.54	$23.00	60%
$17.88	$18.88	$19.89	$21.23	65%
$16.60	$17.53	$18.47	$19.71	70%
$15.49	$16.36	$17.24	$18.40	75%

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Dr. Michael E. Salassi
(225) 578-2713
msalassi@agcenter.lsu.edu
Department of Agricultural Economics & Agribusiness
Louisiana State University Agricultural Center
Baton Rouge, Louisiana 70803

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