Applied Risk Analytics

Forage Harvester Purchase Machine Share Arrangements

Wyoming farmer Bob Mills* is weighing his options pertaining to the harvest of his silage corn. Bob has been using a custom harvester but he is considering purchasing his own machine for a variety of reasons. He thinks that he could harvest his crop in a more timely manner, especially if cold weather in the fall becomes an issue. Bob considers high quality silage one of his biggest assets to his feeding operation and putting it up at the right time is important from a quality and a value perspective.

Bob is considering purchasing a used self-propelled forage harvester. The main obstacle Bob faces is the equipment cost; self-propelled forage harvesters are very expensive. Even older machines, 10-15 years old, are selling for high prices and Bob is concerned that they may be out of his price range. Bob also admits he does not have a clear idea of what the machine will cost to operate. He needs an accurate cost estimate to compare with custom harvesting.

One option Bob is considering to help deal with the high initial cost of the machine is a machinery sharing arrangement with several neighbors. The idea would be that all of them pool their resources and purchase a machine that none of them on their own could otherwise afford. Bob needs to first determine the cost per acre and per hour for the self-propelled harvester using the Machinery Risk Calculator, then evaluate a potential sharing arrangement.

RightRisk Analytics
Tools and guides are available at no cost at the website https://RightRisk.org

Machine Risk Calculator Overview

The *Machine Risk Calculator* (MRC) from RightRisk.org is a risk analytics tool designed to estimate machinery expenses and the risk sensitivity of these costs to future changes in input factors. The tool uses a comprehensive

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list of related factors to calculate an overall cost including: expected life, repairs and depreciation, housing, insurance, taxes, and annual use.

The MRC estimates repair and operation costs by entering factors, found in the MRC appendix, related to each specific machine . Users can estimate expenses for powered equipment, three different types of implements, vehicles, powered irrigation equipment, non-powered irrigation equipment, and actual field operation costs. The MRC analytics tool generates results based on the specific data entered and provides estimates for annual cost, average operating costs for each machine, and field operation costs (comparable to a custom rate).

Table 1. Forage Harvester Input Information

POWERED EQUIPMENT	
Equipment Name	Self-Propelled Forage Harvester
Equipment Options	10-row Corn Head
Purchase Price	$250,000.00
Year Quoted	2023
Useful Life (Hours)	2,500
Annual Use (Hours)	200
Maximum Life (Years)	12
Cost Factor 1	0.791
Cost Factor 2	0.091
Cost Factor 3	0
Repair Factor 1	0.03
Repair Factor 2	2.00
Opportunity Cost Rate	9.5
Tax, Housing & Insur. Rate	2.0
Fuel Price	$3.50
Fuel Type	DIESEL
PTO Horsepower	750
Percent Load Factor	70

Machine Risk Calculator Overview and Example

The self-propelled forage harvester Bob is considering for purchase is an 8 year old machine with 1,500 machine hours. Using information from the MRC appendices, we assume this machine has 2,500 hours of useful life remaining out of a typical 4,000 hour useful life. The machine is rated at 750 horsepower, include a 10-row corn head, and costs $250,000.

We begin by entering information in the “Powered Equipment” section of the MRC tool. Using the repair factors and cost factor information found in the MRC tool appendix, we enter a maximum life of 12 years, 200 hours of annual use, the cost factors and repair factors, an opportunity cost of 9.5 percent, and a 2 percent rate for taxes, housing, and insurance (THI). We also assume a diesel fuel cost of $3.50 per gallon. Finally, we assume a percent load factor of 70 percent. This information is summarized in Table 1.

Table 2. Forage Harvester Cost Summary

Self-Propelled Forage Harvester
10-row Corn Head

Purchase Price:	$ 250,000		Year Quoted:	2023	
Hours to Wearout:	2,500		Maximum Life:	12	Years
Cost Factor 1:	0.791		Annual Use:	200	Hours
Cost Factor 2:	0.091		Repair Factor 1:	0.030	
Cost Factor 3:	0.0000		Repair Factor 2:	2.00	
PTO Horsepower:	750		Fuel Price:	$3.50	Per Gal.
Fuel Type:	DIESEL		Percent Load Factor:	70.0	percent
Fuel Consumption:	42.53	Gal/Hr	Oil Consumption:	0.16	Gal/Hr

Percent of Average Investment Charged for Opportunity Interest:	9.50	percent
Percent of Average Investment Charged for Tax, Housing & Insurance:	2.00	percent

ESTIMATED ANNUAL COSTS AND COST PER HOUR

		ANNUAL COSTS						COST PER HOUR					
Annual Use HOURS	YRS TO TRADE	TOTAL COST	DEPR	OPP COST	THI	REPAIRS	FUEL & OIL	TOTAL COST	DEPR	OPP COST	THI	REPAIRS	FUEL & OIL
200	12.0	$71,579	$16,118	$14,563	$3,066	$3,600	$34,233	$357.90	$80.59	$72.81	$15.33	$18.00	$171.16

Clicking View Results causes the MRC tool to generate a table outlining estimated total annual costs and cost per hour of operation, divided into the categories: depreciation, opportunity cost, THI, repairs and fuel/oil. Table 2 outlines the results for the forage harvester Bob is considering. Based on 200 hours of annual use and the assumptions described, Bob can expect the machine to cost around $71,579 annually and $357.90 per hour to operate. Fuel and oil is the largest expense, which is not unexpected for a 750 horsepower machine, at $34,233 annually and $171.11 per hour. Note that these costs are before including operator labor or a return to management.

MRC Tool Analysis

The next step in the analysis of this potential machine is to access the MRC Field Operation tab. As discussed above, this harvester has a 10-row head (30-inch row spacing), equating to 25 feet of width. Assuming Bob will chop high-tonnage corn yielding 25 tons per acre, we assume an average speed of 4 miles per hour and an overall efficiency rating of 70 percent, Table 3.

Overall field efficiency refers to how much the machine is actually in use when running, taking into account factors like operator experience, turning, servicing, repairs, and other

Table 3. Field Operation Input Information

Field Capacity	Width (feet)	Speed (mph)	Efficiency (overall)	Rate Acres/Hour
Operation Accomplishment Rate	25.0	4.0	70%	8.48

Operating Input Description	Units/Acre	Cost/Unit	Cost/Acre
	0.00	$0.00	$0.00
	0.00	$0.00	$0.00
	0.00	$0.00	$0.00
	0.00	$0.00	$0.00
		TOTAL	$0.00

	Dollars/Hour
Operator Labor	$30.00
Return to Management	$30.00

Risk Analysis: Fuel and Oil

Most Likely:	Low	High
$171.16	$100.00	$200.00

factors. For this analysis we've selected generally conservative values for both speed and efficiency. These results in a rate of 8.48 acres per hour. We have no additional operating inputs to consider for this field operation and enter operator labor and return to management both at $30/ hour. This brings the total field operation cost per hour of the machine to $417.90, Table 4.

One standout aspect of the MRC tool is its unique feature that empowers users to assess the sensitivity of different costs to change, by inputting low, high, and most likely values. This output is expressed in the form of a probability chart, Figure 1. For example, fuel and oil costs are the largest estimated cost category for this machine. Bob can see the effect of varying fuel prices by entering $100/ hour for the low value and $250/hour for the high value, Figure 1. The most likely outcome, the result with a 50/50 probability, is $48.67 per acre for fuel and oil, with a range of $40.88 to $52.66.

Table 4. Estimated Harvester Costs per Hour

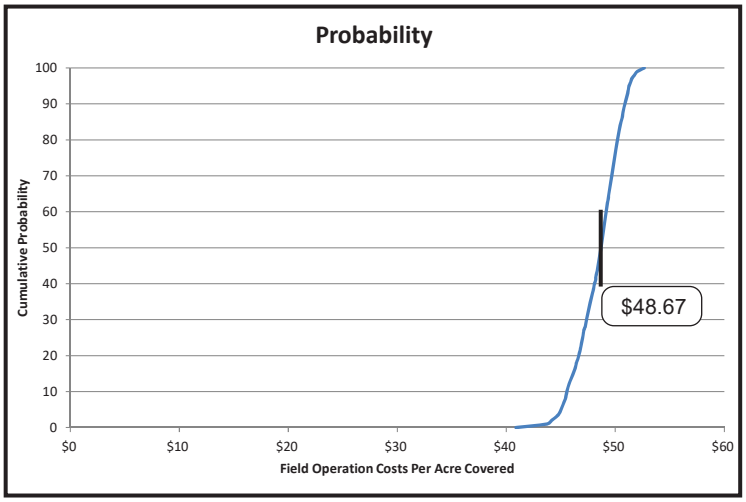
ESTIMATED OPERATING COSTS PER HOUR OF OPERATION	DEPR	OPP COST	THI	REPAIRS	FUEL & OIL	TOTAL COST
Self-Propelled Forage Harvester						
10-row Corn Head	$80.59	$72.81	$15.33	$18.00	$171.16	$357.90
	-	-	-	-	-	-
	-	-	-	-	-	-
	-	-	-	-	-	-
Total Machine Cost PER HOUR:	$80.59	$72.81	$15.33	$18.00	$171.16	$357.90
Operating Inputs:						-
Operator Labor:						$30.00
Return to Management:						$30.00
Total Field Operation Cost PER HOUR						$417.90

Bob has been paying a custom harvester $7.00 per ton for chopping services; Bob supplies the trucks and does the stacking. Bob averages 400 acres of silage corn per year, with an expected yield of 25 tons per acre. Custom harvesting typically results in a total charge of $70,000 or a cost per acre of $175. This compares with cost per acre estimated by the MRC tool of $49.26, assuming 200 hours of annual use.

Using an alternative metric, the average custom rate per hour in Bob's neighborhood is $750/ hour. Bob is expecting to harvest at a rate of 8.48 acres per hour; Bob will need the machine for a total of 47.17 hours (400 acres divided by 8.48). When compared to custom harvesting, the purchased machine would result in a lower cost, $417.90/hour.

A third angle to consider is the total cost. The MRC estimate for total annual cost for the forage harvester is $71,579. Identifying enough partners who can help distribute the expenses associated with the remaining 153 hours of annual use (200 – 47 hours) would be necessary to keep Bob from shouldering the entire cost; otherwise, the machine's total annual cost exceeds that of simply using a custom harvester at $70,000 per year.

Figure 1. Probability Distribution for Field Operation Costs per Acre by Varying Fuel and Oil Expense



Machinery Sharing

Bob now has a solid understanding of the potential per-acre and per-hour costs of the harvester. The next step is to explore different share arrangements and determine the most effective structure. Considering the substantial diversity in crops among different owners of a forage harvester, the most suitable approach may be to establish the agreement on a per-hour of use basis. Using the MRC cost estimates for the forage harvester, we can begin to construct what a potential share arrangement might look like. We will assume Bob has three neighbors of similar size and usage pattern: 45-50 hours each.

Hours of Annual Use

It is important to consider that the efficiency of a forage harvester greatly depends on the supporting operations, such as trucking/hauling and packing. We do not address that side of the operation, due to space constraints. In this example, we consider only the cost of owning and operating the harvester and not the trucks or silage packing associated with it; we assume that the operator will provide trucks and packing needed to keep the harvester operating at peak efficiency. We selected 200 hours of annual use as a baseline, assuming Bob will use the machine a portion of those hours, with other operators using the machine the balance of the hours in a potential machine sharing agreement.

Making use of the Joint Machinery Ownership tool from Iowa State Extension, Table 5, we enter the MRC estimates for each of the cost categories, along with the expected annual use for each potential owner as 50 hours (200 hours, divided equally). The results show that ownership of this machine will cost each party around $20,627 annually to own, Table 5.

This would represent a sizeable savings for Bob over using a custom harvester. In addition, MRC estimates show that Bob could conceivably purchase the machine outright and expect harvest cost to be similar to custom harvesting ($71,579). By entering into a joint ownership or share agreement, Bob could possibly free up almost $50,000 of capital to use elsewhere in his operation.

Table 5. Joint Machinery Ownership Worksheet, Ag Decision Maker - Iowa State University

Joint Machinery Ownership Worksheet — Ag Decision Maker File A3-34

Ag Decision Maker -- Iowa State University Extension and Outreach

For more information see Information File A3-34, Joint Machinery Ownership.

Enter your input values in shaded cells.

			Annual Costs	Amount Paid or Contributed by Each Owner (Costs shared in proportion to usage can be omitted.)				
				Owner A	Owner B	Owner C	Owner D	
Names of joint owners				Bob	Neighbor 1	Neighbor 2	Neighbor 3	Are all costs allocated?
				Show amount of original purchase price contributed by each owner. Leave blank if the machine is leased.				
Original investment in machine[1]	$ 250,000			$ 62,500	$ 62,500	$ 62,500	$ 62,500	YES
Current value of machine (purchase price if new)[2]	$ 250,000			$ 62,500	$ 62,500	$ 62,500	$ 62,500	
Annual interest rate on investment[3]	9.5%		$ 23,750	$ 5,938	$ 5,938	$ 5,938	$ 5,938	Interest
Depreciation rate[4], %	6.5%		$ 16,125	$ 4,031	$ 4,031	$ 4,031	$ 4,031	Depreciation
				Allocate total annual costs according to who pays for or contributes them.				
Insurance cost rate[5], %	0.7%		$ 1,650	$ 412.50	$ 412.50	$ 412.50	$ 412.50	Insurance YES
Housing cost rate[6], %	0.7%		$ 1,650	$ 412.50	$ 412.50	$ 412.50	$ 412.50	Housing YES
Property tax rate[7], %	0.6%		$ 1,500	$ 375.00	$ 375.00	$ 375.00	$ 375.00	Property tax YES
Annual lease payment if machine is leased			$ -	$ -				Lease payment YES
Fuel and lubrication, annual cost[8]	$ 34,233	/year	$ 34,233	$ 8,558.25	$ 8,558.25	$ 8,558.25	$ 8,558.25	Fuel & lubrication YES
Repairs and maintenance, annual cost[9]	$ 3,600	/year	$ 3,600	$ 900.00	$ 900.00	$ 900.00	$ 900.00	Repairs YES
Labor hours for machine, annually[10]		hours/year	hours					YES
Wage rate for labor[11]		$/hour	$ -	$ -	$ -	$ -	$ -	Labor
Total			$ 82,508	$ 20,627	$ 20,627	$ 20,627	$ 20,627	
Total annual use in acres or hours by all owners			200	50	50	50	50	
Total cost per acre or per hour			$ 412.54					
Annual cost that should be paid by each owner based on use of machine				$ 20,627	$ 20,627	$ 20,627	$ 20,627	
Reimbursement to share costs according to annual usage, $/year				**$0**	**$0**	**$0**	**$0**	**$0**

Owner(s) with a negative value pay(s) that amount to owner(s) with a positive value.

Other Factors to Consider

The cost estimates and prospects for purchasing the harvester may be influenced by several additional factors.

Obviously, access to capital for each of the parties involved is an important consideration. All parties would need a solid written agreement and a good working relationship to make a sharing arrangement of this scope work well. In cases where a share agreement is based on machine usage, an equal distribution of operating and fixed costs is reasonable when all parties use the machine for a similar number of hours annually. However, if one party consistently uses the machine more, adopting a per-acre basis for cost sharing becomes a more equitable arrangement for all parties involved.

A machinery share agreement works best with a staggered schedule for machine use. Obviously, not all parties will be able to use the machine at the same time. These challenges, however, are similar to using a custom harvester where multiple customers may want harvest operations scheduled at the same time, requiring one or more to wait.

In addition, harvest can be extremely variable, the speed and efficiency of the harvester are not the only variables that can speed up or slow down the operation. Trucking, operator skill, the packing process, and other equipment breakdowns and repairs can greatly affect the harvester itself. As a result, assumptions about machine usage are big assumptions. If Bob or one of his potential partners does not use the harvester for the number hours assumed in the share agreement, the ownership costs per hour will increase for all owners.

This analysis demonstrates that there are several advantages and disadvantages to ownership versus using a custom harvester. As a result, Bob will need to carefully weigh the tradeoffs between joint ownership and hiring a custom harvester, as well as his relationships with any potential partners, their access to capital, and the cost of capital over the expect life of any purchased machine.

** The Bob Mills operation is a case study example created to demonstrate RightRisk tools and their applications. No identification with actual persons living or deceased, places, or agricultural operation is intended nor should be inferred.*

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