Applied Risk Analytics

Evaluating Round & Square Bale Systems

Central Wyoming hay producer Pat Grey* raises alfalfa and other types of hay for sale and for feeding his own cattle. Pat has used round balers for many years and is looking to trade or upgrade his current machine. He has priced new round balers, and is wondering if a switch to a 3x3 big-square bale system might be feasible.

While these machines have a much higher cost than round balers, Pat feels there may be advantages to using these systems over his current setup. His main problem is how to compare either system other than by purchase price: mainly, what is an accurate operations cost of each system?

Pat is like many producers; he knows what he paid for his baler, he just doesn't have a good idea of what his machine actually costs him to use. He can pull together expenses like fuel and repairs, but has less of an understanding of what non-cash expenses like depreciation would be. Before making a purchase decision, Pat would like to see if purchasing is profitable on a long-term basis.

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

Using the machinery risk calculator

The Machine Risk Calculator (MRC) from RightRisk.org is designed to help producers quantify as much of their machinery and equipment costs as possible and provide an accurate, overall cost of ownership, as well as the cost of operation. The MRC uses a comprehensive list of related expenses to calculate overall cost, including: expected life values, repairs and depreciation, housing, insurance, taxes, and annual use.

MRC users can estimate expenses for powered equipment, three different types of implements, vehicles, powered irrigation equipment,

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J. Hewlett-University of Wyoming, J. Sedman-Sedman Economics, J.Tranel-Colorado State University, and J. Parsons-University of Nebraska-Lincoln.

non-powered irrigation equipment, as well as actual field operation costs.

The tool generates results based on data entered by the user, including estimates of annual costs and average operating costs for each machine. The tool also supplies tables listing ranges of reported custom rates and information needed to calculate costs for selected field operations.

Table 1. Baler and Alfalfa Hay Prices.

Type	Purchase Price	Hay Price (per ton)
Round Baler (Avg. new 2020/21)	$67,500	$200 to $250
Square Baler (3X3) (Avg. new 2020/21)	$145,000	$225 to $300

Notes: Hay prices are USDA reported Eastern Wyoming/Western Nebraska for September 2022. Baler prices are average listed for sale prices for Wyoming and surrounding states.

Comparing round and square bale systems

Pat would like to compare a new round baler with a potential upgrade to a 3x3 system. There are advantages and disadvantages to each. Round bale technology has progressed rapidly over the last 15 years, improving speed, efficiency, and bale size/quality. The main disadvantage with round bales is their lower sale price when compared to square bales, often due to increased challenges in hauling long distances due to oversized load restrictions. Round balers now require considerably more horsepower than 15 to 20 years ago.

Square balers have set the standard for speed, efficiency, premium bale type, and ease of hauling in recent years. Their main disadvantage is their high purchase price when compared to round balers. For purposes of this analysis, we will assume Pat's existing 150-tractor will operate each type of baler. Average new purchase prices and reported hay prices are listed in Table 1.

Data Entry in the MRC

Pat's first step is to select the power unit navigation tab, implement #1, and the field cost and risk analysis by checking the box next to each in the MRC tool. The next step is to enter the machine data under each input tab. This includes purchase price, useful life, annual use, cost and repair factors, interest rate, and a rate for taxes, housing, and insurance.

For ease of analysis, we will use the pre-entered tractor/power unit, a 150 horsepower tractor adequate for each baler. Under the powered equipment tab, we enter $95,000 for the value of Pat's current tractor. We assume 12,000 hours of useful life, 650 hours per year, and a 20-year useful life, Table 2.

Table 2. Example Wheel Tractor Assumptions and Estimated Annual Costs and Cost per Hour, Machine Risk Calculator Output.

WHEEL TRACTOR - 150 PTO HP
CAB, AIR, STR, PWRSFT

Purchase Price:	$ 95,000	Year Quoted:	2022
Hours to Wearout:	12,000	Maximum Life:	20 Years
Cost Factor 1:	0.976	Annual Use:	650 Hours
Cost Factor 2:	0.119	Repair Factor 1:	0.007
Cost Factor 3:	0.0019	Repair Factor 2:	2.00
PTO Horsepower:	150	Fuel Price:	$4.50 Per Gal.
Fuel Type:	DIESEL	Percent Load Factor:	70.0 percent
Fuel Consumption:	8.51 Gal/Hr	Oil Consumption:	0.04 Gal/Hr

Percent of Average Investment Charged for Opportunity Interest: 8.00 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
650	18.5	$43,623	$4,254	$4,458	$1,115	$5,187	$28,609	$67.11	$6.55	$6.86	$1.71	$7.98	$44.01

We also use the cost and repair factor data from the MRC tool appendix data, entering fuel costs of $4.50 gallon and load factor of 70 percent. The load factor is defined as the percentage of maximum PTO horsepower required to run the implement. By clicking the View Results button at the top right, we

Table 3. Example Round Baler Assumptions and Estimated Annual Costs and Cost per Hour, Machine Risk Calculator Output.

Round Baler
NEW, 5x6

Purchase Price:	$ 67,500	Year Quoted:	2022
Hours to Wearout:	1,500	Maximum Life:	10 Years
Cost Factor 1:	0.852	Annual Use:	150 Hours
Cost Factor 2:	0.101	Repair Factor 1:	0.430
Cost Factor 3:	0.0000	Repair Factor 2:	1.80

Percent of Average Investment Charged for Opportunity Interest: 8.00 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
150	10.0	$15,190	$4,835	$3,466	$866	$6,022	NA	$101.26	$32.23	$23.11	$5.78	$40.15	NA

Table 4. Example Large Square Baler Assumptions and Estimated Annual Costs and Cost per Hour, Machine Risk Calculator Output.

LARGE SQUARE BALER
NEW, 3X3 bales

Purchase Price:	$ 145,000	Year Quoted:	2022
Hours to Wearout:	3,000	Maximum Life:	10 Years
Cost Factor 1:	0.852	Annual Use:	150 Hours
Cost Factor 2:	0.101	Repair Factor 1:	0.100
Cost Factor 3:	0.0000	Repair Factor 2:	1.80

Percent of Average Investment Charged for Opportunity Interest:	8.00 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
150	10.0	$22,702	$10,387	$7,445	$1,861	$3,008	NA	$151.34	$69.24	$49.64	$12.41	$20.06	NA

can view the estimated annual and hourly costs for the tractor.

For the round baler, we enter $67,500 for the purchase price, the year quoted, 1,500 hours for useful life, 150 hours for annual use, and a maximum useful life of 10 years. We also enter the repair and cost factors found in Table 3 of the MRC appendix. For this analysis, we will assume an opportunity cost (interest rate) of 8 percent and 2 percent for taxes, housing, and insurance. For the square baler, we enter a purchase price of $145,000, 3,000 hours useful life, 10-year useful life, and the same cost and repair factors as used for the round baler, Table 4.

Machine Risk Calculator analysis

The Machine Risk Calculator estimates cost per acre, cost per hour, and total annual cost based on the performance estimates entered. We assume a 16-foot windrow and 6.5 miles per hour for the round baler, versus 8 miles per hour for the square baler. In addition, where a square baler does not need to stop to wrap the bale and a round baler does, we enter 80 percent field efficiency for the round baler and 90 percent for the square baler. The MRC tool estimates a field capacity of 10.08 acres per hour for the round baler and 13.96 acres per hour for the square baler. Finally, we enter values for management and operator labor, each at $20 per hour under both bale systems.

The next step is to enter operating inputs and performance data under the Field Operation tab. For balers this would include twine/net wrap expense. We assume the net wrap for the round baler costs $285 per roll for a 9,600-foot roll. At 2 tons/acre of hay and 1500 pound bales, this equates to 2.67 bales per acre at $2.25/bale for net wrap, giving a total per acre cost of $6.01. For the square baler, we assume the same 2 tons/acre of hay with 800-pound square bales. We will assume the twine costs $33 per ball and 40 bales per ball. This equates to $0.825 per bale and $4.125/acre.

Table 5. MRC Estimated Costs for an Example Square Baler and Round Baler System.

	Round Baler	Square Baler
Annual Total Costs	$58,812	$66,325
Field Op. Costs/Acre	$26.68	$22.63
Field Op. Costs/Hour	$208.97	$258.75

Clicking RUN causes the Machine Risk Calculator to generate a set of results for each baling system. Comparing the MRC analysis using the same power unit for each baler, we see from Table 5 that Pat can expect a total field operation cost per acre of $26.68 for the round baler and $22.63 for the square baler. The difference is largely due to the increased speed and efficiency of the square baler.

On a cost per hour basis, the estimated cost of the square baler is considerably higher at $258.75/hour compared to the round baler at $208.97/hour. This is due primarily to higher ownership costs estimated at 1.5 times the cost of the round baler, though repair costs for the round baler are estimated at twice those for the square baler.

Risk analysis with the multi-temporal risk analyzer

Now that Pat has a good estimate of the operating costs of a large square baler, the next question becomes does switching generate a profit over time? In other words, does the higher priced hay from a square bale system outweigh the costs to make that bale over time on a net present value (NPV) basis?

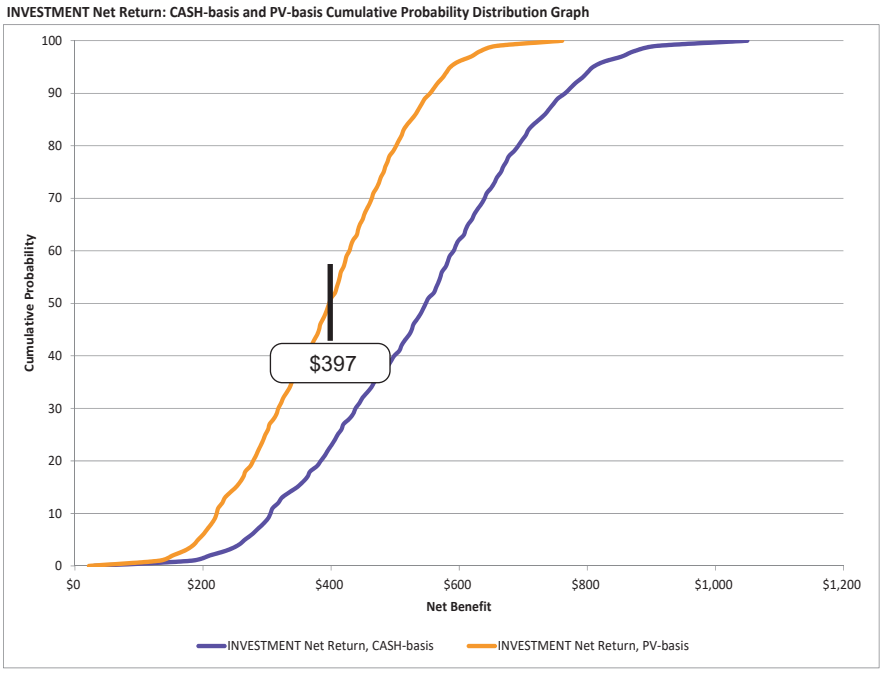
The Multi-Temporal Risk Analyzer (MTRA) helps examine various management decisions over a multi-year timeframe. The key feature is that it can generate probability analysis to account for variability across that timeframe. MTRA can be used to evaluate the effect of variability for a large number of factors for up to 20 years. If Pat decides to upgrade to the 3x3 baler, the main benefit is the potential for receiving a higher price per ton for the 3x3 bale package. Recently, there has been around a $50 per ton advantage, while in past years it has been both higher and lower. If we

assume $25/ton as the most likely price advantage, a low of $0/ton and $50/ton as the high, and an average yield of 2 tons per acre, this results in an increase of $50 per acre ($25 X 2 T/A) as the most likely added revenue, $0 for the low, and $100 per acre for the maximum value ($50 X 2 T/A).

For reduced costs, we enter the reduced cost per acre of the square bale system compared with the round bale system estimated earlier at $4.05 per acre, with a minimum value of $3/A and a maximum value of $5/A per acre. Assuming the square baler has a useful life of 10 years, we check the boxes to indicate each year over the 10-year life for both the increased income and increased cost categories.

MTRA results are based on a thousand random draws of potential outcomes for both cash and NPV results.

Figure 1. MTRA per Acre Net Return for the Estimated Advantage of a Large Square Bale System Compared to a Round Bale System.



One of the important outputs is the probability distribution. Based on the data entered, Pat could expect his decision to purchase a large square baler to generate a net return over 10 years of $397 per acre with a 50/50 probability (the most likely outcome). This equates to an average of $40 per acre net benefit on an annual basis. He should expect this decision to generate no more than $76 and no less than $2 per acre annually.

Further Considerations

Now that Pat has a more complete estimate of the operating and ownership costs on a per hour basis for both baling systems and has evaluated the benefit of switching systems, he is in a much better position to make an informed purchase decision. While the initial purchase price is much higher for the square baler compared with a round baler, the large square bale system is competitive from an operational cost standpoint.

Other potential expenses, not considered in this example, that could influence his choice, include: stacking or handling the bales may require different or more specialized equipment adding additional expense.The equipment necessary to feed square bales may also require changes under a new system, assuming Pat feeds his own hay. Availability of capital and Pat's repayment capacity may or may not be another issue depending on his operation and other enterprises included in his operation.

** The Pat Grey 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.*