



BUL 953

# Risk Assessment and Decision-Making Guidelines for Dairy Risk Management: Part 2

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## Introduction

THIS BULLETIN IS THE SECOND in a three-part series intended to improve dairy farmers' risk-management assessments and decision-making. In this publication, we address partial budgets and capital investments.

## Partial Budgets

One constraint of an enterprise budget is its limitation to a single enterprise. However, *partial budgets* hold no such restriction, thus enabling analyses of the changes involved (e.g., investments, financing, downsizing) among different interacting enterprises. Indeed, partial budgets (Figure 1) help a dairy producer separate out the possible changes or modifications made to a dairy operation and thus help her/him recognize their effect on (potential) profits. Each partial budget ultimately can handle analyses of two alternatives at a time: the current situation and a (single) proposed change.

In short, partial budgets compare the profitability of what is currently being done with a possible change or alternative in the dairy operation. Essentially, you can prepare numerous partial budgets to analyze several different possible scenarios, focusing on those changes that affect income, costs, or both. If you determine from these analyses that some operations aren't affected by the proposed changes, omit the analysis of those operations from your partial budgets. As an example, corn yields are independent from the additional cost and effect of feeding anionic salts to close-up cows and can thus be ignored.

The changes in costs and income from a partial budget can be evaluated according to positive and negative effects:

- What new or additional income will be obtained? (added income/reduced cost)
- What current cost(s) will be reduced or eliminated? (added income/reduced cost)

- What new or additional cost(s) will be incurred? (added cost/reduced income)
- What current income will be reduced or eliminated? (added cost/reduced income)

The financial effect (on overall profit) that occurs in response to management changes is what's important:

- an increase in income => *positive effect*
- a reduction/elimination of costs => *positive effect*
- an increase in costs => *negative effect*
- a reduction/elimination of income => *negative effect*

The acceptance or rejection of potential managerial changes is based solely on finances and their effect on the bottom line.

If the **POSITIVES (E; see Figure 1)** are *greater* than the **NEGATIVES (F)**, then the managerial change *should* benefit the operation financially. Following that:

- If  $E > F$ , then *Accept* the change

If the **POSITIVES** are *less* than the **NEGATIVES**, then the managerial change *should not* benefit the operation financially. Thus:

- If  $E < F$ , then *Reject* the change

There are potential risks involved with partial budgeting, since these budgets are only as precise and accurate as the assumptions made with the information gathered. For example, overestimations or underestimations of prices, yields, and volumes marketed, or other miscalculations, can occur.

**Figure 1.** A simple partial budget.

Added Income:		Added Costs:	
Example 1a	= \$0.95/cwt	Example 1b	= \$1.20/cwt
A. Total added income =	\$0.95/cwt	C. Total added costs =	\$1.20/cwt
Reduced Costs:		Reduced Income:	
Example 1a	= \$0.95/cwt		
B. Total reduced costs =	\$0.95/cwt	D. Total reduced income =	0
E. Positives = A + B	= \$1.40/cwt	F. Negatives = C + D	= \$1.20/cwt

## Steps to implement a partial budget:

1. Identify the objective of the analysis.
2. Use the most accurate information available. For example, draw on the following:
  - Quotations from numerous suppliers
  - Prior on-farm and off-farm information
  - Reports by Extension agents
3. Evaluate the financial impact(s) of each proposed change.
4. Summarize the resulting impacts of the proposed change.
5. Decide how to proceed.

The following hypothetical example provides a clearer idea of how to work through the initial calculations, using data from Figure 2.

### Objective

Evaluate the financial effect of providing biotin supplements to lactating dairy cows.

### Assumptions

- Biotin dose: 20 mg/cow-day (Bergsten et al. 2003)
- Response in milk yield: 2.5 lbs/cow-day (Bergsten et al. 2003)
- Cost: \$0.01/mg biotin (1 cent/mg) (Bergsten et al. 2003)
- Biotin improves foot health by reducing treatments: incidence in cows is reduced from 5% to 3%
- Cost of veterinary treatment: \$216/cow (Cha et al. 2010)

**Figure 2.** Applied example of partial budgets.

Added Income:		Added Costs:	
2.5 lbs milk/cow @ \$16.40 /cwt	= \$0.41/cow	20 mg/cow @ 0.01 \$/mg	= 0.20 \$/cow
A. Total added income =	\$0.41/cow	C. Total added costs =	0.20 \$/cow
Reduced Costs:		Reduced Income:	
0.02 trmt/cow-year @ 216 \$/trmt	= \$0.012/cow-day		
B. Total reduced costs =	\$0.012/cow-day	D. Total reduced income =	0
E. Positives = A + B	\$0.422/cow	F. Negatives = C + D	0.20 \$/cow

Therefore, savings are:

Treatment Costs Before application - Treatment Costs After application:

$$\begin{aligned}
 &= [(5 \text{ treatmts/year} \times \$216/\text{treatmt}) - \\
 &\quad (3 \text{ treatmts/year} \times \$216/\text{treatmt})] \text{ for 100 cows} \\
 &= 2 \text{ treatmts/year} \times \$216/\text{treatmt} \\
 &\quad \text{for 100 cows} = \$432/\text{year for 100 cows} \\
 &= \$432/\text{year} \times \frac{1}{100 \text{ cows}} = \$4.32/\text{cow-year} \\
 &= \$4.32/\text{cow-year} \times \frac{1 \text{ year}}{365 \text{ days}} \\
 &= \$0.012/\text{cow-day}
 \end{aligned}$$

**OVERALL RESULT (Figure 2):**

$$\$0.422/\text{cow} - \$0.20/\text{cow} = \$0.222/\text{cow}$$

Based on the assumptions, it is financially favorable to supplement cows with biotin, because for every \$1.00 spent on biotin, a net (increased) income of \$1.11 should be expected, as indicated by  $(\$0.422 - \$0.20)/\$0.20 = 1.11$ . This translates to a profitability of 111%.

## Capital Investments

Many times, dairy farmers require capital resources (money) to sustain or grow a business. Just as it is important to know how much capital is needed to make an investment, it is equally crucial to identify whether or not the expected returns will be larger than the planned investment. If they will be, the recommendation is to proceed with the investment. Conversely, if the expected returns are lower than the cost of the investment, do not make the investment.

There are different ways to calculate an estimate of a return on investment. A critical matter that needs to be considered in these types of analysis is the *time value of money* (TVM). TVM refers to the notion that the value of a given amount of money changes over time. For example, the market value of one hundred dollars today can rise in worth (unless interest rates are negative) in the future, say a year from now. In effect, assume the bank interest rate is 3% (annual rate); one hundred dollars placed in a bank today would gain in value by three dollars a year later to \$103 (Figure 3):

Present Value		Future Value
Year 0 – now	3% Interest rate	Year 1 – a year ahead
\$100.00	→	\$103.00

Thus:

$$\begin{aligned}
 &\$100.00 : \text{initial amount} \\
 &+ \$100.00 \times 0.03 : \text{earned interest} \\
 &= \$103.00 : \text{future amount}
 \end{aligned}$$

[same as  $\$100 \times (1 + 0.03) = \$103$ ]

In similar way, one hundred dollars a year from now is equal to less than one hundred dollars at today's value. Discounting by the same 3% interest rate, tomorrow's one hundred dollars is valued at less than one hundred dollars today:

Present Value		Future Value
Year 0 – now	3% Interest rate	Year 1 – a year ahead
\$95.24	←	\$100.00

Thus:

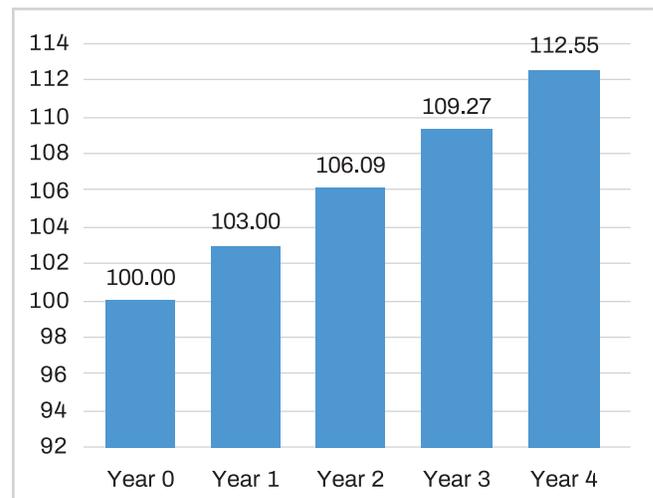
$$\begin{aligned}
 &\$ ? \text{ today} : \text{initial amount} \\
 &+ \$ ? \times 0.03 : \text{earned interest} \\
 &= \$100.00 : \text{a year from now}
 \end{aligned}$$

[same as  $\$ ? \times (1 + 0.03) = \$100$ ]

$$\rightarrow \$ ? = \frac{\$100}{(1.03)} = \$95.24$$

Now, consider the value (or future value) of \$100 four years later (Figure 3):

Present Value	Future Value	Future Value	Future Value	Future Value
Year 0 – now	Year 1	Year 2	Year 3	Year 4
\$100.00	$\times 1.03$ \$103.00	$\times 1.03$ \$106.09	$\times 1.03$ \$109.27	$\times 1.03$ \$112.55



**Figure 3.** The value of today's \$100 **compounded** over the next four years.

$$\text{Summarizing: } \$100.00 \times 1.03 \times 1.03 \times 1.03 \times 1.03 = \$112.55 \text{ (or } \$100.00 \times 1.03^4 = \$112.55)$$

Conversely, what is the present value (today) of \$100 four years from now (Figure 4)?

Present Value Year 0 – now	Future Value Year 1	Future Value Year 2	Future Value Year 3	Future Value Year 4
\$88.85	÷ 1.03	\$91.51	÷ 1.03	\$94.26
		÷ 1.03	÷ 1.03	÷ 1.03
				\$97.09
				÷ 1.03
				\$100.00

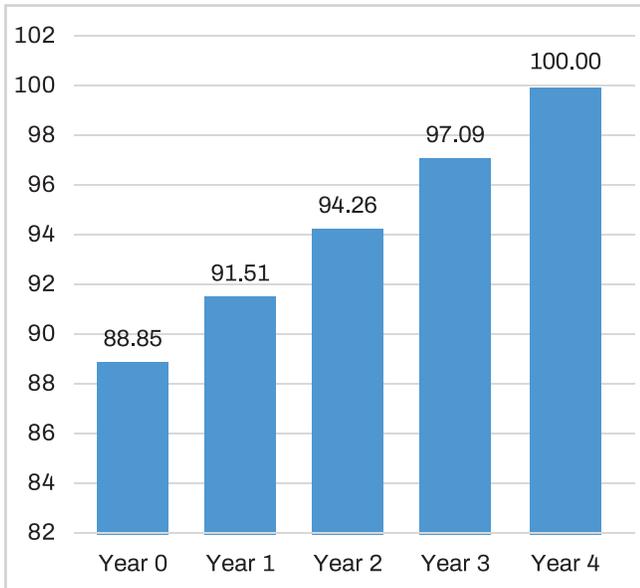


Figure 4. Present value of \$100 four years from now.

Summarizing:  $\$100.00 \div 1.03 \div 1.03 \div 1.03 \div 1.03 = \$88.85$  (or  $\$100.00 \div 1.03^4 = \$88.85$ )

Therefore:

$$\text{Present Value} = \frac{\text{Future Value at period } t}{(1 + r)^t} = \frac{C_t}{(1 + r)^t}$$

Where:

- r is the annual interest rate (in decimals expressed as  $x\% \div 100$ )
- t is the number of time periods ahead (expressed in years)

Let's combine all the concepts we've discussed by applying them in a few hypothetical situations.

## Example 1: Silo Investment Investment

- \$45,000 for a concrete bunker silo
- Assume 15 years of useful life
- No salvage value at the end of 15 years

Expected returns: \$3,050/year savings during the next 15 years due to less shrinkage.

**Do you accept or reject the investment?**

First Approach: Use a simple partial budget (Figure 5)

Figure 5. Partial budget example.

Added Income:		Added Costs:	
		Concrete Bunker Silo	= \$45,000
A. Total added income =		C. Total added costs =	\$45,000
Reduced Costs:		Reduced Income:	
Less shrinkage: \$3,050/year x 15 years	= \$45,750		
B. Total reduced costs =	\$45,750	D. Total reduced income =	
E. Positives = A + B	\$45,750	F. Negatives = C + D	\$45,000

**OVERALL RESULT: \$45,750 - \$45,000 = \$750**

**But the TVM is missing! The value of the yearly (savings) returns must be in present value!**

To obtain a "proper" interest rate, we may look at the rate obtained from *cash deposits* (CD).

The longer the time factor, the greater the risk to the monetary value, since time adds more uncertainty.

Assume the following CD offerings:

14 months: 0.55% annual percent yield (APY)

26 months: 0.80% APY

37 months: 1.26% APY

45 months: 1.66% APY

62 months: 1.92% APY ← (use farthest in time available)

The annual interest rate (r) for 15 years (180 months) should generally be higher than that of 62 months, since the farther ahead in time extends the risk. For comparison in this case, we use the r from 62 months. Calculations appear in Table 1.

**Table 1.** Present value of expected future returns from example 1.

Year	Expected Return	Present Value @ 1.92%	Formula
1	\$3,050	\$2,992	= \$3,050/(1+0.0192) <sup>1</sup>
2	\$3,050	\$2,936	= \$3,050/(1+0.0192) <sup>2</sup>
3	\$3,050	\$2,881	= \$3,050/(1+0.0192) <sup>3</sup>
4	\$3,050	\$2,827	= \$3,050/(1+0.0192) <sup>4</sup>
5	\$3,050	\$2,773	= \$3,050/(1+0.0192) <sup>5</sup>
6	\$3,050	\$2,721	= \$3,050/(1+0.0192) <sup>6</sup>
7	\$3,050	\$2,670	= \$3,050/(1+0.0192) <sup>7</sup>
8	\$3,050	\$2,620	= \$3,050/(1+0.0192) <sup>8</sup>
9	\$3,050	\$2,570	= \$3,050/(1+0.0192) <sup>9</sup>
10	\$3,050	\$2,522	= \$3,050/(1+0.0192) <sup>10</sup>
11	\$3,050	\$2,474	= \$3,050/(1+0.0192) <sup>11</sup>
12	\$3,050	\$2,427	= \$3,050/(1+0.0192) <sup>12</sup>
13	\$3,050	\$2,382	= \$3,050/(1+0.0192) <sup>13</sup>
14	\$3,050	\$2,337	= \$3,050/(1+0.0192) <sup>14</sup>
15	\$3,050	\$2,293	= \$3,050/(1+0.0192) <sup>15</sup>
<b>Total</b>	<b>\$45,750</b>	<b>\$39,425</b>	

The present value of the future returns is \$39,425.

The *net present value* (NPV) is just the difference between the future returns brought to present value and the value of the initial investment.

In the prior example, the NPV is \$39,425 - \$45,000 = -\$5,575, which results in the investment's rejection.

Formally:

$$NPV = \text{Sum of All } \frac{C_t}{(1+r)^t} - C_0$$

Where:

- $C_0$  is the initial investment
- $C_t$  is the net return or net cash flow at time  $t$
- $r$  is the annual interest rate (in decimals expressed as  $x\% \div 100$ )
- $t$  is the number of time periods ahead (expressed in years)

If  $NPV < 0$ , then **REJECT** the Investment.

If  $NPV > 0$ , then **ACCEPT** the Investment.

Since NPV in this case is -\$5,575, we *reject* the investment.

## Example 2: Barn Expansion

### Expansion Project

- New pack barn: \$165,000
  - Purchase 150 heifers @ \$1500 each: \$225,000
  - Parlor upgrade: \$180,000
- Total Investment: \$570,000

### Financing

- 10-year loan @ 3.8% interest

### Expected returns

Additional revenues:

- 150 cows × 24,000 lbs milk/year × \$17/cwt = \$612,000

Additional expenses:

- 85% of income as expenses (rough estimate)
- $0.85 \times 150 \text{ cows} \times 24,000 \text{ lbs milk/year} \times \$17/\text{cwt} = \$520,200$

→ Net Returns or Net Cash Flow: \$91,800/year

Step 1: Calculate the present values of the future returns (net cash flows) and obtain the *total present value* of these net returns (Table 2).

**Table 2.** Present value of expected future returns from example 2.

Year	Expected Return	Present Value @ 3.80%	Formula
1	\$91,800	\$88,439	= \$91,800/(1+0.038) <sup>1</sup>
2	\$91,800	\$85,202	= \$91,800/(1+0.038) <sup>2</sup>
3	\$91,800	\$82,023	= \$91,800/(1+0.038) <sup>3</sup>
4	\$91,800	\$79,078	= \$91,800/(1+0.038) <sup>4</sup>
5	\$91,800	\$76,183	= \$91,800/(1+0.038) <sup>5</sup>
6	\$91,800	\$73,394	= \$91,800/(1+0.038) <sup>6</sup>
7	\$91,800	\$70,707	= \$91,800/(1+0.038) <sup>7</sup>
8	\$91,800	\$68,118	= \$91,800/(1+0.038) <sup>8</sup>
9	\$91,800	\$65,625	= \$91,800/(1+0.038) <sup>9</sup>
10	\$91,800	\$63,222	= \$91,800/(1+0.038) <sup>10</sup>
<b>Total</b>		<b>\$752,049</b>	

Step 2: Calculate the NPV and decide whether or not to make the investment:

$$\begin{aligned}
 NPV &= \text{Sum of All } \frac{C_t}{(1+r)^t} - C_0 \\
 &= \$752,049 - \$579,000 \\
 &= \$173,049
 \end{aligned}$$

Since  $NPV > 0$ , *accept* the investment (it is profitable)

The *salvage value* of an investment is *not always* zero. There may be a *residual value*, which means there is an *expected estimated value (greater than zero)* of the investment *at the end of its useful life*.

Assume the following salvage values:

- Barn has a 10% salvage value: \$16,500
- Parlor has a 24% salvage value: \$43,200
- Total salvage value: \$59,700

The potential salvage value must *always* be considered. The *expected return* has to incorporate (add) the salvage value *at the last year considered* (in this case, ten years), as shown in Table 3.

When the salvage value is considered, the NPV is larger:

$$\begin{aligned} \text{NPV} &= \text{Sum of All } \frac{C_t}{(1+r)^t} - C_0 \\ &= \$793,164 - \$579,000 \\ &= \$214,164 \end{aligned}$$

What would happen if the loan's interest rate is 10.3106% instead of the 3.8% (Table 4)?

The NPV becomes zero when the interest rate is 10.3106%, since  $\text{NPV} = \$579,000 - \$579,000 = 0$ . At a certain interest rate, the investment starts to become unprofitable. In example 2, it is not profitable to borrow money at interest rates larger than 10.3106% since the NPV will become less than zero. The *internal rate of return (IRR)* is a discount rate  $r$  that results in the present value of expected returns (cash flows) to be equal to the initial investment.

(Here,  $r$  is also referred to as “cost of capital” or “cost of borrowing money.”)

$$\text{Present values of Expected Returns} = \text{Investment}$$

$$\text{Sum of All } \frac{C_t}{(1+r)^t} = C_0$$

The IRR is the value of  $r$  that makes the prior equation possible. The IRR is the value of  $r$  that makes the NPV equal to zero.

$$\text{NVP} = \text{Sum of All } \frac{C_t}{(1+r)^t} - C_0 = 0$$

In the previous example, the IRR = 10.3106%. IRR is usually a comparison to the interest rate. Some examples of this include the following:

- When borrowing money from a lender at an interest rate  $r$ :
  - » If  $\text{IRR} > r$ , then it is profitable to borrow the money since the investment provides a better “internal” rate of return (IRR) than the discount rate applied to it.
  - » If  $\text{IRR} < r$ , then it is *not* profitable to borrow the money.
- Another view is to consider the opportunity cost at rate  $r$ :
  - » If  $\text{IRR} > r$ , then it is profitable to invest the money in the project since the “alternative project” provides a lower rate of return.
  - » If  $\text{IRR} < r$ , then it is *not* profitable to invest the money in the project since the “alternative project” provides a greater rate of return.

**Table 3.** Present value of expected future returns from example 2 considering the salvage value.

Year	Expected Return	Present Value @ 3.80%	Formula
1	\$91,800	\$88,439	$= \$91,800/(1+0.038)^1$
2	\$91,800	\$85,202	$= \$91,800/(1+0.038)^2$
3	\$91,800	\$82,023	$= \$91,800/(1+0.038)^3$
4	\$91,800	\$79,078	$= \$91,800/(1+0.038)^4$
5	\$91,800	\$76,183	$= \$91,800/(1+0.038)^5$
6	\$91,800	\$73,394	$= \$91,800/(1+0.038)^6$
7	\$91,800	\$70,707	$= \$91,800/(1+0.038)^7$
8	\$91,800	\$68,118	$= \$91,800/(1+0.038)^8$
9	\$91,800	\$65,625	$= \$91,800/(1+0.038)^9$
10	\$151,500	\$104,337	$= \$151,500/(1+0.038)^{10}$
<b>Total</b>		<b>\$793,164</b>	

**Table 4.** Present value of expected returns from example 2 considering a new interest rate.

Year	Expected Return	Present Value @ 10.3106%	Formula
1	\$91,800	\$83,220	$= \$91,800/(1+0.103106)^1$
2	\$91,800	\$75,441	$= \$91,800/(1+0.103106)^2$
3	\$91,800	\$68,390	$= \$91,800/(1+0.103106)^3$
4	\$91,800	\$61,997	$= \$91,800/(1+0.103106)^4$
5	\$91,800	\$56,203	$= \$91,800/(1+0.103106)^5$
6	\$91,800	\$50,949	$= \$91,800/(1+0.103106)^6$
7	\$91,800	\$46,187	$= \$91,800/(1+0.103106)^7$
8	\$91,800	\$41,870	$= \$91,800/(1+0.103106)^8$
9	\$91,800	\$37,957	$= \$91,800/(1+0.103106)^9$
10	\$151,500	\$56,786	$= \$151,500/(1+0.103106)^{10}$
<b>Total</b>		<b>\$579,000</b>	

In order to invest in a profitable project, the IRR of your investment has to be greater than or equal to your average cost of capital. For example:

- If your investment uses funds from your equity, your average cost of capital may be an expected rate of 7% *return over equity*.
- If your investment uses funds from debt (loan), your average cost of capital may be a 5% *annual percentage rate*.
- If your investment uses 60% of funds from your equity and 40% of funds from debt (loan), then your average cost of capital would be  $7\% \times 0.60 + 5\% \times 0.40 = 6.2\%$

## In Summary

Net Present Value (NPV):

- Informs whether the worth today (present value) of the future returns of a project are larger than the initial investment.
- If  $NPV > 0$ , then accept the project.

Internal Rate of Return (IRR):

- Informs the rate at which the project's NPV equals (=) zero.
- If  $IRR > \text{interest (discount) rate}$ , then accept the project.

The spreadsheet (Figure 6) calculates these in a straightforward manner.

This bulletin covers partial budgets and capital investments to address matters of risk management. The next bulletin covers hedging with futures contracts, which provides information about how to protect against price changes.

## Further Reading

Bergsten, C., P.R. Greenough, J.M. Gay, W.M. Seymour, and C.C. Gay. 2003. "Effects of Biotin Supplementation on Performance and Claw Lesions on a Commercial Dairy Farm." *Journal of Dairy Science* 86(12): 3953–62.

Cha, E., J.A. Hertl, D. Bar, and Y.T. Grohn. 2010. "The Cost of Different Types of Lameness in Dairy Cows Calculated by Dynamic Programming." *Preventive Veterinary Medicine* 97(1): 1–8.

Kay, R.D., W.M. Edwards, and P.A. Duffy. 2008. *Farm Management*. 6th ed. New York: McGraw-Hill.

**Figure 6.** Spreadsheet for calculating the NPV and IRR for capital investment over a 30-year period.

Inputs		
Annual Interest Rate, %		
Capital Investment, \$		
Period, years (for example 1–30)		
Salvage Value, %		
Period	Future Net Return	Present Value
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
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24		
25		
26		
27		
28		
29		
30		
Net Present Value (=NPV)		\$0
Internal Rate of Return (=IRR)		

