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When to Exit Dairy Farming: The Value of Waiting

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Recent low milk prices may cause some dairy farmers to think that now may be the time to exit the industry. Many are not covering variable costs of production, to say nothing about also not meeting their overhead cost of production. But should a farmer exit? That decision depends upon more than the current milk price and the cost of production. Farmers often stay in business and operate at a loss with the expectation that the future will get better. Indeed, if milk prices do increase a farmer may cover costs and make a profit in the future. There is an economic value to wait it out and that value depends upon future conditions in the dairy industry. Thus, expectations of future milk prices are important when deciding whether to exit the industry now.

Thus, a farmer often continues in business during extended periods of low prices under the belief that prices will improve. However, at some milk price level, losses are so great that exit is rational. Knowing an estimate of the low milk price where an exit should be considered can help farmers who are contemplating an exit from the industry. A simple rule is that exit should be contemplated when the price of milk falls below the farmer's total cost of production, and should be seriously considered if the price of milk falls below the variable cost of production. But both of these rules ignore the value of waiting to see if future conditions improve. Including the value to wait will lower the milk price at which a farmer should exit the industry. That exit price is not only lower than the total cost of production but is also lower than the operating cost of production.

In this article we calculate the milk prices at which a farmer should leave the industry given the operating cost of production, the potential sales price of the business invested in an alternative investment, as well as measures of future milk price movements. These estimates were arrived at by using investment analysis coupled with option theory. This concept is summarized in the Appendix. The option value we estimate is simply the option value of waiting to exit. There are other management options that we do not incorporate into the analysis which may be relevant for some farmers. These are strategies such as downsizing or mothballing the operation

temporarily, among many other tactics, which may further lower (or increase) the milk price to exit.

To use the enclosed tables that show milk exit prices you must have an estimate of your operating cost per hundredweight of milk and the liquidation value of your farm assets. Remember that asset values, such as cow prices, may have declined in periods of low prices. Table 1 below contains the average operating costs of production per cwt. from 2006 and 2007 for New York dairy farms. The 2007 New York Dairy Farm Business Summary (DFBS) includes data on average operating cost of production and potential business sales price. Operating expenses include labor, feed, machinery, supplies, taxes, insurance, utilities, interest paid on inventories, but exclude non-milk cash receipts, increases in grown feed & supplies, and increases in livestock. For the purpose of this application operating cost does not include interest on machinery, livestock, or real estate; interest instead is imputed to the liquidation value entered. You can use Table 1 as a template to itemize your own operating costs, which will be different from the costs shown.

Liquidation value, or the business sales price, would include land and buildings, machinery and equipment, cows, feed, and other stock and certificates, less sales commission and auction fees, or simply items that would be sold at farm auction, or in the case of cooperative stock, redeemed. Table 2 below contains the average beginning of year and average end of year values per cow of the items on the balance sheet included in determining liquidation value per cwt. for New York dairies in 2007. Again you will need to determine an estimate for your own farm.

Tables 4 through 8 show milk exit prices for varying costs of production per hundredweight (C), and varying net liquidation (sales) values per hundredweight (l). If the market price of milk drops below these values then a farmer should consider a sale of the business. Each table represents a different scenario given an annual average expected growth rate in milk price (μ), annual expected variance in logarithmic milk price (σ^2), and the interest rate (ρ). Monthly milk price data from 1993-2007 were used to measure the variance of milk price, which provides information of the future movement of milk price.

From 1993-2007 the annual average growth rate in milk price (μ) was 0.0392 (3.92% increase each year on average), and the annual variance in log milk price (σ^2) was 0.0292, so those estimates are used in some of the tables. However, as a stock prospective always states, “The past is not a guarantee of the future”. Thus, tables with different estimates of annual change in milk price and milk price variability are shown, including one with a decrease in the milk price. For each scenario it is assumed the interest rate (ρ) is 8%; considered the rate that could be earned on an investment as risky as dairy farming.

It is not intuitive what an annual variance in log price of 0.0292 means in actual annual milk price changes, so Table 3 shows various possible annual milk price changes with associated probabilities that the milk price would increase or decrease by those amounts or by less than those amounts. These are annual price jumps separate from any baseline annual constant change in the price of milk, which may be zero. You can see that the probability that the milk price would go up or down \$0.27 or less in a year is 0.45. The probability the milk price would go up or down by \$1.45 or less, in contrast, is 0.25. There is only a 5 percent chance the milk price could go up or down \$3.87. These estimates are based on the last 25 years of data. Also shown are price changes for an annual variance in log prices of 0.058.

To find an exit milk price, find the scenario that best fits your expectations in milk price growth, and variability around that growth as measured by the variance, and your farms’ current costs of production and liquidation value per hundredweight of milk. For example, if your operating cost of production is \$15.00 per cwt. and you could sell the operation and clear \$30.00 per cwt., then from Table 4 it is shown that you should sell if the market price of milk falls below \$11.39. This exit price is lower than simply using the variable cost of production. Using the variable cost of production you should exit if the milk price falls below \$15.00. Using total cost of production computed as the variable cost plus 8 percent of the net investment cost you could earn elsewhere at a similar risk by selling the farm, produces an exit price of \$15.00 plus \$2.40, or \$17.40. It is clear that there is value to waiting for a better milk price.

Table 4 assumes no trend increase in milk prices, although with a log milk price variance of 0.029, milk prices will fluctuate in the future. If you expect milk prices to

increase 2 percent a year but still fluctuate at a log variance of 0.029 around that trend, then from Table 5, given operating costs of \$15.00 per cwt. and net investment of \$30.00 per cwt., you sell if the milk price falls below \$9.36, a very unlikely occurrence given the Federal milk support price.

As can be seen in Tables 4-9, the greater the cost of production per hundredweight, the higher the milk price where exit should occur. Also, the higher the net liquidation value per hundredweight of milk sold, the higher the exit price, since selling permits the farmer to receive the high liquidation values. Finally, the greater the expected annual increase in the milk price or variability in milk price, the lower the exit price since the future should be better. It is important to understand that the estimates in our tables are based upon various scenarios of milk price changes in the future which cannot be predicted with certainty. What the results clearly show is that there is value to waiting, but that value depends upon expectations of what will happen in the future. Unless you have a very high cost of production, or can sell your assets at a very high price, or expect little or no increase in the price of milk, you probably would not exit the industry based solely on the current price of milk.

It is important to realize that these exit milk prices strictly depend upon current and expected future profits, the current sales price, the interest rate, and any change in those values will change the milk exit price. We provide these numbers only as information and not as a forecast of the future or whether a farmer should exit. The exit decision can also depend upon considerations other than profits.

**Table 1: AVERAGE COST OF PRODUCING MILK PER CWT.,
New York Dairy Farms 2005 to 2007.**

Item	2006	2007	Your Estimate
<u>Operating Expenses</u>			
Hired Labor	\$2.58	\$2.70	_____
Purchased Feed	4.30	5.21	_____
Machinery repair, vehicle expense & rent	1.04	1.27	_____
Fuel, oil & grease	.58	.67	_____
Replacement livestock	.07	.07	_____
Breeding fees	.23	.24	_____
Veterinary & medicine	.65	.65	_____
Milk marketing	.80	.80	_____
Other dairy expenses	1.29	1.41	_____
Fertilizer & lime	.31	.40	_____
Seeds & plants	.23	.28	_____
Spray & other crop expense	.19	.25	_____
Land, building & fence repair	.22	.32	_____
Taxes	.21	.23	_____
Insurance	.17	.19	_____
Utilities (farm share)	.41	.44	_____
Interest paid on inventory ¹	.05	.05	_____
Misc. (including rent)	.45	.49	_____
Total Operating Expenses	\$13.78	\$15.68	_____
Less: Non-milk cash receipts	1.94	1.75	_____
Increase in grown feed & supplies	.22	.39	_____
Increase in livestock	.27	.30	_____
OPERATING COST OF MILK PRODUCTION	\$11.35	\$13.24	_____

¹ Calculated by using the percentage of total liabilities operating debt, lease on cattle and machinery, and farm credit stock represented multiplied by total interest paid.
Source: 2007 NY DFBS.

**Table 2: AVERAGE LIQUIDATION VALUE, New York Dairy Farms
2007 (\$/cow unless otherwise stated)**

Item	Jan. 1	Dec. 31	Your Estimate
Land and Buildings	\$3,214	\$3,502	_____
Machinery and Equipment	\$1,350	\$1,531	_____
Dairy Cows	\$1,319	\$1,500	_____
Heifers	\$760	\$878	_____
Bulls and Other Livestock	\$11	\$12	_____
Feed and Supplies	\$689	\$968	_____
Other Stock and Certificates	\$157	\$184	_____
Total Investment per cow	\$7,500	\$8,575	_____
Minus: Lost Capital and Sales	\$1,875	\$2,144	_____
Commission (approx. 20% of Total)			_____
Liquidation Value per cow	\$5,625	\$6,431	_____
Average Liquidation Value per cwt.	\$25.00	\$28.00	_____

Source: 2007 NY DFBS.

**Table 3: Possible Increases (Or Decreases) in the Price of Milk in a Year
with a Log Variance of 0.029 and 0.058¹**

Milk price change with log variance of 0.029	Milk price change with log variance of 0.058	Probability milk price would change at least this amount if not more in a year
0.27	0.38	0.45
0.52	0.74	0.40
0.80	1.15	0.35
1.11	1.60	0.30
1.45	2.10	0.25
1.87	2.73	0.20
2.33	3.42	0.15
2.92	4.33	0.10
3.87	5.81	0.05

¹ Beginning milk price of \$12.00 per cwt. and no trend increase in prices. Note that the milk price could also decrease from \$12.00 per cwt..

Table 4: Unchanged Milk Price Trend, ($\mu=0$, $\sigma^2=.029$, $\rho=.08$)

		Liquidation Value per cwt. (I)					
		\$10	\$15	\$20	\$25	\$30	\$35
Cost of Production per cwt. (C)	\$10	\$7.07	\$7.33	\$7.59	\$7.86	\$8.12	\$8.38
	\$11	\$7.72	\$7.99	\$8.25	\$8.51	\$8.77	\$9.03
	\$12	\$8.38	\$8.64	\$8.90	\$9.16	\$9.43	\$9.69
	\$13	\$9.03	\$9.30	\$9.56	\$9.82	\$10.08	\$10.34
	\$14	\$9.69	\$9.95	\$10.21	\$10.47	\$10.74	\$11.00
	\$15	\$10.34	\$10.61	\$10.87	\$11.13	\$11.39	\$11.65
	\$16	\$11.00	\$11.26	\$11.52	\$11.78	\$12.05	\$12.31
	\$17	\$11.65	\$11.91	\$12.18	\$12.44	\$12.70	\$12.96
	\$18	\$12.31	\$12.57	\$12.83	\$13.09	\$13.35	\$13.62
	\$19	\$12.96	\$13.22	\$13.49	\$13.75	\$14.01	\$14.27
	\$20	\$13.62	\$13.88	\$14.14	\$14.40	\$14.66	\$14.93
	\$21	\$14.27	\$14.53	\$14.79	\$15.06	\$15.32	\$15.58
	\$22	\$14.93	\$15.19	\$15.45	\$15.71	\$15.97	\$16.23
	\$23	\$15.58	\$15.84	\$16.10	\$16.37	\$16.63	\$16.89
	\$24	\$16.23	\$16.50	\$16.76	\$17.02	\$17.28	\$17.54
	\$25	\$16.89	\$17.15	\$17.41	\$17.68	\$17.94	\$18.20

Table 5: A 2% Growth Milk Price, ($\mu=0.02$, $\sigma^2=.029$, $\rho=.08$)

		Liquidation Value per cwt. (I)					
		\$10	\$15	\$20	\$25	\$30	\$35
Cost of Production per cwt. (C)	\$10	\$5.81	\$6.02	\$6.24	\$6.45	\$6.67	\$6.89
	\$11	\$6.35	\$6.56	\$6.78	\$6.99	\$7.21	\$7.42
	\$12	\$6.89	\$7.10	\$7.32	\$7.53	\$7.75	\$7.96
	\$13	\$7.42	\$7.64	\$7.85	\$8.07	\$8.28	\$8.50
	\$14	\$7.96	\$8.18	\$8.39	\$8.61	\$8.82	\$9.04
	\$15	\$8.50	\$8.71	\$8.93	\$9.14	\$9.36	\$9.57
	\$16	\$9.04	\$9.25	\$9.47	\$9.68	\$9.90	\$10.11
	\$17	\$9.57	\$9.79	\$10.01	\$10.22	\$10.44	\$10.65
	\$18	\$10.11	\$10.33	\$10.54	\$10.76	\$10.97	\$11.19
	\$19	\$10.65	\$10.87	\$11.08	\$11.30	\$11.51	\$11.73
	\$20	\$11.19	\$11.40	\$11.62	\$11.83	\$12.05	\$12.26
	\$21	\$11.73	\$11.94	\$12.16	\$12.37	\$12.59	\$12.80
	\$22	\$12.26	\$12.48	\$12.69	\$12.91	\$13.12	\$13.34
	\$23	\$12.80	\$13.02	\$13.23	\$13.45	\$13.66	\$13.88
	\$24	\$13.34	\$13.56	\$13.77	\$13.99	\$14.20	\$14.42
	\$25	\$13.88	\$14.09	\$14.31	\$14.52	\$14.74	\$14.95

Table 6: A 2% Annual Decrease in Milk Price, ($\mu=-0.02$, $\sigma^2=.029$, $\rho=.08$)

		Liquidation Value per cwt. (I)					
		C	\$10	\$15	\$20	\$25	\$30
Cost of Production per cwt. (C)	\$10	\$7.97	\$8.26	\$8.56	\$8.85	\$9.15	\$9.44
	\$11	\$8.70	\$9.00	\$9.29	\$9.59	\$9.88	\$10.18
	\$12	\$9.44	\$9.74	\$10.03	\$10.33	\$10.62	\$10.92
	\$13	\$10.18	\$10.47	\$10.77	\$11.06	\$11.36	\$11.66
	\$14	\$10.92	\$11.21	\$11.51	\$11.80	\$12.10	\$12.39
	\$15	\$11.66	\$11.95	\$12.25	\$12.54	\$12.84	\$13.13
	\$16	\$12.39	\$12.69	\$12.98	\$13.28	\$13.57	\$13.87
	\$17	\$13.13	\$13.43	\$13.72	\$14.02	\$14.31	\$14.61
	\$18	\$13.87	\$14.16	\$14.46	\$14.75	\$15.05	\$15.34
	\$19	\$14.61	\$14.90	\$15.20	\$15.49	\$15.79	\$16.08
	\$20	\$15.34	\$15.64	\$15.93	\$16.23	\$16.52	\$16.82
	\$21	\$16.08	\$16.38	\$16.67	\$16.97	\$17.26	\$17.56
	\$22	\$16.82	\$17.11	\$17.41	\$17.70	\$18.00	\$18.29
	\$23	\$17.56	\$17.85	\$18.15	\$18.44	\$18.74	\$19.03
	\$24	\$18.29	\$18.59	\$18.88	\$19.18	\$19.47	\$19.77
	\$25	\$19.03	\$19.33	\$19.62	\$19.92	\$20.21	\$20.51

Table 7: Unchanged Milk Price Trend, with Empirical σ^2 Cut in Half ($\mu=0$, $\sigma^2=.015$, $\rho=.08$)

		Liquidation Value per cwt. (I)					
		C	\$10	\$15	\$20	\$25	\$30
Cost of Production per cwt. (C)	\$10	\$8.00	\$8.29	\$8.59	\$8.88	\$9.18	\$9.48
	\$11	\$8.74	\$9.03	\$9.33	\$9.62	\$9.92	\$10.22
	\$12	\$9.48	\$9.77	\$10.07	\$10.36	\$10.66	\$10.96
	\$13	\$10.22	\$10.51	\$10.81	\$11.10	\$11.40	\$11.70
	\$14	\$10.96	\$11.25	\$11.55	\$11.84	\$12.14	\$12.44
	\$15	\$11.70	\$11.99	\$12.29	\$12.59	\$12.88	\$13.18
	\$16	\$12.44	\$12.73	\$13.03	\$13.33	\$13.62	\$13.92
	\$17	\$13.18	\$13.47	\$13.77	\$14.07	\$14.36	\$14.66
	\$18	\$13.92	\$14.21	\$14.51	\$14.81	\$15.10	\$15.40
	\$19	\$14.66	\$14.95	\$15.25	\$15.55	\$15.84	\$16.14
	\$20	\$15.40	\$15.69	\$15.99	\$16.29	\$16.58	\$16.88
	\$21	\$16.14	\$16.43	\$16.73	\$17.03	\$17.32	\$17.62
	\$22	\$16.88	\$17.18	\$17.47	\$17.77	\$18.06	\$18.36
	\$23	\$17.62	\$17.92	\$18.21	\$18.51	\$18.80	\$19.10
	\$24	\$18.36	\$18.66	\$18.95	\$19.25	\$19.54	\$19.84
	\$25	\$19.10	\$19.40	\$19.69	\$19.99	\$20.28	\$20.58

Table 8: Unchanged Milk Price Trend, with Empirical σ^2 Doubled ($\mu=0$, $\sigma^2=.058$, $\rho=.08$)

		Liquidation Value per cwt. (I)					
		\$10	\$15	\$20	\$25	\$30	\$35
Cost of Production per cwt. (C)	\$10	\$5.96	\$6.18	\$6.40	\$6.62	\$6.84	\$7.06
	\$11	\$6.51	\$6.73	\$6.95	\$7.17	\$7.39	\$7.61
	\$12	\$7.06	\$7.28	\$7.50	\$7.72	\$7.94	\$8.16
	\$13	\$7.61	\$7.83	\$8.05	\$8.27	\$8.50	\$8.72
	\$14	\$8.16	\$8.39	\$8.61	\$8.83	\$9.05	\$9.27
	\$15	\$8.72	\$8.94	\$9.16	\$9.38	\$9.60	\$9.82
	\$16	\$9.27	\$9.49	\$9.71	\$9.93	\$10.15	\$10.37
	\$17	\$9.82	\$10.04	\$10.26	\$10.48	\$10.70	\$10.92
	\$18	\$10.37	\$10.59	\$10.81	\$11.03	\$11.25	\$11.47
	\$19	\$10.92	\$11.14	\$11.36	\$11.58	\$11.81	\$12.03
	\$20	\$11.47	\$11.69	\$11.92	\$12.14	\$12.36	\$12.58
	\$21	\$12.03	\$12.25	\$12.47	\$12.69	\$12.91	\$13.13
	\$22	\$12.58	\$12.80	\$13.02	\$13.24	\$13.46	\$13.68
	\$23	\$13.13	\$13.35	\$13.57	\$13.79	\$14.01	\$14.23
	\$24	\$13.68	\$13.90	\$14.12	\$14.34	\$14.56	\$14.78
	\$25	\$14.23	\$14.45	\$14.67	\$14.89	\$15.12	\$15.34

Table 9: A 4% Growth in Milk Price, ($\mu=0.04$, $\sigma^2=.029$, $\rho=.08$)

		Liquidation Value per cwt. (I)					
		\$10	\$15	\$20	\$25	\$30	\$35
Cost of Production per cwt. (C)	\$10	\$4.16	\$4.32	\$4.47	\$4.63	\$4.78	\$4.94
	\$11	\$4.55	\$4.70	\$4.86	\$5.01	\$5.17	\$5.32
	\$12	\$4.94	\$5.09	\$5.24	\$5.40	\$5.55	\$5.71
	\$13	\$5.32	\$5.48	\$5.63	\$5.78	\$5.94	\$6.09
	\$14	\$5.71	\$5.86	\$6.02	\$6.17	\$6.32	\$6.48
	\$15	\$6.09	\$6.25	\$6.40	\$6.56	\$6.71	\$6.86
	\$16	\$6.48	\$6.63	\$6.79	\$6.94	\$7.10	\$7.25
	\$17	\$6.86	\$7.02	\$7.17	\$7.33	\$7.48	\$7.64
	\$18	\$7.25	\$7.40	\$7.56	\$7.71	\$7.87	\$8.02
	\$19	\$7.64	\$7.79	\$7.94	\$8.10	\$8.25	\$8.41
	\$20	\$8.02	\$8.18	\$8.33	\$8.48	\$8.64	\$8.79
	\$21	\$8.41	\$8.56	\$8.72	\$8.87	\$9.02	\$9.18
	\$22	\$8.79	\$8.95	\$9.10	\$9.26	\$9.41	\$9.56
	\$23	\$9.18	\$9.33	\$9.49	\$9.64	\$9.80	\$9.95
	\$24	\$9.56	\$9.72	\$9.87	\$10.03	\$10.18	\$10.33
	\$25	\$9.95	\$10.10	\$10.26	\$10.41	\$10.57	\$10.72

Appendix

The exit price is determined by a formula that depends upon the cost of production per hundredweight (C), net liquidation value per hundredweight (l), average annual growth rate in the milk price (μ), annual variance in log milk price (σ^2), and the interest rate (ρ). This exit decision is modeled as a put option to exit using real option concepts. The exit decision, or put option should be exercised when the option has sufficient value to offset losses when milk production costs are below the price of milk.

As shown in Dixit (1989) and used by Tauer (2006),

$$(1) \quad \text{exit price} = \{C + \rho l\} \left\{ \frac{\rho - \mu}{\rho} \right\} \left\{ \frac{-\alpha(\mu, \sigma^2, \rho)}{(-\alpha(\mu, \sigma^2, \rho) + 1)} \right\}$$

where

$$(2) \quad \alpha(\mu, \sigma^2, \rho) = \frac{\sigma^2 - 2\mu - \sqrt{(\sigma^2 - 2\mu)^2 + 8\rho\sigma^2}}{2\sigma^2} < 0, \rho > \mu,$$

where the variables μ and σ^2 are the average annual growth rate of milk price, and annual variance of growth rate of milk price. The term $\{C + \rho l\}$ is the exit price using the total cost of production ignoring the value of the option to wait. The additional terms in equation (1) compute the value of the option to wait. Equation (1) can be easily calculated for any value of ρ , μ , σ^2 , C , or l .

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2009-21	Dairy Farm Business Summary, New York Dairy Farm Renters, 2008	(\$16.00)	Knoblauch, W. and L. Putnam
2009-20	New York Economic Handbook 2010	(\$10.00)	Extension Staff
2009-19	Fruit Farm Business Summary, Lake Ontario Region New York, 2008		White, G., DeMaree, A. and J. Neyhard
2009-18	2009 Federal Reference Manual for Regional Schools, Income Tax Management and Reporting for Small Businesses and Farms	(\$25.00)	Bouchard, G. and J. Bennett
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2009-12	Dairy Farm Business Summary, Southeastern New York Region, 2008	(\$12.00)	Knoblauch, W., Putnam, L., Kiraly, M., Walsh, J., Hulle, L. and C. Wickswat
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