A Stochastic Decision Support System for Dairy Expansion

Abstract T236: ADSA - CSAS - ASAS

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INTRODUCTION

Dairy expansion presents many complex problems to which the answers are not easily found. Inclusion of a Dairy Expansion Decision Support System (DE-DSS) is essential to minimize risk exposure throughout an expansion phase. The DE-DSS is a Markov chain simulation model designed to forecast herd structure and production at a future point in time. When coupled with economic figures, the DE-DSS becomes a robust risk-management tool configured specifically for on-farm applications. Forecasts provide vital information needed to properly design facilities/housing, monitor cash flows, and successfully conduct "what-if" analyses under a wide variety of herd management and economic conditions.

OBJECTIVES

- Develop a user-friendly stochastic decision support system tool for risk management in dairy production and expansion.
- Address dairy producer information needs during periods of growth.

MATERIALS AND METHODS

- Four herd growth strategies were evaluated in which the total number of cows grew from 150 to ~300 over a period of 31 months to simulate an expansion phase.
- Outputs for key herd parameters were tracked for a total 54 months (2008 to 2012) to evaluate long-term scenario performance.
- Outputs were generated using a Markov chain simulation model created in Microsoft Excel®.
- Economic considerations were generated from 2003-2008 mean market price levels for culling, milk production, feed intake, and labor requirements. Additional analysis was conducted using +/- 10% of mean price levels to simulate price fluctuation.
- Comparison of income over variable cost (IOVC)between scenarios was conducted using Present Value equation with 5% discount rate

Table 1. Economic assumptions used in support of DE-DSS evaluation.

Segment	Description	Mean Price[1]
Culling		
Cow Cull Rate	38.3%	$708.17[a]
Young Stock Cull Rate	12.0%	-
Milk		
Production Level	76.02 lbs/cow/day	$16.14/cwt
Feed		
Avg. Dry Matter Intake	54.3 lbs/cow/day	$5.13/cow/day[b]
Replacements		
Bred Heifers	9 mo Pregnant at Arrival	$1975.50/heifer
Labor		
Full-Time Equivalent	2,860 hrs	$12/hr

[1]Mean Price = Mean price level from 2003 – 2008
[a]Mean cull cow price based on live animal weight of 1250 lbs
[b]Diet cost based on 50/50 Corn Silage/Haylage diet

Table 2. Movement of animals through the herd structure forecast model. For example, the cell labeled "8,4" denotes all cows that are 8 months in milk and 4 months pregnant.

Stage	Lactation State	Reproductive State	Months in Milk											
			1	2	3	4	5	6	7	8	9	10	11	12	13
1	Milking	Open	1,0												
2	Milking	Open		2,0											
3	Milking	Open			3,0										
4	Milking	Open				4,0									
5	Milking	Pregnant					5,1								
6	Milking	Pregnant						6,2							
7	Milking	Pregnant							7,3						
8	Milking	Pregnant								8,4					
9	Milking	Pregnant									9,5				
10	Milking	Pregnant										10,6			
11	Milking	Pregnant											11,7		
12	Dry	Pregnant												12,8	
13	Dry	Pregnant													13,9

Table 3. Replacement heifer purchasing schedule and total number of replacements purchased for each scenario evaluated with the DE-DSS.

Scenario	Purchasing Months	Total Replacements Purchased
1	3,8,13,18,23,27	108
2	1,2,29,30	87
3	1,2	98
4	29,30	77

Key Equations

I. **Open =** $C_{i+1,p} = C_{i,p}(1 - \text{Cull Rate})$
for i = 1 to 3, where C = cow group, i = MIM, p = pregnant = 0

Pregnant = $C_{i+1,p+1} = C_{i,p}(1 - \text{Cull Rate})$
for i = 4 to 10 and p = 1 to 6

Dry = $C_{i+1,p+1} = C_{i,p}(1 - \text{Cull Rate})$
for i = 11 to 12 and p = 7 to 8

II. **Milk Income =** $\left[\sum_{i=1}^{11} C_i\right]$ [Milk Production] [Milk Price]

Dry Cost = $\left[\sum_{i=12}^{13} C_i\right]$ [Dry Feed Cost]

III. **Total Income =** $\sum_{j=1}^{12}$ [Milk Income + Voluntary Cull Income]$_j$

Total Cost = $\sum_{j=1}^{12}$ [Dry Cost + Feed Cost + Labor Cost]$_j$

Net Present Value = $\sum_{t=1}^{N} \frac{[\text{Total Income} - \text{Total Cost}]_t}{(1+r)^t}$

Where j = month, r = discount rate, t = number of periods

RESULTS

Figure 1. Snapshot of herd structure for each scenario at end of month 54.

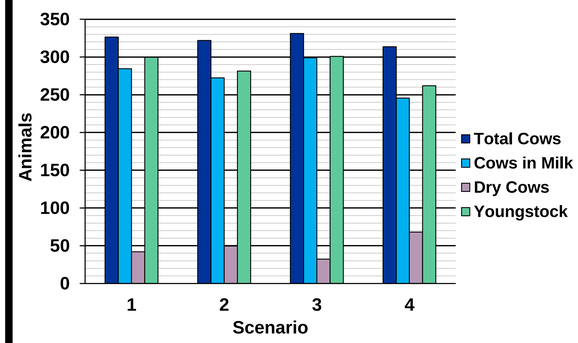


Figure 2. Income over Variable Expenses for each scenario.

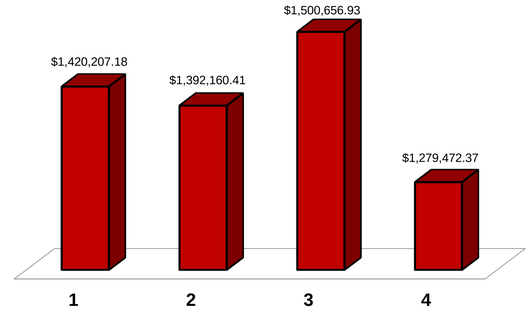
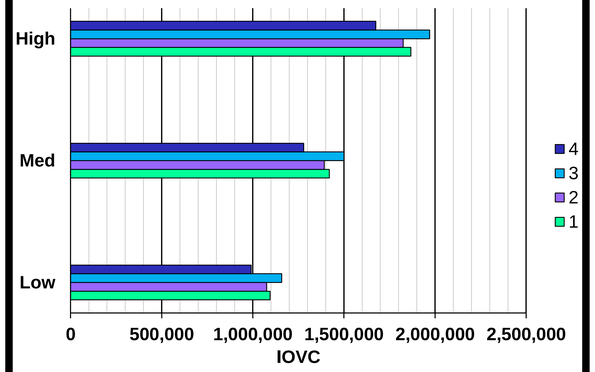


Figure 3. Comparison of Income over Variable Expenses at High, Low, and Medium price levels.



CONCLUSIONS

- Of the scenarios evaluated, the optimal heifer purchasing strategy appears to include purchase of all heifers at the beginning of the expansion phase.
- Regardless of price levels, Scenario #3 provided the highest Income over Variable Expenses.
- The DE-DSS can be readily applied to dairy production settings and empower producers with greater information to aid in complex decision making.