Cow Flow: Impact of Management Changes on Group and Herd Size

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Take Home Messages

- Substantial fluctuations can occur in milking herd size due to the seasonality of breeding success and other management factors.
- Anticipating fluctuations in milking herd size is a key step to both projecting cash flow streams and managing quota.
- Accurately budgeting cash flow streams is important when determining the financial feasibility of an expansion.
- Purchasing large numbers of springing heifers or milking cows without associated youngstock means that additional cattle will need to be purchased to maintain herd size for at least two years. Accurately budgeting the timing and magnitude of these purchases is important to the financial feasibility of an expansion.

Introduction

In the United States, the number of dairy cows has remained constant and milk production has actually risen in the face of declining numbers of dairy farms. In western Canada, total milk production has remained fixed despite a loss of dairy farms. In both countries, this growth or stability is achieved as existing herds add facilities and cattle and new herds enter the industry.

When budgeting the cash flows of these new operations, accurate estimation of the timing and amount of revenues generated is critical to both the short- and long-term success of the dairy. Large fluctuations in the number of milking cows on a dairy, due to the seasonality of breeding success, reproductive efficiency and culling practices can happen without changes in overall herd size. These variations in cow flow impact revenue generation and the ability of producers to meet payment obligations. Accurately estimating milking cow numbers can be the most difficult part of budgeting future revenue streams.

Variations in cow flow cause the same problems in herds that are not undergoing expansion. Revenue can drop dramatically when milking herd size shrinks, necessitating a purchase of cows to maintain cash flow. In Canada, however, the larger impacts of variations in cow flow are the associated difficulties in quota management.

The objective of the Dairy Inventories Simulator (Herd-level), or DISH project is to develop a computerized simulator that generates predictions of herd inventories over time. The model requires a limited amount of input from existing herd-level records. A simple user interface is employed and the model provides rapid feedback.

■ Methods

The DISH model requires herd level input. Output is generated at the group level and is designed to assist in making group-level decisions. The model is programmed using MS Access and VBA.

The simulator is programmed to think of a dairy herd as existing within nine groups (Figure 1). Calves are born and enter the model on the right side of the figure. New bull calves are sold. New heifer calves move to the bottom-left box (Pre-weaned Heifers) and flow to the right as they age. In the middle-right box (Breeding & Pregnant Heifers), heifers are bred and calve. They move to the left through the middle row as they enter the milking herd. In the middle-left box (1st Lact Cows in Breed & Gest), cows are bred, complete their lactations and are moved to the top-right box (Dry Cows). In the top row, older cows cycle through the herd. Within each of the groups, cattle can die, or be culled, purchased or sold.

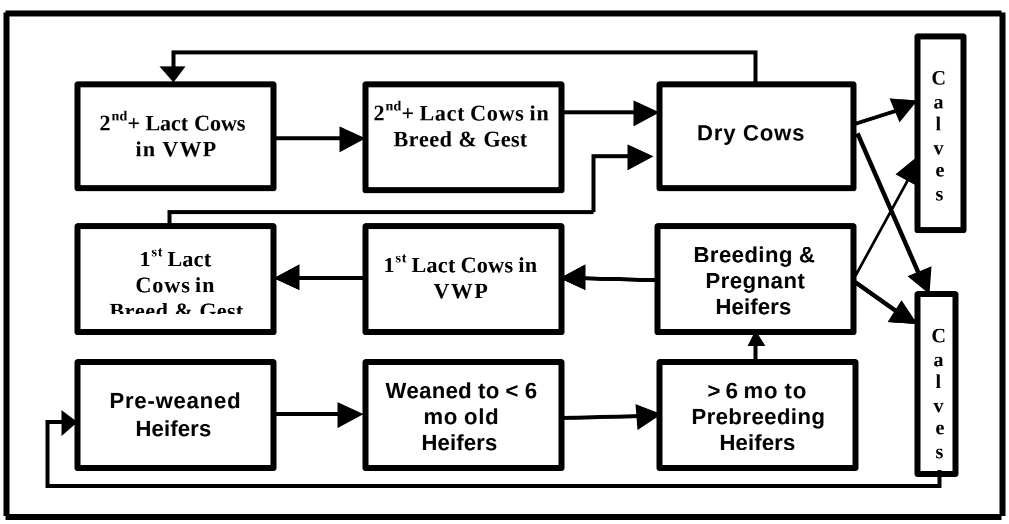

Figure 1. Herd structure employed by DISH model.

The model requires input in four different categories (Table 1). Current inventories for each of the nine groups must be entered. In addition, minimum and maximum groups sizes must be indicated. If a group falls below the minimum limit, cattle are purchased to maintain group size. If a group exceeds the maximum limit, cattle are sold. Rates of death, culling and reproductive efficiency are applied to individual animals using a random process. Because the model is stochastic, or random, running the model several times with the same input data will produce slightly different output. The model can simulate a herd for one to five years. Changes in any of initial input parameters may be initiated at any month within the time period simulated.

Table 1. Input required by DISH.

Input Category	Parameter	Variables
Group Sizes	Current Inventory	Mean, min, max
	Death rate	Mean
	Cull rate	Mean
Production	Rolling herd average	Mean
	Rolling herd average trend	Annual % change
	Percent calves stillborn	Mean
	Weaning age	Mean, min, max
	Age at first calving	Mean, min, max
	Dry period	Mean
Reproduction	Age at first breeding	Mean, min, max
	Heat detection rate – 1st & 2nd+ lact	Mean, min, max
	Conception rate – 1st & 2nd+ lact	Mean, min, max
	Voluntary waiting period – 1st & 2nd+ lact	Mean
Reproductive Cull Rate	Age or days in milk at which an open heifer or cow is culled due to repro failure	Mean

Milk production is estimated using a gamma function. Constants for this formula were generated using Michigan DHIA data. This formula adjusts milk yield for season of calving, parity, and milk production level.

■ Results

The owner/manager of a 75-cow herd in mid-Michigan agreed to provide herd data to help test the model. This dairy raises all its own forages and youngstock. Cows are housed in freestalls and milked in a double-8 herringbone parlor. Cows and heifers are bred AI and the manager keeps good records – both production and financial. Some of the herd's production parameters are listed in Table 2. The farm had not undergone any management or facilities changes in the recent past and was not planning any for the near future.

Table 2. Selected 2000 production parameters for the example dairy.

Parameter	Average	Range
Heat detection rate (HDR)	57%	9-74%
Conception rate	38%	29-53%
Cull rate	22%	
Age at first calving	24 months	20-27 months

Examples of an input screen and output report are shown in Figures 2 and 3. The output in Figure 3 represents a month's worth of activity.

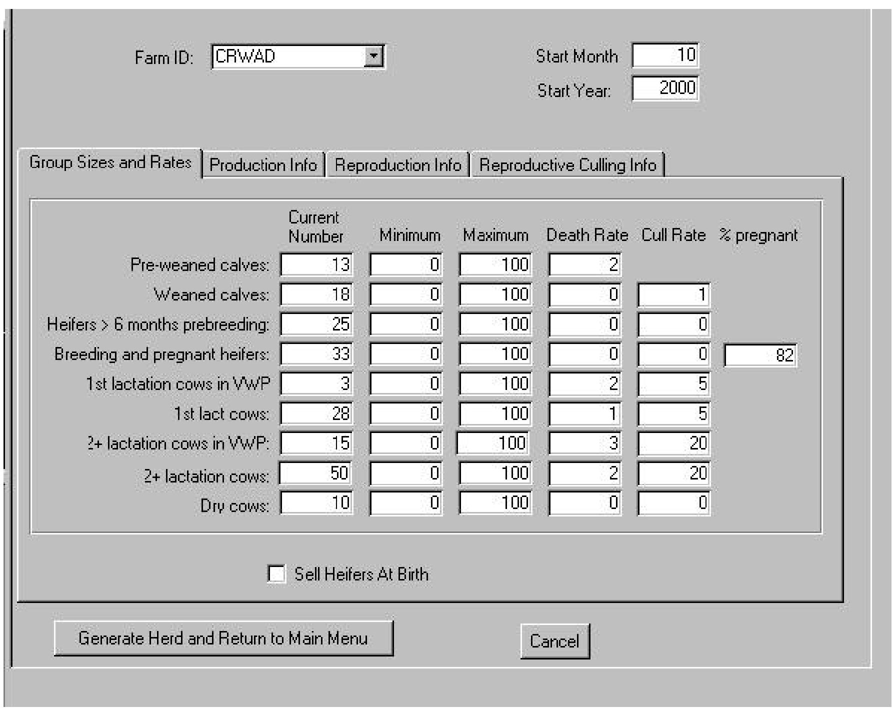

Figure 2. Example of a DISH input screen.

DISH Model Output

MONTHLY DETAILED REPORT

Date: 10/1/2000 - 10/31/00	**BEGIN INV**	**ENDING INV**	**PURCH**	**DEATHS**	**CULLS**	**REDUCT SALES**
Pre-weaned	13	5	0	0	0	0
Weaned heifers < 6 months	18	29	0	0	0	0
Heifers > 6 months	25	26	0	0	0	0
Breeding and preg. heif.	33	31	0	0	0	0
Total	**91**					
Cows in VWP	18	16	0	0	1	0
Lact. Cows	78	80	0	0	1	0
Dry	10	5	0	0	0	0
Total	**101**					
New Born Calves (heifers and bulls)	8					

Figure 3. Example of DISH output report. BEGIN INV = Beginning inventory; ENDING INV = Ending inventory; PURCH = Purchases; REDUCT SALES = Cattle sold to keep groups within limits set by user.

DISH Output

Using records from the above herd, a two-year simulation was run. A graph of the ending inventories for the milking herd and total herd were created in MS Excel (Figure 4). The monthly difference between the number of cows in the milking and total herds represents the number of dry cows.

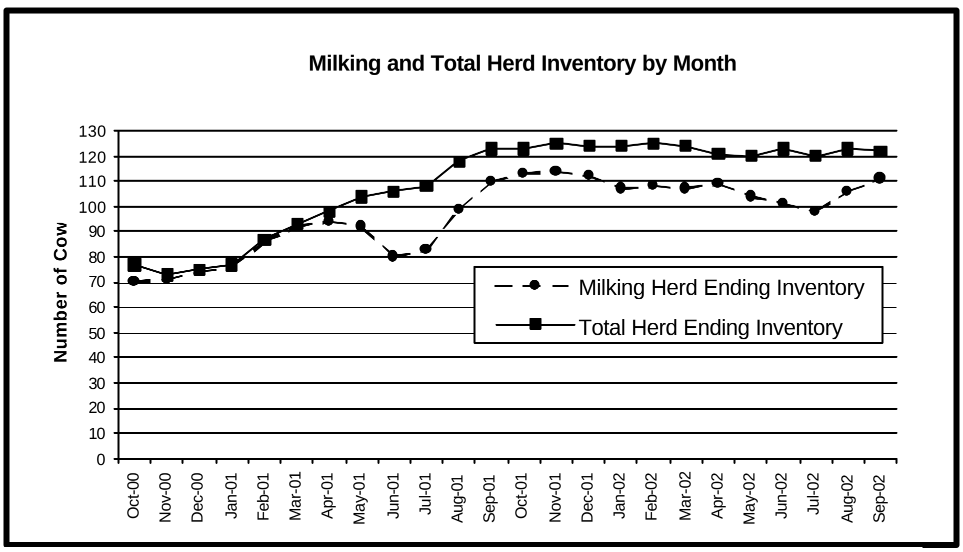

Figure 4. Selected output of the example dairy simulation. Graphed in MS Excel.

The output indicates that there will be slow, but steady growth in herd size over the 2 years. The herd started at about 77 cows, but grew to over 120 in only one year. The herd then appeared to stabilize at this level. In addition, the model indicated that quite some variation in the number of dry cows on hand – from a low of 1 to a high of 26, with an average of 12 on hand in any given month.

Producer Feedback to Simulation

When shown the graph in Figure 4, the dairyman was very surprised. He had not previously been able to increase his herd size internally and the model clearly showed a dramatic increase over only one year – a jump of over 50%! “The model clearly has some problems,” the owner announced.

In an attempt to check the model’s accuracy, the number of cull cows sold per month were collected from financial data and compared to the number culled by DISH. The cows culled per month by DISH are shown in Figure 5. Using the more accurate financial records, the producer’s financial records indicted that he had generally culled more cows per month than the model had. It became clear that the cull rate had been underestimated by almost 50%. After this revelation, reproductive indexes and heifer performance were also reexamined.

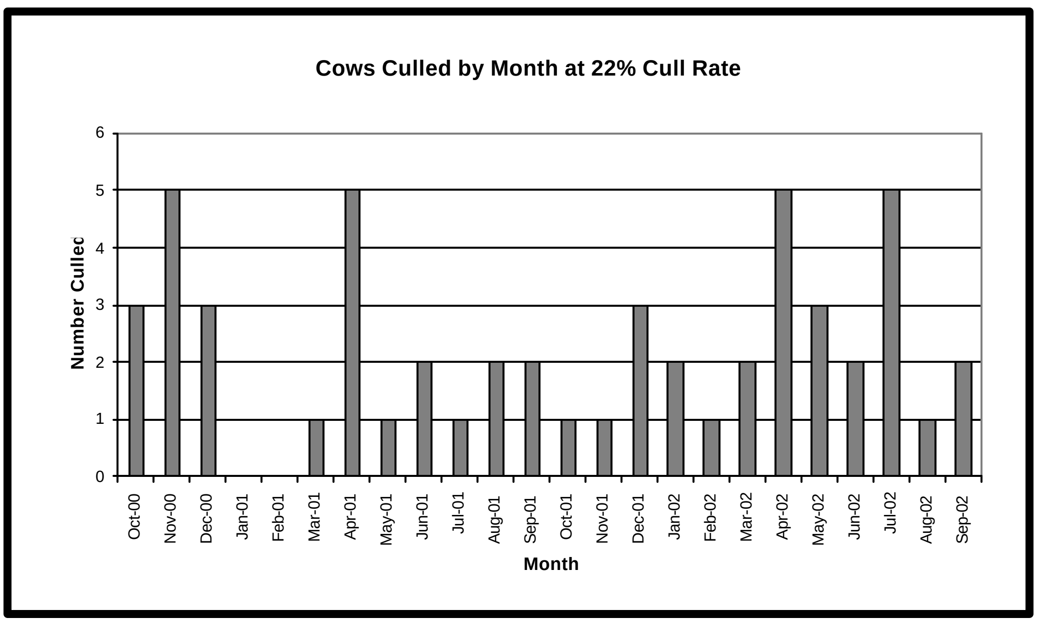

Figure 5. Cows culled by DISH on example dairy. Graphed in MS Excel.

Outcome of Testing

This initial test run of DISH was quite fruitful. Based on the data input, the model generated a reasonable estimation of herd inventories over time. Results of the model prompted an evaluation of producer records and how herd-level parameters were used in decision-making. Even though this farm was not anticipating future changes, useful information was discovered about farm management practices.

■ Discussion and Conclusions

Early testing of DISH has indicated that the model will be able to provide important information that can assist in decision-making. Through prediction of group inventory levels, future resource shortages can be anticipated and planned for. How fast will the herd grow? Will the heifer or lactating or dry cow facilities be adequate? As shown in the example herd, model output can also be compared to historical records to assess the accuracy of herd-level management parameters that have been used to gauge herd performance, like cull rate.

Milk production estimates by group, while not currently functional, will be present in future versions of DISH. The model's ability to predict milk output may provide an important quota management tool. In addition, application of cost and revenue estimates to future inventory changes and milk production levels will enable users to predict future cash flow streams. The model could be particularly important in expansion planning, when additional cash flow is often necessary in the first two to three years after start-up to purchase cattle so that herd size can be maintained. Accurate estimation of the timing and magnitude of these cash flow needs is critical to financial feasibility of an expansion.

The current output of the model is in tabular form, but it is also exportable to a variety of spreadsheet applications. As shown in Figures 4 and 5, this output can then be graphed or analyzed.

DISH is a herd- or group-level simulator that uses a minimum amount of available herd management information to predict changes in group inventories over time. In addition to expansion planning, the model should be useful in modeling changes in reproductive and culling management practices. Expected users of the model include Extension staff, herd consultants, researchers, instructors and dairy producers.