DAIRY HERD SIZE AND INCOME OVER FEED COST

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ABSTRACT

Dairy herd size was examined for possible direct or indirect influence on Income Over Feed Cost per cow. Monthly Dairy Herd Improvement Association records were used to predict daily Income Over Feed Cost by herd size categories. The monetary impact of 146 factors recorded monthly per herd are examined by multiple regression and the findings are presented for the 19 most significant factors. The most important positive contributors to Income Over Feed Cost are the percent of cows in milk, energy value of concentrates fed, mean cow weight, days in milk, and Persistency Index. The most significant negative factors are the days open, percent of herd milking over 305 days, somatic cell count, and mixed herds. Herd size, age, first breeding conception rate, and the percent of possible breedings actually serviced were not significant predictors.

Keywords: Income over feed cost, profitability, herd size, determinants, regression, management, dairy herd, improvements association records.

INTRODUCTION

Does dairy herd size influence income over feed cost (IOFC) per cow? If so, is the relationship direct or indirect? Classical microeconomic theory suggests an indirect relationship. Any economies of scale to be received from increasing herd size will not be directly reflected in IOFC per cow because feed requirements per cow are insensitive to herd size. Economies of scale occur when some or all of the "fixed" costs of farming can be spread over an increasing quantity of ouput (hundredweights of milk), thereby lowering the average cost of producing a unit of output. Typical fixed costs include depreciation, interest, taxes and insurance. Total feed costs for the herd are considered "variable" costs because they are correlated with total herd milk production, whereas total fixed costs do not change with an increase or decrease in total milk yield. Thus, since each new cow must eat like the remainder of the herd, increasing the herd size will increase the farmer's profits only by enlarging the differences between income and fixed costs. However, herd size may indirectly influence IOFC by dictating which management factors are most important for dairy farmers with differing herd sizes.

This study examines the key determinants of IOFC by herd size category for dairy farms in Northeast Texas enrolled in the Dairy Herd Improvement Association (DHIA) record keeping system. It offers theoretically consistent answers to the questions of whether herd size has direct and/or indirect effects on IOFC per dairy cow.

Though the DHIA was established to develop a data base on individual farms to promote productivity (Voelker 1981), little work has enhanced the usefulness of the information for the farmer. The member-farmer receives a great deal of data, but must conduct further analysis if he/she wants to know the precise relationships between many of the variables. This analysis is an attempt to ascertain the quantitative relationships between many of the variables, with emphasis on their impact on IOFC. The purposes of this study are to: 1) enable the dairy farmer to predict changes in IOFC resulting from change in some of the routine management variables, solely using information in the DHIA report, and 2) determine the influence of herd size on IOFC. The goals are to enhance short term decision making and examine the viability of small dairy farms.

In addition to monitoring and considering the latest technological developments and capital investments available to dairies, farmers need to manage their current assets as efficiently as possible. Though much recent concern in agriculture has focussed on optimal farm size and making a transition to permanent sustainability (Richardson 1984, Schwart 1985), a need remains to help managers make better short term decisions; otherwise, adoption of expensive technologies and sophisticated management practices may not be possible

LITERATURE

Several linear programming models have been developed to maximize IOFC via nutrient and price data for various feed ration formulations, but with only a few cow and herd specifications (Bath and Bennett 1980, Bath et al. 1972, Dean et al. 1969, Jones et al. 1980, Reyes et al. 1980). Dairy profit functions have been developed, but their meaning and purpose, i.e. to include fixed costs and enhance genetic evaluation, are different from predicting IOFC (Andrus and McGilliard 1975, Balaine et al. 1981, p. 96, Norman et al. 1981, Pearson and Miller 1981, Tigges et al. 1984). Two studies reported simple correlation, but not multiple regression, analysis of IOFC (Grisley 1985, Williams 1985).

Several studies have estimated the impact on IOFC of a few of the factors examined in this analysis. Increasing herd life from 2.8 to 3.3 lactations was found to increase annual income by $30/cow (Congleton and King 1984). Each additional day open from 40 to 140 reduced daily IOFC by $0.71 and $1.18 for 1st and later lactation cows, respectively (Olds et al. 1979). Three studies indicated that extending the calving interval for high-producing cows from 13-15 months did not hurt IOFC (Reyes et al. 1981, Reyes et al. 1980, Shumway et al. 1982), but two other studies found a negative impact of approximately $7/cow/year for every three days beyond 13 months (Gibson 1984, Holmann et al. 1984). Bakker et al. (1980) argued that assessment of sire profitability requires information beyond the impact on first lactation.

METHODOLOGY

From the approximately 250 variables on the monthly DHI-202 Herd Summary Form, the authors selected the 146 variables related most theoretically to IOFC. Stepwise regression at the 0.05 level was conducted to search for the best set of independent variables in predicting IOFC. The procedure used was the SPSS-X forward stepwise regression with entry based on strength of correlation for the first entry and partial correlation for subsequent entries. Multiple linear regression equations were then estimated on IOFC, with and without use of milk and fat production per cow and feed costs per 45.4 kgs. (CWT) of milk produced, i.e., the "Big Three" predictors of IOFC, as one would expect. The Big Three were dropped in order to search for less obvious determinants of IOFC.

The actual size of the herd (1.#COWSMTLHDTD) was examined as one of the 146 independent variables. Additionally, the effect of herd size was investigated from another perspective: to see if it dictated the determinants of IOFC. This was done by rerunning the model without the Big Three (milk, fat, feed costs) on various size farms after partitioning the data into three herd size groups and then into five herd size groups.

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DATA

Data were collected through the DHIA on 126 farms in a 19-county area (including Hopkins County, one of the major dairy counties in the nation) of Northeast Texas for the two most recent years available, 1982-83. For some of the farms, less than 24 months of data were available. A total of 749 monthly observations were obtained. In essence, the data provide a static picture of the farm by month. Table 1 presents the 19 independent variables found to be most significantly correlated with IOFC when the dairies are partitioned into herd size categories.

Table 1. Variables Selected in Economic Models of Income Over Feed Cost (IOFC)

Dependent:		
Y1.	$IOFCACTD	= Mean daily IOFC per cow, all cows (milking and dry)
Independent:		
	Test Day Data	
3.	%COWSNMKTD	= % of cows in milk
19.	KGSCNTACTD	= Kgs. of concentrates consumed per cow per day
20.	CNTENGVALTD	= Net energy value of the concentrates
21.	CNTCSTPCTD	= Cost of concentrates per cow per day
27.	DYSFSTBDGBRHD	= Mean # of days to first breeding, breeding herd
53.	DYSOPLSTCLVDT	= Mean # of days open per cow since last calving date
55.	#COWSCDPTLHD	= # of cows in total herd with complete dry periods
56.	#DYSDRYCP	= Mean # of days dry per cow in 55.
66.	%MKG>305MKHD	= % of milking herd currently milking> 305 days
67.	AVGWGTKGSTLHD	= Mean body weight of cows, total herd, Kgs.
68.	#HRSBTWNMKGSAM-PM	= # of hours between milkings, a.m. to p.m.
	Rolling Annual Average Data	
109.	$PDSVCSRSTLHD	= Mean $ PD of current and former sires, all lactations
110.	#COWSLFTHDLST12MOS	= # of cows that left herd in last year
118.	#DYSNMKLST12TSTSMC	= Mean # days in milk, last 12 test days, milking cows
120.	PRSTCYNDXLST12TSTS	= Mean test period Persistency Index, last 12 test days
128.	AVGSCCLST12TSTS	= Mean weighted average SCC, nearest 1,000, entire herd, last 12 test days
	Dummy Variables(1 = true, o = false)	
134.	MXHD	: Mixed breeds herd
138.	APR	: Apr. test month
142.	AUG	: Aug. test month

Though Texas dairies produce only about 2.8 percent of total U.S. milk (ERS, 1985), Texas ranks ninth among the states in quantity produced (Knutson et al. 1981). Whereas approximately 30 percent of the total U.S. dairy herd is enrolled in the DHIA, 23 percent of Texas dairies are enrolled. The study area has approximately 114,000 head of dairy cows wich produce around 590 million kilograms of milk annually, both of which represent approximately 34 percent of their respective state total (Texas Crop & Livestock Reporting Service, 1982).

Sample farms ranged in size from 18 to 384 head, with a mean of 127. The highest daily average milk production per milking cow was 29.9 kgs. Daily IOFC per cow (milking and dry) ranged from $0.08 to $6.21, with a mean of $2.70. The minimum projected calving interval was 11.8 months, with a mean of 13.7 months. Average days open ranged from 80 to 275, with a mean of 137 days. Average days dry ranged from 45 to 124, with a mean of 74 days. The average first breeding conception rate was 59.8 percent. Eighty-nine percent of the herds were Holstein, 5 percent were Jersey, 5 percent were mixed herds, and one percent were Guernsey or Brown Swiss. The mean number of hours between milkings was 11.4 from am to pm. Average somatic cell count (SCC) ranged from 7,000 to 984,000, with a mean of 334,335. Two weaknesses in the data were not addressed: the questionable accuracy of DHIA- calculated feed costs and the possible effect of time in the two- year data; both aspects were beyond the scope of the study.

Table 2. Multiple Linear Regression Models of Y1. $IOFCACTD by Three Farm Sizes*

Independent Variable	Beta Coefficient	Standard Error	T Value
(Model A: Farms with <85 cows)			
Intercept	-3.470	0.530	-6.57 [b]
3. %COWSNMKTD	0.040	<0.005	9.55 [b]
20. CNTENGVALTD	0.020	<0.005	7.86 [b]
66. %MKG>305MKHD	-0.020	<0.005	-4.65 [b]
109. $PDSVCSRSTLHD	-0.850	0.230	-3.74 [b]
118. #DYSNMKLST12TSTSMC	0.010	<0.005	3.69 [b]
128. AVGSCCLST12TSTS	>-0.005	<0.005	-3.38 [b]
$R^2 = 0.52$	Sig. F<0.00005		No. of Obs. = 245
(Model B: Farms with 85-132 cows)			
Intercept	-13.380	2.460	-5.45 [b]
3. %COWSNMKTD	0.040	<0.005	8.66 [b]
20. CNTENGVALTD	0.030	0.010	3.50 [b]
21. CNTCSTPCTD	-0.430	0.120	-3.47 [b]
66. %MKG>305MKHD	-0.030	0.010	-4.56 [b]
67. AYGWGTKGSTLHD	<0.005	<0.005	2.17 [a]
118. #DYSNMKLST12TSTSMC	0.010	<0.005	4.66 [b]
120. PRSTCYNDXLST12TSTS	0.090	0.020	3.79 [b]
138. APR	0.430	0.140	2.97 [b]
$R^2 = 0.39$	Sig. F<0.00005		No. of Obs. = 252
(Model C: Farms with >132 cows)			
Intercept	-8.560	2.450	-3.50 [b]
3. %COWSNMKTD	0.050	0.010	8.68 [b]
19. KGSCNTACTD	-0.040	0.010	-2.88 [b]
53. #DYSOPLSTCLVDT	>-0.005	<0.005	-2.12 [a]
68. #HRSBTWNMKGSAM-PM	0.060	0.030	1.88
110. #COWSLFTHDLST12MOS	>-0.005	<0.005	-2.39 [a]
120. PRSTCYNDXLST12TSTS	0.080	0.030	3.17 [b]
128. AVGSCCLST12TSTS	>-0.005	<0.005	-2.49 [a]
134. MXHD	-1.660	0.430	-3.82 [b]
142. AUG	-0.320	0.160	-2.04 [a]
$R^2 = 0.38$	Sig. F<0.00005		No. of Obs. = 249

Without the "Big 3" Predictors: milk and fat production, feed cost.
[a]Denotes significance at 0.05 level.
[b]Denotges significance at 0.01 level.

FINDINGS

The influence of herd size on the determinants of IOFC is reflected in Tables 2 and 3. Partitioning the farms into three group sizes (models A-C) yielded less accurate results than by dividing the data into five group sizes (Models 1-5). With one exception (Model 4:

Farms with 122-171 cows), the ability to predict IOFC rose considerably with the additional delineation of herd size. The latter models are discussed next in further detail.

Table 3. Multiple Linear Regression Models of Y1. $IOFCACTD by Five Farm Sizes*

Independent Variable	Beta Coefficient	Standard Error	T Value
(Model 1: Farms with < 71 cows)			
Intercept	-8.880	2.600	-3.41 [b]
3. %COWSNMKTD	0.050	0.010	7.89 [b]
19. KGSCNTACTD	-0.110	0.020	-4.79 [b]
20. CNTENGVALTD	0.030	< 0.005	7.69 [b]
67. AVGWGTKGSTLHD	0.010	< 0.005	6.18 [b]
68. #HRSBTWNMKGSAM-PM	-0.320	0.070	-4.47 [b]
110. #COWSLFTHDLST12MOS	0.020	< 0.005	6.64 [b]
120. PRSTCYNDXLST12TSTS	0.060	0.020	2.53 [a]
128. AVGSCCLST12TSTS	> -0.005	< 0.005	-3.44 [b]
R^2 = 0.60	Sig. F<0.00005		No. of Obs. = 136
(Model 2: Farms With 71-93 cows)			
Intercept	-3.640	0.730	-4.98 [b]
3. %COWSNMKTD	0.050	0.010	8.28 [b]
20. CNTENGVALTD	0.020	< 0.005	5.52 [b]
27. DYSFSTBDGBRHD	< 0.005	< 0.005	2.18 [a]
66. %MKG-305MKHD	-0.030	0.010	-4.26 [b]
118. #DYSNMKLST12TSTSMC	0.010	< 0.005	2.62 [b]
128. AVGSCCLST12TSTS	> -0.005	< 0.005	-4.64 [b]
134. MXHD	-0.660	0.290	-2.27 [a]
R^2 = 0.57	Sig. F<0.00005		No. of Obs. = 154
(Model 3: Farms with 94-121 cows)			
Intercept	-13.490	3.160	-4.27 [b]
3. #COWSNMKTD	0.040	0.010	7.11 [b]
20. CNTENGVALTD	0.030	0.010	3.78 [b]
21. CNTCSTPCTD	-0.530	0.160	-3.41 [b]
66. %MKG-305MKHD	-0.030	0.010	-3.47 [b]
67. AVGWGTKGSTLHD	< 0.005	< 0.005	2.66 [b]
118. #DYSNMKLST12TSTSMC	0.010	< 0.005	2.84 [b]
120. PRSTCYNDXLST12TSTS	0.080	0.030	2.81 [b]
138. APR	0.380	0.160	2.34 [a]
R^2 = 0.45	Sig. F<0.00005		No. of Obs. = 157
(Model 4: Farms with 122-171 cows)			
Intercept	0.530	0.640	0.83
3. %COWSNMKTD	0.040	0.010	5.15 [b]
21. CNTCSTPCTD	-0.370	0.140	-2.72 [b]
53. #DYSOPLSTCLVDT	> -0.005	< 0.005	-2.51 [a]
110. #COWSLFTHDLST12MOS	0.010	< 0.005	2.24 [a]
R^2 = 0.20	Sig. F<0.00005		No. of Obs. = 148
(Model 5: Farms with > 171 cows)			
Intercept	-15.190	3.010	-5.04 [b]
3. %COWSNMKTD	0.060	0.010	10.18 [b]
53. #DYSOPLSTCLVDT	-0.010	< 0.005	-3.51 [b]
56. #DYSDRYCDP	-0.010	< 0.005	-2.49 [a]
120. PRSTCYNDXLST12TSTS	0.150	0.003	5.18 [b]
128. AVGSCCLST12TSTS	> -0.005	< 0.005	-2.82 [b]
134. MXHD	-1.970	0.450	-4.42 [b]
R^2 = 0.57	Sig. F<0.00005		No. of Obs. = 151

The percent of herd in milk is a good predictor across all herd sizes, increasing IOFC $0.04-0.06 per cow per day for each percentage increase; as is the mean test period persistency index over the last 12 tests, whose influence becomes more pronounced as herd size increases. For smaller herds (Models 1 and 2), the number of hours from am to pm between milkings tended to hurt IOFC, as did the amount of concentrates used. The energy value of concentrates was correlated significantly with an increase in daily IOFC of $0.02-0.03 per cow on small to moderate size dairies. For farms with 94-121 cows (Model 3), the percent of milking herd currently milking over 305 days and the cost of concentrates had negative effects, whereas the month of April was associated with a marked increase of $0.37-0.53. Larger herds (Models 4 and 5) were more sensitive to the mean number of days open since the last calving date, the mean number of days dry for cows with at least one complete dry period, and mixed herds, each of which had a negative impact on IOFC, as did the cost of concentrates. For the largest dairy operations, having a mixed herd was associated with a drop in IOFC of $1.97 per cow per day.

It may be of interest to note that the age of the herd, first breeding conception rate and percent of possible breedings that were actually serviced are generally considered key dairy management variables, yet did not enter any of the models. Also, actual size of the herd was not found to be a statistically significant predictor of IOFC.

CONCLUSION

Assuming that dairy farmers and DHIA field inspectors record accurate information, it is possible to accurately anticipate the direction and magnitude of change in IOFC from change in many of the feeding, breeding, genetic, health and management factors reported on the monthly DHI-202 Herd Summary Form. The size of herd appears to have more of an impact on which factors determine IOFC than it does on the actual level of IOFC, implying that a positive flow of IOFC can be achieved at any herd size, though not neccessarily portending positive profits, which depend further on fixed costs and debt load. The finding reflects the fact that operators of different size farms have different managerial concerns. The beta coefficients presented in this report (most of which are statistically significant at the one percent level and almost all of which are significant at the five percent level) are offered in the hope of helping producers improve short run financial decisions during periods of uncertainty and transition.

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