Methodology

Highlighting Differences Among Dairy Farms by Location

In accordance with the first objective of the study, a highlight of the differences that might exist among dairy farms in the traditional and non-traditional milk-producing States is provided by charting the means of certain variables such as those pertaining to the size of the operation, availability of labor hours, and farm financial performance. While reporting per-farm averages is revealing, using per-farm averages as the basis of discerning which group of farms fares better can be misleading (Backhouse and others, 1988). For example, a higher industry average could be attained if in a given year the equity position of the top 5 percent of farm businesses improved dramatically, while that of others remained unchanged. This would lead falsely to the impression that the equity position of all farms had improved. This report averts the potential for this type of misinterpretation by providing evidence regarding how uniformly each of the variates considered in the analysis is distributed. This is done by first producing tabulations that show how farms are distributed across the ranges of relevant measures. Specifically, this approach starts by first sorting the farms by a variate (e.g., farm debt, farm assets, farm equity, net cash income, etc.), and then by reporting the levels of the variate held by each decile of farms. The larger the spread between the levels of the variate held by the upper decile relative to that held by the lower decile, the larger is the level of concentration, which also implies that farms, in terms of the chosen variate, are dissimilar.

Another method of examining concentration is that of the Lorenz curve where the cumulative percentage of a relevant measure is plotted against the cumulative percentage of farms. Using farm assets as an example, if all dairy farms are equal owners of farm wealth so that each 1 percent of the farms own 1 percent of the wealth, then the Lorenz curve is diagonal, also known as the "egalitarian line." If the upper 1 percent of farms own more than 1 percent of all assets, then the Lorenz curve lies below the diagonal, and will lie even farther away the higher is their proportion of owned wealth. The usefulness of the Lorenz curve becomes limited in cases where a variate contains negative observations. Using equity as an example, the presence of negative values makes the Lorenz curve unsuitable for the measurement of the proportion of equity that is owned by the lower or upper deciles of the population. However, the Lorenz curve of such variate remains useful since it allows for a visual interpretation of the extent of the dissimilarity that may exist across the two groups of milk-producing States.

The third and final method used to assess concentration is that of the adjusted Gini coefficient originally developed by Chen, Tsaur, and Rhai (1982) and further developed by Berrebi and Silber (1985). As Lerman and Yitzhaki note (1985), the benefit of using the adjusted Gini is that it allows for the measurement of concentration regardless of whether the observations constituting a particular distribution are all positive. For the sake of demonstration, let Y_j denote the j^{th} farm's net farm income where Y_1#...#Y_n with some Y_j < 0, and let m be the size of the subset of farms whose combined income is zero with Y_1 #...# Y_m.[4] The adjusted Gini is computed as:

$$G^*(Y) = \frac{(2/n)\sum_{j=1}^{n} j y_i - \frac{n+1}{n}}{\left[1 + (2/n)\sum_{j=1}^{m} j y_i\right] + (1/n)\sum_{j=1}^{m} y_i \left[\frac{\sum_{j=1}^{m} y_j}{y_{m+1}} - (1+2m)\right]}, \qquad (1)$$

where

$$y_j = Y_j / n\overline{Y} \qquad (2)$$

and

$$\overline{Y} = \sum_{j=1}^{n} Y_j / n > 0. \qquad (3)$$

In equation 1, y_j is the income share of the j^{th} farm. This formulation of the Gini normalizes the distribution of Y in such a manner that the upper bound on the Gini coefficient, due to the presence of negative values, does not exceed unity. The Gini coefficient is related to the Lorenz curve in that it is defined as the ratio of the area between the actual distribution depicted by the Lorenz

[4]For computational purposes, m is determined where the sum of the first m farms is negative and the sum of the first m+1 farms is positive.

curve and the line of equality to the area of the triangle under the line of equality (Bronfenbrenner, 1977, p. 401). When all observations are positive, the Gini ratio lies between zero, indicating complete equality, and 1, signifying maximum concentration.

Examining the Determinants of Financial Performance

The primary financial performance measure used here is net farm income (*NFI*). *NFI* is defined as total accrual receipts minus total accrual expenses when cash income is adjusted for changes in crop and livestock inventories.[5] Defined as such, *NFI* thus measures the return to operator and unpaid family labor, management, and equity capital. Lins, Ellinger, and Lattz (1987) find that profitability, which is an indicator of farm financial performance that measures the extent to which a business generates a profit from the use of land, labor, management, and capital is better represented when based on an accrual rather than on a cash measure of income.

The second financial measure used in the analysis is the dairy enterprise's net returns per unit (cwt) of milk sold (*NRU*). Unlike *NFI* which is an absolute amount that relates to the performance of the farm business, *NRU* is defined as gross value of production less cash (both variable and fixed) expenses and capital replacement, per hundredweight of milk sold.[6] The fact that *NRU* is a relative amount makes this measure amenable for comparison between one farm and another.

[5]Based on financial guidelines set forth by the Farm Financial Standards Task Force (FFSTF), financial performance refers to the results of production and financial decisions, over single or multiple time periods (Forbes, 1991). FFSTF further notes that measures of financial performance such as *NFI* include the effect of external and uncontrollable forces (for example, drought and grain embargoes), and the results of operating and financing decisions made during the course of the production period. FFSTF provides detailed descriptions of other measures of profitability such as the rate of return on farm assets, rate of return on farm equity, and operating profit margin ratio. Another potentially useful performance measure that has been widely used in the farm management literature is that of management returns, which is computed as the residual remaining after imputed charges for interest on capital and unpaid labor (operator and family) have been deducted from net farm income (Sonka, Hornbaker, and Hudson, 1989).

[6]Capital replacement costs represent a charge sufficient to maintain production capacity over time and include a charge for purchased breeding stock, but not for replacement stock raised on the farm, which are accounted for in other items of the account (see Short and McBride for more detail).

Commercial dairy farms' financial performance (*FP*) is hypothesized to be a function of farm- and enterprise-specific characteristics, and of experience in dairy production as proxied by operators' age as in the following:[7]

$$FP_i = \alpha_0 + \sum_{k=1}^{11} \alpha_k X_{k,i} + \alpha_{12} TYPE_i + \sum_{k=13}^{15} \alpha_k PRACTICE_{k,i} + \varepsilon_i, \quad (4)$$

where FP_i denotes either *NFI* or *NRU* of the i*th* farm (i=*1,..., n*), X_1-X_{11} are rented acres per total operated acres, size of largest tractor on farm, debt-assets ratio, cow inventory, square of cow inventory, milk sold per cow, forage cost per cow, purchased feed cost per cow, hired labor per cow, land and building and equipment cost per cow, and age of farm operator, respectively; $TYPE_i$, and *PRACTICE*, are dummy variables; α_0 is a constant denoting intercept and α_1-α_{15} are parameters to be estimated using weighted least squares; and ε is random disturbance. The variable *TYPE* takes the value unity if the commercial dairy farm is a multi-owner operation and takes the value zero otherwise. The variables $PRACTICE_{k,i}$ *(k=13,14,15)* take the value unity when the dairy operation's level of technological adoption is that of either a capital-intense, management-intense, or combination of capital- and management-intense technologies, respectively, and take the value zero otherwise.

Variability of Financial Performance. Using equation 4 *(k=1,...,11)* with *NFI* as the dependent variable for demonstration, the variation in *NFI* in the two groups of milk-producing States after performing weighted least squares can be apportioned to the contribution of different explanatory variables as in the two cases discussed next.

Variance effects of each explanatory variable. In the absence of any covariation effects, the unexplained variability in *NFI* can be decomposed into a variability component explained by the linear relationship between the dependent variable *NFI* and each of the explanatory variables, and an unexplained variability component due to the error term as in the following:

$$\sigma_{NFI} = \sigma(NFI \mid \alpha_0, \alpha_1, \ldots, \alpha_k) = \alpha_1^2 \sigma_{11} + \alpha_2^2 \sigma_{22} + \alpha_k^2 \sigma_{kk} + \sigma_\varepsilon, \quad (5)$$

[7]Estimation of a profit equation is not plausible here since the FCRS does not collect information on prices of inputs and of output.

where σ_{NFI} is the unexplained variance of net farm income (NFI_i), α denotes an estimated parameter, σ_{gg} (where $g = 1,.., k$) is variance of variate X_g, and σ_ε is variance of error term ε.

The individual effect (V_j) in percentage terms that each of the explanatory variables has on the variation in *NFI* can be measured as:

$$V_1 = \left[(\alpha_1^2 \sigma_{11}) / \sum_{j=1}^{k} \alpha_j^2 \sigma_{jj} \right] 100$$
$$V_2 = \left[(\alpha_2^2 \sigma_{22}) / \sum_{j=1}^{k} \alpha_j^2 \sigma_{jj} \right] 100 \tag{6}$$
$$\cdots$$
$$\cdots$$
$$V_k = \left[(\alpha_k^2 \sigma_{kk}) / \sum_{j=1}^{k} \alpha_j^2 \sigma_{jj} \right] 100$$

Variance effects of all explanatory variables. While equation 6 shows the extent that each variable alone contributes to the variation in net farm income, relative to other variables, a more useful variance decomposition allows for the incorporation of the variance effects along with those of the covariances as in the following:

$$\begin{aligned} \sigma_{NFI} &= \sigma(NFI | \alpha_0, \alpha_1, ..., \alpha_k) = \\ &\alpha_1^2 \sigma_{11} + \alpha_1 \alpha_2 \sigma_{12} + ... + \alpha_1 \alpha_k \sigma_{1k} + \\ &\alpha_2 \alpha_1 \sigma_{12} + \alpha_2^2 \sigma_{22} + ... + \alpha_2 \alpha_k \sigma_{2k} + \\ &\cdots \\ &\cdots \\ &\alpha_k \alpha_1 \sigma_{k1} + \alpha_k \alpha_2 \sigma_{k2} + ... + \alpha_k^2 \sigma_{kk} + \sigma_\varepsilon \end{aligned} , \tag{7}$$

where σ_{gg} and σ_{gh} ($g \neq h$) are variance of variate X_g and covariance of variates X_g and X_h, respectively. The variance of *NFI* as described in equation 7 can, hence, be described as the sum of explained variance-covariance effects attributed to the model's explanatory variables (Ω) and unexplained variance due to an error term. Thus, equation 7 can be rewritten as:

$$\sigma_{NFI} = \Omega + \sigma_\varepsilon \tag{8}$$

Consequently, the coefficients of separate determination are computed as:

$$\begin{aligned} C_1 &= (\alpha_1^2 \sigma_{11} + \alpha_1 \alpha_2 \sigma_{12} + ... + \alpha_1 \alpha_k \sigma_{1k}) / \sigma_{NFI} \\ C_2 &= (\alpha_2 \alpha_1 \sigma_{21} + \alpha_2^2 \sigma_{22} + ... + \alpha_2 \alpha_k \sigma_{2k}) / \sigma_{NFI} \\ &\vdots \\ C_k &= (\alpha_k \alpha_1 \sigma_{k1} + \alpha_k \alpha_2 \sigma_{k2} + ... + \alpha_k^2 \sigma_{kk}) / \sigma_{NFI}. \end{aligned} \tag{9}$$

The explained variation of the dependent variable *NFI* is described by the goodness of fit measure, R^2, which is equivalent to the following:

$$R^2 = \sum_{j=1}^{k} C_j = \Omega / \sigma_{NFI}, \tag{10}$$

where C_j indicates the j^{th} coefficient of separate determination. The unexplained variation in *NFI* is, hence, equal to 1 minus R^2.

By replacing *NRU* for *NFI*, the estimation procedures outlined by equations 5-10 become those that measure the variability in financial performance based on per-unit returns rather than on income per-farm.

Variability of States' Farm Financial Performance. Net farm incomes NFI_i, where $i=1,..., n$, and net returns per unit of output are first sorted by the 11 States that comprise the two major groupings of milk-producing States used in the report. Second, weighted means of $NFI_i(\overline{NFI}_s)$ and $NRU_i(\overline{NRU}_s)$ and Gini coefficients ($Gini_{v,s}$) for v variates (debt capital, farm assets, equity, cow inventory, and milk sales) are computed for the respective s milk-producing States. Third, linear regression models are used to express the relationships between $\overline{NFI}$ and $\overline{NRU}$ and each of the v concentration ratios. Using $\overline{NFI}$ for demonstration, the relationships between the weighted means of NFI_t by milk-producing State and each of the v concentration ratios result in v regressions that take the following general form:

$$\overline{NFI}_s = \alpha_0 + \alpha_1 Gini_{v,s} + \varepsilon_s, \tag{11}$$

where α_0 and α_1 are parameters to be estimated and ε_s ($s=1,...,11$) is the error term. The explained variation of $\overline{NFI}_s$ is described by the goodness of fit measure, R^2, also known as the coefficient of determination, and is expressed as:

$$R^2 = \alpha_1^2 \sigma_{11} / \sigma_{\overline{NFI}}, \tag{12}$$

where σ_{11} is variance of $Gini_{v,s}$ and $\sigma_{\overline{NFI}}$ is variance of $\overline{NFI}_s$.

Independence of Managerial Practices and Expected Financial Performance

Because managerial practices in general have been found important to the success of the farming operation (Sonka, Hornbaker, and Hudson, 1989), this study identifies those practices that are relevant to commercial dairy farming, using what is commonly referred to in the literature as the *F*-test of independence (Fuller and others, 1986, p. 44). To accomplish this, net farm incomes and per-unit returns of commercial dairy farms in milk-producing States are first sorted, then two groups of farms are identified based on whether their net farm incomes and per-unit returns exceeded the thresholds marking the incomes and returns of the top 20 percent of the population. The design of hypotheses tested is illustrated by accepting or rejecting the null hypothesis, H_0, of independence between a farm's undertaking of a certain management practice and its financial success. Success is defined here as being in the top 20 percent of the net farm income and the per-unit returns distributions.

Results

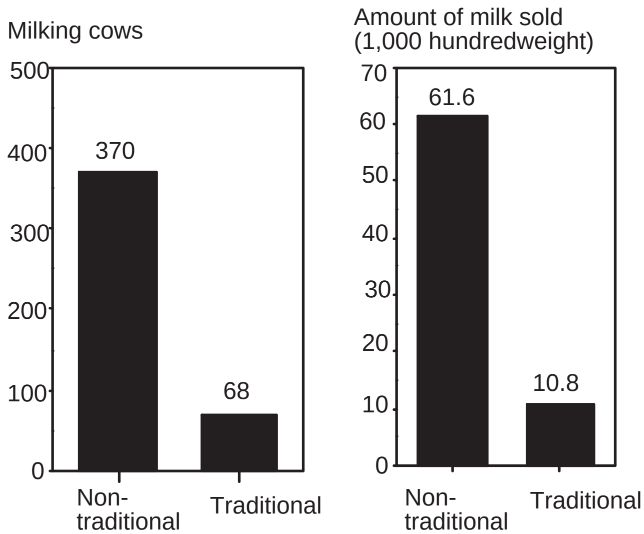
Figures 5-10 provide a pictorial representation of the differences among dairy farms in terms of size, labor availability, balance sheet, and farm profitability based on the location of the dairy operation. The following is a summary of these differences:

• Commercial dairy farms in non-traditional milk-producing States are at least five times (both in terms of cow inventory and in amount of milk sold) larger, with nearly two-thirds operating with herds of 150 milk cows or more (figs. 5 and 6).

• Commercial dairy farms in non-traditional areas use twice as much labor, 2,732 hours per quarter year, compared with 1,234 hours for commercial dairies in the traditional milking areas, with a portion of the labor hours in both milking areas used to produce other commodities beside milk. On a per-hundredweight-of-milk-sold basis (cwt), this amounts to 0.04 and 0.11 hours per cwt, respectively. Unlike dairies in traditional milk producing-areas, which tend to rely more on the operator as the main source of working labor, dairies in non-traditional milk-producing areas tend to rely on full-time paid labor for more than half of their total labor requirement (fig. 7).

Figure 5

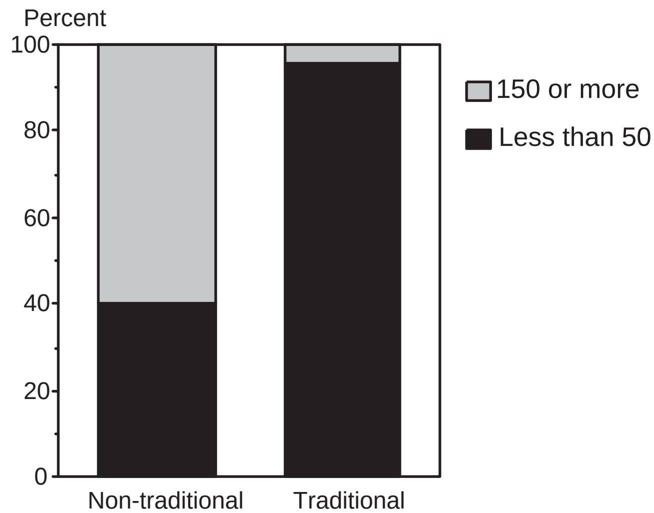
Average size of commercial dairy farms, in selected milk-producing States, 1993



Source: USDA, Economic Research Service, Farm Costs and Returns Survey, 1993.

Figure 6

Distribution of commercial dairy farms, in selected milk-producing States, by number of milking cows, 1993



Source: USDA, Economic Research Service, Farm Costs and Returns Survey, 1993.