Appendix

Test of Difference Between Means

The decision rule for testing the null hypothesis (H_0) that the means μ_1 and μ_2 of variate X across two groups of sample sizes n_1 and n_2 are equal starts by computing the following t-statistic (t*):

$$t^* = \frac{\mu_1 - \mu_2}{\sqrt{\sigma_{\mu_1} - \sigma_{\mu_2}}}, \qquad (13)$$

where σ denotes variance. If $|t^*| <= t(1\text{-}\alpha/2; n_1+n_2\text{-}2)$, conclude H_o (that is, H_o: $\mu_1 = \mu_2$) where α is the attained significance level. The alternative hypothesis (H_a) that the means are significantly different (that is, H_a: $\mu_1 \neq \mu_2$) is concluded if $|t^*| > t(1\text{-}\alpha/2; n_1+n_2\text{-}2)$.

It is important to note that because FCRS has a complex survey design, the formulation for the variance differs from that if data were based on simple random samples (Fuller and others, 1986, p. 75; Dubman, 1997). Further, the proper degrees of freedom to be used in establishing the critical t-statistic, particularly when $n_1+n_2<30$, is the number of segments (that is, primary sampling units) minus the number of strata (that is, mutually exclusive groups of farms that partition the targeted population of farms) instead of n_1+n_2-2. For further detail regarding FCRS survey design, see U.S. Department of Agriculture, 1994.

Test of Equivalency of Two Regressions

The data for the commercial dairies in the non-traditional and in the traditional milk-producing States are pooled. A dummy variable *D* is constructed with *D* = 1 if the dairy operation is located in a traditional milk- producing State, *D* = 0 otherwise. Using the model in equation 4 less the dummy variables as an example, the following regression for the pooled data is formed:

$$NFI = \alpha_0 + \sum_{k=1}^{11} \alpha_k X_k + \delta_{12} D + \sum_{k=13}^{23} \delta_k D_k + \xi, \qquad (14)$$

where α and δ denote coefficients to be estimated, and ξ is an error term.

The decision rule for testing the null hypothesis (H_0) that the dummy coefficients $\delta_{12},...,\delta_{22}$ are all jointly equal to zero originates by performing the following *F*-statistic (*F**):

$$F^* = m^{-1} \hat{A}'_m C^{-1}_{mm} \hat{A}_m, \qquad (15)$$

where A_m denotes the m-dimensional vector, a subset of the vector *A* ($A=[\alpha_0,..., \alpha_k, \delta_{12},...,\delta_{23}]$), for which it is hypothesized that A_m = 0, and where Cmm is the *m x m* portion of the estimated covariance matrix of $\hat{A}$ that is associated with $\hat{A}m$ (Fuller and others, 1986, p. 81).

If $F^* <= F$(12; segments-strata), conclude H_o where H_o: $\delta_{12} = \delta_{13} =...= \delta_{23} = 0$, and where α is the attained significance level. The alternative hypothesis (H_a) that the coefficients of the dummy variables are significantly different from zero (that is, H_a: $\delta_{12} \neq \delta_{13} \neq ... \neq \delta_{23} \neq 0$) is concluded if $F^* > F$(12; segments-strata). Rejecting H_0 is equivalent to rejecting the adequacy of one profit equation representing the net farm incomes of commercial dairy farms across the two milk-producing States considered in the analysis.

Logistic Regression

Benefiting from Pindyck and Robinfeld's (1981) discussion on logistic regression, let *I* be a binary index coded 1 if the i^{th} (i=1,..., n) commercial dairy farm has adopted a combination of capital- and management-intensive technology (*AMP-PRS*), and zero otherwise. The probability (*P*) of technological adoption is represented by the following:

$$P_i = E(I = 1|X_i) = \frac{1}{1 + e^{-\beta' X_i}}, \qquad (16)$$

where *e* is the base of the natural logarithm, *E* is the expectation operator, β is a vector of coefficient to be estimated, and *X* is a vector of explanatory variables.

The probability of not adopting *AMP-PRS* can be written as:

$$1 - P_i = \frac{1}{1 + e^{\beta' X_i}}, \qquad (17)$$

and, correspondingly, the odds ratio in favor of technological adoption can be represented as:

$$\frac{P_i}{1-P_i} = \frac{1+e^{\beta' X_i}}{1+e^{-\beta' X_i}} = e^{\beta' X_i}. \qquad (18)$$

The log of the odds ratio (ζ), commonly known as the logit, is derived by taking the natural logarithm of equation 18:

$$\zeta_i = \ln\left[\frac{P_i}{1-P_i}\right] = \beta' X_i. \qquad (19)$$

Maximum likelihood procedures are employed using *PC-CARP* to estimate the coefficients and test hypotheses regarding the factors that affect the technology adoption decision of the dairy operator. Substituting the values of the estimated coefficients in equation 16 allows for the estimation of the adoption probabilities.

Test of Equivalency of Separate Coefficients Across Two Regressions

Demonstrating with equation 4 after dropping the dummy variables, let the following represent the regression performed on pooled data:

$$NFI = \alpha_0 + \sum_{k=1}^{11} \alpha_k X_k + \delta_{12} D + \sum_{k=13}^{23} \delta_k D_k X_k + \xi, \qquad (20)$$

where *D* is a dummy variable that equals one if the dairy operation is located in a traditional milk-producing area, zero otherwise. Since each of the dummy coefficients $\delta_{12},...,\delta_{23}$, also known as differential slope coefficients, measures the difference in slopes across the two groups of milk-producing States, resulting t-tests from the regression performed on equation 20 provide useful information. For example, if the *t*-test that corresponds to δ_{13} indicates that δ_{13} is significantly different from zero, then this is equivalent to the finding that the coefficients of *RAC* based on two separate regressions, one for each of the two milk-producing States, are significantly different. If the resulting *t*-ratio is positively signed, this indicates that the *RAC*'s coefficient in the traditional milk-producing States is significantly larger than its counterpart in the non-traditional milk-producing States.