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Human resource management on dairy farms: Does investing in people matter?

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Abstract

As farm businesses grow larger, their organizational charts become more complex and typically deeeper, with middle managers being added. Human resource management practices, such as training, job descriptions, and standard operating procedures, may help employees become better, thereby increasing the effectiveness of the labor input and increasing profitability. We utilize Data Envelopment Analysis to test for differences in the efficiency with which several large dairy farms use their productive inputs to generate outputs, including profits. Our preliminary results show that there is no statistical differences in the efficiency scores between those who do use certain practices and those who do not. However, we recognize this as a first step and suggest that efforts be made to collect improved data for similar future analyses.

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1. Introduction

The dairy industry, like many other components of American agriculture, continues to become increasingly dominated by larger-scale farm operations. However, increases in productivity mean that fewer farms, and in fact fewer cows, now generate more milk in some states than was previously produced. However, the structural shift means that larger farms must use more labor, whether that is from family or hired resources.

This increase in labor usage means that organizational charts on farms must change, most likely becoming deeper. That is, larger farms tend to have additional layers of managerial control. While one individual, often the owner, may serve as a general manager, the farm may now have several middle managers. These may oversee various farm enterprises such as cropping, milking, replacement animals, feeding, etc. Additionally, those providing labor are more likely to become specialized in one or more areas of production. Positions such as "feeders" or "milkers" are common on larger dairy farms as these become intensive enough to warrant full-time jobs.

As farm organizational charts become deeper and better defined, the role of human resource management (HRM) may become increasingly important. The term "human resource management," as used here, refers to any number of specific practices that may be implemented to make the labor input more efficient. Such practices include training, job descriptions, performance reviews, standard operating procedures, and others. The objective of this research is to assess the impact of each of several HRM practices on the farm's ability to generate profits. We implement a non-parametric method, data envelopment analysis (DEA), to achieve the objective.

2. Review of Literature

The topic of farm profitability has received a great deal of attention from researchers over a number of decades. The body of literature on factors affecting farm profitability is quite large at this point. However, in some respects, little is known. The literature provides several seemingly contradictory results and, to a large extent, focuses only on the nature of the relationships between key variables and profitability. To a large extent, researchers have only just begun to consider why certain relationships are found in some cases but either don't exist or have a different sign in other cases.

In general, the literature does show that factors such as farm size positively affect profitability. This is true regardless of whether profits are measured in absolute terms, such as net farm income, or in a relative sense such as by the rate of return on farm assets (ROA) (e.g., Kauffman and Tauer, 1986; Ford and Shonkwiler, 1994; Purdy, Langemeier, and Featherstone, 1997; and Gloy, Hyde, and LaDue, 2002). The literature also shows that, *ceteris paribus*, the farm's debt level is negatively related to profitability (e.g., Haden and Johnson, 1989; Mishra and Morehart, 2001; and Gloy, Hyde, and LaDue, 2002). For a more complete review of this literature, see Gloy, Hyde, and LaDue (2002).

Very little research has been published to assess the link between human resource management and farm performance. Frequently, however, researchers have employed measures of an owner/operator's human capital. Such measures include use of Extension programs/services, operator's age, or educational attainment. These variables are not typically useful in explaining differences in farm profitability, however. Gloy, Hyde, and LaDue (2002) found no statistically significant effects between age and education and their measures of profitability. This is consistent with other work (Kauffman and Tauer, 1986). Others, though, have found statistically significant relationships. Haden and Johnson (1989) and Purdy, Langemeier, and Featherstone (1997) showed that the operator's age was negatively related to profitability. It is notable that the use of Cooperative Extension services was positively related to profitability in one study (Mishra and Morehart, 2001).

This literature suggests that age in an imperfect measure of human capital. While one might expect older operators to be wiser (that is, have more human capital), anecdotal evidence suggests that older operators often fail to adopt technologies (including machinery, equipment, and managerial practices) that might positively impact profits. These individuals are often slow to change. Thus, age is a poor proxy for human capital.

We find only one previous attempt to explore the relationship between specific practices and farm profitability (Hyde, Stup, and Holden, 2008). In that study, three relative measures of farm profitability were used; ROA, rate of return on farm equity (ROE) and net income per cow (NIPC). Those results showed that offering a premium to employees based on milk quality was positively related to ROA and NIPC. However, providing an annual performance review for full-time employees was negatively related to ROE. Additionally, a variable that indicated whether the owner had received training in HRM practices was negatively related to ROA and NIPC. These results are inconsistent with expectations in some cases and should, therefore, be analyzed further.

The relationship between HRM and profitability has been explored only slightly more outside of agriculture. Huselid (1995) and Huselid, Jackson, and Schuler (1997) provide two examples of this work. In each case, HRM programs were shown to be positively related to firm profitability. While these studies affirm a potential important linkage, the data are from larger, publicly traded corporations. The applicability of the findings to other types of businesses, such as large farms, should be explored.

The theoretical relationship between HRM practices and profitability was shown by Hyde, Stup, and Holden (2008). They defined $\Lambda = A(t)L$ where L is the quantity of labor in the firm's production function and A(t) is a vector of elements that impact labor effectiveness in time period T such that $A(t) \geq A(t-1)$ indicates that the labor input is more effective in period t than in period t-1. Their theoretical derivation supports the work done here.

3. Data & Methods

Our data are from a 2003 survey of Pennsylvania dairy farmers. The survey was implemented as part of a project to capture a "snapshot" of successful dairy farmers, with the non-random sample developed by asking dairy industry members to nominate farm owners. (Because DEA is a non-parametric method, issues normally associated with non-random samples in statistical analyses do not apply here.) The scope of the survey was quite broad, capturing numerous financial and production-related factors. The breadth of the survey precluded a large sample from being drawn. Therefore, few observations are available to perform a parametric analysis. Thus, we have chosen to use a non-parametric method, data envelopment analysis (DEA), to explore the relationship between specific practices and farm profitability.

DEA provides a nice tool for assessing the efficiency with which a decision making unit (DMU), a farm in this case, produces a bundle of outputs using a bundle of inputs. Those DMUs that produce outputs using the fewest inputs are said to be relatively DEA-efficient. Figure 1 helps to clarify the general concept in a single output – two input framework. In the figure, there are six DMUs represented by the letters A to F. The points show the level of each input needed to produce one unit of output.

DMUs C, D, E, and F form the "efficient frontier." That is, these firms combine inputs (though in different proportions) to minimize the level of inputs needed to produce one unit of output. Those DMUs, as well as convex combinations of those DMUs, form the efficient frontier.

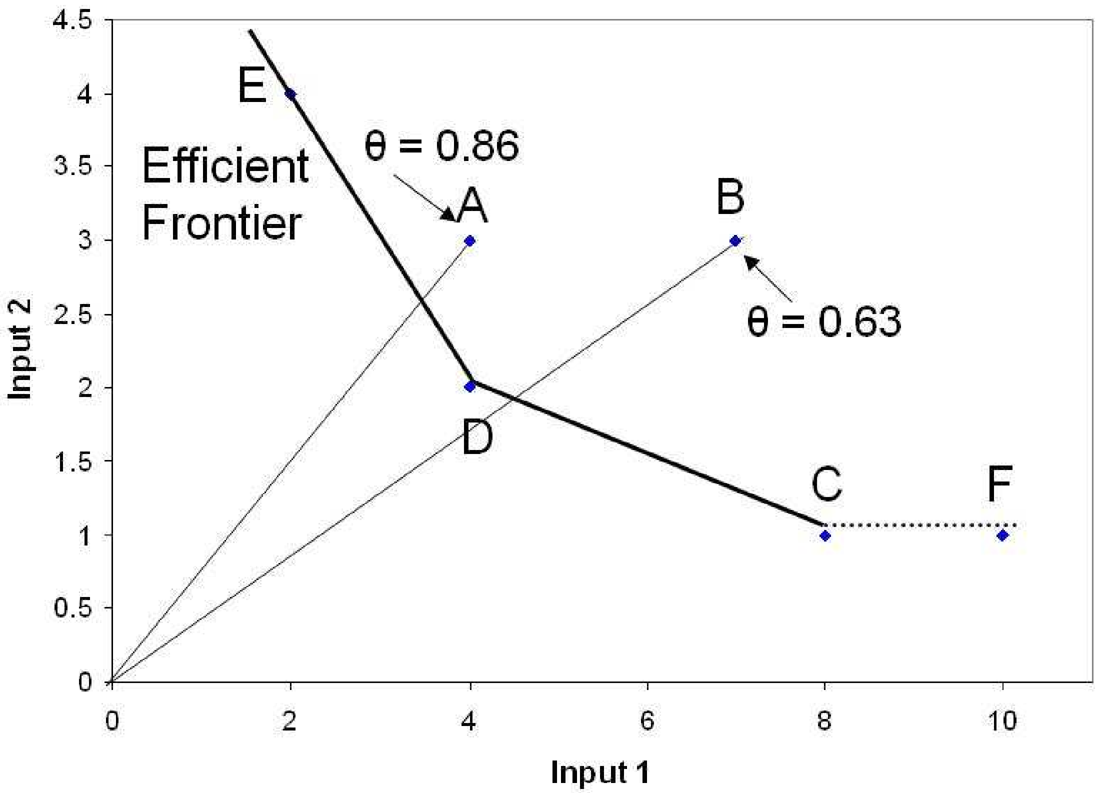

Figure 1. Example Decision Making Units Showing DEA-Efficient and DEA-Inefficient DMUs.

An estimate of DEA efficiency, denoted as θ, can be obtained for any DMU by drawing a ray from the origin to the point representing that DMU. The DMU's efficiency score can be measured as the length of the ray from the origin to the efficient frontier divided by the length of the ray from the origin to the point in question. Along the frontier, that ratio equals unity. For DEA-inefficient DMUs, that ratio is between zero and one. DMU A, for example, has a DEA efficiency score of 0.86. Thus, DMU A could theoretically reduce the use of both inputs to 86 percent of current levels and, in so doing, reach the efficient frontier.

DMU F, although on the efficient frontier, is not fully efficient. Note that DMU C uses the same amount of Input 2, 1 unit, but two fewer units of Input 1. Thus, DMU F can be referred to as "weakly efficient" (Zhu, 2003).

In practice, there are numerous forms of DEA models from which to choose. We selected an input-oriented Charnes, Cooper, Rhodes (CCR) model (Charnes, Cooper, and Rhodes, 1978). Mathematically, the model may be represented as a linear program for each DMU j.

$$\min \theta_j \tag{1}$$

$$\theta_j x_{jm} \geq \sum_{k=1}^{K} x_{km}\lambda_{jk} \text{ for all } m$$

$$\sum_{k=1}^{K} y_{ki}\lambda_{jk} \geq y_{ji} \text{ for all } i$$

$$\lambda_{jk}, \theta_j \geq 0$$

Here, m indexes inputs and i indexes outputs. Thus, x_{jm} represents the amount of input m used by DMU j and y_{ji} represents the amount of output i produced by DMU j. Additionally, k indexes DMUs such that x_{km} represents the amount of input m used by each of the other K DMUs. Similarly, y_{ki} is the amount of output i produced by each of the other K DMUs. The λ_{jk} are weights that satisfy all constraints and yield an efficiency score, $0 \leq \theta_j \leq 1$. The weights provide important information for interpreting the model results. Specifically, the weights show which DMUs are most appropriate to serve as benchmarks for the DMU in question. The greater the weights, the more appropriate the other DMU is to serve as a benchmark. In this way, the data indicate which other DMUs are the best benchmarks.

Table 1. Summary Statistics of Model Data

Variable	*Units*	*Description*	*Mean*	*St. Dev.*
EMPTOT	Employees	No. of employees on farm	9.2	8.0
HERDSIZE	Cows	No. of cows in herd	251.0	243.9
ALLACRE	Acres	Total number of acres farmed	605.4	339.9
ASSETS	$	Total value of farm assets	1,973,065	1,753,276
NETINC	$	Total net farm income	363,089.7	210,301.4
TOTMILK	Pounds	Total milk produced by herd	5,721,313.9	5,808,589.8
RSCC		1,000,000 – somatic cell count	729,287.5	114,553.6

We chose to employ a model with four inputs and three outputs. (The data are summarized in Table 1.) The inputs are the total number of employees (EMPTOT), the number of milking cows in the herd (HERDSIZE), the total number of acres (rented and owned) farmed (ALLACRE), and the total value of assets invested in the business (ASSETS). These inputs represent land, labor, and capital. These are combined to produce financial returns measured by total net income (NETINC), milk (TOTMILK), and milk quality (RSCC). The somatic cell count (SCC) is a measure of milk quality. Lower levels are preferred to higher levels. In general, DEA outputs should be established such that higher levels are preferred. Thus, we revised the farm's SCC by subtracting it from one million. Thus, higher quality milk is now represented by greater numbers.

To test for statistically significant differences in DEA efficiency by specific HRM practice, listed below, we calculated a DEA efficiency score (based on the model described above) for each DMU based on the set of DMUs that could be included in each analysis. (Some did not respond to one or more questions so we were unable to categorize them.) We then used a Wilcoxon-Mann-Whitney Rank Sum test to assess differences between the group that did versus those that did not employ the practice. The test requires four steps.

1. Order the DEA scores from highest to lowest.
2. Give rank scores to the data, using the midpoint value for ties
3. Sum the rankings for each group
4. Calculate a t-statistic based on the following equation

$$T = \frac{S - m(m+n+1)/2}{\sqrt{mn(m+n+1)/12}}, \tag{2}$$

Where S is the sum of the rankings for one group, m is the number of DMUs in that group, and n is the number of DMUs in the other group. T is approximately distributed as a standard normal distribution. Summary statistics on the sample farms' DEA efficiency scores are reported in Table 2.

Table 2. Summary Statistics for DEA Efficiency Scores of Sample DMUs

Measure	*Value*
Mean	0.94
Median	1.00
Standard Dev.	0.094
Minimum	0.65

4. Results

We assessed differences between groups of DMUs based on six different practices. Table 2 provides the details about the basic results. You can see that many of the analyses yield very low T-statistics. Indeed, four of the six are less than unity. Here, we briefly describe each comparison and then draw broader conclusions about the work.

4.1 DESCFULL

HRM experts generally agree that workers perform better when they have a clearly defined job description that includes a list of responsibilities, indicates the employee's position in the organizational chart, and any other pertinent information. The data show that 50 percent of the farms employed job descriptions for their full-time employees. Those farms for which DESCFULL=1 had a mean DEA efficiency score of 0.91 while those who did not had a mean score of 0.97. Statistically, the T statistic of 1.97 is significant at the five percent cutoff.

Table 3. Results of Analysis of Differences in DEA Scores of Farms Grouped by HRM Practice

Variable	*Description*	*n*	*% using practice*	*T*	*Mean DEA; Variable = 1*	*Mean DEA; Variable = 0*
DESCFULL	Uses job descriptions for all full-time employees	38	0.50	1.97	0.91	0.97
HISPNC	Has at least one Hispanic employee	40	0.30	0.01	0.95	0.93
QUALPERK	Offers a pay bonus based on milk quality	40	0.13	0.00	0.91	0.94
REVWFULL	Provides at least annual reviews for full-time employees	40	0.30	0.13	0.94	0.93
TRANFULL	Has a training program for full-time employees	38	0.90	1.43	0.94	1.00
SOPMILK	Has adopted a standard operating procedure for milking	40	0.435	0.90	0.93	0.94

4.2 HISPNC

Thirty percent of the sample farms had at least one Hispanic employee. While this is not an HRM practice, *per se*, the employment of Hispanic workers may indicate something about the farmer's willingness to work with a diverse labor pool, cater to the unique needs of this population, and mentor others. Thus, we chose to analyze the data grouped in this way. While the data show that the mean DEA score is 0.95 for those for whom HISPNC=1 and 0.93 for those for whom HISPNC=0, the T statistic of 0.01 shows no statistically significant differences.

4.3 QUALPERK

Dairy farmers are eligible for bonuses in their checks from the milk cooperative if they provide high quality milk. Thus, some choose to pass part of the bonus along should the employees perform in a way that leads to higher milk quality. This analysis is problematic because only five of the farms used such a bonus. Nonetheless, the average DEA score is 0.94 for those who do not offer a bonus for milk quality versus 0.91 for those that do offer a bonus.

4.4 REVWFULL

An annual (or more frequent) performance appraisal, accompanied by a one-on-one discussion with a supervisor, allows the employee to understand the supervisor's evaluation of performance, strengths and weaknesses, and any recommendations for improvement. If done properly, these can steer employees toward better performance. In our data, only thirty percent of the farms used this practice. There is no evidence of statistical differences between the two groups. The mean DEA score for those that did use this practice is 0.94 while it is 0.93 for those that do not.

4.5 TRANFULL

Providing training for the employee allows the farm owner to be sure that the employee knows how to perform the tasks required of them. A training program can take many forms; mentoring, videos, on-the-job-training, shadowing, etc. The data indicate only that a training program does or does not exist for full-time employees. Unfortunately, because the question was rather vague, only four farms indicated that they did not have such a program. Those farms each had a DEA score of 1.00. The others had a mean DEA score of 0.94.

4.6 SOPMILK

If implemented appropriately, standard operating procedures (SOPs) assure that a particular task is performed consistently. When working with cows, this is important. Cows appreciate a routine that does not change. This makes them more comfortable which may lead to higher levels of production. Thus, we analyzed differences between those farms that employed a milking SOP and those that did not. There is no evidence of a statistical difference between the two. Those that do not have an SOP had a mean DEA score of 0.94 while those that did have a mean score of 0.93.

5. Discussion

It is clear that these data yield little support for differences between groups based on adoption and implementation of HRM practices. Although DESCFULL is nearly significant at a 5 percent level, those farms that did not use this practice had higher DEA scores, on average. This is a counterintuitive finding.

Because these data were collected with the objective of describing "successful" dairy farmers, the data do not necessarily represent the population of dairy farmers. We might find more variability in DEA efficiency scores, and thus more significant differences between groups, with a sample that includes farms that might not have been good candidates for the survey. We believe, however, that this work represents an important first step in understanding the contribution of HRM practices to farm success, as measured here by the efficiency with which "inputs" generate "outputs." As noted previously, statistically significant linkages between HRM and firm profits have been shown to exist outside of agriculture. If the same holds true in medium- to large-scale agriculture, then agriculture should consider adopting some of the types of HRM programs seen in other sectors.

A logical extension of this work would be to assess these relationships on a more diverse, and maybe larger, set of farm operations. It might also be worthwhile to assess those farms that truly have an HRM program, as opposed to individual practices. Each of these practices comprises only a small portion of a program on a farm operation. If one were to indicate that a program needed to include, at a minimum, training, job descriptions, and a milking SOP, for example, we could group based on those that have a program and those that do not. This might shed more light on how a comprehensive program, as opposed to individual practices, might affect DEA efficiency.

One key conclusion is that the data must be available to analyze these relationships. Large data sets, such as those collected by Cornell or USDA-ERS have not included specific HRM practices. Hyde, Stup, and Holden (2008) set forth a theoretical argument for assessing HRM practices (or programs) as labor-augmenting technology. That is, just like capital, these practices may improve the productivity of the labor on the farm. All else equal, that should have positive effects on the outputs measured here; profitability, milk output, and milk quality. To test their theory, however, better data are needed.

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