

Technology Use and Business Performance on Wisconsin Dairy Farms¹

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July 2007

Introduction

This study addresses technology adoption by dairy farms in Wisconsin. Determining the impact of technology on business performance is the goal of this study. The results from this study provide empirical evidence supporting the possible farm business impact of a specific technology adoption.

Technology adoption has occurred in agriculture for generations.³ The transition from animal powered to machinery powered agricultural production early in the 20th century is one example. Hybrid seed adoption in the 1940's and 1950's and the chemical revolution of the 1950's and 1960's are examples. Genetically Modified Organisms would be another example. Recently, information oriented technology like computers, cell phones and geographical information systems have become available. The general argument for this continuous pattern of technology adoption centers on a basic economic fact: farm businesses operate in a competitive market structure and lack control over output price. With no control over output price, farmers pursue other options for creating additional profit margin. Technology should improve the productivity of a farm business' resources, increasing output per unit of input and, depending on technology cost, create additional profit. It's this drive for additional profit that encourages technology adoption.

The technologies investigated in this study are: Bovine Somatotropin (BST) use, Total Mixed Ration (TMR), Milking System, Primary Housing Type and Free Stall Housing Type. This study considers each of these as separate, stand-alone technologies. Milking systems compared include Pipeline, Pit Parlor and Flat Barn. Primary Housing Type comparison is between Free Stall and Stanchion. Free Stall Housing type comparisons included 3 row, 4 row, and 6 row curtain sided.

¹ This project was supported by a Federal Administration Extension Grant from the USDA Cooperative State Research, Education and Extension Service.

² Department of Agriculture Economics, University of Wisconsin – River Falls. The author would like to thank the Center for Dairy Profitability for providing the data and Drs. Gary Frank(CDP) and Nate S. Splett (UW-RF) and for their editorial & collegial review.

³ Cochrane, Willard W. The Development of American Agriculture: A historical analysis. – University of Minnesota Press, 1981.

Various technologies are often adopted in combination with other technologies suggesting positive synergies and correlations exist between technologies – Free Stall housing and Pit parlor milking systems are adopted together, for example. This study does not consider those overlapping, synergistic aspects of technology; rather it treats each technology as independently generating a set of business performance parameters.

Data and Methodology

The Agriculture Financial Advisor (AgFA©)⁴ data set was used for this study. AgFA is a sample of Wisconsin dairy farms from which financial and production data are collected annually. This study used 2005 data composed of a sample of approximately 600 dairy farms. Table 1 compares the herd size distribution of the AgFA sample with the population of Wisconsin dairy farms. The AgFA sample is over represented in the 50 cow and above herd sizes and under represented in the less than 50 cow herd sizes relative to the Population.

Table 1
2005 Wisconsin Dairy Farm Size Groups: Population vs AgFA⁵

Size (head)	Population	AgFA
1-29	14.4%	1.8%
30-49	25.5%	15%
50-99	41.8%	48%
100-199	12.1%	20%
200-499	4.9%	10%
500+	1.3%	4.6%

This creates a potential problem when inferring statistical results from the AgFA sample to the general population. Since technology tends to favor adoption by larger farms, the over representation of large dairy farms in the sample may bias results.

Hypothesis Testing is the statistical procedure used in this study to identify differences between technology adopters and nonadopters. The P-values presented in Tables 2 through 6 are a component

4 AgFA© (Agriculture Financial Advisor) – <http://cdp.wisc.edu>. AgFA© is an active/real time database for collecting and analyzing data.

5 2006 Wisconsin Agricultural Statistics. Department of Agriculture, Trade and Consumer Protection, October 2006.

of the hypothesis testing process. The P-value provides an indication of the probability of a difference existing between two groups (technology adopters and nonadopters) with the smaller the P-value, the larger the chance of a difference. P-values of 10% or less usually indicate a difference, referred to as statistically significant, between two groups and will be the criteria of measure used in this study. The Hypothesis Testing procedure requires a Null Hypothesis for each attribute studied. A hypothesis is simply a statement about the value of the attribute for each of the two groups. In all cases the Null Hypothesis, given the symbol H_0 , states that the arithmetic means of the two groups are NOT statistically different. In this study, rejecting the Null Hypothesis requires a P-value of 10% or less and suggests there is a business performance attribute difference between those farms that adopt technology and those that don't.

Results

Results are presented in Tables 2 through 6. Each table presents group means and P-values for five business performance measures selected because of their importance in the technology adoption process. Rate of Return on Assets (ROROA) is used as the profit measure. The impact on profit should be the most important deciding factor for the farmer-adapter. Milk per Cow is used to capture the impact of technology adoption on physical production. Income per Cow is used to measure the impact of technology on revenue generation. Finally, two total cost measures are presented, one on a per cow basis and the other on a cwt of milk produced basis.

BST

BST or Bovine Somatotropin is injected into cows to increase milk production. As BST increases milk production, how does it impact business performance? The true test of any technological innovation and the critical determinant of its adoption is solid evidence of financial benefits especially increased profit.

Two comparisons of BST use were made: Nonusers were compared to Users as well as to dairy farms using BST on more than 50% of the herd (*Users above 50%*). Table 2 shows the results. The sample means for each group are presented as the P-value. If the P-value for a particular attribute is 10% or less then a probable, or statistically significant, difference can be assumed to exist in the population between the two groups. For instance, in the Nonusers vs Users part of the table, the mean ROROA for nonusers of BST is 4.53%, for users it is 6.48% and the P-value is 0%. The 0% P-value indicates that the Null hypothesis(H_0) is rejected and the difference in ROROA between

BST nonusers and users and direction of difference is statistically significant which means there is a high probability that users of BST have higher ROROA than nonusers. Other statistically significant differences between nonusers and users are as follows: BST users have higher Milk per Cow, Income per Cow and higher Total Cost per Cow which is likely due to greater cow nutritional needs and technology costs. The costs however don't increase by as much as income which results in higher ROROA. There was no statistical difference in Total Cost per Cwt between the two groups.

Table 2
BST use and Business Performance

Attribute	H ₀ : Nonusers = Users			H ₀ : Nonusers = Users above 50%	
	Means		P-Value (%)	Means	P-Value (%)
	Nonusers	Users		Users above 50%	
ROROA (%)	4.53	6.48	0	7.99	0
Milk per Cow (lbs)	19,241	21,668	0	23,706	0
Income per Cow (\$)	3,851	4,403	0	4,689	0
Total Cost per Cow (\$)	3,512	3936	0	4,192	0
Total Cost per Cwt (\$)	18.59	18.78	36	18.06	19

The statistically significant differences between Nonusers and BST Users above 50% of the herd are similar to the Nonuser vs User results: BST users above 50% of the herd have higher Milk per Cow and Income per Cow and higher Total Cost per Cow. The income increase however exceeds the cost increase creating additional margin for the BST users above 50% of the herd and thus higher ROROA. There was no difference in Total cost per Cwt between the two groups.

Total Mixed Ration (TMR)

Using a TMR provides the feed to cows with greater physical efficiency and accuracy. Feed costs represent a sizable percent of a typical dairy's production costs, and as such, how does TMR adoption impact milk production and financial performance? Table 3 presents group mean and P-value information for TMR nonusers and users.

Table 3
TMR Use and Business Performance

Attribute	H ₀ : Nonusers = Users		
	Means		P-Value(%)
	Nonusers	Users	
ROROA (%)	3.92	6.64	0
Milk per cow (lbs)	18,745	21,580	0
Income per cow (\$)	3,703	4,316	0
Total Cost per cow (\$)	3,403	3,856	0

Total Cost per cwt (\$)	18.57	18.14	16
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Dairy farms that use TMR technology have significantly higher Milk and Income per Cow and also Total Cost per Cow but as is the case with BST, the income increase exceeds the cost increase resulting in significantly higher ROROA. There is no statistical difference in Total Cost per cwt between the two groups.

Primary Housing Type

Cow housing technologies considered are Stanchion and Free Stall. Housing type usually dictates a milking system where Stanchion housing would normally use a Pipeline milking system while Free Stall would use a Pit Parlor. Thus, as noted earlier, it's problematic attempting to isolate the impact of individual technologies. The results comparing Stanchion to Free Stall housing are presented in Table 4.

Table 4
Housing type and Business Performance

Attribute	H ₀ : Stanchion = Free Stall		
	Means		P-Value(%)
	Stanchion	Free Stall	
ROROA (%)	4.06	7.98	0
Milk per Cow (lbs)	19,777	21,671	0
Income per Cow (\$)	3,976	4,255	0
Total Cost per Cow (\$)	3,638	3,776	4
Total Cost per Cwt (\$)	18.74	17.71	1

These results are similar to BST and TMR adoption. Dairy farms using Free Stall housing technology have significantly higher Milk and Income per Cow and also higher Total Cost per Cow but the income increase exceeds the cost increase resulting in significantly higher ROROA. Total Cost per Cwt is significantly lower for Free Stall compared to Stanchion housing. While not investigated, the lower cost per cwt may have part of its explanation related to dairy farm size.

Milking System

The milking technology used should theoretically impact business performance because of its impact on the productivity of the producer's labor and capital. The three systems evaluated are:

1. Pipeline-- the system usually associated with stanchion housing.
2. Pit Parlor -- system of fixed milking units surrounding a pit within which the milker works.
3. Flat Barn --similar to the Pit Parlor but without the pit.

The results are presented in Table 5.

Table 5
Milking System and Business Performance

	H₀: Pipeline = Pit Parlor		H₀: Pipeline = Flat Barn		H₀: Pit Parlor = Flat Barn	
	Means		P-value (%)	Mean	P-value (%)	P-value (%)
Attribute	Pipeline	Pit Parlor		Flat Barn		
ROROA (%)	4.06	8.48	0	7.29	1	22
Milk per cow (lbs)	19,800	21,309	0	21,193	3	44
Income per cow (\$)	3,971	4,219	1	4,135	20	32
Total Cost per cow (\$)	3,643	3,700	25	3,688	39	47
Total Cost per cwt (\$)	18.74	17.65	1	17.83	17	41

Comparing Pipeline to Pit Parlor technology, farms with Pit Parlors have significantly higher Milk and Income per Cow, no statistical difference in Total Cost per Cow and significantly lower Total Cost per Cwt, resulting in significantly higher ROROA.

When comparing Pipeline to Flat Barn technology, Flat Barns have significantly higher Milk per Cow but no statistical difference in Income per Cow, Total Cost per Cow or Total Cost per Cwt although the group means do favor Flat Barn technology. ROROA is significantly higher for Flat Barn technology farms.

Finally, there is no statistical difference between Pit Parlor and Flat Barn technology in terms of the attributes noted in Table 5.

Free Stall Housing Type

Different types of Free Stall housing technology includes 3 row curtain side, 4 row curtain side and 6 row curtain side. The results are presented in Table 6.

Table 6
Free Stall Housing Type and Business Performance

Attribute	H ₀ : 3 row = 4 row		H ₀ : 3 row = 6 row		H ₀ : 4 row = 6 row	
	Means		P-value (%)	Mean		P-value (%)
	3 row	4 row		6 row		
ROROA (%)	6.58	8.70	12	12.14	0	3
Milk per cow (lbs)	20,917	22,020	9	23,690	0	3
Income per cow (\$)	3,950	4,446	1	4,623	0	20
Total Cost per cow (\$)	3,655	3,909	9	3,807	12	29
Total Cost per cwt (\$)	17.85	18.08	43	16.20	2	4

Comparing 3 row to 4 row curtain sided Free Stall housing, farms with 4 row technology have significantly higher Milk per Cow, Income and Total Cost per Cow with no statistical difference in Total Cost per Cwt or ROROA.

Comparing 3 row to 6 row curtain sided Free Stall housing, farms with 6 row technology have significantly higher Milk production and Income per Cow, significantly lower Total Cost per Cwt and significantly higher ROROA.

Comparing 4 row to 6 row curtain sided Free Stall housing, 6 row technology farms have significantly higher Milk per Cow, significantly lower Total Cost per Cwt and significantly higher ROROA.

Conclusion

This study, using Wisconsin data from the Agriculture Financial Advisor (AgFA©) database, attempts to measure the impact various technologies have on dairy farm business performance. Although correlation and interdependency exists between technologies, this study tries to measure the impact of each technology independently of any other technology coexisting simultaneously on a farm.

Some of the results were expected. For instance, Milk Production per Cow was significantly higher for farms using BST, TMR, Free Stall compared to Stanchion housing, Pit Parlor or Flat Barn compared to Pipeline milking systems. Similarly, Income per Cow was significantly higher for farms using BST, TMR, Free Stall and Pit Parlor compared to Pipeline. Also, ROROA was significantly higher for farms using BST, TMR, Free Stall and Pit Parlor or Flat Barn compared to Pipeline. Finally, farms using Free Stall housing had lower Total Costs per Cwt when compared to Stanchion and the Pit Parlor milking system had lower Total Costs per Cwt when compared to the Pipeline milking system.

Some of the results were unexpected. Theoretically, technology should increase production per unit of input thus reducing costs per unit of production and increasing profit. While increases to production, income, and profit are noted, the decrease in cost per unit of production was not statistically identified except in two cases - Free Stall housing compared to Stanchion and the Pit Parlor milking system compared to Pipeline. In some cases, the opposite was true. For instance, Total Cost per Cow was significantly higher for adoptors of BST, TMR and Free Stall housing. This isn't surprising given technology acquisition costs and the additional operating costs, such as feed, associated with some of these technologies. Total Cost per Cwt of milk produced, which captures the increased milk production associated with technology adoption, was statistically similar for farms using BST and TMR compared to nonusers. Farms using Flat Barn milking system technology compared to Pit Parlor or Pipeline also had statistically similar Total Cost per Cwt of milk.