Decision to Adopt and Exit Best Management Practices by Dairy Farmers

Larry M. Hall

Krishna P. Paudel

Wayne M. Gauthier

John V. Westra

Department of Agricultural Economics and Agribusiness

101 Agricultural Administration Building

Louisiana State University

Baton Rouge, LA 708100

Phone: 225 578 3282

Fax: 225 578 2716

Corresponding Author: lhall2@lsu.edu

Preliminary Draft - Do not Quote

Selected paper prepared for presentation at the American Agricultural Economics Association Annual Meeting, Portland, Oregon, July 29 - August 1, 2007.

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Abstract

Dairy farmers in Louisiana were surveyed to find out the factors leading these farmers to terminate best management practices. Results indicated that only few farmers have exited the practices once they adopt those. However, the longevity of best management practices adoption can be increased by emphasizing on education and targeting to operators who have already been in dairy practices for a longer time period.

Key words: Best management practices, dairy, entry, exit, Louisiana

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Best management practices (BMPs) are voluntary practices recommended by the USDA under the Environmental Quality Incentive Program (EQIP) to overcome nonpoint source pollution. Government supports up to 95% of the total cost to implement these practices but still the adoption rate of the BMPs are not at the rate that the policy makers like to see. The main contention regarding the adoption has been its cost which is private in nature and benefit that is public in nature. Therefore, the adoption and thereafter continuation of these practices have been of a serious concern. Most of the past studies on adoption uses probit/logit model to explain the probability of a firm adopting a new technology at a time. There is a lack of study explicitly addressing the time path of adoption which is an important aspect for adoption of environmental practices like BMPs which generally have contract obligation for as long as ten years.

Dairy Production in Louisiana is an important agricultural enterprise contributing significantly to the income of farmers in the three-parish-area of Washington, St. Helena and Tangipahoa. Dairy farmers in the region are also blamed for environmental pollution due to which there has been a closure of popular recreational area. Additionally, nitrogen leaching and volatilization and phosphorus runoff from dairy operation and land application of manure have compromised the integrity of ecosystem health in the watersheds encompassing these parishes. Having situated on the North of a very productive Lake Ponchartrain Basin, dairy production in these parishes is also blamed for the elevated level of N in waterbodies in the basin. To overcome these pollution concerns, dairy farmers in the region are adopting best management practices with the assistance from the USDA/NRCS program and cleaning their manure lagoon more responsibly with the help of Lake Pontchartrain Basin Foundation financial support.

USDA/NRCS in collaboration with the Louisiana State University Agricultural Center have recommended eighteen different best management practices for the farmers to adopt to address environmental concerns in the region. Out of these eighteen best management practices, Paudel *et al.* report that farmers have adopted waste management lagoon and waste management practices extensively. However, the other best management practices have not been adopted and efforts need to be put to increase the adoption of these BMPs in the dairy farming operation. In addition to the low adoption of BMPs, there is also concern that farmers once adopted may not continue these practices because some of the practices are costly and BMPs adoption is done voluntary. Additionally, the cost share contractual agreement obligates them to adopt these practices for maximum of 10 years. Our objective in this paper is to find the characteristics of the farmers who have adopted best management practices and stayed adopting those practices. We also identify the characteristics of farmers who have adopted these practices in the past but had since exited from adopting the BMPs. We used survey data collected from Louisiana dairy producers to identify the variables determining the entry and exit from adopting best management practices.

Literature Review

Adoption of BMPs may be influenced by market structure. Research into adoption of innovative technology showed those firms not participating in a concentrated market will adopt the technology sooner than firms who do not fit that description (Levin *et al.*). The Louisiana dairy industry may be classified as low concentration since the industry is composed mainly of many

small farms. Therefore, these producers should adopt best management practices early if there is profit to be made from adopting the practices.

Theoretical literature has recognized that incentive based policies can achieve a higher adoption rate compared to conventional regulations such as technological or performance standards. BMP adoption is an incentive based approach as a cost-share percentage paid by the Federal government provides the incentive for adoption. Kerr and Newell showed that adoption of technology increased as cost to the firm falls. They further added that firms with lower benefits and higher costs will adopt more slowly. BMP adoption by the dairy farmers should increase if more cost share is provided to the dairy producers to adopt these environmentally friendly practices.

Socioeconomic characteristics of the dairy farm operator may have an impact on BMP adoption. Gould and Saupe researched these factors and determined that investments in human capital yielded positive and measurable results. The level of education of the dairy farm's principal operator may have an impact on entry or exit of adoption. The use of a personal computer may increase informational awareness concerning environment benefits of adoption and thus increasing human capital. On-the job experience is another way to increase human capital concerning dairy farm operation

A barrier to entry may be the cost of capital to implement the BMP. MacDonald found that capital commitment deters both entry and exit of firms into and from the U.S. food manufacturing industry and sunk physical capital costs acts as a general barrier to mobility of resources. Even with a substantial governmental cost-share, the dairy producer may refuse BMP implementation.

Size of the dairy farm may play a role in entry and exit of BMP adoption. Dunne and Roberts determined in firm entry and exit patterns in U.S. manufacturing industries that there was significant variation in the entry patterns and subsequent size and exit patterns for different categories of those entrants. Larger firms that enter are less likely to exit than smaller firms. Baldwin and Gorecki showed that exit is not solely a small-firm phenomenon. Larger size firms did not experience exit (close down) rates of zero. This study used estimated net farm income as a proxy for size (capitalization) to determine the relationship between farm size and BMP entry and exit.

Hopenhayn developed and analyzed a dynamic stochastic model for a competitive industry that endogenously determined entry and exit and introduced the term "stationary equilibrium." This concept implies that in the steady state as many firms were entering as exiting as well as job creation and destruction.

Method

To address BMPs adoption decision at first and then ultimately decide to terminate BMPs in a farm, we employ a proportional hazard model. A proportion hazard model helps to analyze the effect of economic and regulatory variables on adoption and exit decision by dairy producers with respect to adopting new environmental friendly technology. The hazard model is appropriate because our focus is on the timing of new technology.

We followed Wooldgridge (2002) to develop our theoretical model. Indicate an initiate state as an adoption of a BMP by a dairy farmer. T is the time measured in years until the dairy farmer discontinues the BMP in his farm. The cumulative distribution function of T is defined as

F(t) = P(T $\leq$t), here t denotes a particular value of T. The survival function, defined as the probability of a farmer adopting BMP past time t, is s(t) = 1-F(t) = P(T>t).

We assume a random draw i from dairy producers in Louisiana. Let $a_i \in [0,b]$ denote the time at which dairy farmer i adopts BMP, let t_i^* denote the length of time which s/he adopts a given BMP and let x_i denote the vector of observed explanatory variables. Assume that t_i^* has a continuous conditional density function $f(t \mid x_i;\theta); t \geq 0$ where θ is the vector of unknown parameters. To account for the right sensoring, we assume that the observed duration t_i is obtained as $t_i = \min(t_i^*, c_i)$. We assume that conditional on the covariates, the true duration is independent of the starting point a_i and the censoring time c_i. The conditional distribution D(.) can be written as $D(t_i^* \mid x_i, a_i, c_i) = D(t_i^* \mid x_i)$. Letting d_i be a censoring indicator (1/0 variable), the conditional likelihood for observation i can be written as:

$f(t_i \mid x_i, \theta)^{d_i} [1 - F(t_i \mid x_i; \theta]^{1-d_i}$.

If we have data on (t_i, d_i, x_i) for a random sample of size N, the maximum likelihood estimator of θ is obtained by maximizing:

$$\sum_{i=1}^{N} \{d_i \log[f(t_i \mid x_i;\theta)] + (1-d_i)\log[1 - F(t_i \mid x_i;\theta)]\}$$

The coefficients are then estimated using a maximum likelihood approach.

We estimated the parameterized baseline hazard approach for adoption and exit decisions. For robustness of the model, we conducted sensitivity analyses assuming that a hazard function possesses exponential, lognormal, log logistic, and Weibull density functions. These assumptions allow for the possibility that the baseline hazard increases or decreases over time.

Data

Data were collected using survey of dairy farmers. The survey was conducted using the tailored design method (Dillman). A focus group, consisting of dairy farmers and county agents from the three parishes in the principal milk production area of Louisiana, was used to help design and pre-test the survey instrument. The survey was mailed to all 325 Louisiana dairy farmers with an option to complete the survey online. Two weeks after the initial mailing, non-respondents were contacted with a postcard reminder request to complete the survey. A second round of surveys was mailed to dairy farmers three weeks after the first round. To further encourage participation, payments of $10 per survey for the first fifty fully completed surveys were promised along with an opportunity for all respondents to qualify for a $250 lottery cash prize drawing. The size and number of payments offered were limited by the availability of funds. A graduate student repeatedly contacted dairy farmers by phone requesting survey completion.

The twelve-page survey had four distinct sections including dairy manure disposal, milk reduction programs, dairy best management practices (BMP) adoption, and socio-economic characteristics of the principal operator. One section of the survey asked questions related to the adoption of best management practices (BMP) in terms of: 1) cost shares and EQIP incentive payments; 2) sources of information most important in making the adopt/non-adopt decision; and 3) the role of USDA-NRCS in the responder's adoption or non-adoption decision. Eighteen BMPs identified by USDA-NRCS as most appropriate for Louisiana dairy farms were identified in terms of cost-share or EQIP incentive payment per practice. A common format used in presenting each of the eighteen BMP practices and in eliciting responses is follow:

Residue Management or Conservation Tillage Practices (NRCS code 329A, B, C): *A system designed to manage the amount, orientation and distribution of crop and other plant residues on the soil surface year round (such as No-till, Strip-till, Ridge-till and Mulch-till systems). Incentive payment =$10 -15 per acre, 100 acre limit, 2-3 years.*

Have you adopted this BMP on your farm?

[ ] YES → **If YES, in which year? If stopped, in what year_____?**

Total Incentive Payment received for this BMP $_____ per acre

[ ] NO → **If NO, would you adopt this BMP on your farm?**

[ ] YES

[ ] NO

[ ] Not suitable for my farm

The BMP was described in the survey and identified with its USDA-NRCS code number and an estimated reference cost. The BMP reference cost was an average cost based on adoption information of the BMP in Louisiana between 1997 and 2001.

Results

The model specified in the method section is estimated using the SAS software. We estimated the right sensored model assuming the hazard density function as Weibull, log logistic, logistic, log normal and gamma functions. Descriptive statistics of the results indicated that there were 133 observations. Only four of these eighteen BMPs were adopted and then later on discontinued by operators. Some of the BMPs were adopted as early as 1952. Observing closely, we found that almost half of the BMPs have been adopted by the farmers even before the start of the EQIP program in 1997. The average retention time for the BMPs was close to 15 years. We have also found that more than half of the farmers own computers. Almost all of the operators are male and one of the spouses worked off-farm. This is perhaps to supplement income from

dairy farming. Additionally, twenty five percent farmers said their farm is close to a subdivision. This indicates continuous development of subdivisions in these parishes probably because people from New Orleans have been moving up to these parishes.

Results from survival analysis were not encouraging as almost all of the parameters estimated came out to be insignificant. Therefore, we are not going to discuss these results. However, the results are presented in Table 2. Because of the insignificance of the parameters estimated, we resorted to an OLS method to describe whether the time duration a BMP has been adopted has any relationship with farm and operator characteristics. We have series of BMPs with each adopted at different length of time by the dairy farmers. We regressed this duration (or length of time a BMP is adopted in the farm) to four explanatory variables. Most of these variables are also the variables that Paudel *et al.* have selected in their study. The first variable used is the number of years the operator has worked in the farm. If an operator has been familiar with the dairy farming, s/he would know the practices that would help to reduce pollution and also help to abide by the existing environmental regulations. Education is the second variable we have chosen as an explanatory variable. It is likely that higher educated individual would be more conscious about environment and would therefore adopt BMPs for a longer period. Therefore, we expect this variable to have a positive sign. EQIP is a binary variable with adoption done before 1997 getting 0 value or 1 otherwise. This is the year that the government has started the EQIP program. Income share is a continuous variable indicating the share of income from a dairy operation. The more dependent is a farmer in a dairy operation, the less likely is that he would have extra money to adopt BMPs or to that matter able to cost share the needed expenses to adopt BMPs. Therefore, we hypothesized a negative coefficient associated with this variable.

Our results provided signs of the parameters consistent with our *a priori* belief. However, we did not find age and income-share to be significant. EQIP and education variables had positive signs. EQIP indicated that if a BMP has been adopted after 1997, it is less likely to be adopted for a long time. This may be because our observations are right sensored after 2004. Or it could be that farmers would implement the practice and terminate the practice after they are no longer obligated to continue it. Education increases the longevity of BMP adoption. A farmer who has a college education would like to increase the adoption duration by four years.

Conclusions

We examined the behavior of dairy farmers to adopt or exit BMP practices. We estimated right sensored hazard model but the parameters of the model were found to be insignificant. When the duration of BMP adoption is regressed on age that operator has been in a dairy farming practice, education of the operator, a binary EQIP variable and income share, we found consistent sign across these parameters. We also found education to have a positive significant effect in the longevity of adopting a given BMP practice. Therefore, this study indicates a need to target educated farmers to promote best management practices to get the most benefit. Additionally, longer the individual has been in a dairy business, he is more receptive to adopting these environmental practices.

Table 1. Descriptive Statistics:

Variable	Label	N	Mean	Std Dev	Minimum	Maximum
Entry	Entry	133	1989.14	10.3241273	1952.00	2004.00
Exit	Exit	133	45.0225564	297.4965868	0	2002.00
d2a	d2a	117	52.4700855	8.7233067	26.0000000	63.0000000
d3a	d3a	102	31.6862745	18.5461588	2.0000000	60.0000000
retention1		133	14.6842105	10.3684899	0	52.0000000
age		117	26.4871795	10.5000947	7.0000000	46.0000000
age2		117	810.8803419	581.1979478	49.0000000	2116.00
education		133	0.4210526	0.4955946	0	1.0000000
computer		133	0.5488722	0.4994871	0	1.0000000
male		133	0.8872180	0.3175220	0	1.0000000
offtime		133	0.4812030	0.5015356	0	1.0000000
subdivision		133	0.2406015	0.4290648	0	1.0000000
netincome		133	1.0000000	0	1.0000000	1.0000000
censor		133	0.0225564	0.1490457	0	1.0000000
ols		133	0.0827068	0.7390116	0	8.0000000

Table 2: Parameter Estimates

Variables	OLS	PHREG	PHREG (Hazard)	Weibull	Log-logistic	Log-Normal	Gamma
Intercept	12.49633[8]			43.5153	43.1695	24.7616	15.196
Age	0.09764	-0.03763	0.963	0.0455	0.0463	0.054	0.0457
Education	4.33339[8]	16.98261	23738601	-37.151	-36.9359	-17.5661	-8.598
EQIP	-13.0486[8]	1.51848	4.565	34.8445	34.72	16.2945	6.6247
Income-share	-0.00352	0.00583	1.006	0.0073	0.0074	0.0081	0.0064
Scale				1.4479	1.4274	3.2967	2.5588
Weibull/Gamma				0.6906			0.0945

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