

**DAIRY PROGRAMS TO REDUCE MANURE-RELATED ENVIRONMENTAL PROBLEMS: THE CASE OF THE LOUISIANA MILKSHED**

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**ABSTRACT**

Decreasing the amount of dairy manure by lowering the population of dairy cows is one route for coping with the problems associated with dairy manure. In Louisiana's major milkshed, a recent survey of dairy gave insights into rules that would both reduce levels of dairy manure and minimize conflicts with efficiency and equity. Payments to dairy producers for undertaking voluntary practices that either reduce cow numbers or mitigate environmental damages associated with dairy manure were more acceptable than mandatory programs. This study uses the "cheap talk" method to elicit values for willingness to accept (WTA) payment to participate in the milk diversion program (MDP) or the dairy termination program (DTP). The study compares the survey respondents' participation and amounts received in the MDP twenty years ago to hypothetical WTA payments if the programs were to be instituted today. Logistic and tobit regression models were used to identify the factors affecting dairy program participation and levels and reported bid values submitted by producers. Results indicated that past participation is the key variable in explaining future participation in a voluntary milk reduction program. Bootstrap results confirm that most of the estimated parameters fall within the range of the bootstrap confidence interval.

## INTRODUCTION

Manure is a natural byproduct of milk production. Unfortunately in most areas, it is a problematic byproduct because current technologies and price relationships do not provide sufficient incentive for it to be used profitably as a soil amendment in environmentally sensitive areas. Because of landscape characteristics and the concentration of cows, manure from Louisiana's major milkshed contributes significantly to the degradation of local waterbodies. The challenge then, is to design a program that addresses both physical limitations and economic constraints so that the positive economic returns from milk production in the milkshed are maintained or increased while the costs of environmental degradation attributable to the concentration of dairy cows is minimized. A reduction in the number of cows within the milkshed offers some resolution but at both public and private costs.

A reduction in the number of cows entails private costs to the dairy producer because the reduction in cow numbers reduces the productive capacity of the farm. Thus, such reductions are not likely to be made unless society is willing to incur public costs to offset those private economic losses. The private cost to a dairy producer from reducing the productive capacity of the farm includes, but goes beyond quantifiable economic costs, because of the dairy producer's unique socio-economic attributes. Policymakers are charged with designing programs that offset private costs enough to entice a sufficient number of producers in the milkshed to reduce the number of cows and thus the quantity of manure in the milkshed to more socially-acceptable levels. Any program designed to accommodate the interests of both producer and society must address the conflict among freedom, efficiency, and equity inherent in both the physical and economic dimensions of the problem.

A voluntary program open to all dairy producers addresses the requisite of freedom. Equity and efficiency principles are addressed through the resolution of society's willingness to pay and the dairyman's willingness to accept payment. This value, similar to the private cost of participation, is unique because of the socio-economic attributes of the dairy producer.

The program designed by policymakers consists of a set of rules designed to resolve the conflicts among these three principles at a minimum cost to society. The information gathered from a survey of dairy producers helps design rules that aim to achieve desired reductions in dairy manure at minimum costs and conflict between society and dairy producers.

The socio-economic attributes of dairy producers are key determinants in the success of a cow reduction program because they influence levels of participation and public costs. Past programs to reduce cow numbers had the objective of enhancing farm level milk prices and reducing costs of the dairy price support program. Serendipitously, these programs also helped to reduce pollution attributable to milk production. This article examines how reduction in cow numbers may

reduce manure production or the adverse impacts of manure on the environment. Ancillary and serendipitous effects include price enhancements and reductions in the costs of the dairy price control program. The purpose of this article is to identify and describe characteristics of dairy producers most likely to participate in a voluntary program to reduce cow numbers, and to identify the level of payments necessary to enlist their participation. More specifically, the study aims

- i) To identify levels of Louisiana dairy producer participation and payments in the two milk supply reduction programs implemented in the mid-1980s, and their willingness to participate in similar programs in the future;
- ii) To determine the level of bid values necessary to entice dairy producers to participate in a future voluntary milk supply reduction program with features similar to a Dairy Termination Program, Milk Diversion Program, or 2003 Cooperatives Working Together (CWT) program; and
- iii) To identify factors most likely to influence a decision to participate in a voluntary milk supply reduction program by Louisiana dairy producers.

### **Environmental Impact of Dairy Production in Louisiana Watersheds**

Most of the dairy production in Louisiana is limited to three parishes located in the Pontchartrain Basin. The Tangipahoa River, which flows through the region, is known to have been affected by bacteria and nutrient pollution from dairy production in the region. Inadequate management of dairy manure has been identified as the suspected source of the total fecal coliform that impaired 66 miles of the Tangipahoa River and its tributaries in Louisiana [1, p. 17]. The Lake Pontchartrain Basin, which is of great economic and ecological significance in the region, is estimated to be the recipient of about 40% of the nitrogen and 70% of the phosphorus excreted by the dairy cows raised in adjacent parishes. Volatilized nitrogen in the amount of 5.79 million pounds per year from dairy waste is estimated to enter Lake Pontchartrain threatening the ecological integrity of the basin [2]. Significant abatement of nutrient loads from agricultural sources through adoption of BMPs has a potential to improve water quality over the entire basin [3]. Another way to reduce manure-caused water pollution is to reduce the number of cows, which is the interest of this article.

### **Past Milk Reduction Programs, Their Serendipitous Effects on Reducing Pollution and Instructive Insights for a Specific Locale**

The three programs identified in objective two were voluntary, national programs designed to: reduce the milk supply by reducing cow numbers; increase milk prices at the farm; and reduce the costs to the government of buying and storing surplus dairy products. These programs are of interest to individuals

concerned with minimizing pollution from dairy manure because a serendipitous consequence of reducing cow numbers is reducing manure production. A review identifies key features of these programs and their impacts upon behavior. The participation decision and level of bids submitted varied across the U.S. Louisiana dairy producers participated at high rates and submitted low bids [4]. Observations about participant behavior in light of program features help instruct the design of programs to minimize the loss in total milk production while simultaneously minimizing environmental degradation.

#### *Milk Diversion Program (MDP)*

Prior to the MDP, dairy programs were mandatory. The MDP was the first voluntary program implemented by the federal government and it began in 1984-1985. It provided participating producers with a fixed payment of \$0.22 per kilogram (kg) or \$10.00 per hundredweight (cwt) in exchange for 5 to 30% reductions in the milk they marketed from baseline levels. Participating producers made these reductions by first culling their least productive cows so that the percentage of cows culled exceeded the contracted levels. Because the least productive cows were culled, producers experienced lower average variable costs of production from their remaining cows. The level of MDP payments (\$0.22/kg) exceeded the fixed costs of producers for the milk contracted out of production. Thus, greater net returns were realized by producers at the contracted level.

The program did not work as fully expected in reducing total U.S. milk production because higher producing cows were retained, fed at a higher level while the cull cows that were higher producers from a participating producer replaced the low end producing cows of non-participating dairymen. The program also provided dairymen who were planning to retire with windfall payments. While the program was not necessarily effective in reducing total milk production, it did have the effect of reducing manure pollution through reductions in dairy cow numbers. Because the objective of MDP (reducing total milk production) was not achieved, the Dairy Termination Program (DTP) was initiated to reduce milk output in the United States.

#### *Dairy Termination Program (DTP)*

DTP was one of the provisions of the Food Security Act (FSA) of 1985. Under this program, dairy producer could submit a sealed bid to USDA. If the Secretary of Agriculture accepted the bid, the dairy producer agreed to completely exit dairy farming for five years with all female dairy animals being sold for slaughter or export. In exchange, the participating producers were paid their bid price for their annual historic milk production level. Amounts of money realized from participation included the DTP payment, receipts from the sale of all of their female animals, and receipts from the sale of assets specific to that dairy farm. This program was more effective than the MDP in reducing total milk production

because it totally eliminated the milk production capacity of the participating farm by removing all cows from that farm, not just the least productive. These government sponsored programs (MDP and DTP) were not repeated, but a voluntary program sponsored and administered by producers was instituted. The goal of this Cooperatives Working Together (CWT) program was to reduce milk production so that milk prices would rise.

#### *Cooperatives Working Together (CWT)*

The CWT program was developed by the National Milk Producers Federation (NMPF). The objective of the CWT program was to increase the milk prices received by dairy producers by reducing the domestic supply of milk. To date, there have been four buyouts of dairy cattle throughout the United States under the CWT program. In the first year (2003-2004), 32,724 head of cattle were retired with a reduction in milk production of 696 million kilograms. In the second year (2004-2005), 50,478 head of cattle were retired and milk production was reduced by 412 million kilograms. In the third round (2005-2006) of the CWT program, 64,050 cows were retired and milk production was reduced by 544 million kilograms. And in the most recent round (2006-2007), 53,000 cows were retired and milk production was reduced by 454 million kilograms [5].

Unlike the government programs (MDP and DTP) which were open to all producers, the CWT program, which is privately funded, is more selective in allowing dairy producers to participate. The CWT program is funded by a \$0.001/kg voluntary contribution from dairy producers and it is completely administered by the NMPF. It seeks to reduce the milk supply through whole herd retirements, reduced milk marketing and export assistant program. Selection of whole herd retirements is targeted to areas prioritized by the NMPF. The relative merits of the CWT program, with respect to its impact on large or small dairy farms and specific areas of the country, are not the topic of this article. For this article, the importance of the CWT program lies in that fact that the reductions in cow numbers it achieves also minimizes the pollution attributable to dairy farms. The objectives in this article are to discern and identify the features of these programs that most appeal to participating producers and to determine characteristics associated with producers most likely to participate in these programs.

In effect, the DTP was more successful in reducing milk production because it removed entire farms from production for a five-year period and prohibited the transfer of animals between farms. On the other hand, the MDP redirected resources from cows removed from production to cows still in production. Thus it not only enhanced production per cow, but preserved the productive capacity of the farm. If the primary objective is to minimize pollution while minimizing reductions in total milk production, the MDP would be the more effective as the reduction in cow numbers is realized from the least productive cows. Thus, more

cows and pounds of manure are removed per hundredweight of milk loss and the milk production capacity of the farm is retained.

Under conditions of a voluntary milk supply control program, the decision to reduce cow numbers rests with the dairy producer. Policymakers must be concerned with the rules they create so that dairy producers act in a manner consistent with the policy objectives. The following literature describes the variables influencing participation and the level of participation in voluntary milk supply control programs.

#### *Contributions from the Literature Regarding the Significance of Socio-Economic Attributes*

Gale studied the characteristics of DTP participants in North Carolina and Virginia to determine if human capital and lifecycle variables had any effect on producers' willingness to quit dairying [6]. Older and less experienced producers whose children were not likely to continue dairy farming were found to be more willing to participate in a dairy termination program.

Klemme provided a generic classification framework for classifying dairy producers as either turnkey, established, or debt-free [7]. Though not totally dependent on it, this classification scheme was closely related to age. Classification criteria included level of capital investment, level of debt, and length of the planning horizon. The turnkey and debt-free producers were at opposite ends of the spectrum. The turnkey producer was a relatively new entrant with a high level of capital investment, a high debt load and a long planning horizon. On the other hand, the debt-free producer had a relatively short planning horizon primarily due to age and had a relatively low capital investment that was fully depreciated and therefore debt-free. The established producer fell somewhere between these other two producer types. This framework embodied a set of socio-economic variables that rendered every dairy producer unique even among dairy farming.

Knight and Kubiak evaluated the consistency in the formats of the templates developed by extension economists in different states to help producers make decisions about their dairy termination options [8]. Though unknown until after bids were submitted, the discrete bid value that determined participation was \$0.496/kg. Because of the inconsistencies observed in formats across states, some producers may have underbid themselves given their economic condition and this effective termination value. Knight and Kubiak suggest that equity and efficiency considerations vary between locations as well as between individuals within the same location as a function of their socio-economic characteristic [8].

Because of its impact on dairy cow numbers, the DTP increased the red meat supply within a relatively short time and generated a price shock in the red meat market during the eighteen months the program was implemented [9]. However, as Dixon, Susanto, and Berry indicated, the DTP was deemed ineffectual because it did not produce a long-term reduction in milk supplies [10]. On

the other hand, the MDP had a short-term impact on the milk supply. The effect of these two programs on the milk supply was inconsistent throughout the top milk producing states. Work by Bausell, Belsley, and Smith indicated that the MDP and DTP programs were less effective in reducing costs to consumers and government than a lower support price [11]. Because of the incentives in these dairy termination programs, Zepeda asserted that they may eventually result in only large dairy farms in the United States in the not-too-distant future [12].

Both the DTP and the MDP required joint decisions by producers. The first decision was whether or not to participate. The second decision, conditional on participating, was at what level to participate (0 to 30%) for the MDP and at what level to bid for the DTP. Work by Kaiser and Lee indicated that prior participation in the MDP had a positive effect on DTP participation, but a negative effect on the bid level [4].

None of these studies concerned themselves with evaluating the impact one environmental quality from voluntary dairy supply reduction programs reducing on the number of dairy cows in an area. Dairy cow numbers have trended downward in Louisiana since 1983 [13]. In this study, we identify characteristics associated with dairy producers deciding to participate in a voluntary milk production control program. Additionally, by viewing dairy cow number reductions through the lens of a pollution reduction measure in an impacted watershed, we estimate the payments necessary to entice their participation.

### **Data and Model**

Data were collected from a survey sent to all 325 Louisiana dairies using a mail survey following the tailored designed method [14]. The survey queried producers about: Dairy Manure Disposal, the Dairy Termination Program (DTP), the Milk Diversion Program (MDP), and their adoption of specific Best Management Practices (BMPs). The DTP and MDP sections were designed to evaluate the effectiveness of these policy instruments in reducing cow numbers as a means of potentially minimizing the negative environmental impacts of cow manure. The BMP adoption section was designed to determine the willingness of respondents to pay to enhance the cow carrying capacity of their land without compromising the environment, and to identify the socio-economic characteristics of willing payers.

Survey questionnaires were mailed in the beginning of May, 2004. Two weeks after mailing the follow-up questionnaire, a reminder postcard was mailed to each nonrespondent. Follow-up questionnaires were mailed to nonrespondents three weeks after the first mailing (one week after the reminder postcard). Additionally, telephone contacts were made to nonresponding producers to encourage them to complete the questionnaire. Only 49 questionnaires were received for a response rate of 14% despite the fact that respondents were paid \$10 to answer the survey, survey was posted on the Internet, dairy farmers were contacted by

telephone follow-up calls, and extension agents made farmers aware of the importance of completing the survey. Several potential explanations exist for the low response rate. First, the current dairy industry in Louisiana is in decline; some producers on the mailing list were either out of business or had retired. Second, in conversations with producers on the phone, many expressed a sense of frustration with being constantly surveyed and they indicated they were tired of the process. A related issue is that dairy farming by its very nature is time consuming; leaving producers with little free time to pursue other “fun” activities like completing questionnaires. Last, several producers felt that nothing good ever came out of such surveys because “the price for their milk just keeps falling.” Additionally, a low response rate is not uncommon in dairy survey as found in Paudel, Gauthier, Westra, and Hall [15] and Rahelizatovo and Gillespie [16].

Analyses of the data collected were completed using logit and tobit models. In the logistic regression model we analyzed, the respondents’ willingness to participate in a voluntary milk reduction program was regressed against three explanatory variables. Mathematically, the logistic model can be represented as:

$$\text{Participation in program (YES/NO)} = \beta_0 + \beta_1 * \text{Income} + \beta_2 * \text{Age} + \beta_3 * \text{PP} + v_i$$

The dependent variable “Participation in program” indicates whether or not an individual dairy producer would be willing to participate in a dairy reduction program. The independent variables included: “income” or net returns from the dairy operation; “age” which served as a proxy for the number of years dairying; and “PP” which indicated the respondent’s participation in at least one of the past dairy programs.

Tobit models were used to identify how or at what level socio-economic characteristics of participants affected their willingness to participate in the previous and current milk supply control programs. Identifying the factors affecting the willingness to participate in such programs, and the bid level in the 2003-2004 CWT, were of particular interest as they suggest how much money would be required to encourage these producers to participate.

For example, consider a continuous random variable  $Y$ . In this instance, the dependent variable is the dairy producer’s reported bid price. Since it cannot be less than zero, the bid values take on the form of a truncated normal distribution. Because of this population characteristic, the Tobit model is the best tool for analyzing this problem as it seeks to explain the (nonnegative) bid required by a dairy producer to reduce his level of milk production. It is assumed that dairy producers are asked the amount required to enroll the whole herd into the program. The model can be represented mathematically as:

$$Y_i^* = \alpha_0 + \alpha_1 * PP + \alpha_2 * M + \alpha_3 * I + \alpha_4 * R + \alpha_5 * E + \alpha_6 * Age + \varepsilon_i$$

$$Y_i = 0 \quad \text{if} \quad Y_i^* \leq 0$$

$$Y_i = Y_i^* \quad \text{if} \quad Y_i^* > 0$$

In this Tobit model,  $Y$  is a dependent variable that equals 1 if an individual producer participates in the program and is 0, otherwise. If the responding producer reports CWT participation, there is a follow-up question to assess his/her willingness to accept the bid value. Respondents are assumed to know the previously accepted upper level bid value of \$0.475/kg under the DTP and the fixed \$0.22/kg payment under the MDP. Knowledge of the earlier payments, variable cost minimization and fixed cost enhancements associated with the earlier programs creates a hypothetical bias. This bias is minimized through the cheap talk method as in Cummings and Taylor [17] and Carlsson, Frykblom, and Lagerkvist [18].<sup>1</sup> The cheap talk method accounts for the observation that survey respondents are more likely to report higher values when presented with a hypothetical scenario in which money is not involved as compared to “real world” scenarios involving money. Since no payments are involved, people tend to inflate the values they report. When the cheap talk method is used to solicit information, respondents are made aware of the tendency to inflate values and of the significance of their response to the design of policy. They then are requested to provide a response that is most likely to indicate the sum that would be paid under conditions of actual monies being exchanged.

An alternative to the cheap talk method entails calibrations of the hypothetical values. However, this has been found to be too situation specific and inferior to the cheap talk method. Because the cheap talk method is being employed, the expectation is that the survey values reported by respondents willing to participate in a program designed to reduce cow numbers will be close to the historical DTP value of \$0.496/kg.

Six independent variables were specified in the Tobit model. PP designated a Past Program Participant, M represented membership in a dairy cooperative, “E” referred to the debt-to-asset ratio, income (“I”) was the percentage of income derived from the dairy farm, reasons (“R”) identified specific reasons for participation in either DTP or MDP in 2003, and “age” was the number of years the principal operator had managed a dairy. However, the final Tobit model estimated had the same variables used in the logistic regression model.

A logistic regression analysis of producers’ decisions to participate in milk reduction programs also was conducted. This was followed by a Tobit model to assess the bid values given by respondents and used in the logistic regression model. The validity of parameters estimated from logistic regression was evaluated by using 1,000 bootstrap replications. Bootstrap replication is a procedure used in the absence of sufficient primary data for establishing statistical reliability. Sets of simulated replications are made using parameters characterizing

<sup>1</sup> There exists a large volume of articles on the effect of a cheap talk method to reduce a hypothetical bias in CV surveys. These two references are an indicative, and by no means inclusive, of that literature.

the available data. The simulation allows for confidence intervals to be created such that the data can be used for analysis and inference.

## RESULTS AND DISCUSSION

Hypothetical bias is a serious problem when attempting to derive willingness to accept values. A cheap talk method is supposed to reduce this hypothetical bias [17]. This study uses a cheap talk method using a contingent valuation (CV) survey to elicit willingness to accept bid values to participate in voluntary programs to reduce milk cow numbers and thus the productive capacity of a dairy herd. The cheap talk format used in this survey is presented in Appendix 1 along with the set of questions asked in assessing the respondent's participation in the three earlier milk supply control programs. Voluntary participation in such programs required reductions in the farm's productive capacity by eliminating cows. Respondents were provided with past bid values so that there was a set of common reference values. Although this may have had an anchoring effect, it should bring the stated values closer to the true value. Willingness to accept values were elicited for respondents who participated in the MDP, DTP, and 2003 CWT programs. None of the survey respondents had been accepted into the 2003 CWT program. Responding producers indicated the average bid value submitted by them was \$0.09/kg. This value was between the mid-1980s MDP and DTP values of \$0.22/kg and \$0.496/kg, respectively.

Most respondents indicated they would "continue to farm full time but not dairy" or "seek nonfarm employment" if their CWT bid had been accepted. These responses suggest that a significant number of CWT participants would exit dairy or even production agriculture if given the opportunity. Only one respondent indicated to continue being involved in milk production. Among respondents, many had been MDP participants. Only one indicated DTP participation.

The majority of respondents who had been MDP participants had contracted out 10% of their milk production. Twenty-eight percent of responding producers indicated a willingness to participate in another MDP program. The minimum average payment required by these producers to participate in the program was \$0.405/kg. This value is 184% above the \$0.22/kg payment in the earlier MDP when considering inflation-adjusted level for the intervening 20-year period (175% vs. 184%). MDP participants also realized variable cost savings associated with culling marginally less productive cows from the herd. Thus, actual payments for participation included both the \$10/cwt direct payment plus savings in variable production costs less any increases in fixed production costs per unit of milk associated with reduction in the volume of milk produced. Respondents also indicated they would be willing to reduce their total milk production by 49% on average.

Respondents indicated a willingness to enter into the DTP at \$0.53/kg. Adjusted for inflation, this value is well below the \$0.496/kg upper value in the DTP. The

Table 1. Descriptive Statistics of Responding Producers

Variables	N	Mean	Std. Dev.	Minimum	Maximum
Program participation (Yes = 1, 0 otherwise)	49	0.265306	0.446071	0	1
Bid values	44	5.011364	8.604683	0	25
Estimated net income	39	3.128205	1.301406	1	6
Why participating in Milk Diversion Program	28	1.535714	0.838082	0	3
Participation in the past (Yes = 1, 0 otherwise)	49	0.142857	0.353553	0	1
Number of years in dairy	49	31.22449	11.13341	7	55
Bidder to participate in the CWT program (Yes = 1, 0 otherwise)	47	0.06383	0.247092	0	1
Post-CWT	16	2.875	1.360147	1	5
Member of a dairy cooperative (Yes = 1, 0 otherwise)	49	0.918367	0.276642	0	1
Income from dairy	49	32.18571	34.61137	0	100
Debt to asset ratio (1 if D/A is less than 20%, 0 otherwise)	49	0.530612	0.504234	0	1

majority of respondents indicated they would participate in another DTP or MDP primarily because the future for dairying in Louisiana did not appear bright. Descriptive statistics derived from responding producers are found in Table 1.

A logistic regression model was estimated to identify which socio-economic variables in equation 1 were associated with an increased likelihood in a producer participating in a voluntary program to reduce the number of cows. However, coefficients from original model were insignificant. Accordingly, a model selection procedure was used to identify the best fitting model, which included only three of the original model variables. Results for this final model are shown in Table 2.

Table 2. Logistic Regression Results and Confidence Interval of the Estimated Parameters Resulting from 1,000 Bootstrap Replications

Variables	Estimate	p-Values	Odds-ratio	Marginal effect	Bootstrap 90% lower CI	Bootstrap 90% upper CI
Intercept	-1.4449	0.1576				
Income from dairy	0.0148	0.1477	1.015	0.002541	0.0148	0.0160
Years as a dairy producer	-0.0137	0.6566	0.986	-0.00235	-0.016	-0.0125
Past program participation	1.8137	0.0429	6.133	0.310668	1.9524	2.2746

The results presented in Table 2 suggest that only variables associated with the participation in the milk diversion program had a significant positive marginal effect. Any DTP participant would have experienced a five-year hiatus. MDP participants had aged 20 years and probably had 20 more years of experience as a dairy producer. Thus, they had more than likely moved from “turnkey” producers to “established” or “debt-free” producers, using Klemme’s classification. Years in dairy production was negatively associated with participation in a voluntary milk supply reduction program that included reducing cow numbers. This is not surprising given that longer-tenured producers are likely to be less mobile, having invested considerable human and financial capital in this endeavor, as well as the length of their planning horizons. Additionally, long-tenured dairy producer’s goal would be to maximize profits or economic rents. Such a producer could probably best be described by the “debt-free” moniker and have fully depreciated capital assets with a relatively short planning horizon. The market value of his capital assets are approaching zero. However, their capacity to generate revenues remains relatively high as compared to market value, suggesting low fixed costs. Thus, as long as variable costs of production are covered producers will produce a profit. The proportion of total income derived from dairy farming had a positive, but insignificant influence on voluntary participation in milk programs designed to reduce cow numbers.

Values reported under the odds ratio column identify the amount of change expected in the odds ratio for a one unit change in the independent or predictor variable when all other variables in the model remain constant. An odds ratio close to 1.0 suggests that there is no change attributable to the predictor variable [19]. Income from the dairy operation and years in production are continuous variables. The odds ratio indicated that a 1% increase in the income share from dairying increases the chance of dairy program participation by 1.015%. A producer highly

dependent on dairy farming for income is suggestive of a producer seeking to exit dairy farming. The odds ratio of 1.015 suggesting that a 1% change in income would not change the level of participation in a voluntary dairy program to reduce cow numbers. One year spent dairying is likely to decrease the producer's willingness to participate in a milk reduction program by 1.4%. Thus, the longer producers milk cows, the less likely they are to participate in a voluntary program to reduce the productive capacity of his farm. Past program participation increases the likelihood of participating in a voluntary milk supply reduction program for reducing cow numbers. Study findings suggest that producers who participated in past programs are six times more likely to participate in a dairy reduction program than producers who had never participated in such a program.

Bootstrap results based on 1,000 replications indicated that two out of three parameters (parameters associated with "income from dairy" and "years as a dairy producer") fell within the 90% confidence interval. This indicates that the parameters estimated in this regression are representative of the population sampled.

Willingness to accept bid values were analyzed using a tobit regression model. Results are shown in Table 3. As with the logistic model, only past participation had a significant effect on bid values. The average value for willingness to accept bids was \$0.221/kg, as calculated from the model equation.

## CONCLUSIONS

One way to reduce nonpoint pollution in dairy-producing regions in Louisiana is to reduce cow numbers. A dairy cow reduction program may be an attractive option for dairy producers facing low milk price, increasing production cost, and increasing competition from imported milk supplies. Dairy producers'

Table 3. Tobit Regression Results from the Selected Model

Variables	Estimate	p-Values	Marginal effect	90% Lower confidence level	90% Upper confidence level
Intercept	-16.4991	0.2178		-42.7363	9.738
Income from dairy	0.143	0.2938	0.14	-0.124	0.41
Years as a dairy producer	-0.1407	0.7181	-0.14	-0.9047	0.6233
Participation in milk programs in the past	20.441	0.0679	20.44	-1.5005	42.3826
Scale	22.6118	5.5771		13.9441	36.6674

willingness to participate in three different milk supply reduction programs was analyzed. The values necessary to attract participants to a future milk supply reduction program from this study were comparable to the values paid for MDP and DTP participation 20 years ago. Willingness to accept payment levels in this study were close to real values from participating producers. This phenomenon may be due to the reference values of \$0.496 and \$0.22 per kilogram associated with the DTP and MDP, respectively that were provided to survey respondents. This possibility of an anchoring effect was recognized.

These derived values that were close to reference values suggests that the cheap talk method of eliciting bids may be minimizing hypothetical bias. Hypothetical bias is the situation where respondents consider a question in a survey to be too hypothetical, and this may cause them to provide a willingness to pay value greater than their “real” willingness to pay.

Results indicated that only past participation in a voluntary milk supply reduction that required reductions in cow numbers was a significant factor in determining future participation in a milk supply reduction program. Coefficients estimated from a logistic regression were validated through a bootstrap simulation procedure. Two of the three parameters estimated fell within the bootstrap confidence interval indicating the results were valid. These results help inform policymakers on programs designed to reducing potential nonpoint pollution from dairy manure.

## APPENDIX 1

### Section III. Milk Reduction Programs

**Please read the following paragraphs before you answer the questions in this section.**

Some consider dairy farms in Louisiana's Florida Parishes to be both point and nonpoint sources of pollution. This means there are two possible alternatives for minimizing pollution problems attributable to dairy farms. The first alternative is to reduce the number of dairy cows in the area. The second alternative is for dairy farmers to adopt the maximum number of applicable best management practices (BMPs) to minimize the negative environmental problems attributable to dairy farms.

The dairy termination program (DTP) of 1986 and the milk diversion program (MDP) of 1984-1985 were implemented to reduce the amount of milk produced by reducing the number of dairy cows. The purpose of these programs was to reduce milk production so as to raise milk prices and reduce the costs of the dairy price support program to the government. Similarly, the amount of manure being produced can be reduced by decreasing the number of cows. In the DTP, the producer submitted a bid price per hundredweight of milk for which the producer agreed to slaughter or export all female dairy animals and to exit milk production

for at least five years. All bids of \$22.50 or less per hundredweight of milk were accepted. In the MDP, the producer entered into a contract with the government to reduce milk production 5-30% from some base period level of production in exchange for a payment of \$10.00 per hundredweight for an 18-month period. Since the rational producer would cull the lowest producing cows first, a participating producer would cull a percentage of cows that was higher than the contracted percentage of production. Both programs had the effect of reducing cow numbers, which reduced the total milk supply, put upward pressures on milk prices and reduced surplus stock levels. It follows that any reductions in cow numbers will reduce the volume of cow manure and its contribution to water pollution and phosphorous buildup in the soil.

When requesting hypothetical values for participating in a milk reduction program, previous research indicates that respondents over-estimate the amount they are willing to accept to participate in a supply control program. If your responses are not well thought out, policy makers would most likely ignore the responses. Therefore, it is imperative that you respond with values you believe to be true for you today, not historical values from other programs.

Now, we would like to ask you a series of questions regarding your participation in supply control programs.

**1. Did you participate in the Milk Diversion Program or the Dairy Termination Program in the past?**

Milk Diversion Program (MDP) (1984-85)     YES     NO

Dairy Termination Program (DTP) (1986)     YES     NO

**If YES, what was the minimum amount you bid to participate in the DTP (that is, to stop producing milk for at least five years, and to slaughter or export all of your female dairy animals)? \$ \_\_\_\_ per cwt milk. What was the maximum contraction in milk production you agreed to under the MDP for the \$10 per hundredweight payment? \_\_\_\_%.**

**2. Would you consider participating in a Milk Diversion Program (MDP) if it were offered today?**

YES     NO

**If YES, what is the minimum payment you would be willing to accept to reduce your milk production? \$ \_\_\_\_ per cwt milk.**

**For that payment, what is the maximum percent you would be willing to reduce your milk production? \_\_\_\_%. What percentage of your cow herd would be culled to achieve this rate of reduction? \_\_\_\_%.**

**What would you bid to participate in a Dairy Termination Program today? \$ \_\_\_\_ per cwt milk.**

**3. What reasons contributed to your willingness to participate in a DTP or MDP today? Check all that apply.**

- Dairy operation is not profitable.
- Dairy operation is reasonably profitable, but the future for dairying in Louisiana does not appear bright.
- I am of retirement age.
- Other (Specify) \_\_\_\_\_

**4. Did you submit a bid to participate in the August 2003 CWT program?**

- YES      NO
- If YES, how much did you bid? \$\_\_\_\_\_ Per cwt milk.
- Was your bid accepted?  YES      NO

**5. What would have you done if your August 2003 CWT bid had been accepted and you had to exit the dairy industry?**

- Retire from full-time farming
- Continue to farm full-time, but not dairy
- Continue to farm part-time, but not dairy
- Seek nonfarm employment
- Other (Specify) \_\_\_\_\_

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