Producer Response to a Subsidized Agricultural Water Conservation Loan Program

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ABSTRACT

Texas voters approved the sale of bonds to finance low interest agricultural loans for purchasing water conservation equipment. However, results from a pilot program indicated that the low interest loan program had been used only to a limited extent. Qualitative choice modeling was used to identify factors that influenced producer participation. Results indicate that educating producers about water use efficiency and minimizing water district administrative procedures would enhance the producer participation in the low interest loan program.

KEYWORDS: Logit, water conservation

Texas is a leading producer of food grain, fiber, feed grain and beef in the U.S. In 1990, the contribution level of the agribusiness sector to the Texas economy was estimated at $40 billion. The development of crop production agriculture in Texas has been influenced by the availability of relatively cheap sources of irrigation water. Texas farmers irrigated approximately 6 million acres of land in 1990, with 60 to 70% of the irrigated acreage located on the southern High Plains of Texas (Texas Almanac, 1991). The majority of this acreage (over 99%) is irrigated from ground water sources, mainly the Ogallala Aquifer (Texas Water Development Board). The value of crop production from irrigated acreage in Texas is estimated at 50 to 60% of the total value of all crop production, although only about 30% of the state's total harvested cropland is irrigated (Agricultural Statistics, 1992).

In recent years, water has become a limiting resource due to declining groundwater levels and rising costs of pumping in several of the state's major aquifers. Because net withdrawal of water continues to exceed recharge, the continued overdraft has resulted in the decline of groundwater tables from 50 ft to 200 ft in some areas (High Plains Associates). The High Plains Associates (HPA) project that aquifer water remaining in storage in Texas will be down by almost 200 million acre-feet by 2020, a 69% decline from the 1977 level, unless additional sources of water are developed, irrigation efficiencies are significantly improved or crops and cultural techniques are developed to reduce water use requirements.

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A study was conducted in 1982 to evaluate the rate of depletion for the six-state Ogallala Aquifer by HPA. High Plains Associates recommended voluntary water management to achieve water use efficiency and water conservation through adoption of available technologies stimulated by new or expanded incentive programs.

In 1985 the Texas Legislature established a state sponsored low interest loan program to finance the purchase of agricultural water conservation equipment. Texas voters approved a constitutional amendment authorizing the state to sell $200 million in bonds to fund a low interest loan program for water conservation. The legislation authorized the Texas Water Development Board (TWDB) to lend funds to state soil and water and underground water conservation districts for the sole purpose of financing the purchase of approved water conservation equipment (Carver and Williams, 1992).

A preliminary assessment of the Water Conservation Loan Program found only limited use by farmers (Lacewell and Segarra, 1993). Information gaps, lack of knowledge and uncertainty may have contributed to non-participation in the program, even though the loans were subsidized. Why more farmers did not take advantage of the loan program is not clear. The principal objective of this study was to identify program structure and characteristics that influenced producer non-participation in the agricultural water conservation loan program. Results drawn from the study should help in formulating program attributes that would ensure effective implementation of the program now and in the future.

SURVEY DESIGN AND DATA

During the summer of 1993, a mail survey was conducted among 1121 producers residing in the High Plains, Winter Garden and Lower Rio Grande Valley regions of Texas. The agricultural area of the Texas High Plains is located on the Ogallala Aquifer. The Winter Garden Region includes the Carrizzo-Wilcox Aquifer and the Edwards Balconies Fault Zone Aquifer. Irrigation water for the Lower Rio Grande Valley is drawn from the Rio Grande River through a series of surface canals. The survey resulted in 256 (23%) responses of individuals that have participated or would be eligible to participate in the low interest loan program. Participants were asked a variety of questions concerning the subsidized water conservation loan program and their attitudes toward the importance of water conservation.

Average land owned by the producer respondents was about 640 acres, about 72% of which was irrigated. Producers, on average, leased about 540 acres of farmland, of which about 356 acres were irrigated. Gross farm income ranged between $63,000 in the Winter Garden and $1,880,258 for the respondents in the Rio Grande Valley. Gross off-farm income averaged $25,000. Average age for operators was slightly over 56 years. Long-term debts for all farms was about $170,000 and the short-term debts average was approximately $100,000.

Table 1 summarizes producer attitudes about water conservation. Ninety-two percent of the responding producers thought that water has become a limited resource and there is an immediate need to emphasize efficiency in water use. While only 30% of the respondents believed that the agriculture sector is most responsible for inefficient use and loss of water, a majority (about 70%) held the commercial sector, households and other entities responsible for low water use efficiency. Most producers (94%) also believed that one approach to increase water

Table 1. Respondents opinion about water conservation

Item	Yes	No	Don't Know	Total
Do you believe that water has become a limited resource and there is an immediate need to emphasize water use efficiency?	234	9	9	254
In your opinion, who is most responsible for inefficient use and loss of water?				
commercial sector, household, or other entities	167	71	NA	238
agricultural sector	71	167	NA	238
Do you believe that one approach to increase water use efficiency in agriculture is to adopt water conserving irrigation equipment?	237	8	6	251
Do you believe that benefits of agricultural water conservation exceed the costs?	141	75	35	249
Do you believe that the government should take legislative actions to encourage water conservation?	64	159	26	251

NA = Not applicable; no response for this category.

use efficiency in agriculture is to adopt water conserving irrigation equipment. Fifty-seven percent believed that the benefits of water conservation exceeded the costs of implementation. Although producers perceived conservation of water with the help of new irrigation equipment to be necessary and important, the majority (63%) opposed any government intervention through legislative actions.

CONCEPTUAL RELATIONSHIPS AND METHODS

Producer decision to participate in the low interest water conservation loan program is hypothesized to be an economic decision influenced by assessments of conventional factors such as income maximization, risk minimization and satisfaction maximization. Income maximization may be influenced by irrigation water lift cost, labor cost and timing of application. Factors that lead to risk minimization may

include stabilization of the water table, life expectancy of an irrigation system and an assurance of future stability for the agricultural enterprise. Factors that relate to maximizing satisfaction could be based on producers' socioeconomic characteristics and their perception of the program attributes. Conceptually, there should exist some optimal combination of the various factors leading to income maximization, risk minimization and satisfaction maximization that maximizes a farmer's utility.

As discussed earlier, a majority of the respondents indicated that water conservation is important and believed that one approach to increase water use efficiency in agriculture is to adopt water conserving irrigation equipment. Thus, it can be argued that producers recognize the risk minimizing potential of the low interest water conservation loan program. Most of the respondents also believe that benefits of water conservation exceed the costs, thus the potential for income maximization. Given the perception about risk minimization and income maximization, it can be hypothesized that the producers' decision to participate in the low interest loan program was primarily influenced by factors that relate to maximizing satisfaction.

Assuming that a combination of socioeconomic and program attribute characteristics determined producers' participation decision, the theoretical foundation of this study was based on the assumption of random utility maximization as developed by McFadden (1981).

Consider a sample of T producers, each facing a set of M discrete alternatives. Each alternative i (i = 1, ..., j, ..., M) provides satisfaction, U_i, to producer t (t = 1, ..., T). A producer chooses an alternative i that maximizes his satisfaction among M alternatives. The maximum satisfaction attainable, given each alternative i, can be expressed as:

$$U_i = u\,(A_k, S_n),\ k = 1, \ldots, K;\ n = 1, \ldots, N, \tag{1}$$

where U_i is the maximum satisfaction attainable when alternative i is chosen; A_k is a vector of K attributes associated with alternative i; and S_n is a vector of N socioeconomic characteristics of producer t. For estimation purposes, the u(.) is assumed to be a linear function of A_k and S_n, which can be decomposed into a deterministic component $(A_k, S_n; \theta_i)$ and a stochastic component $(\tau)_i$, so that equation (1) can be rewritten as:

$$U_i = (A_k, S_n; \theta_i) + \tau_i\ , \tag{2}$$

where θ is a vector of parameters associated with A_k and S_n.

An individual will choose alternative j, if and only if it provides the highest satisfaction,

$$U_j \geq \max\,(U_i \mid i = 1, \ldots, j, \ldots, M;\ j \neq i). \tag{3}$$

U_j represents a variable which is not observable and only the outcome of the decision process is observed. Thus, let Y be the observed variable that is ordinal in nature and Y = j is the observed outcome when response category j is chosen. The decision making process under study leads to outcomes that are categorical, i.e., Y_j equals one ($Y_j = 1$) if the producer decides to participate in the low interest loan program and Y_j equals zero ($Y_j = 0$) otherwise. It follows that a

regression relation implied can be specified and estimated with logit procedure (Cramer, 1991):

$$Y_i = \alpha + \beta X_i + \epsilon_i \text{ , and}$$

$$Pr(Y_i = 1) = F(Z_i),$$

where $Y_i = 1$ if the producer reported to have participated in the low interest program and $Y_i = 0$ if otherwise, X_i is a set of explanatory variables that represent factors that maximizes the producer's satisfaction , α and β are unknown parameters, ϵ_i is the identically distributed error term with zero mean and F(.) is the cumulative probability function. The parameter coefficients are estimated using maximum likelihood estimation available in the LIMDEP computer package (Greene, 1990). The maximum likelihood estimation is defined as the values of α and β that maximize the following log likelihood function:

$$\log L = \sum_{i=1}^{n} [Y_i \log F(Z_i) + (1-Y_i) \log(1-F(Z_i))]. \quad (4)$$

The maximum likelihood coefficients are consistent and asymptotically normally distributed allowing application of conventional tests of significance.

MODEL SPECIFICATION

Variables were identified to capture reasons for Texas producers' participation decision in the low interest loan program based on the conceptual relationship developed in the previous section. Participation choice was the dependent variable. Variables selected to explain the participation choice related to producer and program characteristics included region of residence, gross farm income and short-term debt. Awareness of the loan program, opinions about characteristics of the program, awareness of the program and whether the loan for the low interest program is made under the direction of a commercial lender were also hypothesized to influence participation decision. The variables used in the model are defined in Table 2 . For the empirical analysis, data were available from only 116 producers; the remaining respondents failed to provide complete answers to questions in the survey. The sample size was substantially reduced due to exclusion of respondents who failed to provide complete answers to a number of questions used in the variable construction. A t-test was conducted of the hypothesis that the means of a few selected variables of the survey sample and the subsample selected for empirical analysis are the same. It was found that the two samples do not differ significantly at the .05 level of significance as far as means of respondent participation, short-term debt and opinions about characteristics of the program. However, gross farm income did differ significantly between the survey sample and subsample selected for empirical analysis.

Table 2. Definition of the variables used in the model

Variable	Definition
Participation	
Participate:	If participate = 1; otherwise = 0.
Respondents Location	
Sandy Land Panhandle Winter Garden Rio Grande High Plains†	If respondent is from a specified district or region = 1; otherwise = 0.
Gross Farm Income	
GFI1	If gross farm income is ≤ $100,000 = 1; otherwise = 0.
GFI2	If gross farm income is > $100,000 but ≤ $200,000 = 1; otherwise = 0.
GFI3†	If gross farm income is > $200,000 = 1; otherwise = 0.
Debt	
STD1	If short-term debt is less than $100,000 = 1; otherwise = 0.
Awareness	
Aware	If aware of program = 1; otherwise = 0.
Program Characteristics	
Paperwork Interest	Strongly like = 1; Like = 2; Indifferent = 3; Dislike = 4; Strongly dislike = 5.
Demonstrational	
Program	If attended program = 1; otherwise = 0.
Involvement of Commercial Lender	
Commercial	If loan made under direction of commercial lender = 1; otherwise = 0.

†Base variables were excluded from regression analysis to avoid dummy variable trap.

EMPIRICAL RESULTS

The estimation results from the logit model are presented in Table 3. Several goodness-of-fit measures are also reported in that table. One measure is the log-likelihood ratio. A second measure used is the pseudo-R^2 (Maddala, 1983). A third measure examines how well the model classified the respondents correctly based on the estimated probabilities. These measures indicate that the model has satisfactory explanatory power and fitted the data reasonably well. The overall ability of the model to yield correct predictions on a respondent's decision to participate in the low interest loan program was 81%.

The negative signs and the statistically significant coefficients associated with respondents living in the Sandy Land and the Panhandle Water Conservation Districts indicate that producers in these areas have a lower probability of participating in the low interest loan program than producers residing in the High Plains Underground Water Conservation District #1 (base variable). The estimated coefficients for Winter Garden and Rio Grande Valley were not statistically significantly different from zero. Analysis of marginal probabilities (Table 3) indicate that the probability of participation by producers in the High Plains Underground Water Conservation District #1 was 0.2648 greater than for producers in the Sandy Land Water Conservation District and 0.4494 greater than for producers in the Panhandle Groundwater Conservation District.

The coefficient for the interest variable has a negative sign. This indicates that the more the producers dislike the existing interest rate, the lower the probability of them participating in the low interest loan program. A unit increase in the producers' dissatisfaction with the interest rate will result in 0.1621 decrease in the probability of their participation.

Results indicate that higher levels of gross farm income increase the probability of producer participation in the low interest loan program. This is indicated by the negative sign associated with the estimated coefficient for GFI2. The estimated coefficient for the GFI1 variable is not statistically significant. Respondents with gross farm income of greater than $100,000 but less than or equal to $200,000 (GFI2) have a 0.4635 lower probability of participating in the low interest loan program when compared to the participation probability of 0.7263 for individuals grossing more than $200,000. However, caution should be exercised in generalizing this finding to the survey sample since the mean of the gross farm income differed significantly between the survey sample and subsample used for empirical analysis.

The positive sign for the "Aware" variable and the statistical significance of the coefficient suggest that farmers who are aware of the loan program are more likely to participate in it. The probability of participation of a farmer who is aware of the program is 0.5951 higher than that of one who is not aware of the program. Importance of producer awareness about the program is further evident from the statistical significance of the coefficient of the "Program" variable. Those who have attended a program illustrating the benefits of water conservation had a 0.3084 higher probability of participating in the program.

The negative sign and the statistical significance of the "Paperwork" variable imply that the respondents who dislike the paperwork associated with obtaining a water conservation loan are less likely to participate in comparison to their counterparts. Results indicate that a unit increase in producer dissatisfaction with paperwork will result in 0.2460 decrease in the probability of their participation.

Table 3. Logit estimates and the probabilities of producer participation in the Texas Low Interest Loan Program

Variable	Estimated coefficient	Significance level	Marginal probability
Constant	3.07360*	0.07654	NA
Aware	2.97650*	0.03197	0.5951
Paperwork	-1.03440*	0.00513	-0.2460
Interest	-0.68191*	0.02986	-0.1621
Program	1.31020*	0.02454	0.3084
Commercial	-0.79429	0.17860	NA
Sandy Land	-1.14490*	0.11022	-0.2648
Panhandle	-1.93840*	0.05376	-0.4494
Winter Garden	-8.81530	0.95720	NA
Rio Grande	-1.85070	0.36826	NA
High Plains (Base)			
GFI1	-0.01944	0.97927	NA
GFI2	-2.00740*	0.01043	-0.4635
GFI3 (Base)			
STD1	0.07903	0.89789	NA

Summary statistics:

Number of observations = 116
-2 x Log-likelihood ratio = 104.26†
Pseudo-R^2 = 0.4063
Percent correctly identified = 81

NA = Not applicable.
†The likelihood ratio statistic is distributed as Chi-square with 12 degrees of freedom and is significant at the .01 level.
*Indicates significance at the .10 level or lower.

SUMMARY AND CONCLUSIONS

The purpose of the survey of producers was to identify program characteristics and the socioeconomic characteristics that influence producer participation in the newly implemented agricultural water conservation loan program. The survey resulted in 256 returned questionnaires, representing a response rate of 23%.

A logit model was formulated and used to estimate marginal probabilities of producer participation in the low interest loan program. The analysis suggests that producers in the High and Southern Plains areas with income more than $200,000 and short-term debt of less than $100,000 are more likely to participate in the low interest loan program. The results also show that interest rates charged by water districts for water conservation loans and paperwork involved in obtaining these loans can play a very important role in the producers' participation decision. Furthermore, the results indicate that the probability of producer participation in the low interest loan program can be increased significantly by emphasizing the benefits of water conservation. Making producers aware of the purpose and financing of the low interest loan program could also increase producer participation. These findings should help state agencies and water and soil conservation districts in formulating regulations that would ensure effective implementation of the program now and in the future.

Some policy implications emerge from this study. The low interest loan program could be modified to streamline qualifying requirements for producers and to minimize paperwork to apply for a loan. The TWDB and water districts could work to promote educational programs at local and district levels to justify benefits of water conservation to producers and all other interested parties in rural communities. Also, survey results indicate that commercial lenders should be encouraged to participate in the educational structure because benefits received on a long-term basis provide financial strength and flexibility to communities.

REFERENCES

Carver, K., and B. Williams. 1992. Agricultural water conservation equipment low interest pilot loan program. High Plains Underground Water Conservation District No. 1., Lubbock, TX.

Cramer, J.S. 1991. The Logit Model. Edward Arnold Co., London.

Greene, W.J. 1990. LIMDEP. Econometrics Software, Inc., New York.

Lacewell, R.D., and E. Segarra. 1993. Farmers, lenders and water districts response to Texas' low interest loan program for water conservation in agriculture. Texas Water Resources Institute, Texas A&M University, College Station.

Maddala, G. 1983. Limited-dependent and qualitative variables in econometrics. Cambridge University Press, New York.

McFadden, D. 1981. Econometrics models of probabilistic choice. In C.F. Manski and D. McFadden (eds.) Structural analysis of discrete data with econometrics applications. The MIT Press, Cambridge, MA.

Texas Almanac. 1991. The Dallas Morning News. Gulf Publishing Co., Houston.

U. S. Department of Agriculture. 1992. Agricultural statistics. Washington, DC.