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# ECONOMICS AND MARKETING

## Factors Influencing Southwestern Tennessee Farmers' Willingness to Participate in the Boll Weevil Eradication Program

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### INTERPRETIVE SUMMARY

Because the boll weevil is important in cotton production, growers in Tennessee are implementing an area-wide insect management program to eradicate this pest. The boll weevil eradication program is a cooperative government- and grower-sponsored program. A two-thirds majority of cotton growers in a designated area must vote in favor of the eradication program in a referendum before it is implemented. There has been little research done to evaluate the factors that influence farmers' decisions to vote for the boll weevil eradication program. The objective of this study was to analyze some of the factors that influenced cotton farmers' willingness to vote for the boll weevil eradication program in southwest Tennessee.

Data reported by a subset of cotton producers in a 1997 mail survey were used to evaluate farmers' willingness to vote for the boll weevil eradication program. The survey was administered immediately after the February 1997 eradication program referendum for cotton growers in southwest Tennessee. Producers in the referendum area who responded to the survey were asked to indicate how they voted in the referendum. The logit statistical procedure was used to evaluate factors that may have influenced farmers' yes-no decisions for the referendum. Explanatory variables used to estimate the logit model were age of the principal operator; county-level pheremone trap counts indicating the total number (population) of boll weevils entering cotton fields for springtime 1994, 1995, and 1996; farmer ratings of the importance of boll weevil eradication program education presentations; and producer ratings of the importance of newspaper and magazine articles about the eradication program. The pheremone trap data were used as a proxy for boll weevil yield damage and control costs experienced by farmers for each county in the referendum area. The estimated model was used to analyze the probability of participation for an average individual in the sample of producers from the survey.

The expected relationship between producer age and willingness to vote for the program was uncertain because of its positive correlation with years of experience growing cotton. The estimated coefficient for producer age had a positive sign in the logit model. Farmers with more experience growing cotton may see the benefit of the program based on their history with boll weevils. Boll weevil population parameter estimates for 1994 and 1995 had the expected positive signs indicating that higher yield damage and control costs increased producer willingness to vote for the eradication program. However, the parameter estimate for boll weevil population in 1996 had a negative sign rather than the hypothesized positive sign and lowered producer willingness to vote for the eradication program. The likely reasons for the population influence in the model were heavy infestations of boll weevils in 1995 compared with 1996. Farmers likely had much smaller yield losses and control costs in 1996 relative to 1994 and 1995. Producers focused on problems in 1995 to make their voting decision that would make the negative sign on boll weevil population for 1996 somewhat spurious. For 1995, a farmer who experienced the maximum boll weevil population was 27% more likely to vote yes for the program than a farmer who experienced the minimum population.

The expected positive sign on the coefficient for the importance of the eradication program education meetings indicated that these presentations were important in influencing producers' support for the program. A producer who stated that the education presentation

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information was very important was 45% more likely to vote for the eradication program than a farmer who rated the education information as not important. The sign on the newspaper and magazine article information variable was negative indicating that information about the eradication program in these articles tended to reduce producer willingness to vote for the program. Producers in the sample who rated the information as very important were 36% less likely to vote in favor of the boll weevil eradication program than individuals who rated the information as not important.

Taking all the variables together, the producer most likely to have voted yes in the 1997 referendum (i) was an older individual with more years of experience growing cotton, (ii) experienced high boll weevil populations in 1995, (iii) rated eradication program presentations by the extension service highly, and (iv) discounted the importance of negative articles about the program in magazines and newspapers. Boll weevil eradication program education presentations had the most significant influence on a farmer's willingness to vote for the program.


## ABSTRACT

**The boll weevil (*Anthonomus grandis* Boheman) is an important pest problem in cotton (*Gossypium hirsutum* L.) production. Cotton growers in Tennessee are implementing an area-wide insect management program to eradicate the boll weevil. Data reported by a subset of producers in a 1997 mail survey were used to evaluate southwest Tennessee farmers' willingness to participate in a boll weevil eradication program. A logit model was used to evaluate the factors that influence farmers' willingness to participate. Producer age, high boll weevil populations in 1995, and eradication program education presentations were significant and positive factors in determining producer willingness to vote for the program. The importance of information from newspaper/magazine articles had a significant, negative influence on willingness to participate. Boll weevil eradication program education presentations had the most significant influence on a farmer's willingness to participate in the program.**


The boll weevil has been the primary pest problem for Tennessee cotton growers. Because of the importance of the boll weevil in cotton production, Tennessee producers are implementing the boll weevil eradication program as a way to control this pest. The boll weevil eradication program is a cooperative-government-and-grower-sponsored area-wide cotton insect management program designed to eliminate the boll weevil in a production area (USDA, 1997). The program has been successfully implemented in many areas of the U.S. Cotton Belt. In most states, the boll weevil eradication program can only be implemented when 67% of growers in a proposed eradication area vote positively in a referendum. Once the program is implemented, all cotton producers in the designated area are required by state law to participate. Producers pay a yearly assessment that lasts from 5 to 7 years to fund the program. Boll weevil eradication program personnel, rather than farmers, are responsible for boll weevil control after the program starts. However, farmers are still responsible for controlling other cotton insects. Producers may opt out of the program by not growing cotton. This study deals with some of the factors that influence producers' decisions to vote for the boll weevil eradication program in Tennessee.

The first area in Tennessee to adopt the program was middle Tennessee in 1994, and currently, it is in the final stages of the program. A referendum was held for the boll weevil eradication program in seven southwest Tennessee counties in February 1997. The referendum passed with 68% of producers voting in favor of implementation (Robinson, 1997). The program for this area began in August 1998. Farmers in the 15 counties that comprise northwest Tennessee voted to implement the eradication program in a January 1999 referendum. The referendum passed with 78% of northwest Tennessee producers voting to start the program by the year 2000 (Robinson, 1999). The northwest area includes 60% of the cotton growers and three-quarters of the total cotton produced in the state (Tennessee Department of Agriculture, 1998).

Several studies have evaluated the farm and off-farm costs and benefits of the boll weevil eradication program (Carlson et al., 1989; Hammig et al., 1984; Ahouissoussi et al, 1993; Duffy et al., 1994). However, less research has been done to evaluate the factors that influence farmers' participation in pest management groups such as the boll weevil eradication program. Rook and Carlson

(1985) conducted a logit analysis of factors that influenced participation of North Carolina cotton producers in pest management cooperatives. They found that the significant factors that increased participation in pest management groups were acres in time-competing crops, farm size, cost of membership in the cooperative, group service quality subsidies, high expected cotton yields, and small differences between individual and group pest control demands.

Kazmierczak (1996) used a logit model to evaluate the importance of socioeconomic and demographic factors on a landowner's or producer's decision to support a boll weevil eradication program in Louisiana. He found that age, knowledge of the program, and experience were significant in determining a producer's support for the boll weevil eradication program. Also, reports of previous performance of other states' programs may play a significant role in determining producers' support. Kazmierczak also suggests that a boll weevil eradication education presentation centered on the economic benefits associated with area-wide insect management may have a positive impact on producers' support for the boll weevil eradication program. Robinson (1993), in a logit analysis of cotton producers in the Texas Coastal Bend region, found results similar to Kazmierczak.

Until this research, little specific information was available on the factors that influence farmers' decisions about voting for the boll weevil eradication program in West Tennessee. Because of uncertainty about the costs and benefits of boll weevil suppression, a farmer's use of information related to the eradication program along with socioeconomic and demographic characteristics of the producer may influence the decision to participate in the program. The objective of this study was to analyze some of the factors that influenced cotton farmers' willingness to vote for the boll weevil eradication program in southwest Tennessee.

## Theoretical Model

Before the boll weevil eradication program was implemented in southwest Tennessee, cotton growers voted on the program in a February 1997 referendum. Economic theory hypothesizes that growers based their yes-no decision about the program on how much utility they gain from their choice. Utility is defined as an index of attractiveness used implicitly or explicitly by an individual to rank a set of decision alternatives. The utility index embodies the trade-offs among the different attributes of the choice that is being considered by the decision maker. For the boll weevil eradication program decision, this might include expected savings in insecticide costs, projected increases in cotton yields, the cost of the program, etc. An individual faced with a decision such as the yes-no vote in the boll weevil eradication program selects the alternative that yields the greatest utility.

A random utility model was used to analyze the dichotomous participate-not participate boll weevil eradication program decision (Ben-Akiva and Lerman, 1985). Utility is treated as a random variable in the model because the utility function of a producer cannot be directly observed. From this perspective, the random utility model is used to evaluate the probability that a producer will decide to participate based on information that describes the decision maker. For the eradication program participation decision, the indirect utility function specified was:

$$V_i = \beta_0 + \beta_1 Y + \beta_2 C + \beta_3 D + \beta_4 I + \varepsilon, \qquad [1]$$

where $V_i$ is the indirect utility gained by the producer from voting either yes ($i = 1$) or no ($i = 0$) in the boll weevil eradication program referendum; $Y$ is current income from all sources; $C$ is the costs of yield damage and insect control caused by the boll weevil; $D$ is a vector of personal characteristics that influence willingness to participate including socioeconomic and demographic characteristics; $I$ represents a vector of information sources used by the producer to determine participation; $\beta_j$ are the parameters of the model, and $\varepsilon$ is the random error term. The subscript for individual responses is suppressed in Equation (1).

A binary logit model estimated with the maximum likelihood technique was used to empirically implement the random utility model (Ben-Akiva and Lerman, 1985). The logistic function, which has a similar shape to the cumulative normal distribution, facilitates the modeling of probabilities within the 0 to 1 interval. The dependent variable is the yes-no decisions made by cotton producers about the boll weevil eradication program. Equation (2) represents the binary logit model to be estimated for the analysis:

$$P_1 = \frac{e^{V_1}}{e^{V_1} + e^{V_0}} \ , \qquad [2]$$

where $P_1$ is the probability that a cotton producer voted yes in the boll weevil eradication program referendum and base $e$ is the numerical value of the natural logarithm function.

## DATA AND METHODS

### Survey Data

Data for this analysis were from a mail survey of Tennessee cotton producers administered in February and March of 1997. The survey was conducted to provide information for an economic study of the boll weevil eradication program in Tennessee. Information collected from producers who participated in the survey included the following: (i) cotton production and insect control practices for the 1994, 1995, and 1996 growing seasons; (ii) personal characteristics of the principal operator including socioeconomic and demographic characteristics; (iii) farm financial characteristics including taxable income; and (iv) decision maker attitudes about the boll weevil eradication program. Because the survey was administered immediately after the February 1997 boll weevil eradication program referendum for southwest Tennessee, producers were asked if they voted in the referendum and, if so, how they voted. In addition, producers were asked to rate the importance of information they may have used to determine their willingness to participate in the boll weevil eradication program.

Following general mail survey procedures outlined by Dillman (1978), a cover letter explaining the survey, the questionnaire, and a postage-paid return envelope were sent to 2327 individuals or entities identified as cotton producers (J. Bradley, 1996, personal communication; D. Fraser, 1996, personal communication). The first mailing of the survey instrument was on 28 Feb. 1997. On 7 Mar. 1997, a reminder postcard to return the questionnaire was mailed to all cotton producers. A follow-up mailing with another cover letter indicating the importance of the survey and another questionnaire were sent 21 Mar. 1997 to producers who had not responded to the first mailing or reminder postcard. The total number of responses to the survey was 802 (34%). Of those responses, 258 producers provided data on their cotton farming practices. The other individuals that responded indicated that they did not grow cotton in the past 3 years. Assuming that the remaining individuals who did not respond to the survey were active cotton producers, the overall usable response rate to the survey was 15%.

The number of producers who answered the southwest Tennessee boll weevil eradication referendum yes-no vote question totaled 63. Of those responses, 28 individuals could not be established as living in or owning land within the referendum area based on the primary county of their farm. Three attempts were made by telephone inquiry to establish either residency or land ownership in the referendum area for these producers. Based on the telephone follow up, the 28 respondents were excluded from the analysis. Of the 35 usable observations, 23 individuals reported that they voted yes and 12 reported that they voted no in the referendum. The 66% yes votes in the sample closely parallels the 68% yes votes in the southwest Tennessee referendum (Robinson, 1997).

### Logit Model Estimation

Table 1 contains the variables used in the logit model estimation, along with their definitions, summary statistics, and hypothesized signs of the independent variables.

### Dependent Variable

The dependent variable *VOTE* was evaluated as an indirect utility measure determined by the reported yes-no decision of the farmer in the boll weevil eradication program referendum. A value of 1 was assigned to producers who indicated that they voted to start a boll weevil eradication program in southwest Tennessee. A value of 0 was assigned to farmers who said they voted against the program.

## Independent Variables

Based on the theoretical model, the explanatory variables considered for the empirical logit model were demographic characteristics that describe the farm decision maker, 1996 taxable income reported by the producer, costs of boll weevil damage experienced by the producer in 1994, 1995, and 1996, and sources of information used by farmers to help decide their vote for or against the program.

The demographic characteristic included in the model was the principal operator's age (*AGE*). The number of years of experience producing cotton was also considered, but was excluded because of high correlation with age and because fewer producers answered the experience question. In other studies involving some form of technology adoption, age was found to be negatively related to adoption (Amponsah, 1995; Turner, Epperson, and Fletcher, 1983). One reason for this relationship is older producers may tend to resist change (Turner et al., 1983). Older farmers may have a different planning horizon (i.e., how many years left in farming) compared with a farmer who is younger and may expect less benefits to accrue to them because of this shorter horizon when compared to the cost of the program. Due to the high level of correlation between the age of the operator and experience growing cotton, *AGE* also embodies the influence of producer experience. Grower experience growing cotton would be expected to have a positive influence on willingness to participate. Farmers with more experience may be more aware of the risks of not adopting new technology (Kenkel and Norris, 1995). Because *AGE* includes the effects of both experience growing cotton and the producer's age, the hypothesized sign for *AGE* is indeterminate.

The income question in the survey was structured to let respondents check one of nine categories (in $30 000 increments) that best fit their taxable income in 1996. A total of 24 out of the 35 producers in the sample answered the income question. Attempts to include this variable in the logit model failed because a global maximum was not found using the maximum likelihood procedure in SAS (SAS Institute, 1997). Given these problems, the income variable was excluded from the empirical model. Its exclusion may bias the estimates of the remaining parameters (Kennedy, 1992).

The cost of boll weevil damage includes the estimated revenue foregone from yield losses and the expenses of insect control operations targeted at the boll weevil. Farmers were asked in the survey to estimate their yield losses and insect costs for the boll weevil. Several farmers were unwilling or unable to provide estimates of damage or costs, severely limiting the number of observations for the purpose of estimating the model. To overcome this problem, springtime boll weevil pheremone trap count data collected by extension personnel in each county of the referendum area were used as a proxy for boll weevil damage experienced by farmers. These traps are monitored weekly by extension service personnel during April, May, and June (C. Jones, 1997, personal communication). The number of boll weevils caught in each trap indicates population moving into fields of cotton and causing damage. Higher boll weevil populations may indicate higher revenue losses from boll weevils resulting in a more positive willingness to participate in the boll weevil eradication program. Thus, the expected relationship between the two is positive, that is, higher boll weevil populations may indicate higher probability of willingness to

**Table 1. Summary statistics of the variables used to estimate the logit model for the boll weevil eradication program producer participation analysis.**

| Variable name | Variable description | Mean | Maximum | Minimum | Expected sign |
|---|---|---|---|---|---|
| VOTE: | 1 = willing to participate<br>0 = otherwise | | | | |
| AGE: | age of the respondent | 46 | 71 | 23 | ? |
| BW94: | boll weevil population for 1994 | 539 | 770 | 134 | + |
| BW95: | boll weevil population for 1995 | 4352 | 4902 | 3570 | + |
| BW96: | boll weevil population for 1996 | 171 | 276 | 64 | + |
| PROG: | ranking of importance of boll weevil eradication education programs | 3 | 5 | 1 | + |
| MEDIA | ranking of importance of newspaper and magazine articles read by producers | 4 | 5 | 1 | ? |

participate. Moreover, farmers likely do not make decisions based on what happened in 1 year but over a longer period. For that reason, spring-time boll weevil population data for the 1994, 1995, and 1996 growing seasons were included as explanatory variables in the model.

In the survey, farmers were asked to rate the importance of the following sources of information used to make eradication program decisions: the extension service, boll weevil eradication program education presentations, magazine and newspaper articles, radio and television reports, crop or integrated pest management consultants, and other farmers. The ordered scale representing the importance of the information is as follows: 1 = not important, 2 = minor importance, 3 = somewhat important, 4 = important, and 5 = very important. An evaluation of the responses indicated a high degree of positive correlation (0.69) between the extension service and boll weevil eradication program education presentations. The University of Tennessee Agricultural Extension Service helped conduct education presentations for the Southeast Boll Weevil Eradication Foundation, Inc. which has primary responsibility to implement the eradication program in the state. For this reason, the boll weevil eradication program education presentation variable was chosen to represent education information in the model. The eradication program education presentation variable was hypothesized to have a positive influence on participation. Other studies have found that producers frequently use the extension service as a source of information for decision making (Amponsah, 1995).

Due to the small number of farmers that listed radio and television reports as a source of information, the importance of magazine and newspaper articles was chosen to represent media information in the model. Turner et al. (1983) suggested that those producers who read trade magazines were more open to the adoption of new ideas suggesting a positive influence on program participation. On the other hand, negative reports in the media about problems with the program may erode producer support for the program. For example, reports of secondary insect problems allegedly caused by the boll weevil eradication program led to a recall vote to terminate the program in Mississippi (Luttrell et al., 1997). Consequently, the hypothesized relationship between media and willingness to participate is uncertain.

A small number of respondents rated the importance of information provided by crop/integrated pest management consultants and by other farmers. Therefore, these sources of information could not be evaluated in the model.

Based on the previous discussion, the following logistic model was estimated:

$$\log \frac{P_1}{(1-P_1)} = \beta_0 + \beta_1 AGE + \beta_2 BW94 + \beta_3 BW95 + \beta_4 BW96 + \beta_5 PROG + \beta_6 MEDIA + \varepsilon, \qquad [3]$$

where $P_1$ is the probability that a farmer will vote for the boll weevil eradication program; $\beta_j$ are model parameters; *AGE* represents the age of the principal operator; *BW94*, *BW95*, and *BW96* are spring-time boll weevil populations entering cotton fields for 1994, 1995, and 1996, respectively; *PROG* represents an ordered scale (1-5) of the importance of the boll weevil eradication education presentations; *MEDIA* represents an ordered scale (1-5) of the importance of newspaper and magazine articles; and $\varepsilon$ is the random error term.

## RESULTS AND DISCUSSION

### Logit Model Parameter Estimates

Due to missing values for one or more of the variables, nine observations were deleted from the model estimated using the PROC LOGISTIC procedure in the SAS computer program (SAS Institute, 1997). Of the 26 observations used, 19 reported they voted yes and 7 voted no in the referendum. The percentage of yes votes for the 26 observations used in the model is 73% which is greater than the 66% yes votes with all 35 observations. However, the sample means for the independent variables included in the final model were almost identical for the 26 and 35 observation data sets.

The maximum likelihood estimated coefficients and the chi-square probability, change in probability, likelihood-ratio test, pseudo *R*-square,

**Table 2. Parameter estimates and statistical relationships of the logit model used to evaluate the yes-no votes in the February 1997 Southwest Tennessee Boll Weevil Eradication Program referendum.**

| Variable name | Coefficient | Probability chi-square | Change in probability/ statistics |
|---|---|---|---|
| AGE | 0.3011 | 0.0558 | 0.006871 |
| BW94 | 0.0017 | 0.6970 | 0.000039 |
| BW95 | 0.0087 | 0.0545 | 0.000199 |
| BW96 | -0.0654 | 0.0382 | -0.00149 |
| MEDIA | -3.9219 | 0.0360 | -0.0895 |
| PROG | 4.9818 | 0.0353 | 0.113688 |
| Constant | -44.4404 | 0.0496 | -1.01416 |
| Log-likelihood ratio test | | | 30.29 |
| Pseudo $R^2$ | | | 0.40 |
| Prediction success: | | Concordant | 92.5 |
| | | Discordant | 6.8 |

and prediction success statistics are presented in Table 2. Goodness-of-fit measurements indicate that the model fits the data well. The likelihood-ratio test, which measures the significance of the logit function, has a score of 30.29. The pseudo *R*-square of 0.40 is in the 0.20 and 0.40 range which is considered to be a good fit for this type of model (Hensher and Johnson, 1981). The model correctly predicted 92.5% (24 out of 26) of the responses in the sample.

Logistic model parameter estimates cannot be directly used to determine change in probability from a one unit change in an independent variable. To calculate changes in probability, each parameter estimate was multiplied by its mean for the corresponding independent variable (Table 1). Next, a density function was calculated using

$$\frac{e^{\sum_{i=0}^{6} \beta_j \overline{X}_j}}{1 + e^{\sum_{i=0}^{6} \beta_j \overline{X}_j}}, \qquad [4]$$

where base *e* is the numerical value of the natural logarithm function and the exponent $\Sigma\beta_j\overline{X}_j$ is the sum of the parameter estimates, $\beta_j$, multiplied by the sample means $\overline{X}_j$. The change in probability for each independent variable was found by multiplying the density function by the parameter estimate. The change in probability is a function of the probability itself and when multiplied by 100 is the percentage change in the probability of the event occurring given a one unit change in the variable, *ceteris paribus*. For example, a 1 level increase in importance of information from *PROG* results in a 11.37% increase in the probability of the producer voting for the program in the 1997 referendum.

Evaluation of the model parameter estimates indicates that the *AGE*, *BW95*, *BW96*, *MEDIA*, and *PROG* variables were statistically significant at the 5 or 10% probability levels. The *BW94* variable was not significant in explaining yes-no votes in the referendum.

The *AGE* variable positively influences producer willingness to vote for the boll weevil eradication program. The positive sign on *AGE* suggests that the positive influence of producer experiences outweighs the negative influence of the shorter planning horizon associated with older decision makers.

As expected, the *BW94* and *BW95* variables had positive signs indicating that higher boll weevil populations increased producer willingness to vote for the eradication program. However, the *BW96* variable had a negative sign rather than the hypothesized positive sign and lowered producer willingness to vote for the eradication program. The likely reasons for the boll weevil population influence in the model are as follows. As indicated by the boll weevil population statistics in Table 1, the 1995 growing season was characterized by heavy infestations of boll weevils and other insects that caused large yield losses and control costs for producers. By contrast, the 1996 growing season was characterized by low insect populations. Farmers likely had much smaller yield losses and control costs in 1996, relative to their experience in 1994 and 1995. Due to the high infestation levels experience in 1995, producers likely focused most on problems of that growing season to make their decision which would make the negative sign on *BW96* somewhat spurious. Using the change in probability given in Table 2 for *BW95*, a producer who experienced the maximum boll weevil population (4902) was 26.5% more likely to vote yes for the program than a farmer who experienced the minimum boll weevil population (3570) in the sample.

Variables estimating the impact of information on the boll weevil eradication program decision have the highest significance in the model. The expected positive sign on the coefficient of the

*PROG* variable indicates the importance of the education presentation in influencing producers' support for the program. The change in probability suggests that a producer who rated the information with a 5 versus another farmer who rated it with a 4 would be 11.37% more likely to vote for the boll weevil eradication program. Given the change in probability for *PROG*, a producer who stated that the eradication program education presentation was very important was 45.48% more likely to vote for the program than a farmer who rated the education presentation as not important.

The sign on the *MEDIA* variable was negative indicating that newspaper and magazine information about the program tended to reduce producer willingness to vote for the program. A one unit increase in the importance of *MEDIA* reduced the probability of voting yes in the referendum by 9%. Producers in the sample who rated the information as very important were 35.8% less likely to vote in favor of the program than individuals who rated the information as not important.

Taking all the variables together, the producer most likely to have voted yes in the referendum (i) was an older individual with more years of experience growing cotton, (ii) experienced high boll weevil populations in 1995, (iii) rated eradication program education presentations highly, and (iv) discounted the importance of negative media reports about the program.

## Discussion

The parameter estimates from the logit model indicated that high boll weevil populations experienced by southwest Tennessee farmers positively impacted the outcome of the 1997 referendum. Boll weevil pheremone trap counts in southwest Tennessee were extremely heavy in 1995 and were only exceeded by the record number of boll weevils measured in 1989 (Seward, 1998). Large boll weevil populations likely had a positive impact on producer acceptance of the boll weevil eradication program in northwest Tennessee. As indicated previously, 78% of northwest Tennessee producers voted in January 1999 to implement the eradication program. Heavy boll weevil populations in the1998 growing season prior to the referendum surpassed the large numbers measured in 1995 and exceeded the previous record set in 1989 (Seward, 1998). As indicated by the large positive referendum vote margin for the northwest, cotton growers may have been interested in making sure that the large amount of damage caused by boll weevils did not happen again.

Another important factor that may explain voting behavior in the 1997 referendum was the boll weevil eradication program education presentations. The education presentations were conducted by personnel from the Southeast Boll Weevil Eradication Foundation, Inc., the Tennessee Department of Agriculture, and the University of Tennessee Extension Service (Tennessee Boll Weevil Eradication Foundation, Inc., 1997). The foundation is a nonprofit corporation organized by participating states including Tennessee to carry out the program in the southeast United States. For southwest Tennessee, education presentations were conducted in each county of the referendum area before the end of the voting period in late February of 1997. The education presentation outlined how the program would be implemented (i.e., program start date and duration, insecticide application criteria, other insect control practices, legal responsibilities of producers, the per acre cost of the program to a producer, and the expected benefits of the program). Producers were told that the 5-year program would have a maximum cost of \$211.77 per acre of cotton with payments spread over 7 years and ranging from \$11.77 to \$36.45 per acre per year. They were also told that the total cost may be less depending on boll weevil populations and availability of funding from other sources. Expected benefits were defined to include a reduction in direct control costs, a decrease in pesticide usage, and a reduction in direct yield losses caused by the boll weevil. Studies of the positive economic benefits of the program in other areas were cited in the presentation. The potential for Tennessee cotton producers having a competitive disadvantage to other producing areas that have already eradicated the boll weevil was also emphasized in the meeting. According to the model results, these education presentations had a significant positive impact on the outcome of the February 1997 referendum. The logit model analysis indicates that an aggressive education program may be a key factor in gaining producer support for pest management groups such as the boll weevil eradication program.

Finally, information about problems related to the boll weevil eradication program may have been another important factor explaining voting behavior in the February 1997 referendum. Media such as *Cotton Grower* magazine and the Mississippi Agricultural and Forestry Experiment Station have printed articles focusing on problems related to the boll weevil eradication program. For example, some growers and crop consultants blame the boll weevil eradication program for causing an increase in damage from secondary pests in Alabama, Mississippi, and Texas in 1995 (Sandusky, 1995; Luttrell et al., 1997; Williams and Layton, 1996). Intensive applications of malathion (diethyl(dimethoxythiophosphorylthio)succinate) may suppress beneficial insects causing populations of aphids (*Aphis gossypii* Glover), beet armyworms (*Spodoptera exigua* Hubner), and tobacco budworms (*Heliothis virescens* Fabricius) to increase (Jones, 1995; Smith, 1994; Layton et al., 1996).

In the spring of 1996, growers in eastern Mississippi initiated a recall vote where they voted to terminate the eradication program (Luttrell et al., 1997). Also, growers in Alabama saw an increase in tobacco budworms and armyworms after boll weevil eradication treatments began and a documented resistance to pyrethroids used to control the worm (Jones, 1995; Luttrell et al., 1997; Duffy et al., 1994).

## CONCLUSIONS

This study evaluated the yes-no responses of cotton producers voting in the February 1997 referendum to start a boll weevil eradication program in southwest Tennessee. The results of the analysis of producers' responses using a binary logit model indicated that producer age (also a proxy for years of experience growing cotton), high boll weevil populations in 1995, and eradication program education meetings had statistically significant, positive influences on producers' willingness to participate in the boll weevil eradication program. Boll weevil population in 1996 and the importance of media information had a statistically significant, negative influence on willingness to participate.

Boll weevil population levels indicating the severity of yield damage and control costs of infestations may influence the willingness of producers to implement a program. If boll weevil populations are low before a boll weevil eradication program referendum, the boll weevil eradication program may be difficult to implement. On the other hand, if high levels of boll weevils are experienced before the program vote, farmers may be eager to begin the program. Producers in southwest Tennessee most likely focused on the heavy 1995 boll weevil population over the light population in 1996. Farmers may have been more interested in making sure that the 1995 disaster did not happen again.

Importance of information from the media and eradication program education presentations had the most significant impact on willingness to participate. A producer that rated media information as very important decreased the probability of voting yes in the referendum by 35.8% when compared to a grower who rated the information as not important. A producer that rated the eradication program education presentation as very important increased the probability of participation by 45.48% compared to a grower who rated the information as not important.

Results of this study should be viewed as preliminary given the small number of observations in the sample. This study highlights the need to convince cotton growers to actively participate in surveys given that this information is critical in trying to derive information about factors influencing participation in group insect management programs such as the boll weevil eradication program. Despite the small size analyzed, this study contains useful information that may prove helpful to cotton farmers, the extension service, and boll weevil eradication program officials.

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## REFERENCES

Ahouissoussi, N.B.C., M.E. Wetzstein, and P.A. Duffy. 1993. Economic returns to the boll weevil eradication program. J. Agric. Appl. Econ. 25:46-55.

Amponsah, W.A. 1995. Computer adoption and use of information services by North Carolina commercial farmers. J. Agric. Appl. Econ. 27:565-576.

Ben-Akiva, M.E., and S.R. Lerman. 1985. Discrete choice analysis: Theory and application to travel demand. The MIT Press, Cambridge, MA.

Carlson, G.A., G. Sappie, and M. Hammig. 1989. Economic returns to boll weevil eradication. Agric. Econ. Rep. 612. USDA-ERS, Washington, DC.

Dillman, D.A. 1978. Mail and telephone surveys, the total design method. John Wiley & Sons, New York.

Duffy, P.A., D.L. Cain, G.J. Young, and M.E. Wetzstein. 1994. Effects of the boll weevil eradication program on Alabama cotton farms. J. Agribusiness 12:1-14.

Hammig, M.D., J.W. Jordan, and R.P. Griffin. 1984. An economic evaluation of a regional pest suppression program: Boll weevil eradication in South Carolina. J. Agric. Entomol. 1:219-226.

Hensher, D.A., and L.W. Johnson. 1981. Applied discrete-choice modelling. John Wiley & Sons, New York.

Jones, D. 1995. Weevil eradication offers tremendous advantages. Cotton Grower 31:18.

Kazmierczak, R.F. 1996. Factors influencing the support of Louisiana cotton producers and landowners for boll weevil eradication. J. Agric. Entomol. 13:375-391.

Kenkel, P.L., and P.E. Norris. 1995. Agricultural producers' willingness to pay for real-time mesoscale weather information. J. Agric. Res. Econ. 20:356-372.

Kennedy, P. 1992. A guide to econometrics. 3rd ed. The MIT Press, Cambridge, MA.

Layton, M.B., M.R. Williams, G. Andrews, and S.D. Stewart. 1996. Severity and distribution of the 1995 tobacco budworm outbreak in Mississippi. p.820-822. *In* P. Dugger and D. Richter (ed.) Proc. Beltwide Cotton Conf., Nashville, TN. 9-12 Jan. 1996. Natl. Cotton Council Am., Memphis, TN.

Luttrell, R.G., F.T. Cooke, T.B. Freeland, Jr., J. Gibson, F.A. Harris, D.H. Laughlin, J.T. Reed, and C.E. Watson. 1997. Study of cotton insect control problems in Mississippi during 1995 with special emphasis on boll weevil eradication and tobacco budworm. Mississippi Agric. and Forestry Exp. Stn. Tech. Bull. 217.

Robinson, E. 1997. Tennessee passes boll weevil referendum. Delta Farm Press. Intertec Publishing. Available online at: http://www.homefarm.com/cotton/cott035.html. Accessed Nov.9, 1997.

Robinson, E. 1999. West Tennessee zones approve eradication. Delta Farm Press. Intertec Publishing. Available online at: http://www.homefarm.com/dfp/articles/990130.htm. Accessed Feb, 17, 1999.

Robinson, J.R.C. 1993. Estimation of non-market benefits from boll weevil eradication in the Texas Gulf Coast region. Ph.D. diss. Texas A&M Univ., College Station (Diss. Abstr. 94-03581).

Rook, S.P., and G.A. Carlson. 1985. Participation in pest management groups. Am. J. Agric. Econ. 63:563-566.

Sandusky, D. 1995. In RGV's first season for boll weevil eradication: Worms eradicated cotton production. Cotton Grower 31:14-15.

SAS Institute. 1997. SAS/STAT user's guide. 6.12 ed. SAS Institute, Cary, NC.

Seward, R. 1998. Cotton insect update. *In* IPM newsletter for pests in field crops. p. 1-4. Entomol. and Plant Pathology Info. 71, week 1, 28 May 1998. Univ. of Tennessee Agric. Ext. Serv., Knoxville.

Smith, R.H. 1994. Changes in secondary pests during and after boll weevil eradication. p.796-797. *In* D.J. Herber (ed.) Proc. Beltwide Cotton Conf., San Diego, CA. 4-8 Jan. 1994. Natl. Cotton Council Am., Memphis, TN.

Tennessee Boll Weevil Eradication Foundation, Inc. 1997. Tennessee Boll Weevil Eradication Questions and Answers. Handout to cotton producers attending Boll Weevil Eradication Program Education Meetings, February 1997.

Tennessee Department of Agriculture. 1998. Tennessee agriculture, 1998. Tennessee Agricultural Statistics Serv., Nashville, TN.

Turner, S.C., J.E. Epperson, and S.M. Fletcher. 1983. Producer attitudes toward multicommodity electronic marketing. Am. J. Agric. Econ. 65:818-826.

United States Department of Agriculture, APHIS Plant Protection and Quarantine. 1997. Boll weevil eradication program. Document available online at: http://www.aphis.usda.gov/ppq/weevil.html. Accessed Feb. 1997.

Williams, M.R., and J.B. Layton. 1996. Taken by storm: A report of the tobacco budworm problem in Mississippi. p. 823-825. *In* P. Dugger and D. Richter (ed.) Proc. Beltwide Cotton Conf., Nashville, TN. 9-12 Jan. 1996. Natl. Cotton Council Am., Memphis, TN.