PRODUCTION TERMINATION AS AN ALTERNATIVE TO MITIGATE NUTRIENT POLLUTION

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ABSTRACT

Nutrient runoff from agricultural land can be reduced through production termination to mitigate water pollution. The willingness to accept value to terminate the broiler production is evaluated using sample selection model. The result showed a positive relationship between the decision to participation and stated WTA value indicating the producers are willing to terminate the production but at high cost. The farmer's perception about government role on water pollution, farm income, information and awareness about other pollution reduction alternatives play a major role on stated WTA amount as well as on participation decision.

I. INTRODUCTION

Incentive payments have been a very popular policy vehicle to motivate agricultural producers toward more environmentally friendly production practices. Conservation Reserve Program (CRP) Wetlands Reserve Program (WRP), Environmental Quality Incentive Program (EQIP) and Dairy Termination Program (DTP) are the major examples of the incentive payments to support producers to employ environmental friendly agricultural production practices.

CRP was established with the goal of retiring environmentally sensitive area from active crop production. The CRP provided incentive payments to the farmers who were willing to retire their land from production process in order to reduce soil erosion as well as the crop production. Similarly, EQIP was established to provide technical and financial support to the farmers who agreed to adopt environmentally friendly production practices (Claassan and Horan, 2000). Further, the Dairy Termination Program offered incentive payments to milk producers for cutting down the milk production either temporality (at least for five years) or permanently. The programs are considered to be successful to meet the desired goals.

A similar concept of incentive payments for production termination can be borrowed to mitigate water pollution problem associated with broiler production in Louisiana. Thus, the main focus of this chapter remains on the production control program with direct consequence of reducing pollution in a given watershed. Incentive payment is a viable option to motivate Louisiana broiler producers to terminate (permanently or temporarily) the broiler production and help reduce the water pollution in environmentally sensitive areas. On the other hand, the incentive payments help farmers to balance farm income while meeting the environmental goal.

The question remains on how to estimate the dollar amount that represents producers' desired level of incentive payment to encourage production termination in order mitigate water pollution in the watershed. In fact, to obtain a number representing an amount that a producer desires to receive to be willing to forgo their production practices is difficult. The dollar amount that encourages producers can't be obtained through market transactions. Contingent valuation studies are designed to assess the amount that reflects a minimum monetary amount required by the producers to relinquish one unit of broiler production from their current operation level. The value is assumed to represent an amount of incentive payment that the farmers require if they were to incorporate pollution reduction effort on their production function. The payment level is evaluated based on farmer's household income, their perception about governmental role on pollution control, and other farm characteristics.

In order to examine the farmer's desired level of incentive payment, a clear understanding of their utility function is required. It is because the producers should be paid the amount that leaves the producers at least indifferent to either continue (remain on same level of utility) or to terminate the production practices (move to new utility level with addition income in the form of incentive). I examine producers willing to accept (WTA) amount which suffices the producers to forgo their production practices and move to the new utility level.

It is assumed that by terminating the broiler production, the problem of nutrient pollution can be mitigated through reduced level of broiler litter. Cutting of the litter production is one of the viable alternatives to save Louisiana water from nutrient pollution. While not judging the existing or current policies, this chapter highlights the WTA value elicitation and examination under the hypothetical but potential governmental policy of production termination for pollution reduction.

This chapter is based on the assumption that an establishment of appropriate baseline incentive payment is important in order to avoid negative consequences of incentive payments on either production process or in environmental services. For the purpose, it becomes imperative to understand the underlying factors that impact the amount of incentive payments that the broiler produces require. I therefore, estimate the broiler produces WTA function using the existing broiler production as a vehicle to elicit the WTA amount.

A crucial assumption made in this chapter is that reducing the litter production decreases the nutrients flow/leaching to the surface/ground water. This will help to meet the pollution reduction goal in Louisiana.

II. LITERATURE REVIEW

The producers fail to accommodate environmentally sound management practices on their production function. This is mainly because producers fail to receive any economic incentives associated with accommodating pollution abatement effort on production decision. Under those circumstances, the government's incentive payment programs are considered as a viable tool to motivate farmers to incorporate pollution reduction practices on their production function (Cooper, 1997; Batie, 1999; Classen and Horan, 2000). Incentive payment significantly increases the likelihood of farmers' participation as well as the acreage enrolled on environmentally friendly conservation reserve program (Cooper, 1997).

Producers are willing to participate on the programs only if the size of incentive payment covers the full cost of participating on the program (Classen and Horan, 2000). Wossink and Swinton (2007) examined the cost of producing environmental services. The study showed how complementary or substitutive relationships change the cost of producing environmental services.

Producing environmental service as complementary to market good costs less to the producers as compared to the ones produced as substitutes which are produced outside of agricultural practices (Wossink and Swinton, 2007). Thus, their study supports the idea of bringing farmer on pollution control programs.

However, recognizing an appropriate amount of incentive payment becomes difficult. Establishing the incentive payment based on individuals' production function becomes inappropriate because of the varied nature of production function. The production cost of environmental service depends on farm characteristics such as geographic areas, soil type etc. making the prediction difficult (Classen and Horan, 2000).

The next approach of estimating the incentive payment depends on return from agricultural land (Seikh *et al.* 2007). Relying on the amount of return also becomes inappropriate since, it fails to accommodate nonmarket values, risk attitudes and unobservable transaction cost. Thus, determining the baseline payments needed by producers, in response to establishing environmentally friendly production practices, becomes a difficult task.

The measure of WTA has widely been used to evaluate compensation requirement to keep an individual's utility at his/her desired level. The method is extensively used for the goods lacking a clear market for the good in question. Either WTP or WTA can be employed to elicit the value that an individual assign for the goods. In the issues, such as finding an amount that motivates the farmers to participate on environmentally sound production practices, WTA is preferred to WTP.

Goldar and Misra (2001) estimated resident's WTA values to decrease the number of trees in a public park, while, Brox *et al.* estimated the values in the context of water pollution reduction (2003). The majority of existing literatures focus on estimating incentive payments for environmentally sound production or land use practices. Few examples included the studies on land conservation (Amigues et al. 2002); forest and habitat development (Kline *et al.* 2000; Seikh *et al.* 2007); water pollution reduction practices (Cooper, 1997; Brox *et al.*, 2003) etc.

WTA produce valid estimates of individuals true compensation required to encourage using environmental friendly management practices (Goldar and Misra, 2001). Seikh *et al.* (2007) employed WTA measure to evaluate the compensation required by farmers in order to convert marginal land into forest for carbon sequestration. The study found the lower value of WTA as compared to the value obtained by another approach. Their study concluded that the value elicitation using WTA benefits the government without hurting the utility of producers, while setting up the incentive payments.

The WTA values elicited using contingent valuation technique raises the issues of hypothetical bias. Studies have focused on the appropriate approaches to deal with the hypothetical bias under the field (Goldar and Misra 2001) as well as experimental settings (Nape *et al*. 2003). Under field setting, Golder and Misra suggested using a functional forms that accommodate positive bias along with random error to obtain valid estimates for WTA.

On the other hand, Nape *et al*. (2003) conducted an experiment to examine the presence of hypothetical bias on WTA value. The study found significant presence of bias originated from hypothetical market setting where individuals do not own the good in question. While the bias was not significant if the individuals possessed the good in question before experiment started (Nape *et al*. 2003). Thus the result implied that the hypothetical bias is less if the concern is over a good which an individual possesses. I closely followed their concept on setting up the hypothetical market scenario (more will be discussed in Methodology section) and involved a good in question that the farmer possess. I tried to reduce such bias by incorporating the farmers owned good (the broiler production in which the individual's livelihood is based) in the hypothetical market description.

The contingent valuation approach is often condemned for eliciting the values that fail to represent the true WTA. In addition to hypothetical bias, zero bid value is a very common for contingent valuation studies either at open ended or payment card option (Bowker et al. 2003, Goodwin *et al*. 1993). Failure to accommodate zero and missing values produces sample selection bias leading to biased and inconsistent parameter estimates.

Bowker et al. 2003, Goodwin *et al*. 1993 treated zero bids as if the data was censored at zero and employ tobit model to estimate WTP bid function. However, under the contingent valuation scenario, the zero responses are the result of non-observability rather than the true censoring (where the censoring at zero may represent some negative values). Then the use of tobit model becomes inappropriate (Singelman and Zeng, 1999).

Strazzera *et al.* (2003) allowed the zero values estimating the model in two stages. The study employed two-stage simultaneous equation model to correct for the bias caused by the zero responses. Similarly, in response to the existing bias, Amigues et al. (2002) permits the zero responses by estimating the model in two stages. The study found that the estimated hypothetical WTP value better represented true willingness to pay amount when the zero responses were treated separately in the model.

In general, the WTA value has been a convincing approach to assign monetary value for nonmarket good if estimated using appropriate methodology. Thus, this paper evaluates the WTA values that encourage broiler producers to participate on pollution reduction program. It accommodates the two-stage estimation approach to correct for the bias originated sample selection criteria with zero bid values for the flock of birds.

III. DATA

Dependent variables:

Hypothetical market scenario was developed in order to elicit farmers' WTA value. The respondents were asked how much they desire to receive as an incentive payment from the government if they were to comply with the proposed regulation. It is assumed that the individuals who answered the WTA questions positively are willing to cooperate with the proposed program, while the individuals who either did not respond to that question or listed zero as WTA values were assumed to be not interested on the program.

The variable is operationally defined as 1 if the individual responded with positive amount on WTA question and 0 if otherwise. A question asked the individual that “if you were asked to terminate your production process to help reduce nutrient pollution, how much are you willing to accept per flock”.

WTA represented the amount that an individual is willing to accept as an incentive payment in order to trade one flock. The average WTA amount was about 4,000 dollars per flock that represents an individual’s stated price of production termination to reduce water pollution.

Explanatory variables:

The variables that entered the final model are selected based on economics reasoning as well as on stepwise regression. A priory economic theory does not guide much about the variables to affect the willingness to participate and pay. Therefore, a stepwise selection process is also employed to choose the final set of variables. Table 1.1 presents the list of explanatory variables and summary statistics.

The stepwise variable selection process that started with all potential explanatory variables provided the ones that met 0.30 percent significance level. Few other variables such as farm income, farm size and perception of individual regarding government role on water pollution control are used in the model even though they did not meet the selection criteria. The variables that were selected in the selection process but didn’t meet the conversion criteria at two stage maximum likelihood estimation approach were also dropped from the model. At the end of the variable selection trial, farm income, broiler number, housing in nearby, asset liability ratio and age were kept for the first stage probit model (Brox *at el.,* 2003). The same approach was employed to select the variables for the second stage.

The *Number of broilers* represents the total number of broiler birds raised by an individual producer in 2003. The numbers are divided by 100,000 for easier computational purpose. Larger the number of birds implies larger production size. The production size is found to be positively related to the willingness to participate on environmentally friendly agricultural practices (Saikh, *et al*, 2007). It is assumed that the larger broiler farmers are expected to be willing to participate on the proposed pollution reduction program. It is also likely that the larger operators are afraid of potential pollution control regulation and are more likely to participate on the production termination program.

Farm income is defined as the household income generated from broiler industry. Based on the existing literatures, it is not clear what effect the farm income has on willing to participate on production termination program. Farm income showed negative income effect on accepting to participate on terminating production land into forest land (Saikh, *et al,* 2007). However the effect was positive on adopting environmentally friendly production practices (Gillespie *et al.*, 2007).

In this study, farm income is defined in four categories at the interval of $50,000 starting from "negative profit up to $50,000", "$0 to $49'999", "$50,000 to $99,999", and "$100,000 to $149,999". Producers with higher farm income are financially more secure as compared to others and are more interested to forgo the production to reduce water pollution. The individuals with high farm income may spend on pollution abatement technology instead of terminating the ongoing production practices. In addition, the farmer who generates more farm income expects higher incentive payment if he has to forgo his production to reduce nutrient generation.

Farmer's own characteristics play a major role on the decision associated with water pollution. The variable *Age* provides mixed result in previous studies. Age is positively associated with the likelihood of environmentally friendly dairy production practices (Gillespie *et al.*, 2007), while it is negatively related with environmentally friendly irrigation practices (Koundouri *et al.,* 2006). Younger farmers are found to be more knowledgeable and more risk taking due to longer planning horizon and therefore, are more likely to participate on environmentally friendly agricultural practices (Adesina and Zinnah, 1993).

Housing in surroundings represents a dummy variable representing whether residential subdivisions are located near broiler farm. Deterioration of air quality from the broiler litter is one of the major pollution issues associated with broiler production. Complains of strong and objectionable orders is voiced by the neighbors causing serious legal actions against broiler producers (http://www.epa.gov/agriculture/anafobmp.html#Odors; 20th May). Such threat from the nearby residents forces broiler producers to implement appropriate measures to reduce those air problems. Presence of housing subdivision in the neighborhood is therefore assumed have significant positive effect on likelihood of participation on pollution control program.

Table 1.1: Summary Statistics of Explanatory Variables

Variable	Mean	Std Dev.	Min	Max
WTA value ($)	3961.21	3664.18	0	18750
Number of broilers/100000	4.706	3.020	0.18	19
Individual has off-farm income =1	0.324	0.471	0	1
Perception that government should pay for water conservation, scale 1-5	3.292	1.378	1	5
If there are housing subdivision in nearby =1	0.108	0.313	0	1
Ownership of business; individual owner=1	0.726	0.449	0	1
Heard about BMP	0.811	0.394	0	1
Age of farmer at the time of survey	53.284	12.184	25	79
Farm income up to 49,999	0.315	0.468	0	1
Farm income up to 50,000 to 99,999	0.356	0.482	0	1
Farm income greater than 99,999	0.233	0.426	0	1
Willing to participate on the program=1	0.838	0.371	0	1
Percentage of land owned by the grower	86.092	27.320	0	100
Number of years plans to be in business	13.932	10.168	0	50

Business *ownership* is a dummy variable indicating whether the firm is individually or family owned. Individually owned businesses are assumed to have solo power to make decisions and thus easier to decide. Therefore, the single ownership makes individual to decide easily but may have either positive or negative effect on participation decision or on stated WTA values.

The producers don't believe that their production practices causes threat to the nearby water bodies. Therefore, farmer's perception about *government's role* on pollution control is an important factor to decide whether to participate on the pollution control program (Hite *et al*. 2002). In addition, the WTA amount to trade a flock increases if the producers don't see their production practices as a threat to the water resources.

Awareness about the alternative practices, was constructed using the information obtained indicating whether an individual have *heard about BMP*. This represents whether the respondent has only heard about the BMP or have implemented the practices. The variable is then used as proxy for his/her general knowledge about the availability of alternative practices that can be implemented to reduce nutrient runoff. Thus the availability of substitutes is assumed to have negative effect on production termination decision.

The off-farm income is often found to be significant variable on individuals' decision to implement environmentally friendly production practices. Respondent's off-farm income affected the decision to adopt environmentally sound best management practices negatively (Gillespie *et al*., 2007). The variable measure whether an individual broiler producer has off-farm income in addition to farm income.

Having off-farm income implies additional income and therefore financially more secure to seek for other options to comply with pollution regulation rather than changing production level. It is therefore, hypothesized that the broiler growers with off-farm income state higher WTA value and are unwilling to participate on proposed pollution reduction program. Similarly, the individuals, expecting to remain (Number of years plans to be in business on the business) longer than others, tend to expect larger WTA vale and may also be willing to cooperate on pollution reduction programs.

Fraction of land owned by the broiler grower over total land operated is hypothesized to be negatively related to the participation decision as indicated by Rahelizatovo, 2002. Having more land allows broiler growers some flexibility on litter application with no/little restriction. Individual therefore, tends not to seek for other alternative solution for water pollution control measures.

IV. MODEL

Economic model for WTA

Broiler production is assumed to be a component of individual's utility function. Thus, terminating the existing production practices directly affect the individual's utility level. Therefore utility theoretic approach is preferred to examine broiler producer's preferences over current production level or reduced/terminated production level with an additional income of WTA value.

The farmers are considered to have strictly quasiconcave utility function defined over a quantity constrained good (flocks of broiler), a non-constrained good (numerarie) and money income M. The M represents the individual's household income consisted of farm as well as off-farm incomes. A broiler producer's utility function that accommodates environmental component, respondent's socioeconomic characteristic and payment option is expressed as;

$$U^l = U(\boldsymbol{Z},\ M + I^l,\ Q^l) \qquad (1.1)$$

$U^l(\cdot)$ defines a broiler producer preferences over market goods and water quality improvement through reduction in litter production (measured by reduction in production size). $\boldsymbol{Z}$ is a vector of variables containing farmer's as well as farm characteristics; I^l is the WTA amount under the proposed policy. I^l is zero under the current condition since there has no effort been made to reduce pollution production thus, no changes on income is required.

The broiler producers are now expected to maximize their utility function U^l with respect to constrained budget. However, the individual is faced with the two options, whether to produce at the current scale or terminate the production practices at $I as an incentive payment. The reduced broiler production is expected to reduce nutrient pollution production and obtain better water quality.

The utility maximizing individuals desires to receive an incentive level that leaves him/her at least as better off as he was before the change on production. Suppose, $U^1 = U(\boldsymbol{Z},\ M + I^1,\ Q^1)$ represents the utility level with new production level and positive income change assuming $l = 1$, while the existing utility level is $U^0 = U(\boldsymbol{Z},\ M,\ Q^0)$.

Then an individual will be willing to terminate the production process if the following holds;

$$U(\boldsymbol{Z},\ M + I^1,\ Q^1) \geq U(\boldsymbol{Z},\ M,\ Q^0) \qquad (1.2)$$

Hanneman (1984) suggested that the individual's utility functions should be treated as random variables. The U^1 and U^0 are random utility function that can be expressed (respectively) as;

$$V(\boldsymbol{Z},\ M + I^1,\ Q^1) + \varepsilon^1 \text{ and } V(\boldsymbol{Z},\ M,\ Q^0) + \varepsilon^0 \qquad (1.3)$$

$V(\cdot)$ on equation 1.3 represents the deterministic component and the ε^0 and ε^1 represent the random error of a respondent's utility function. $V(\cdot)$ is defined as individual's indirect utility function either after production termination with an I^1 increase in income, or under the existing production practices.

It is assumed that the individual then evaluates their utilities at both conditions and decides whether to terminate the production process at given payment of WTA value (which is defined as I^1).

Then, the individual's first stage decision of whether participate on production termination program is observed with following probability distribution.

$$P\{Participates\} = P\{V(\boldsymbol{Z},\ M + I^1,\ Q^1) + \varepsilon^1 \geq V(\boldsymbol{Z},\ M,\ Q^0) + \varepsilon^0\}$$
$$= P\{\varepsilon^0 - \varepsilon^1 \leq V(\boldsymbol{Z},\ M + I^1,\ Q^1) - V(\boldsymbol{Z},\ M,\ Q^0)\} \qquad (1.4)$$

The terms ε^0 and ε^1 are assumed to be independently and identically distributed random errors. The WTA function is then evaluated using an approach which allows the non-participants to enter the model.

The second stage decision of stated WTA value can be formulated as;

$$WTA = f\{\boldsymbol{Z}, M, I^l, Q^l\}$$

Econometric model for WTA

Since the survey collects information on WTA value from the individual who are willing to participate on the production termination program, the observation may be nonrandom. In addition, the two responses, whether to participate on the program, and the value that the individuals desires to receive so as to terminate the production process, are correlated. A regression on nonrandomly selected sample produces inconsistent estimates of the parameters (Davidson and Mackinnon, 1993).

Thus, the design of the WTA elicitation on survey questionnaire requires an econometric modeling that fully accounts for the possible correlation between the "Yes/No" answer of participation question and the size of the WTA amount. Thus, the information elicitation design requires simultaneously explain participation decision and stated WTA values.

In the present context, let the decision to participate be represented by the binary variable B_i for an individual i. If an individual record a positive WTA value on the survey question $B_i = 1$ is assigned while, if respondent state WTA value be zero then $B_i = 0$ is assigned indicating that he/she is not willing to participate on the proposed pollution reduction through production termination.

The variable W_i is the individuals' stated value representing the amount of incentive (WTA) that an individual would need to trade one flock of broiler birds from his existing production practices.

$$B_i^* = \boldsymbol{Z}_{ib}\boldsymbol{\beta}_b + \varepsilon_{bi} \qquad (1.5)$$

$$B_i = \begin{cases} 1 \text{ if } B_i^* > 0 \\ 0 \text{ if } B_i^* \leq 0 \end{cases}$$

$$W_i = \boldsymbol{Z}_{iw}\boldsymbol{\beta}_w + \varepsilon_{wi} \qquad (1.6)$$

where $i = 1,2, \dots \dots \dots, n$ represents the number of individuals in the sample. $\boldsymbol{Z}_{ib}$ and $\boldsymbol{Z}_{iw}$ represent a set of explanatory variables on binary response equation (1.5) and WTA (1.6) equation respectively. There may be some overlap on variables on the vector $\boldsymbol{Z}_{iw}$ and $\boldsymbol{Z}_{ib}$. The $\boldsymbol{\beta}_b$' and $\boldsymbol{\beta}_w$ are the unknown coefficient vectors.

The respondent chooses to state $B_i = 1$ if the latent variable turn out to be positive. Otherwise, the respondent chooses to answer no to the participation question ($B_i = 0$). The explanatory variables ($\boldsymbol{Z}_{ib}$, $\boldsymbol{Z}_{iw}$) and the binary response variable, B_i are always observable while the willingness to pay value, W_i, is observed only when $B_i = 1$. This makes the error terms ε_{bi} and ε_{wi} to be correlated. Thus, $\varepsilon_{bi} \sim N(0,1)$ and $E(\varepsilon_{wi}/\varepsilon_{bi}) = \gamma\varepsilon_{bi}$.

$$\begin{bmatrix} \varepsilon_{wi} \\ \varepsilon_{bi} \end{bmatrix} \sim NID\left(0, \begin{bmatrix} \sigma^2 & \rho\sigma \\ \rho\sigma & 1 \end{bmatrix}\right) \qquad (1.7)$$

σ is the standard deviation of ε_{wi} and ρ is the correlation between ε_{wi} and ε_{bi}. A nonzero correlation between the two equations is a result of dependence of B_i^* on the respondent's stated WTA value (W_i). The negative correlation between the ε_{bi} and ε_{wi} implies that the individuals who are willing to participate on the production termination program demand smaller WTA as an incentive. However, the ε_{bi} and ε_{wi} are independent of the explanatory variables ($\boldsymbol{Z}_{ib}, \boldsymbol{Z}_{iw}$).

Maximum likelihood estimator

The conditional probability density function of an individual chooses to participate on production termination program is $f(B_i|z) = [\Phi(\boldsymbol{Z}_{ib}\boldsymbol{\beta}_{\boldsymbol{b}})]^{B_i}[1 - \Phi(\boldsymbol{Z}_{ib}\boldsymbol{\beta}_b)]^{1-B_i}$. If an individual accepts to participate on the production termination program, the probability density function of the amount of WTA is calculated as;

$$f(W_i|B_i = 1, \boldsymbol{Z}) = \frac{P(B_i=1|W_i,\boldsymbol{z})f(W_i|\,\boldsymbol{Z})}{P(B_i=1|\boldsymbol{Z})}$$

$(W_i|\boldsymbol{Z}_i) \sim N(\boldsymbol{Z}_{iw}\boldsymbol{\beta}_w, \sigma_w^2)$ and $B_i = \boldsymbol{Z}_{ib}\boldsymbol{\beta}_b + \sigma_{bw}\sigma_w^{-2}(W_i - \boldsymbol{Z}_{ib}\boldsymbol{\beta}_b + \epsilon)$

where ϵ is independent of $(\boldsymbol{Z}_{iw}, \boldsymbol{Z}_{ib}) \sim N(0,\ 1 - \sigma_{bw}\sigma_w^{-2})$

So, $P(B_i = 1|W_i, \boldsymbol{Z}) = \Phi\{[\boldsymbol{Z}_{ib}\boldsymbol{\beta}_b + \sigma_{bw}\sigma_w^{-2}(W_i - \boldsymbol{Z}_{iw}\boldsymbol{\beta}_w)](1 - \sigma_{bw}\sigma_w^{-2})^{-1/2}\}$

Now combining all these and taking log of the likelihood function we get the following log likelihood function;

$$l(\boldsymbol{\theta}) = (1 - B_i)\log[1 - \Phi(\boldsymbol{Z}_{ib}\boldsymbol{\beta}_b)] + B_i\left(\log\Phi\left\{[\boldsymbol{Z}_{ib}\boldsymbol{\beta}_b + \sigma_{bw}\sigma_w^{-2}(W_i - \boldsymbol{Z}_{iw}\boldsymbol{\beta}_w)](1 - \sigma_{bw}\sigma_w^{-2})^{-\frac{1}{2}}\right\} + \log\phi\,[(W_i - \boldsymbol{Z}_{iw}\boldsymbol{\beta}_w)/\sigma_w] - \log(\sigma_w)\right) \quad (1.7)$$

V. RESULT AND DISSCUSSION

The data showed that nearly sixteen percent of respondents are willing to accept zero amounts in order to participate on production termination program. The zero bid response is common for contingent valuation studies (Bowker *et al.*, 2003; Goodwin *et al.* 1993). However, observing zero bid values in WTA to trade a flock with cleaner water quality may not imply that the respondents are willing to sell a flock of bird at zero prices.

It is therefore assumed that the zero value originates from first stage of decision where an individual decides whether/not to participate on the pollution reduction program (Strazzera *et al.* 2003, Cho, et al., 2005). Then, at the second stage, the individual decides how much he/she requires receiving to forgo their production practices. Thus, the respondents having zero bid values on contingent valuation questions are considered to be not interested to trade a flock/s to trade for pollution reduction. The term B_i^* is then considered to be unity if an individual responded positively to the WTA question and zero otherwise.

The WTA amount is observed only if the individuals are interested to participate on the program or if the $B_i^* > 0$. For the contingent valuation question the W_i represents the dollar amount that an individual desires to receive so as to trade one flock of birds for better water quality. The average value of WTA is about three thousand nine hundred and sixty dollars whereas the profit from one flock is only one thousand and four hundred dollars.

The selection nature of data collection gives rise to an estimation problem since the errors in the two decision process (participation and WTA value) are correlated. Excluding the non-participants from the analysis, or using only the positive WTA values produces the inconsistent estimation of parameters (Cameron and Trivedi, 2005). And an efficient and unbiased estimate for WTA function requires a method that simultaneously explains the both decision.

Davidson and MacKinnon (1993) suggest employing two step heckman's procedure in order to test the hypotheses of no selection bias. The hypothesis of "absence of selection bias" can be tested by checking whether the coefficient of inverse mills ratio is significantly different than zero. The result indicated that the coefficient of inverse mill's ratio is significantly different from zero with the p value of 0.069. Since, the null hypothesis of "no sample selection effect" is rejected, the ordinary least square (OLS) process can't be used because it produces biased and inconsistent parameter estimates for WTA (Cameron and Trivedi, 2005; Baum, 2006).

With the rejection of sample selection hypothesis, and with the nature of sample selection while collecting data, I preferred to employ heckman's sample selection models for the analysis. It is recommended to employ maximum likelihood approach to estimate the parameters once the sample selection hypothesis is rejected form two step heckman's procedure (Davidson and MacKinnon, 1993).

A priori economic theory doesn't provide a guide to decide which variable should be included either on participation or on WTA equation. Therefore, except for farm income, farm size, and perception toward government's role on water quality issues, other variables are selected using stepwise regression process through linear regression for WTA equation, and through probit model for decision equation.

Since, it is unlikely that the individual's decision to participate and his WTA amount are determined by the different sets of covariates, a selection model started from the full set of variables. The variables significant at 0.30 were allowed in the heckit model. In addition, the demographic variables that failed to generate the Z values of at least one on heckit procedure were simultaneously dropped from the model. The process is consistent with variable selection process employed by Brox *et al*., (2003). The results from final model are presented on table 1.2 and 1.3.

The table 1.2 provides the parameter estimates and their standard errors of binary choice of participation decision. The first step of the analysis estimates the decision equation of whether to participate (or not to participate) on the proposed program. The only variables that came out to be insignificant, on the first step probit regression, are farm size measured by broiler number, and the dummy representing whether there are housing subdivision/s in nearby.

The result indicated that the older individuals are less likely to participate on the production termination program and thus on the pollution reduction programs. Existing studies also show that the older individuals are reluctant to participate on the pollution reduction program through BMP adoptions (Gilespie, *et al*., 2007). The result implies that the older farmers have shorter time horizon to be on the production business and therefore, prefer not to modify the production practices with the tools that are designed for long term goals.

The off-farm income is often found to be significant variable on individuals' decision to participate on environmentally friendly production practices. The result showed that the participation decision is negatively affected by the level of off farm income. Individuals, who work off farm, are less likely to participate on pollution reduction through cutting off their production practices. Gillespie *et al*. (2007) also find the negative impact of off farm income on employing pollution reducing production practices.

Fraction of land owned over total land operated for agriculture was hypothesized to be negatively related to the participation decision as indicated by Rahelizatovo, (2002). The result supported the hypothesis showing that one percent increase in fraction of owned land decreases the likelihood of participation on flock trading for pollution control program by 0.07.

The result showed that the individual who solely won the broiler firm are less likely to participate on production termination programs (Table 1.2). These individuals also stated higher

WTA value than the individuals who operate the business on partnership (Table 1.3). The result is contradictory with Gilespie, *et al*. (2007) but the variable is barely significant at 0.111.

Table 1.2: The determinants of willingness to participate: binary variable B_i^*

WTA value ($)	Coef.	Std. Err.
Number of broilers/100000	0.158	0.109
If there are housing subdivision/s in nearby =1	0.106	1.291
Individual has off-farm income =1	-1.212**	0.635
Percentage of land owned by the grower	-0.071***	0.029
Ownership of business; individual owner=1	-1.011	0.635
Perception that government should pay for water conservation in the scale of 1-5	-0.614**	0.271
Age of farmer at the time of survey	-0.095***	0.036
Heard about BMP	-1.369**	0.615
Constant	14.512***	4.821
Pseudo R-square	0.419	
LR chi2(8)	25.54	
Prob > χ^2_8	0.001	

Note: *, ** and *** stands for the variable is significant at 0.10, 0.05 and 0.01 percent level of significance respectively.

The perception that the government should pay for water pollution control programs is measured in Likert scale, 1 indicating disagree to 5 indicating strongly agree. Perception among producers that government should be involved on pollution reduction programs reduces the likelihood of farmers' participation. Thus, the individuals who strongly believe that government should pay for water pollution control programs are less likely to participate on the production termination program to mitigate water pollution problem.

The individual who has heard about the BMP is less likely to participate on the proposed program (Table 1.2) and willing to accept larger amount to trade one flock of broiler (1.3). The result implied that if the individuals are aware of other alternatives such as BMP to reduce pollution then the individuals tend not to participate on the production termination program and state greater amount of WTA.

For the specific determinants for WTA value that motivates the individuals to participate on the program, it is noticed that production size, off-farm and farm income, individual's perception about government's role on water pollution, ownerships of farm, and knowledge about alternative pollution control programs are the significant factors affecting stated willingness to accept value. In fact almost all of the variables are significant at least at ten percent level of significance. The only variable that are not significant are the dummies for income level that falls between 50,000 to 99,999 and existence of housing subdivisions in the surroundings.

Table 1.3:The determinants of WTA: The sample selection and no-selection models for (W_i)

	OLS selection (heckman two-step)		OLS no-selection	
Variables	Coef.	Std. Err.	Coef.	Roust Std. Err.
Number of borilers/100000	-276.480**	125.389	-192.035	138.061
Individual has off-farm income =1	2703.157***	876.635	1699.734	1156.593
Perception that government should pay for water conservation in the scale of 1-5	1059.606***	297.540	729.680**	337.543
If there are housing subdivision/s in nearby =1	495.785	1212.170	-732.914	1298.205
Ownership of business; individual owner=1	1580.870**	814.630	1608.133*	909.450
Heard about BMP	2000.754**	1038.465	2805.682***	1083.750
Age of farmer at the time of survey	-20.387	33.661	-53.384	40.207
Farm income upto 49,999	3456.066***	1406.414	3789.173**	1778.140
Farm income upto 50,000 to 99,999	1717.795	1398.308	1530.968	1437.255
Farm income greater than 99,999	2637.818*	1450.289	2354.555*	1473.871
Constant	-2684.595	2825.590	-822.357	3645.072
λ	1191.657	1106.518	----	----
ρ	0.461	0.409	----	----
σ	2585.917	254.559	----	----
No of observations	70		67	
Censored	11			
Uncensored	59			
Wald χ^2_{10}	51.02			
Prob $>\chi^2_{10}$	0.0000			

Note: ***, **, and * stands for the variables are significant at 0.01 0.05 and 0.1 percent level of significance respectively.
λ is significant at 0.092

The result showed that the size of production is negatively related to the stated value of WTA (Table 1.3) and positively related to the likelihood of participation (Table 1.2). The, larger broiler growers are more likely to participate on the program and need lower incentive payments if they were to forgo their production practices either partially or fully to meet the pollution reduction goal. The result is consistent with the finding of Rahelizatovo (2002).

This result has two implications. First, the larger farmers fear from the potential government regulation (for example, CAFO affects the larger producers more than/not the smaller producers) and therefore, like to decrease the flock size at lower WTA value and avoid dealing with the regulations. In general, the result implies that the larger farmers are more responsive to the water pollution issues and potential government regulation to mitigate the nutrient pollution problem.

Farm income is classified into four categories and a dummy variable is assigned for each category. The first level stated whether the firm is running at loss and is employed as reference group. The result showed that the individuals earning less than $50,000 net farm income desire higher amount of WTA value as compared to the individual who face up to $50,000 loss per year.

The third level of farm income also showed significant positive impact on WTA value. The producers who earn up to $50,000 farm income per year require about $3456 per flock per year in order to terminate the production program as compared to the individuals who bear loss up to $50,000. The farmers with more than $100,000 farm profit also showed significant positive impact on stated value of WTA. Surprisingly, the second level of income category showed insignificant impact on stated value of WTA.

The perception about the role of government on pollution control, positively and significantly increases the WTA value. The individuals who strongly believe that the government should pay for the pollution control program are stating higher WTA values. The higher WTA values may also be due to the unwillingness to participate on pollution reduction program.

The ρ, which represents the cross equation correlation, is positive. The result indicates that individuals are interested to forgo their production practices only if they receive sufficient amount of incentive payment. The positive effect of perception that government should pay for water pollution control programs also supports this finding. The positive correlation is also consistent with the finding of Hite *et al.* (2002) who concluded that the farmers don't realize their production practices contribute to nutrient pollution and hesitate to invest on pollution reduction practices. However, Brox et al. (2003) found a negative relationship between the decision to participate on pollution reduction program and stated WTA value.

VI. CONCLUSION

Nutrient production and runoff originated from agricultural production practices can be reduced through production termination. The economic incentives have proven to be effective tool to encourage farmers' participation on pollution reduction programs. Establishing appropriate baseline incentive payment seems crucial to avoid unintended negative consequences of governmental incentive payments. This study provides an insight over the factors to be considered before setting up the incentive payments which encourage broiler producers to practice environmentally friendly production practices. The factors that affect broiler producer's decision to cooperate with water pollution reduction programs are evaluated using heckman's sample selection model.

Size of the farm, measured by the number of broiler birds raised per year, significantly affected the size of WTA value. Larger farmers are more serious about water pollution and potential regulation and thus state a lower WTA values to help reduce water pollution. On the other hand, the significant positive effect of perception that government should pay farmers to participate on pollution abatement program suggested that a sufficient economic incentive is required to encourage farmers to participate on environmentally friendly production practices.

This study will be novel in the area of environmental economics in sense that this study evaluated the farmers' attitude toward contributing to pollution reduction programs, whereas, the past studies mainly focused on WTA for only conservation programs. This paper is important also because very little is known about the broiler producers' attitude and willingness to participate on the pollution reduction programs. And the understandings of the factors that affect farmer's interest to participate on those programs are critical for the success of national and state level policy formulation in order to mitigate water pollution.

VII. REFERENCES

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