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RESEARCH PAPER

Consumer acceptance of genetically modified Bt brinjal: A study in Coimbatore district of Tamil Nadu

P. BALAJI, K.R. ASHOK, C. VELAVAN AND K.C. PRAKASH

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ABSTRACT

This study applies on ordered probit model to estimate the relationship between consumer's personal attributes and their acceptance of Bt brinjal. The analysis would facilitate better understanding of consumers' attitudes towards genetically modified crops in general and Bt brinjal in particular and their willingness to accept these crops. It will also help companies involved in the production of these crops to understand the profile of consumers who are more likely to accept Bt brinjal. The main objective is to study the consumer behaviour in relation to recent trends in vegetable retail with regards to consumer acceptance of genetically modified vegetables. The co-efficient of all the independent variables specified in the model like education, income, awareness on genetically modified crops, awareness on pesticide reduction and trust in scientist are significant and positively related to acceptance of Bt brinjal.

KEY WORDS : Consumer Acceptance, Ordered Probit and Bt Brinjal

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Biotechnological approaches for crop improvement and crop protection got greater emphasis in the past few years. But release of genetically modified genetically modified crops generated lot of debates on its potential benefits and risks. Hence, it is imperative to assess the acceptance of genetically modified crops by the consumers. This study applied on ordered probit model to estimate the relationship between consumer's personal attributes and their acceptance of Bt brinjal. The analysis would facilitate better understanding of consumers' attitudes towards genetically modified crops in general and Bt brinjal in particular and their willingness to accept these crops. It will also help companies involved in the production of these crops to understand the profile of consumers who are more likely to accept Bt brinjal. The main objective was to study the consumer behaviour in relation to recent trends in vegetable retail with regards to consumer acceptance of genetically modified vegetables.

MEMBERS OF THE RESEARCH FORUM

Correspondence to:
P. BALAJI, Centre for Agriculture and Rural Development Studies, Tamil Nadu Agricultural University, COIMBATORE (T.N.) INDIA

Authors' affiliations:
K.R. ASHOK, C.VELAVAN AND K.C.PRAKASH, Centre for Agriculture and Rural Development Studies, Tamil Nadu Agricultural University, COIMBATORE (T.N.) INDIA

METHODOLOGY

Retailers in the Coimbatore city can be broadly classified into five categories *viz.*,. National Corporate Retail Chains (NCRC), Regional Corporate Retail Chains (RCRC), Private Sector Specialized Stores (PRSS), Public Sector Specialized Stores (PUSS) and Traditional Mom and Pop Stores (Kirana Stores) adopting the classification of NABARD (2011). One retail outlet from each of retail store type was selected based on sales volume (maximum) with respect to fruits and vegetables for conducting the study. Accordingly Reliance Fresh was selected for NCRC, Shri Kannan Departmental Store was selected under RCRC, Pazhamudhir Nilayam for PRSS and Uzavar Santhai (Farmers Market). Two Kirana store, near each of the four retail store type were selected by simple random method. In each kirana

store ten customers were selected. The adult consumers irrespective of gender and age who had purchased for at least one year at the same retail outlet were considered as respondents for this study. Amoung the customers visiting each of the retail outlet, eighty consumers were selected as respondents using simple random sampling. Thus, the total sample respondents selected from the retail stores for the study was 400. The primary data were collected through "mall intercept survey method" in the selected sample retail store outlets in the city of Coimbatore. The consumers were approached randomly to participate in the survey. Respondents were contacted at a designated spot outside the main entrance of the retail outlet after their purchases and were requested to participate in the survey (Phau and Teah, 2009). The data were collected in the year 2011 through a well structured and pre-tested interview schedule.

In the ordered probit model, Yi = 0 implies approve and strongly approve the genetically modified Bt brinjal produce, Yi = 1 implies disapprove the genetically modified Bt brinjal produce and Yi =2 implies disapprove the enetically modified Bt brinjal produce. The variable was transformed into a 0 to 2 scale for computational reasons.

Adopting the methodology of Govindasamy *et al.* (2007), it is assumed that the consumer faces a choice between approving genetically modified crops (A) and disapproving (D) the genetically modified crops. Utilities derived from approval and disapproval of genetically modified crop are given by U_A and U_D, respectively, which are not observable. The observable variables are process attributes a (a=A,D) and a vector of consumer characteristics (x). The utility of consumer i is postulated as follows:

$$U_{ai}=V_{ai}+\varepsilon_{ai} \quad \text{.....(1)}$$

where,

U_{ai} is the latent, unobserved utility for choice alternative a, V_{ai} is the explainable part of the latent utility that depends on the chosen process with attributes and personal characteristics of consumer i, and ε_{ai} is the random or 'unexplainable' component of the latent utility associated with the choice of product attribute *a* and consumer i.

Consumer i's choice ordering between approval and disapproval of the genetic process to produce genetically modified Bt brinjal (*i.e.*, between attributes A and D, respectively) is modeled in the following way: consumer i ranks a genetically modified process in one of the three categories based on the indicator function:

$$Z_i=(V_{Ai}+\varepsilon_{Ai})-(V_{Di}+\varepsilon_{Di})=(\varepsilon_{Ai}-\varepsilon_{Di})-(V_{Ai}-V_{Di}) \quad \text{.....(2)}$$

where,

Z_i can be interpreted as additional utility derived by the i^{th} consumer by choosing to approve a genetic modification process over disapproval. Consumer expresses strong disapproval in the genetic modification process if Z_i is below some threshold value (e.g., $\propto_1$), shows moderate disapproval if Z_i is above $\propto_1$ but below another threshold value $\propto_2$ and reveals approval in the process if Z_i is above $\propto_2$. Formally, consumer i's choice ordering (denoted by Y_i where Y = 0 implies strong approve, Y = 1 implies moderate disapproval and Y = 2 implies strongly disapprove) can be expressed as follows:

$$\begin{aligned} &Y_i = 0 \text{ if } Z_i < \propto 1, \\ &Y_i = 1 \text{ if } \propto_1 < Z_i < \propto_2 \text{ and} \\ &Y_i = 2 \text{ if } Z_i > \propto_2, \end{aligned} \quad \text{.....(3)}$$

Since part of the utility is random in nature, a researcher cannot perfectly predict the choice of a consumer. From the researchers'perspective, the problem is inherently stochastic, which naturally leads to formulating the i^{th} consumer's choice problem in probability terms:

$$\begin{aligned} &P(Y_i=0 \mid \text{Choice set}) = P[Z_i=(\varepsilon_{ai}-\varepsilon_{Di})-(V_{Ai}-V_{Di}) <\propto_1) \\ &P(Y_i=1 \mid \text{Choice set}) = P[\propto_1 < Zi = (\varepsilon_{Ai}-\varepsilon_{Di})-(V_{Ai}-V_{Di}) <\propto_2) \\ &P(Y_i=2 \mid \text{Choice set}) = P[Zi = (\varepsilon_{Ai}-\varepsilon_{Di})-(V_{Ai}-V_{Di}) >\propto_2) \end{aligned} \quad \text{.(4)}$$

Under the assumption that the random term $(\varepsilon_{Ai} - \varepsilon_{Di})$ follows standard normal distribution, the above probabilistic model is the well-know ordered-probit model. In empirical estimation, the indicator Z_i for the i^{th} consumer is modeled as a function of his/her socioeconomic and value attributes and can be expressed as:

$$Zi = \beta'X + V_i = \beta_0 + \beta_1 X_i 1 + \beta_2 x_i 2 + ... + \beta_k x_i k + V_i, i = 1,2...,n \quad \text{....(5)}$$

where,

x_{ij} = j^{th} attribute of the i^{th} respondent;

$\beta = (\beta_0, \beta_1, ...,\beta_k)$ = the parameter vector to be estimated and

v = random error.

In this setting, the probabilities of choice for Y_i = 0, 1, and 2 are given by:

$$\begin{aligned} &P(Y_i=0 \mid \text{Choiceset}) = \Phi(\propto_1 - \beta'X_i) \\ &P(Y_i=1 \mid \text{Choiceset}) = \Phi(\propto_2 - \beta'X_i) - \Phi[\propto 1 - \beta'X_i] \\ &P(Y_i - 2 \mid \text{Choiceset}) = 1 - \Phi[(\propto_2 - \beta'X_i), \end{aligned} \quad \text{.....(6)}$$

where,

Φ is the cumulative function of a standard normal distribution.

In the above model, the $\propto$'s are unknown threshold parameters that separate the adjacent rankings or categories. In empirical estimation stage, both the β-vector and the $\propto$'s are estimated jointly using the maximum likelihood (ML) procedure*. The estimated β-co-efficients of equation (5)

do not directly represent the marginal effects of the independent variables on the probabilities of choice. The marginal effects are given by the following expression (assuming continuous explanatory variables):

$$\frac{\partial P(Y_i = 0)}{\partial X_j} = \ddot{} (\propto_1 - \beta' X)\beta_j \quad \text{.....(7)}$$

$$\frac{\partial P(Y_i = 1)}{\partial X_j} = \ddot{} (\propto_1 - \beta' X) - \ddot{} (\propto_2 - \beta' X)\beta_j$$

$$\frac{\partial P(Y_i = 2)}{\partial X_j} = \ddot{} (\propto_2 - \beta' X)\beta_j$$

where,

φ is the density function of standard normal variable. In the case where the explanatory variable is discrete or categorical in nature, the marginal effect of such a variable is obtained by evaluating the probabilities at alternative values of x_{ij}. The co-efficient estimates are not equal to the marginal effects of the explanatory variables x on the probabilities. The marginal effects of the explanatory variables are calculated in the following manner:

$$\partial Probj/\partial x_i = [f(\propto_j - 1 - \beta' x_i) - f(\propto_1 - \beta' x_i)].\beta \quad \text{.....(8)}$$

where,

f(.) is the standard normal density. The marginal effects for the dummy variables are calculated as the difference between two resulting probabilities when the dummy variable equals its two values 0 and 1 (Nayga *et al.*, 2004). Actual estimation of the empirical model was performed using the software package LIMDEP (Econometric Software, 2002).

The following empirical model is used to estimate the relation between the probability that a will approve the use of biotechnology in food production and his/her personal attributes:

$Z_i = \beta 0 + \beta_1$ Education+ β_2 Annual income
+ β_3 Awareness about genetically modified crops
+ β_4 Awareness on pesticide reduction
+ β_6 Trust on scientists
+ β_7 Trust on media + u_i.

where,

Z_i = 0 if the respondents approve and strongly approve the genetically modified Bt brinjal,

Z_i =1 respondents disapprove the genetically modified Bt brinjal, and

Z_i = 2 if the respondents strongly disapprove genetically modified Bt brinjal

β0= Constant

u_i = Error term.

ANALYSIS AND DISCUSSION

Consumer debate on biotechnological applications in agriculture has centred mainly on its potential benefits and risks to society and the environment. An analysis was made to assess the consumer acceptance of Bt brinjal using an ordered probit econometric model. This model estimates the relationship between consumers' personal attributes and their approval of Bt brinjal. Information generated by the study would be useful in formulating appropriate private and public policies and in education or outreach with regards to the use of genetic technology in agriculture and food production. The function with value, the dependent variable used in the model is the respondents' acceptance of Bt brinjal. The acceptance of genetically modified crops by the consumer is captured through 3 possible responses like strongly agree, disagree and strongly disagree.

The estimated Ordered Probit model to study the Consumer Acceptance of Genetically Modified Bt brinjal is given below:

$CAcceptance_{Bt.brj}$ = Constant-(0.42779***) Education-(0.78141***) Annual income-(0.47290***) Awareness of genetically modified corps (0.49025***) Awareness on pesticide reduction-(0.33598**) Trust on Scientist-(0.01893) Trust on media+ u_i

Definition of variables and descriptive statistics of ordered probit model:

The independent variables in the model and the descriptive statistics of the variables are given in Table 1. Most of the variables are defined as dummy or indicator variable. It could be observed from the table that 55 per cent of the respondents approved Bt brinjal and 30 per cent of the customers disapproved genetic modification of Bt brinjal and 15 per cent of the consumers strongly disapproved genetically modified brinjal.

Education:

While some studies indicated positive relationship between education and approval of food biotechnology, the evidence is far from condusive. Educations of respondents are classified in to six groups. The level of educational group comprised of graduate (29.25%) diploma holders (22.00%) and secondary school level (19.75%).

Annual income:

Five different annual income levels were identified. About 45.75 per cent of the respondents earned an annual income between Rs. 2 lakhs to 5 lakhs, 28 per cent belonged to the income range from Rs. 90000 to 2 lakhs followed by 14.50 per cent in Rs. 5 lakhs to 10 lakhs income group. No apriori assumption was made about the effect of income on an individuals' approval of genetically modified technology

in agriculture and food production.

Awareness of genetically modified crops:

Awareness of genetically modified crops is likely to influence the acceptance of genetically modified crops. Socio-economic studies on public perception of biotechnological applications on food and agriculture found that the consumers knowledge of science related to biotechnology influences their acceptance of genetically modified crops. The effect of this variable is an open empirical question. Respondents were classified into 2 categories based on the awareness about genetically modified foods. Majority of the respondents were found to be aware of genetically modified crops (70.50%).

Awareness about pesticide reduction:

The genetic modification in Bt brinjal is aimed at reducing the pest attack in brinjal crop, which would reduce the yield loss and pesticide use in brinjal crop. The dummy variable on pesticide reduction was assigned a value of 1 if the respondent is aware of pesticide reduction and 0 otherwise. Higher the awareness about the pesticide reduction potential of Bt brinjal, it is more likely that the technology is accepted.

Consumer trust:

Asian Food Information Centre found that the consumer considered scientists as well as non-governmental institutions, such as FAO, to be the credible sources of information about food biotechnology. A dummy variable was constructed to capture the trust in media and in scientists for consumers agreement or disagreement with the following statement: (Name of the institution) "will tell the truth" and, 'has the expertise to make competent judgment".

Trust over scientist:

The dummy variable was assigned value 1, if the respondents agreed somewhat or strongly agreed with the

Table 1: Definition of variables and descriptive statistics of ordered probit model (No. of observations = 400)

Variables and definitions	Range	No.	Per cent	Mean	Std. deviation
Dependent variable: Consumer acceptance				0.59	0.74
Consumer accept = 0	Approve and strongly approve	222	55.50		
Consumer accept = 1	Disapprove	117	29.25		
Consumer accept = 2	Strongly disapprove	61	15.25		
Education				4.10	1.33
0 = Illiterate	0 = Yes,1 = No	11	2.75		
1 = Primary school	1 = Yes, 0 = No	3	10.75		
2 = Secondary school	1 = Yes, 0 = No	79	19.75		
3 = Diploma	1 = Yes, 0 = No	88	22.00		
4 = Under graduate	1 = Yes, 0 = No	117	29.25		
5 = Post graduate	1 = Yes, 0 = No	62	15.50		
Annual income (Rs.)					
1 = Less than 90,000	1 = Yes, 0 = No	29	7.25	305839	0.93
2 = 90,000 to 2,00,000	1 = Yes, 0 = No	112	28.00		
3 = 2,00,000 to 5,00,000	1 = Yes, 0 = No	183	45.75		
4 = 5,00,000 to 10,00,000	1 = Yes, 0 = No	58	14.50		
5 = More than 10,00,000	1 = Yes, 0 = No	18	4.350		
Awareness about	1 = Yes,	282	70.50	0.70	0.45
GM crops	0 = Otherwise	118	29.50		
Awareness about	1= Yes,	280	70.00	0.70	0.45
pesticide reduction	0= Otherwise	120	30.00		
Trust in scientist	1= Yes,	321	80.25	0.80	0.39
(has expertise to make competent judgement)	0= otherwise	79	19.75		
Trust in media	1= Yes,	91	22.75	0.22	0.41
(will tell truth)	0= otherwise	309	78.25		

Table 2: Consumer acceptance of genetic modification in brinjal: Ordered probit estimates

Variables	Co-efficient	t value
Constant	0.00	
Education	-0.42779***	-7.02
Annual income	-0.78141***	-4.77
Awareness of genetically modified crops	-0.47290***	-3.02
Awareness on pesticide reduction	-0.49025***	-3.31
Trust on scientist	-0.33598**	-2.10
Trust on media	-0.01893	-0.13

*, ** and *** indicate significance of values at P=0.01, 0.05 and 0.1, respectively, No. of observations : 400, LR Chi^2 (6) : 180.02*** Prob.Chi- square : 0.000 and Pseudo R^2 : 0.2312

Table 3: Marginal effects of predictor variables of OPM

Variables	Outcome 0 : Y=Pr (Strongly approve) =0.5668	Outcome 1: Y=Pr (Disapprove) =0.3528	Outcome 2 :Y=Pr (Strongly disapprove) =0.0803
Education	0.16826***(7.03)	-0.10447***(-5.61)	-0.06379***(-5.87)
Income	0.30311***(5.11)	-0.14216***(-5.68)	-0.16094***(-3.61)
Awareness of GM crops	0.18645***(3.04)	-0.10551***(-3.19)	-0.080933***(-2.60)
Awareness on pesticide reduction	0.19317***(3.36)	-0.10911***(-3.49)	-0.08406***(-2.83)
Trust on scientist	0.13311**(2.10)	-0.07544**(-2.28)	-0.05766*(-1.82)
Trust on media	0.00743(0.13)	-0.00463(-0.13)	-0.00280(-0.13)

Figures in the parenthesis indicate the t-ratio for ordered probit model, *, ** and *** indicate significance of values at P=0.05, 0.01 and 0.1, respectively

trust statement. And 0, if otherwise. Overwhelming majority (80.25%) of the respondents agreed with the trust statement.

Trust over media:

The dummy variable was assigned a value of 1, if the respondents somewhat or strongly agreed with the trust statement. And 0, if otherwise. Overwhelming majority (78.25) of the respondents disagreed with the trust statement.

The estimated model co-efficients and the associated t ratio and marginal effects of the explanatory variables are presented in the Table 2 and 3.

The overall significance of the independent variables is tested using the Chi-square distribution. The calculated Chi-square value was found to be significant at 1 per cent level. Therefore, the model has significant explanatory power.The estimated β co-efficients in an ordered probit model provides limited information on consumer acceptance of Bt brinjal.

The estimated β co-efficients do not directly represent the marginal effects of independent variables on the probability of choice. The co-efficient of all the independent variables specified in the model like education, income, awareness on genetically modified crops, awareness on pesticide reduction and trust in scientist are significant and positively related to acceptance of Bt brinjal. Hence, the marginal effects of independent variable on the consumer acceptance of Bt brinjal were worked out and presented in Table 3.

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