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Original Research

The Current Issues About Waste Prevention and Willingness to Pay: A Case Study of Greenhouse Production in Turkey

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Abstract

Regarding the regulation of waste, many policies and legal rules exist throughout the world. However, people often see the effort and money spent on "waste" as a "wasted resource" ironically. Waste is generated in every sector where production exists, and agriculture is one of them. The agricultural sector faces various challenges related to different types of waste. Especially, intensive agricultural systems like greenhouses have a more complex structure in waste classification. This study aims to draw attention to economic and social factors and focuses on behaviors and trends in waste management. Its original value is the evaluation of the factors affecting the waste management preferences of the producers. Within the scope of the research, a survey was conducted with 250 tomato producers selected by sampling in Antalya and its districts. Willingness to Pay (WTP), one of the contingent valuation methods, was applied for the research method, and bivariate probit models were used for the econometric model. As a result of the field study conducted with the producers, it was analyzed how demographic and socio-economic variables affect WTP and WTP amount. Additionally, as well as the waste disposal preferences of producers, waste types generated by agricultural production and how they are treated are also discussed.

Keywords: waste management, disposal methods, contingent valuation, bivariate probit model

Introduction

Centuries ago, while estimating the population and calculating the nutritional needs of the increasing population, it was not thought that the waste produced by the consumed ones could reach today's size [1]. But as a result of this growth, materials like garbage have turned into waste and gained economic value. Today, the importance of waste is increasing day by day in every corner of the world. Even in "Point Nemo" one of the most desolate regions in the world, an area called "spacecraft cemetery" located in the southern Pacific Ocean, wastes have become a concern [2].

There is no other man-made object that has traveled as long and spread over such a wide range as waste. The waste covers the oceans, the bottom of the seas, the peaks, the rocks, and almost the entire planet [3]. Thus, apart from the waste generated on Earth, the garbage in space also poses a problem. It is not known whether the phenomenon called development will one day be called being able to live by achieving production

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and consumption without waste, but waste is seen as one of the most important problems.

Being one of the major waste types, waste resulting from agricultural activities consists of different materials like plastics, fertilizers, herbicides, pesticides, etc. [4] which may seriously damage the environment when not properly evaluated. But non-agriculture related wastes may affect agricultural activities too such as the pollution caused by industrial activities making some regions unsuitable for agriculture. For example, in the Chinese city of Guiyu, which is seen as the world's largest electronic garbage dump, agriculture has become impossible. Apart from the inability to carry out agricultural activities in this place, which used to be a rice region in past, access to clean water has also become impossible [5]. A major environmental disaster occurred at an aluminum plant in Ajka, Hungary, which caused 1 million tons of heavy chemicals to enter the waters. Many animals died and plants were destroyed in this accident [6].

By-products resulting from agricultural activities are generally called "agricultural waste" while they lose their character as the main product. Agricultural waste primarily comes from agro-industry, aquaculture routes, livestock, and crop residues. Accordingly, its management is a hot topic that requires advanced planning and implementation. It's been considered a significant concept in countries where economic growth relies solely on agriculture [7]. Wastes are generated not only after the consumption of the final product but also during the extraction and processing of raw materials. Having the advantages of renewable, cost effective, and broad range of resources, agricultural waste can also be used for environmental pollution control in a way that its chemical structure containing carboxyl, hydroxyl, and other active groups can remove pollutants better [8]. For this reason, producers and their behaviors are of great importance in terms of agricultural wastes arising in agricultural production.

Since human behavior is strongly dependent on many influences such as social demographics, attitudes, subject norms, education, perceptions, and perceived behavioral control, there is a need for field studies on the behaviors, thoughts, and tendencies of producers on "agricultural wastes" to develop effective policies.

This study, conducted in the Antalya region where the agricultural activities are intense, focuses on the attitudes and behaviors of greenhouse tomato producers on waste, waste disposal, their Willingness to Pay (WTP), and Willingness to Pay Amount (WTPA) for waste recycling. Generally, WTP can be described as the maximum price at or below which a consumer agrees in buying a single unit of a product or service without losing its usefulness [9]. Within the scope of the econometric model application of the research, the study aims to determine the socio-economic and demographic factors affecting the WTP of the producers for environmentally friendly disposal of the wastes generated as a result of tomato production and the target group is producers. In addition, waste management strategies and policies are discussed.

Materials and Method

The sources of the materials used in the study (the methods of creating the data) and the methods used to achieve the objectives of the study are explained in this section, respectively. The research was carried out with original (primary) data, which was supported by secondary data based on literature research but obtained largely through a face-to-face interview with the target audience. The scope of the study is the city center of Antalya and its districts. The target audience consists of greenhouse tomato producers. In the districts within the scope of the study, greenhouse tomato production is carried out intensively. In the first part of the survey, questions about the socio-economic characteristics of the producers like the population, gender, age, education level, and the permanent and foreign workforce working in the enterprise were asked. In the second part, questions to measure the amount of vegetable waste (number of seedlings, organic materials), greenhouse material waste, equipment (heating, electricity, irrigation, etc.), and use of pesticides and fertilizers for variable inputs are asked.

Before the questionnaire form was applied, the producers were informed about the subject. Preliminary information was given that the information obtained during the interviews would not be shared with third parties and that personal information would not be requested from the producers. Before starting the survey interviews, an "ethical approval certificate" was obtained from the Scientific Research Commission of Akdeniz University.

In the determination of the number of producers, a stratified sampling method was used based on the size of the production area among the agricultural holdings included in the "Greenhouse Registration System". As a result of probabilistic stratified sampling, the number of survey participants was calculated as 250 producers. For this number to represent the region and be sufficient, stratified sampling reduces the sampling error and provides more representation of the population. In this sampling method, a large population is required to reduce the sampling errors [10]. The population was divided into three strata according to the farmland width. How many units of the sample will be drawn from each stratum was found by Neyman allocation and sample volumes were distributed to strata according to this method.

Method

Contingent Valuation and WTP Method

"Contingent Valuation Method" was used for the data analysis of this study. The contingent valuation is a method that aims to calculate the possible market prices of goods and services that do not change hands (not traded) in the market. Being extremely flexible, contingent valuation can be used to estimate the economic value of almost anything [11]. It's widely applied to determine the monetary value of environmental policy measures [12]. Asking individuals to consider hypothetical questions, CVM is often more useful than the revealed preference techniques in extracting individuals' WTP for environmental goods and services [13]. It is stated by [14] that the use of this method has been increasing in recent years by international organizations such as the World Bank and Development Bank, as well as the USA and Europe. This shows that it is a useful and accepted method for valuing environmental goods [15]. WTP, one of the contingent valuation methods, was found to be suitable for the study. It is defined as one of the non-market valuation methods used in environmental economics research [16, 17].

Although non-market resources provide benefits to individuals, it is not possible for them to be subject to market prices and sold directly in the market due to their nature. The "payment amount" is determined through field research by asking people how much money they would be willing to give to maintain the current situation or how much money they would be willing to pay. Since the demand for payment value resulting from the survey depends on the characteristics of the defined corporate markets, it is called contingent valuation. Measuring WTPA for public goods is important when deciding on public investments and determining the political tools to regulate environmental impacts [18]. This method is mainly about asking people how much they will pay for a certain benefit or how much they will accept by participating in a certain expense [19].

Since the producers are the end users of agricultural inputs, how they dispose of the waste is also important. Especially the disposal of hazardous wastes such as pesticides makes the issue more critical [20]. Therefore their behaviours are decisive for organizing waste management tools. In a study conducted in Ethiopia in 2020, the factors affecting WTP were investigated and it was found that the degree of farmers' amount to pay is strongly influenced by environmental perception, farm shortage, labour days, government subsidies, economic conditions, knowledge of agricultural waste and living in harmony with nature [21]. In a study conducted in another African country Burkina Faso, the rate of preferring environmentally friendly waste disposal methods was found to be low. For example, the majority of producers bury or burn empty pesticide boxes [22]. Research in China revealed that farmers often avoid risk when it comes to environmentally friendly disposal of pesticide packaging. They prioritize profit maximization and they are not willing to invest extra money since green disposal of pesticide packaging wastes could generate relatively lower economic income [23]. In Canada, a different answer came to the question of producers' willingness to pay for agricultural waste. Farmers stated that they are both willing to take on-farm actions and pay a small amount to support Agriculture Plastic Waste (APW) recycling program. However, they are also disappointed with the existing APW management services. They oppose any program that requires them to participate in 'off-site' activities, such as transportation of materials to a central warehouse [24]. This situation also indicates that farmers expect an institutional solution from the state.

The Bivariate Probit Regression Model

To apply the WTP method in the study, the analysis was made by choosing the bivariate probit model, which is one of the qualitative response regression models. These are also called reactive qualitative preference models [25]. The dependent variable can take two or more values in qualitative response regression models. In two-choice models, the person chooses the one that provides the most benefit from these options [26] and the independent variable or variables can be of any type (qualitative, quantitative, etc.) [27]. The multivariate probit model was proposed by Ashford and Sowden [28] to model the system of correlated binary outcomes within the framework of regression. The bivariate probit model is a special case of the multivariate probit model in which there is more than one variable [29, 30]. Unlike independent variables, in bivariate probit models, correlations are sought between dependent variables shown as "y". Two variables that are thought to be related to each other are analyzed together [30]. It is defined by the following equations [31].

$$y_1^* = x_1' \beta_1 + \varepsilon_1 \qquad y_1 = \begin{cases} 1, if\ y_1^* > 0 \\ 0, if\ y_1^* \leq 0 \end{cases}$$

$$y_2^* = x_2' \beta_2 + \varepsilon_2 \qquad y_2 = \begin{cases} 1, if\ y_2^* > 0 \\ 0, if\ y_2^* \leq 0 \end{cases}$$

$$E[\varepsilon_1] = E[\varepsilon_2] = 0 \qquad Var[\varepsilon_1] = Var[\varepsilon_2] = 1$$

$$Cov[\varepsilon_1, \varepsilon_2] = \rho \tag{1}$$

y_1^*, y_2^* = The dependent variable, x_1', x_2' = Independent variable, ε_1, ε_2 = Error term
β_1, β_2 = Independent variable coefficient,
$E[\varepsilon_1]$, $E[\varepsilon_2]$ = Error terms expected value $Cov[\varepsilon_1, \varepsilon_2] = \rho$ = Covariance between error terms
$Var[\varepsilon_1] = Var[\varepsilon_2]$ = Error terms variance

The least squares method is insufficient in estimating the econometric model used because it acts on the assumption that the dependent variable has a normal distribution. While this method is used in regression estimation, it is not used in regression models with qualitative variables. None of the qualitative response models can be predicted consistently with linear regression models, and for this reason, in most cases, estimation is made using the maximum likelihood method [26]. The maximum likelihood estimation method function is given below.

$$Prob\ (x_1 < x_1, x_2 < x_2) = \phi_2(x_1, x_2, \rho) = \int_{-\infty}^{x_2}\int_{-\infty}^{x_1} \phi_2(z_1, z_2, \rho) d_{z_1} d_{z_2}$$

$$\phi_2(x_1, x_2, \rho) = \frac{e^{-(1/2)\,(x_1{}^2 + x_2{}^2 - 2px_1x_2)\,(1-\rho^2)}}{2\pi(1-\rho^2)^{1/2}} \quad (2)$$

To generate the log probability,
$q_{i1} = 2\ y_{i1} - 1$ and $q_{i2} = 2\ y_{i2} - 1$
So that, $q_{i1} = 1$
If $y_{ij} = 1$ and -1
If $y_{ij} = 0$ and j = 1 and for 2,
$z_{ij} = \acute{B}_j x_{ij}$ and $w_{ij} = q_{ij} z_{ij}$, j = 1,2
$\rho_i{}^* = q_{i1}\ q_{i2}\rho$ probabilities to enter the probability function:

$$\text{Prob}\ (Y_1 = y_{i1}, Y_2 = y_{i2}) = \Phi_2(w_{i1}, w_{i2}, \rho_t\ *) \quad (3)$$

In the main hypotheses of the study, the null hypothesis argues that the variables used in the model have no effect, while the alternative hypothesis argues that the variables are effective.

H_0: Variables do not affect WTP and WTPA.

H_1: Variables do not affect WTP and WTPA.

For the Bivariate Probit regression application, the data set consisting of tomato producers using plastic greenhouses for production in Antalya city center and districts were used. For this purpose, the dependent variable Y_1 is a latent variable that takes the value of 1 for producers willing to pay, 0 for producers who are not willing to pay, and the dependent variable named Y_2 is 1 for producers willing to pay, and a latent variable for producers who are not willing to pay.

Dependent variables in the model:
Y_1 = WTP of greenhouse tomato producers
Y_{11} = Accept WTP, Y_{12} = Refuse WTP
Y_2 = Greenhouse tomato producers' willingness to pay (bid price)
Y_{21} = Accept the WTPA, Y_{22} = Deny the WTPA

Findings

Evaluations about WTP

The evaluations regarding the WTP of the producers are given in Table 1 using a likert scale. 44% of the producers stated that they would not pay for environmentally friendly pesticides, while 29% stated that they would be able to pay. Producers who answered "undecided" constitute 8% of the participants. The producers were asked whether they could allocate a budget for waste management and pay. 63.29% of the producers stated that they did not agree to pay, 29.12% could pay for the recycling of waste, and 63.93% stated that they could not pay. Participants also mentioned that waste separation requires time and labor. When asked if they would like to pay for this separation before the collection process, 65.82% of them stated that they could not pay.

Separation of waste before collection is needed for the system to function properly [32] and this process has an important place in waste management. Producers describe the process of separating waste as a labor and time-consuming activity. 67% of the participants stated that they could not pay for the separating process. Regarding whether they can pay for the agricultural wastes generated as a result of production to be taken from the production area and taken to the recycling facility, approximately 29% of the producers answered that they were willing to pay and 7% were undecided. 65% stated that they would not be able to pay (Table 1).

According to the results of the bivariate probit regression model, education, income, business size, age, and experience do not affect the WTP of producers. On the other hand, participants who think that the effects of waste on human health and the environment are negative, accepted the WTP.

Variables in the model, coefficients related to these variables, features such as standard deviation, etc. are specified in Table 2. A positive correlation was found between Y_1 and Y_2 variables and it was calculated as r = 0.034. The established model as a whole was statistically significant (Prob > $\chi 2$ = 0.000). Rho (ρ) measures the correlation of error terms in the two models [30]. The ρ value between both models of WTP and the accepting payment amount was 0.330 (0.115). The meaning of this number indicates a moderate relationship between both models. The estimated correlation coefficient / estimated st. error value for the Rho (ρ) = 0 hypothesis test was found to be 2.855. Since the calculated value was greater than the critical value of 1.96, ρ was significant [33]. The ρ value being

Table 1. Evaluations about WTP.

Status	I will never pay	I do not pay	I'm undecided	I pay	I will definitely pay	Total
WTP for environmental awareness	44	19	8	23	6	100
WTP for waste management	44.3	18.99	10.76	21.52	4.4	100
WTP for waste recycling	44.94	18.99	5.7	23.42	5.7	100
WTP for separation before collection of waste	45.57	20.25	6.96	22.15	5.06	100
WTP for the displacement of waste	44.94	19.62	6.96	22.15	6.33	100

Table 2. Bivariate probit regression model prediction results.

Variables	Y_1				Y_2			
	Coefficient	St. Error	z	p	Coefficient	St. Error	z	p
Age	0.867	0.846	1.03	0.305	-0.885	0.939	-0.94	0.346
Waste Amount (Below Average)	0.501	0.209	2.39	0.017*	-0.279	0.245	-1.14	0.254
Marital Status (married)	-0.057	0.367	-0.16	0.877	0.283	0.425	0.66	0.506
Perception	0.016	0.002	5.82	0.000*	-0.009	0.003	-2.78	0.005*
Education: Secondary Education and High School	-0.200	0.210	-0.95	0.341	0.008	0.233	0.03	0.972
Education: University and above	0.137	0.327	0.42	0.674	0.209	0.334	0.63	0.531
Land Width	0.255	0.167	1.53	0.127	0.067	0.182	0.37	0.711
_Cons**	-1.958	1.469	-1.33	0.183	0.452	1.572	0.29	0.773
	Coefficient		St. Error		z		p	
/Athrho***	0.343		0.130		2.64		0.008	
Rho	0.330		0.115					
Likelihood =- 238.115	chi2(1) = 6.98403		Prob > chi2 = 0.0082		Wald chi2(18) = 83.49		Prob > chi2 = 0.0000	

* indicates significance, **represents the constant, *** the transformed version of rho, the correlation between the error terms.

significant indicates that both dependent variables are related to each other and if these dependent variables are analyzed one by one, the parameters will be biased and this model should be analyzed simultaneously, that is, by using the bivariate probit model [34].

The magnitude of the estimated value of ρ means that the independent variables which are important for the two dependent variables are neglected. The fact that the ρ value is 0.330 (not close to 1) indicates that there is no significant neglected variable [35]. In the estimated model, age (0.305 and 0.346>0.05), marital status (0.877 and 0.506>0.05), education at secondary and high school level (0.341 and 0.972>0.05), education at university and higher level (0.674 and 0.531>0.05) holding size (0.127 and 0.711>0.05), and their coefficients are meaningless. Since the coefficients of all shadow variables of the education variable are meaningless, it is understood that the education level of the producers does not have a significant effect on WTP. Additionally, marital status, age, and field variables do not affect WTP.

In the model whose dependent variable is Y_1, the amount of waste is (0.017<0.05) and its coefficient is significant. A one-unit increase in the holdings with below the average amount of waste generated as a result of tomato production in the greenhouse, increases WTP by 0.501 units. It was found that the WTP for the disposal of waste and sending it to the facilities was lower in the holdings producing more waste when compared to the ones producing less than average. A one-unit increase in producers who think that wastes harm human health and the environment increases WTP by 0.016 units, and this variable is statistically significant (0.000<0.05). A one-unit increase in producers who think that wastes harm human health and the environment reduces the WTPA by -0.009 units, although the producers are willing to pay, and it is statistically significant (0.005>0.05). In other words, the producers who think that the waste generated as a result of production in greenhouses damages human and environmental health, react more positively to WTP, while their response to the monthly offer price of 50 TL (6.22 EURO average for 2020) was perceived as negative (Table 3).

For the levels of the independent variable in the model, the probability of the dependent variable taking the value 1, in other words, the probability of the event of interest for each independent variable can be calculated [36]. The marginal effects of the independent variables showing the possible changes in the dependent variable by increasing the variables by 1 unit, were examined [34]. In the study, first of all, these probabilities were calculated for the qualitative independent variables.

The probability of WTP and WTPA of producers with primary or below education level is 0.12, secondary or high school level is 0.112, and university or above education level is 0.168. It is significant as the p values for these 3 levels are 0.000, 0.001, 0.018<0.05 respectively.

For the marital status variables, the probability for married producers is 0.124 and for single producers, it is 0.082 which is statistically insignificant (0.167>0.05).

For the producers having a waste amount above the average, the probability is 0.128 while it's 0.1 for

Table 3. Marginal coefficients of qualitative independent variables.

Variables		Probability	Delta-Method St. Error	p	Reference
Marital status	Single	0.082	0.059	0.167	[37] [38]
	Married	0.124	0.022	0.000*	
Education	Primary or below	0.120	0.027	0.000*	[39] [40]
	Secondary or high school	0.112	0.336	0.001*	
	University or above	0.168	0.071	0.018*	
Waste amount	Above Average	0.128	0.026	0.000*	
	Below Average	0.100	0.034	0.003*	

* indicates significance.

Table 4. Marginal coefficients for continuous variables.

Variables		Probability	Delta-Method St. Error	p	Reference
Age	19-59	0.127	0.062	0.041*	[41] [42] [43]
	60-89	0.097	0.026	0.000*	
Agricultural holding size	Below 10 da	0.083	0.028	0.003*	[44] [45]
	10-119 da	0.120	0.026	0.000*	
Perception	40 and below	0.129	0.026	0.000*	[46] [47]
	40-80	0.111	0.022	0.000*	
	80 and above	0.068	0.029	0.019*	

* indicates significance.

producers below average. It is significant as the p values are 0.000, 0.003<0.05 respectively.

In the model, age, agricultural holding size, and perception variables are continuous variables and marginal coefficient results are given in Table 4.

For age variables, the p value of 19-59 range is (0.041<0.05), 60-89 range is (0.000>0.05) and the probabilities are significant (0.12 and 0.09 respectively). For holding size variables, the probabilities for below 10 da is 0.08 (p=0.003>0.05), 10 da and above is 0.12 (p = 0.000<0.05). For the perception of the impact of waste on humans and the environment variables, the probabilities for producers with 40 and below points are 0.12, between 40 and 80 points are 0.11, 80 and above points are 0.06. p values are significant for all perception levels.

Conclusion

This study was carried out to bring a different perspective to the waste management subject by revealing economic and ecological approaches to the disposal of agricultural wastes and analyzing the behavior of producers. The key actors found in the study are the producers whose behaviors in evaluating waste are also of great importance. The content of the wastes formed with the start of the production phase, and the information at what time and in what amount was disposed of is also determined by the producers. For this reason, to develop effective policies, there is a need for field studies on the behaviors, thoughts, and tendencies of producers on "agricultural wastes".

Agricultural wastes have certain advantages over other wastes. In the agriculture sector, the continuity of the wastes is higher and it is easier to be obtained because they are formed annually or in a shorter period of time. If wastes are evaluated in areas where agricultural holdings are intense, it is estimated that transportation costs will be low. In addition, if appropriate evaluation methods are developed for plant wastes, economic benefits will be gained and environmental pollution will be prevented.

The most accepted solution in the literature for the waste problem is preventing it before its occurrence, but if not possible, creating "the least waste" is the second alternative. Although the waste generation process varies according to the product and the growing environment, with respect to the tomato plant harvest index, 1 kg of vegetable waste is generated to produce

1 kg of product in general. This shows that waste management will become more difficult as production increases or scale grows.

Within the scope of the study, a survey was conducted with 250 tomato producers (selected by sampling) on their waste disposal preferences and WTP. The research area is selected as Antalya province in Turkey where agricultural activities are intense. As a result of the field study, it was determined that the most common waste type during the production period is the vegetable waste. Vegetable wastes are degraded in a short time due to their organic character and are disposed of in nature without causing environmental damage. If a product deteriorates in a very short period of time, the same is true for waste, so it is necessary to evaluate post-harvest plant wastes simultaneously.

Also, it has been found that vegetable wastes are generally buried in the soil and given to garbage collectors. It was revealed that the most frequently incinerated wastes are empty fertilizer bags.

By looking at the marginal coefficients of the econometric model used in the study, the WTP probabilities of the producers in the manner of socio-economic characteristics were examined. According to these results, it is seen that the probability values of producers in the 60-89 age range, producers with a holding size of less than 10 da, and producers having secondary or high school level education are relatively low. Thus, policymakers may consider giving free training about the importance of waste management for the producers having low probability values. In addition, since the producers with high probability values have more payment potential, it will be efficient to consider them as the priority group in waste disposal chain planning.

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Conflict of Interest

The authors declare no conflict of interest.

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