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A Case Study Investigating Farmers' View Regarding Soil Analysis: Estimates Using a Logit Model

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ABSTRACT

The objective of this study was to assess the level of knowledge of the Turkish farmers with regard to fertilizer usage. Farmers in the Kazova district of Turkey's Tokat Province were interviewed regarding their soil maintenance practices. The interview was based on a standardized questionnaire the answers being recorded at the time of interview. Simple random sampling method was used to determine the sample size of the research. According to the results, sample size was determined as 61 farmers. The fundamental question (dependent variable) was to determine if farmers have the soil in their fields analysed. The independent variables were: education level of farmers (EDU); whether the farmer shares information regarding fertilization (EI); whether the farmer sows according to the results of the soil analysis (SA); whether the farmer uses pesticides (UPI); and the level of concern the farmer has for production rate (PQ). With the exception of farmers' concern over production rate (PQ), all the independent variables had a positive effect on weather or not farmers have the soil in their fields analysed. The econometric model selected for the analysis is a binomial logit model in which the dependent variables take only two values: either 1 or 0. Cronbach's Alpha coefficient was calculated as 0.7358.

Keywords: Farmer behaviours, Logit model, Soil protection.

INTRODUCTION

The increase in the world's human population has resulted in an increase in the demand for food. Land available for cultivation is limited, thus the increasing need for food can only be met by an increase in the production per unit area of cultivated land. One of the primary methods employed to increase on-farm productivity is through the application of fertilizers. Today, fertilizer is an indispensable component of the modern farm. However, problems will arise if fertilizer is used improperly.

Farming exherts both positive and negative impacts on the environment. On the other hand, agricultural production enhances oxygen production and affects the climate positively. On the other hand, intensive farming affects the environment negatively (Karaer and Gurluk, 2003). Modern intensive commercialized farming has proved to cause severe environmental degradation. All components of the environment: the soil, water, air, and nature's balance, have been affected by agricultural activities (Olhan, 2004). Soil pollution has become a concern for an increasingly large number of researchers. (Huffman *et al.,* 2000). Land misuse and land degradation caused by soil mismanagement have begun to threaten food safety (Oldeman, *et al.,* 1990). Dumanski and Pieri (2000) have stated, "For the first time, the sustainable management of the land resource is more important than land

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supply for development. However, land degradation and mismanagement are threatening our opportunities and flexibility for increased services from the land, requiring increased investment in soil conservation and even rehabilitation and reclamation". Oldeman and his colleagues have suggested that approximately forty percent of land degradation has been caused by humans.

Soil of good quality can be described in various ways (Doran, Parkin, 1994; Bouma, Drogers, 1998), however, an indispensable component of good soil is the quality and quantity of nutrients (Jansen *et al.,* 1995). The basic requirement for undisturbed and good quality soil is effective land management. One of the most important tools to meet this basic requirement is appropriate fertilization based on local soil conditions.

In this study, farmers' behaviour towards soil analysis, one of the most important requirements of proper fertilizer usage, was examined. In general, farmers in Turkey have little knowledge about the proper usage of fertilizers (Goktolga *et al.,* 2006). A large number of farmers determine the amount of fertilizer to use on their land either based on the opinions of their neighbours or by sticking to their previous usage patterns (Goktolga *et al.,* 2006). Fertilization, based on past usage patterns is an inappropriate methodology as soil nutrient levels change over time. Further, there is a necessity for farmers to share knowledge about their soil's condition with public institutions and technical staff who serve them. Unfortunately, the rate of knowledge transfer with technical staff is low. One methodology to ensure proper soil nutrition is through soil analysis and the application of fertilizers based on the results of that analysis.

Examining farmers' behaviour is important both as a way to improve farming practices and to help prevent environmental degradation. Past studies have examined the behaviour of farmers in various researches (Funk and Downey, 1983; Isin and Yildirim, 2007; Bayard and Jolly, 2007). It has been determined that socio-economic factors have important impacts on land conservation (Burton *et al*., 1999; Featherstone and Goodwin, 1993; Sureshwaran *et al*., 1996).

In Turkey, the number of farmers having soil in their fields analysed is rather low (Goktolga *et al*., 2006). The objective of this study is to determine factors affecting farmers' behaviours towards soil analysis and to determine how these factors affect the way fertilizers are applied. It is important to identify the factors that encourage or discourage farmers to utilize soil analysis as well as the factors that contribute to their likelihood of using that information when applying fertilizers. This information can then be employed to develop programs that can facilitate proper soil maintenance techniques. It is hoped that this information, coupled with improved farm practices, will improve farm productivity and limit environmental damage in rural areas within Turkey.

MATERIALS AND METHODS

Data was colleted by means of a questionnaire survey filled out by the investigators during personal interviews with farmers. The survey was conducted in May 2007. The district of Kazova in the province of Tokat, Turkey, was chosen as the research area, because agricultural productivity there, is high and agricultural inputs (synthetic fertilizers, cow dung, pesticides, and soil conditioners) are intensively used. Simple random sampling method was used to determine the sample size of the research. The sampling equation used to determine the scope of the research is as follows: (Cicek and Erkan, 1996). Random sampling method is suitable to represent, if the variance of the farmland, known. Farmland shows homogeneity distribution (VC= 37.33%), therefore no need for stratification.

$$n = \frac{N * s^2 * t^2}{(N-1)d^2 + s^2 * t^2} \quad (1$$

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Where, *n*= Sample size; *s*= Standard deviation; *t*= *t* value with a 95 % confidence interval, *N*= Total farm number in the sample population and, *D*= Acceptable error (5% deviation).

According to calculations, sample size was determined as 61 farmers, the sample size representing the area. In the previous studies an equal sample size had been determined for the area (Karkacier *et al.,* 2000; Bayramoglu, *et al.,* 2006). Following this, questionnaires were pre-tested and any necessary changes made.

The dependent variable used in the analysis was whether farmers let their soil be analysed for nutrient levels. Independent variables used in the research were: farmers' level of education (EDU), whether the farmer shares information concerning fertilization (EI), whether the farmer believes that fertilization negatively affects the environment (BH), whether the farmer sows his seed according to the results of soil analysis (SA), whether the farmer uses pesticides (UPI), as well as farmers' level of concern about production rate (PQ).

The mathematical expression of the model is shown in Equation (2).

$$Prob_i = \beta_0+\beta_1 EDU1+\beta_2 EI+\beta_3 BH+\beta_4 SA+\beta_5 UPI+\beta_6 PQ4+\beta_7 PQ4+\beta_8 PQ4+\beta_9 PQ4+\beta_{10} PQ4 \quad (2)$$

The model selected for the analysis is a binomial logit one in which the dependent variables take only two values: either 1 or 0. The theoretical framework of this model is as follows:

In logit econometric models, the probability of a farmer having his soil analyzed is a function of the set of independent variables. The logit model is estimated by the method of maximum likelihood (MLE) because of the consistency of asymptotic normal distributions characteristic of large samples. A logit model is based on the independent variable vector (X_{ij}s), which is related to the following parameters: the probability the farmer will conduct soil analysis ($P_{i)}$; farmer (i); variable (j); and an unknown (β). This probability is given by:

(3

$$Pi = F(Z_i) = F(\alpha+\beta Xij) = 1/[1+exp(-Z_t)]$$

Where, $F(Z_i)$= Cumulative logistic function value of each probable value of Index Z_i; P_i= Given his demographic, economic and social characters, a farmer's behaviours towards having his soil analyzed; *Exp*= Natural logarithm function, $Z_i = \beta X_{ij}$ and, α= Fixed value.

The index number is a linear combination of independent variables βX_{ij} and is depicted in Equation (4):

(4

$$Z_i = \log[P_i/(1-P_i)] = \beta_0 + \beta_1 X_{11} + \beta_2 X_{12} + \ldots + \beta_n X_{1n} + \varepsilon$$

Where, *i*= 1,2,……., persons (farmers); *j*= 1,2,……,n independent variables; Z_i= for the observation no *i*, log odd value and unobserved index level of the selection; X_{ij}= *j* explanatory variable for the person *I*, β = Parameters to be estimated and, ε= error term.

In Equation (4), the dependent variable is the logarithm of the odd ratios for the time when the farmers made a decision whether to have their soil analysed. Estimated parameters do not represent the changes in independent variables directly. Changes in these probabilities depend on the original probabilities; thus, all independent variables and the first initial values of their coefficient. In the logit model, a probability change for Y_i= 1 (P_i) which is caused by a change in the independent variables (X_{ij}) is computed as:

(5

$$(\partial P_i/\partial X_{ij}) = [\beta_j \exp(-\beta X_{ij})]/[1+\exp(-\beta X_{ij})].$$

At the same time, when independent variables are qualitative, $(\partial P_i/\partial X_{ij})$ X_{ij} does not exist, since it is discontinuous and there is no continuous change. In this case, the probability changes are determined by the evaluation of P_i for alternative values of X_{ij} and computed as:

(6

$$(\partial P_i/\partial X_{ij}) = [P(Y_i \mid X_{ij}=1) - P(Y_i \mid X_{ij}=0)]/[1-0].$$

In this study, Limdep 7.0 statistical X In this study, Limdep 7.0 statistical program was used to employ the binomial logit model. Definitions, means, standard deviations, and the number of the variables used in the study are depicted in Table 1.

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Table 1. Description of variables.

Descriptive	Mean	St. dev.	Number
Dependent Variable			
Whether farmers have the soil in their fields analysed	0.409	0.495	
Farmers who had their soil analyzed = 1			25
Otherwise= 0			36
Independent Variables			
Education (EDU)	1.850	0.928	
Illiterate= 0			1
Primary school= 1			26
Secondary school= 2			17
High school= 3			15
University= 4			2
Whether the farmers share information about fertilization *(*EI*)*	0.229	0.424	
Farmers who share information about fertilization =1			14
Otherwise= 0			47
Whether the farmer believes that fertilization has a negative impacts on the environment *(*BH*)*	0.721	0.452	
			44
The farmer believes that fertilization has a negative impacts on the Environment=1			17
Otherwise= 0			
whether the farmer sows according to the results of the soil analysis *(*SA*)*	0.360	0.484	
Sows according to the results of the soil analysis =1			22
Otherwise= 0			39
Whether the farmer uses pesticides *(*UPI*)*	0.704	0.459	
Farmer uses pesticides=1			43
Otherwise= 0			18
The farmer is concerned cares about production rate *(*PQ*)*	3.360	0.731	
Extremely unimportant= 0			0
Not important= 1			0
Important= 2			9
Very important= 3			21
Excessively important= 4			31
Interaction term (INT-1) (EDU×EI)	0.360	0.753	
0			47
1			8
2			4
3			2
Interaction term (INT-2) (EDU×BH)	1.377	1.199	
0			18
1			18
2			11
3			12
4			2
Interaction term (INT-3) (EDU×SA)	1.245	1.220	
0			22
1			17
2			9
3			11
4			2
Interaction term (INT-4) (EDU×UPI)	1.262	1.167	
0			19
1			21
2			9
3			10
4			2

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RESULTS AND DISCUSSION

Table 1 shows the descriptions of the variables. Of the farmers interviewed, 42.62% graduated from primary school, 27.86% finished secondary school, 24.59% completed high school and 3.27% were university graduates. The education levels in Turkey, are in general as follows: 12.68% of the population are illiterate, 37.03% have finished primary school, 6.95% completed secondary school as graduates, 10.18% graduated from high school, and 5.27% are university graduates (Anonymous, 2007). The proportion of farmers who share knowledge about fertilizer usage is rather low (22.95%). The proportion of farmers who believe that chemical fertilizer negatively affect the environment is 72.13%. The proportion of farmers who utilize the results of soil analysis when applying fertilizer and believe that soil analysis contributes to crop productivity is 63.93%. The UPI variable was included in the model because there might be a correlation between the fertilizer usage and farmers who use pesticides and insecticides. The UPI variable suggests that 70.49% of the farmers participating in the study use fertilizers. Farmers' level of concern about production rate (PQ) is examined. It is seen that no farmer had stated that PQ is "extremely unimportant" or "not important". 14.75% of farmers think PQ is "important"; 34.42% view PQ as "very important", and 50.82% felt it was "extremely important".

Table 2 outlines the farmers' judgements with regard to the environment and fertilization. This table is important in a distinction of the farmers' opinions with respect to different aspects of fertilization. A vast majority of the farmers (78.68%) stated the environment in this relationship to be either extremely important or very important. It was an essential concern for them to be able to use land for long periods without contaminating the environment. The relationship between fertilizer usage and human health was thought to be either extremely or very important for 77.05% of the respondents. The relationship between fertilizer usage and the environment was stated as extremely or very important by 72.14% of the farmers. None of the respondents felt that the relationship between fertilizer and the environment (Table 2) was "extremely unimportant".

In the theoretical framework, it is aimed to determine the factors affecting the farmers' opinion in having the soil in their fields analysed. Farmers' base objective from agricultural production is a maximization of profit. In addition, the aim is to determine farmers' perspective of environmental factors. Moreover, variables were put forward in the model to determine farmers' adaptation to technological innovations.

Table 2. The level of concern farmers have with regard to the relationship between fertilization, the environment and human health.

	Extremely important		Very important		Important		Not important		Extremely unimportant	
	No	%	No	%	No	%	No	%	No	%
Land use for a long time as convenient to the agriculture and with no environmental pollution	23	37.70	25	40.98	11	18.03	2	3.28	0	0.00
The relationship between fertilizer usage and human health	21	34.43	26	42.62	14	22.95	0	0.00	0	0.00
The relationship between fertilizer usage and environment	22	36.07	22	36.07	16	26.23	1	1.64	0	0.00

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It is hypothesized that EDU variable positively affects the dependent variable. One expects the farmers who benefit from a high-education level are more likely to make soil analysis of their fields in comparison with those who benefit from a lower education level. It is hypothesized that (EI) variable has positive effect on opinions because farmers who are in favor of knowledge sharing, will more easily adopt new innovations. It is hypothesized that BH variable' effets are positive because, farmers who had their soil anlysed are more likely concerned about the harmful effects of fertilizer than those who did not have their soil analysed. It is hypothesized that (SA) variable also affects positively. It is assumed that farmers who sow according to the results of soil analysis are more likely to make soil analysis than otherwise. It is hypothesized that (UPI) variable affects positively. One expects that farmers who use pesticides conscientiously will also be more likely to have their soils analysed. Farmers who use fertilizer conscientiously will also use other farm inputs like fertilizer and pesticides, in a responsible manner. It is expected that (PQ) variable has positive coefficient, because the main objective of a farmer is profit maximization.

Table 3 shows the estimated parameters of the logit model. The model chi-square is statistically significant at 0.01 level. With the exception of the BH variable, all variables are significant based on the t-statistics calculated by the model. The variables EDU, EI and PQ are significant at the 0.1 level; SA and UPI are significant at the 0.05 level.

The coefficient of the EDU variable is positive (Table 3). There is a positive relationship between education level and soil analysis. It is more likely, as also shown by the results, that a well-educated farmer will have his soil analyzed in comparison with a poorly educated one.

The coefficient of the EI variable is positive (Table 3); thus, there is a positive relationship between farmers' sharing knowledge about fertilization and having the soil in their fields analysed. It seems more likely that a farmer who shares knowledge with the public or private institutions will be willing to adopt innovations. Previous studies have indicated that a farmer who shares knowledge with either the public or private institutions will be more likely to adopt innovations (Aydin and Tatlidil, 1988; Marsh and Coleman, 1956).

Table 3. Parameters in the logit estimation.

Variables	Coefficient	*t*-ratio
Constant	-167.897*	1.000
(EDU)	59.814*	1.000
(EI)	30.065*	1.000
(BH)	-0.434	0.857
(SA)	91.819*	1.000
(UPI)	87.794*	1.000
(PQ)	-0.792	0.1946
(INT-1)	30.629*	1.000
(INT-2)	-0.494	0.6696
(INT-3)	-30.711*	1.000
(INT-4)	-28.417*	1.000

Chi-squared (χ^2): 34.825
Significance level: 0.1337067E-03
Degrees of Freedom: 10
Log likelihood function: -22.468
Restricted log likelihood: -39.881
* Denotes statistically significant at 1%.

The relationship between the dependent variable and farmers who utilize fertilization according to results of soil analysis is examined by SA variable. The positive coefficient of the SA variable is assumed as follows: "if the number of farmers who utilize fertilizer based on the results of soil analysis increases, the likelihood that farmers will be in favor of soil analysis will also increase. This emphasizes the importance of demonstrating the utility of soil analysis and the proper application of fertilizers in an applied setting. An increased number of producers who sow and apply fertilizers based on the results of soil analysis, the more likely its benefits will be seen and other producers will adopt these techniques". Farmers need to apply agricultural inputs without damaging the environment. For this reason, awareness of environment protection and an optimal use

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of resources, including agricultural inputs, must be enhanced. Nevertheless, this requires opportunities for education (Ozcatalbas, 1996).

The existence of a relationship between pesticide use and environmental consciousness has been found in previous studies (Kizilaslan and Kizilaslan, 2005). In the present study, UPI variable was added because there could exist a relationship between pesticide use and soil analysis. There is a positive correlation between the use of pesticides and insecticides (UPI) and the likelihood of having soil analysed. This is assumed as follows: "If the number of farmers who use pesticides increases, the likelihood that they will have their soil analyzed will also increase. This relationship is related to a farmer's behaviour towards adopting innovation. A farmer who uses agricultural inputs will more easily adopt innovations".

The last variable in our model is the farmers' behaviours concerning production rate (PQ). This is the only variable which has a negative coefficient among the other significant variables in the model. This dose not conform to the theoretical model. A main objective of the farmers is to attain profit maximization and high productivity. However, farmers who live in Tokat Province are not seriously conscious about soil analysis (Kizilaslan and Kizilaslan, 2005). Many of the farmers who participated in the survey are not of the opinion that productivity will increase with making soil analysis. To increase productivity, the farmers believe in themselves' experience more than on soil analysis (Kizilaslan, 2005a). This unconsciousness is caused by a low level of education in the region and in Turkey (Anonymous, 2008; 2008a).

Therefore, it is highly probabe that farmers who do not pay attention to the environment will also be unlikely to have their soil analyzed.

Table 4 shows the marginal elasticity coefficients. The elasticity coefficient for the EDU is 0.289. When education level increases by 1 unit, the probability a farmer will have his soil analyzed will increase by 29 percent. When the EI variable increases by 1 unit, the probability a farmer will have his soil analyzed will increase by 15 percent. The SA variable carries the highest marginal elasticity coefficient. When SA variable increases by 1 unit, the probability a farmer will have his soil analysed will increase by 44 percent. UPI is another variable whose marginal elasticity coefficient is high. When the UPI variable increases by 1 unit, the probability a farmers will have his soil analysed will increase by 42 percent. The elasticity coefficient for PQ is negative. When the PQ variable increases by 1 unit, the probability a farmer will have his soil analyzed decreases by 38 percent.

Table 4. Marginal effects.

Variables	Coefficient
Constant	-0.856
(EDU)	0.289
(EI)	0.145
(BH)	-0.210
(SA)	0.444
(UPI)	0.425
	-0.383
(INT-1)	0.148
(INT-2)	-0.239
(INT-3)	-0.148
(INT-4)	-0.137

CONCLUSIONS

The main objective of this study was to determine the sociological factors that influence farmers with regard to having their soil analysed for nutrient content to aid with their usage of fertilizers. According to the results of this research the variables education (EDU), knowledge sharing (EI), whether the farmer sows according to the results of the soil analysis (SA), fertilizer usage (UPI), and concern about production rate (PQ), are statistically significant. However, the variable (BH), which arises concern regarding the harmful effects of fertilizer and the environment, does not influence soil analysis.

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The results of this study can be interpreted as follows: the variable EDU is one of the most important factors that positively affects the likelihood a farmer will have his/her soil analyzed. Therefore, the best way to increase the proportion of farmers who employ soil analysis as a production aid is to advance the education level of the farmers.

Further, there is a positive relationship between knowledge sharing and the likelihood of having one's soil analyzed (EI). It would seem logical that if the proportion of educated farmers increases, the likelihood of farmers who utilize soil analysis will also increase. It is well known, that knowledge is unstable, ever changing and progressive. If the farmers are in favour of knowledge sharing, they will also easily adopt new innovations. Thus, soil analysis and its utilization when employed as a tool during fertilizer application can be considered a new innovation in Turkey.

The negative relationship between production rate and having soil analysis is also related to farmers who do not care about environmental issues. This finding should be of concern to policy makers, particularly those concerned with environmental issues.

In Turkey, legislation concerning soil usage was enacted to prevent the soil degradation through mismanagement (Anonymous, 2005). However, this law is not enforced properly due to insufficiencies in equipment and technical staff. In addition, farmers and public officials, who are not aware of environmental problems, are of concern as they can make the application of this legislation more difficult.

Education is the key to the responsible usage of agricultural inputs, agricultural production, and the likelihood of utilizing soil analysis. The education level among farmers must be quickly enhanced. The number of illiterate farmers, especially high among older farmers in Turkey, must be timely reduced. The Turkish government manages 97 % of primary education and 81.13 % of higher education; thus, it can be stated that one of the main objectives of the government should be to improve farmer education (Anonymous, 2007a).

In conclusion, farmers must be made aware of the value of their land and become more conscious of the fact that land is needed not only for the present but also for future generations. Training farmers in proper soil management techniques must be accelerated in order to increase agricultural production within a sustainable frame. The effectiveness of these efforts can be improved by employing the results of research on land conservation from all around the world.

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ع. کارکاسیر و ز. گوکالب کوکتولگا

چکیده

هدف این مطالعه واکاوی سطح دانش کشاورزان کشور ترکیه نسبت به مصرف کودهای شیمیایی بود. در این تحقیق کشاورزان منطقه (استان) توکات ترکیه نسبت عملیات حفاظت خاک مورد مصاحبه قرار گرفتند. مصاحبه با فرم (پرسشنامه) استاندارد و با ضریب آلفای ۰/۷۴ و ضبط مذاکرات با ۶۱ کشاورز که با روش نمونه گیری ساده انتخاب شده بودند بانجام رسید. سئوال اصلی یا متغیر وابسته تحقیق این بود که آیا کشاورزان نسبت به تجزیه خاک‌های مزرعه خود اقدام می‌کنند یا خیر؟ برای تجزیه و تحلیل از مدل دو جمله‌ای لوجیت (مدل اقتصاد سنجی) که به متغرها ارزش‌های صفر و یک داده می‌شود استفاده شد. نتایج تحقیق نشان می‌دهد که متغیرهای مستقل سطح سواد کشاورزان، تبادل اطلاعات بین کشاورزان نسبت به مصرف کودهای شیمیایی، کاشت محصول بر پایه تجزیه خاک مزرعه، و مصرف سموم شیمیایی با متغیر وابسته (تجزیه خاک) رابطه مثبت و معنی‌دار ولی تمایل و دل نگرانی کشاورزان نسبت به افزایش تولید با متغیر وابسته هیچگونه رابطه‌ای را تبیین نکرد.

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