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Comparative Analysis of Factors Affecting the Decisions of Producers to Have Soil Analysis in Edirne and Tekirdağ Provinces

Edirne ve Tekirdağ İllerinde Üreticilerin Toprak Analizi Yaptırma Kararlarını Etkileyen Faktörlerin Karşılaştırmalı Analizi

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Abstract. The structural characteristics and the factors affecting the soil analysis decisions of the farmers in Edirne and Tekirdağ provinces were determined in this study. The factors affective on the soil analysis decisions of the farmers were analyzed by using logistic regression analysis and artificial neural networks and the comparison of the methods was done. In each province, 3 laboratories which had the most sample acceptance number for soil analysis were selected. The surveys were conducted with total of 60 farmers who referred to the laboratories and utilized from soil analysis subsidies and 40 farmers who did not utilize from soil analysis subsidies and had the similar characteristics with the farmers who utilized from soil analysis subsidies in each province and total of 200 farmers participated in the survey in 2019. The most significant factors on soil analysis decisions of the farmers were determined as total land size, age, agricultural experience, experience on taking soil sample, family size, education period and the activity type in each two methods. Total accurate classification ratio was found as 77% in logistic regression analysis and 80.67% in artificial neural network analysis. It was determined that the classification percentages obtained by two methods were pretty close to each other. The farmers who had low yield and low qualified crop due to not having soil analysis should be informed and necessary publication studies should be done.

Keywords: Logistic regression, soil analysis, artificial neural network

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Özet. Bu çalışmada Edirne ve Tekirdağ illerinde faaliyet gösteren üreticilerin yapısal özellikleri belirlenmiş ve toprak analizi yaptırmalarında etkili olan faktörler tespit edilmiştir. Üreticilerin toprak analizi yaptırma durumunu etkileyen faktörler lojistik regresyon modeli ve yapay sinir ağları kullanılarak analiz edilmiş olup, yöntemlerin karşılaştırılması yapılmıştır. Laboratuvar seçimi toprak analizi için numune kabul sayısı en fazla olan laboratuvarlar arasından 3'er tane gayeli olarak yapılmıştır. Her il için 2015 yılında laboratuvarlara başvuran ve toprak analiz desteğinden yararlanan üreticilerden toplamda 60 kişi ile yine aynı laboratuvarların olduğu yörelerde, benzer özelliklere sahip toprak analizi desteğinden yararlanmamış olan 40 üretici olmak üzere, 2019 yılında toplamda 200 üretici ile görüşülmüştür. Her iki yöntemde de üreticilerin toprak analizi yaptırmalarındaki en önemli faktörlerin sırasıyla üreticilerin sahip olduğu toplam arazi büyüklüğü, yaşı, tarımsal deneyimleri, toprak örneği alma konusundaki deneyimleri, ailelerindeki birey sayısı, eğitim süreleri ve uğraştıkları faaliyet türü olduğu belirlenmiştir. Toplam doğru sınıflandırma oranı lojistik regresyon analizinde %77, yapay sinir ağı analizinde ise %80.67 olarak bulunmuştur. Her iki yöntemle elde edilen sınıflandırma yüzdelerinin birbirine oldukça yakın olduğu tespit edilmiştir. Toprak analizi yaptırılmamasından dolayı düşük verim ve kalitede ürün elde eden üreticilerin bu konuda bilgilendirilmesi ve gerekli yayım çalışmalarının yapılması gerekmektedir.

Anahtar Kelimeler: Lojistik regresyon, toprak analizi, yapay sinir ağları

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INTRODUCTION

The increase in agricultural activities such as the use of chemical products and soil cultivation activities in order to meet the food requirement of the increasing population causes the physical, chemical and biological properties of soils to be adversely affected. In addition, depending on various natural events such as topography and precipitation, some quality parameters of soils may decrease below the level they should be in a healthy soil. In particular, inappropriate land use management negatively affects the function and stability of the soil. Since the determination of soil quality has become a necessity in terms of sustainable soil management, the determination of quality parameters emerges as the most important tool for the sustainability of soil and land use practices (Anonymous, 2020; Yılmaz and Uysal, 2010). The quality of the soils and thus the fertility status; varies depending on the adequate and balanced content of plant nutrients and the suitability of its physical, chemical and biological properties, and these factors can be determined by soil analysis (Sağlam, 2005).

Chemical fertilization, which is one of the most important agricultural applications, contributes to production on the one hand and can cause some negativities on the other hand. Nitrate pollution in groundwater, toxicity caused by phosphorus compounds, destruction of ammonia in the atmosphere can be counted as an example of environmental problems caused (or increased) by excessive fertilization applications (Wang *et al*., 2013). Besides, when fertilizers are used excessively and for a long time; Environmental problems such as salinization in soils, heavy metal accumulation, nutrient imbalance, deterioration of microorganism activity, eutrophication and nitrate accumulation in water, introduction of nitrogen and sulfur-containing gases into the air, depletion of the ozone layer, and greenhouse effect begin to occur.

It can be said that while the use of incomplete fertilizers causes a decrease in the yield and production in agricultural production, the excessive use of fertilizers has an effect on increasing the foreign trade deficit due to the import of fertilizer raw materials, and also on increasing the financing deficit of the public due to fertilizer subsidies (Özkaya and Özdemir, 1992). Which fertilizer when, how and in what quantity to be given is determined as a result of soil analysis. With soil analysis, the use of less or more fertilizer than the soil needs can be prevented. In addition, the properties of the soil can be determined and the improvement of the soil can be realized with some suggestions. When processing is done according to soil analysis; by avoiding the use of more fertilizer than necessary, both environmental pollution is prevented and costs are reduced, the nutritional needs of the plant are met by giving the right fertilizer at the right time, and the physical, chemical and biological properties of the soil are improved or protected.

The aim of this study was to determine the characteristics of the farmers and their enterprises operating in Edirne and Tekirdağ provinces and to determine the factors that affected their soil analysis decisions. The factors affecting the soil analysis of the producers were analyzed using the logistic regression model and artificial neural networks, and the methods were compared.

MATERIAL AND METHOD

The material of the research consisted of data obtained from primary and secondary sources. The primary data of the research consisted of the data obtained from the survey studies conducted with the producers in 2019 who had soil analysis in 2015 in the laboratories that accepted the most sampling for soil analysis and gave fertilizer advices in the provinces of Edirne and Tekirdağ, which had the largest number of laboratories in the Thrace Region.

In the provinces determined in the research, 3 laboratories was selected among the laboratories with the highest number of sample acceptances for soil analysis. For each province, total of 60 producers who applied to the laboratories in 2015 and who utilized from soil analysis subsidies, and total of 40 producers with similar characteristics (land size, product pattern, etc.) who did not utilize from soil analysis subsidies and consequently, total of 200 producers were interviewed.

Descriptive statistics and cross tables were used in the analysis of the data obtained. When the number of groups was 2 in continuous data, t-test was used for normally distributed variables, Mann-Whitney U test for non-normally distributed variables, and chi-square test for discrete data.

The tendencies of the producers to have soil analysis were analyzed using logistic regression analysis and artificial neural networks and the methods were compared. The purpose of using logistic regression analysis is to establish a generally acceptable model that can define the relationship between the dependent (outcome) variable and the set of independent variables (explanatory variables) with the best fit by using the fewest variables. If the dependent variable in the model is expressed with two categories, the model is expressed as "Binary Logistic Regression Model", if it is expressed with more than two categories, it is expressed as "Multiple Logistic Regression Model" (Leech *et a*l., 2004).

If the G statistic with chi-square distribution used to determine the general significance of the model in logistic regression analysis is larger than the chi-square table value in the relevant degree of freedom, it is decided that the explanatory variables in the model are important for the dependent variable. If the Hosmer and Lemeshow test statistic, which is used to determine the goodness of fit provided by all the variables of the model, is less than the relevant degree of freedom and the chi-square table value, it is decided that the fit of the model is good (Oğuzlar, 2001).

Artificial neural networks (ANN) are parallel and distributed information processing structures that are inspired by the human brain, are connected to each other through weighted connections, and consist of processing elements, each of which has its own memory.

Artificial nerve cells imitate human nerve cells and show a working principle like them. The artificial neuron consists of five basic parts: inputs, weights, summation functions, activation functions and output (Hamzaçebi, 2011).

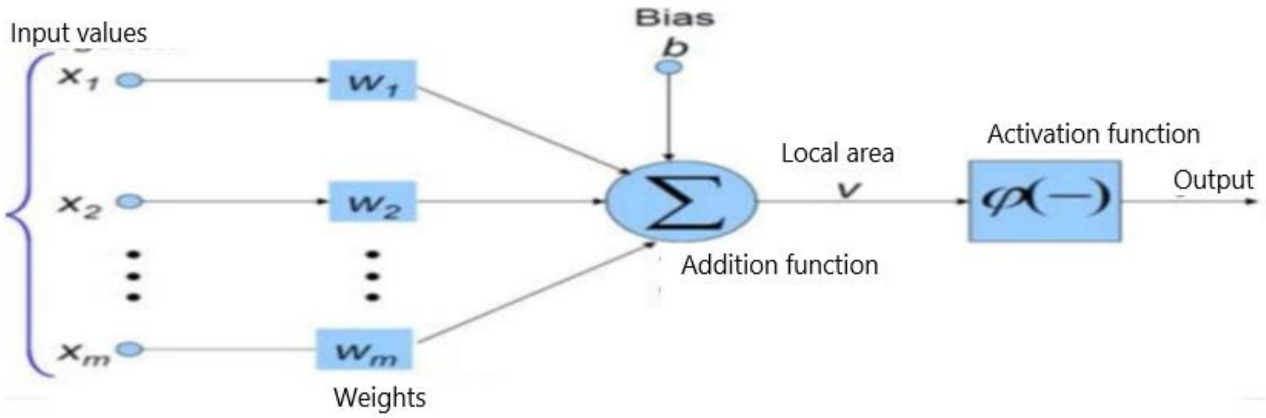

Figure 1. General structure of artificial neural network (Keskenler and Keskenler, 2017).
Şekil 1. Yapay sinir ağının genel yapısı.

The X1, X2, Xm values specified in Figure 1 are the information coming from the environment in an artificial neuron and are specified as input values. Information can come from the environment as well as from other cells or itself. This information is determined by the examples that the network is asked to learn (Öztemel, 2012). W1, W2…Wm values show weight values. Weight values show the effect of general information received from the environment by artificial nerve cells on the cell. Each entry has its own weight value (Elmas, 2007). A large weight does not mean that this input is important, or a small weight does not mean that the input is unimportant, and a zero weight value may be the most important event for that network. Negative values also do not mean that the input is unimportant, plus and minus weights indicate that the effect of the input is positive or negative (Öztemel, 2012).

RESULTS AND DISCUSSION

Findings of the Producers Who Had and Didn't Have Soil Analysis

Some socio-demographic characteristics of the producers who had and did not have soil analysis are given in Table 1. The average age of the producers who had soil analysis was 54.26, and 53.91 for those who did not. While the average education period of the producers who had the analysis was 9.27 years, it was determined as 7.94 years for the producers who did not have the analysis. It was determined that the education level of the producers who did not have the analysis was slightly lower than the producers who had the analysis. The agricultural experience of the producers who had the analysis was determined as 29.72 years, and the producers who did not have the analysis as 32.11 years. While the average number of family members of the producers who had the analysis was 4.29, this value was 3.64 in the producer group who did not have the analysis. As a result of the statistical analysis, it was determined that the education period and the number of family members of the producers changed according to the producer groups.

Table 1. Some socio-demographic characteristics of producers.
Çizelge 1. Üreticilerin bazı sosyo-demografik özellikleri.

Socio-demographic characteristics	Age		Education period		Agricultural experience		Number of family members	
	Av.	P	Av.	P	Av.	P	Av.	P
Soil analysis	54.26	0.836	9.27	0.009***	29.72	0.192	4.29	0.002***
No soil analysis	53.91		7.94		32.11		3.64	

The distribution of producers according to their status of having any income other than agriculture is given in Table 2. It was determined that the ratio of producers with non-agricultural income in both groups was very close to each other and above 50%. As a result of the chi-square test, it was determined that the non-agricultural income status of the producers did not change according to the producer groups.

Table 2. Non-agricultural income of producers.
Table 2. Üreticilerin tarım dışı gelir durumu.

Nonagricultural income	Soil analysis		No soil analysis		Total	
	Number	%	Number	%	Number	%
Yes	69	57.50	44	55.00	113	56.50
No	51	42.50	36	45.00	87	43.50
Total	120	100.00	80	100.00	200	100.00
Chi-square: 0.122 p: 0.727						

Land ownership status in enterprises is given in Table 3. The total size of the land cultivated by the producers who had the analysis was 628.14 decares, the share of the property land in the total cultivated land was 73.15%, the share of the land cultivated with rent was 26.72%, and the share of the land cultivated by sharecropping was determined as 0.13%.

The total size of the land cultivated by the producers who did not have the analysis was 270.48 decares, the share of the property land in the total cultivated land was 61.38%, the share of the land cultivated with rent was 38.29%, and the share of the land cultivated by sharecropping was determined as 0.32%.

It was determined that the total size of the land cultivated by the producers who had the analysis was quite high compared to the producers who did not have the analysis. As a result of the statistical analysis, it was determined that the size of the land owned by the producers, the land they cultivated with rent and the total land they cultivated changed according to the producer groups.

Table 3. Land ownership status in enterprises.
Çizelge 3. İşletmelerde arazi mülkiyet durumu.

Land ownership status	Soil analysis		No soil analysis		Average	
	Da	%	Da	%	da	%
Property land[1]	459.50	73.15	166.03	61.38	342.11	70.53
Rented land[2]	167.81	26.72	103.58	38.29	142.12	29.30
Shareholding land[3]	0.83	0.13	0.87	0.32	0.85	0.18
Total cultivated land[4]	628.14	100.00	270.48	100.00	485.08	100.00

[1] P: 0.000; [2] P: 0.061; [3] P: 0.973; [4] P: 0.000

The land use situations of the producers are given in Table 4. While the irrigated land was 71.05 decares and its share in the total land was determined as 11.31% in the producer group who had soil analysis, the irrigated land was determined as 23.86 decares and its share was 8.82% in the total land in the producer group who did not have soil analysis.

While the share of the unirrigated land in the total land was 88.69% in the producer group who had the analysis, this ratio was 91.18% in the producer group who did not have the analysis. It was concluded that the production status of the producers who had the analysis under irrigated conditions was slightly higher than the producers who did not have the analysis. As a result of the statistical analysis, it was determined that the irrigated and dry land sizes of the producers changed according to the producer groups.

Table 4. Land use in the enterprises.
Çizelge 4. İşletme arazisinin kullanılış biçimi.

Land use	Soil analysis		No soil analysis		Average	
	Da	%	Da	%	Da	%
Irrigated land[1]	71.05	11.31	23.86	8.82	52.18	10.76
Unirrigated land[2]	557.09	88.69	246.62	91.18	432.9	89.24
Total cultivated land	628.14	100.00	270.48	100.00	485.08	100.00

[1] P: 0.005; [2] P: 0.000

Information on the average number of parcels and parcel sizes in the enterprises are given in Table 5. It was determined that the total land on which the producers who had soil analysis made production consisted of approximately 26 pieces, and the average parcel size was 24.03 decares. On the other hand, it was determined that the producers who did not have the analysis had 16.43 pieces of land on which they produced, and the average parcel size was 16.46 decares. As a result of the statistical analysis, it was determined that the average parcel number and size of the land that the producers worked changed according to the producer groups.

Table 5. Average number and size of parcels in the enterprises.
Çizelge 5. İşletmelerde ortalama parsel sayısı ve büyüklüğü.

Number and size of parcels	Soil analysis	No soil analysis	Average
Enterprise land (da)	628.14	270.48	485.08
Average number of parcels (pieces)[1]	26.14	16.43	22.26
Average parcel size (da)[2]	24.03	16.46	21.79

[1] P: 0.005; [2] P: 0.001

The distribution of enterprises according to their activity types is given in Table 6. 80.83% of the producers who had soil analysis and 66.25% of the producers who did not have a soil analysis stated that they only made plant production. It was determined that the status of dealing with animal husbandry in the producer group who did not have the analysis was higher than the producer group who had the analysis. As a result of the chi square test, it was determined that the activity types that the producers were engaged in changed according to the producer groups.

Table 6. Type of activity in the enterprises.
Çizelge 6. İşletmelerde faaliyet türü.

Type of activity	Soil analysis		No soil analysis		Total	
	Number	%	Number	%	Number	%
Vegetative	97	80.83	53	66.25	150	75.00
Vegetative + animal	23	19.17	27	33.75	50	25.00
Total	120	100.00	80	100.00	200	100.00
Chi-square: 4.694 p: 0.030						

Analysis of Factors Affecting the Status of Soil Analysis

In the binary logistic regression and artificial neural network model used in the research, having soil analysis (1) and not having it done (0) were used as dependent variables. The independent variables of the model were determined as; producer's age (years), producer's education period (years), number of family members (numbers), experience (years), total cultivated land size (da), irrigated land size (da), non-agricultural income (0: no, 1: yes), exposure to risks in agriculture in the last three years (0: no, 1:yes), type of activity (1: vegetative, 2: vegetative + animal), experience in taking soil samples (0: no, 1: yes)

First of all, it was analyzed whether there was a multicollinearity between the independent variables (Table 7). Multicollinearity is the problem that arises from the correlation between independent variables. Tolerance and variance increase factors (VIF) values were determined and it was determined whether there was a multicollinearity problem. A tolerance value of 0.10 or less and a VIF value of 10 or higher indicate a multicollinearity problem. As a result of the analysis, it was concluded that there was no multicollinearity problem between the variables, and analyzes were made with all selected variables.

Table 7. Tolerance and VIF values of the independent variables.
Çizelge 7. Bağımsız değişkenlerin tolerans ve VIF değerleri.

Variables	Tolerance	VIF
Age	0.304	3.288
Education period	0.605	1.653
Agricultural experience	0.268	3.738
Number of family members	0.924	1.082
Total land size	0.762	1.313
Irrigated land size	0.903	1.108
Non-agricultural income	0.876	1.142
Type of activity	0.920	1.087
Encountering risks in agriculture in the last three years	0.966	1.035
Experience in taking soil samples	0.920	1.087

Logistic Regression Analysis Results

Significance test results of model coefficients are given in Table 8. It was determined that the chi-square value of the model in the first step was 76.617 and the significance level was 0.000, and it was concluded that the model coefficients were significant ($p<0.05$). It was determined that the predicted model was generally significant and at least one of the independent variables in the model was effective on the dependent variable.

Model summary and Hosmer and Lemeshow test results are given in Table 9. The Cox&Snell R^2 statistic was determined to be 0.318 in the first step. Nagelkerke R^2 is the improved Cox&Snell R^2 coefficient and is higher than Cox&Snell R^2. The Nagelkerke R^2 statistic was found to be 0.430. This value shows that there is a 43% relationship between the dependent variable and the independent variables, and 43% of the dependent variable is explained by the independent variables in the model.

In the first step, the chi-square value of the model was found to be 9.216 and the significance level as 0.324, and it was decided that the model was appropriate since the significance level was greater than

0.05. It was concluded that the difference between the observed values and the predicted values was not significant.

Table 8. General significance test of the model coefficients.
Çizelge 8. Model katsayılarının genel anlamlılık testi.

		Chi-Square	Degree of freedom	Significance level (P)
Step 1	Step	76.617	10	0.000
	Block	76.617	10	0.000
	Model	76.617	10	0.000

Table 9. Model summary and Hosmer and Lemeshow test.
Çizelge 9. Model özeti ve Hosmer ve Lemeshow testi.

Model summary			
Step	-2 Log likelihood	Cox & Snell R^2	Nagelkerke R^2
1	192.588a	0.318	0.430
Hosmer and Lemeshow test			
Step	Chi-square	Freedom	Significance Level (P)
1	9.216	8	0.324

The classification results for the dependent variable are given in Table 10. According to the results obtained, it was determined that the classification ratio of the dependent variable in the first step was 77% and the logistic regression model had a good prediction ratio.

Table 10. Classification results for the dependent variable.
Çizelge 10. Bağımlı değişken için sınıflandırma sonuçları.

Observed			Estimated		
			Soil analysis		Verification rate (%)
			No	Yes	
Step 1	Soil analysis	No	56	24	70.00
		Yes	22	98	81.70
		General			77.00

Logistic regression analysis results are given in Table 11. When the significance levels of the variables in the model were examined, it was concluded that the variables of the size of the irrigated land, the non-agricultural income of the producers and the situation of encountering risks in agriculture in the last three years were not statistically significant and did not affect the situation of having soil analysis. It is possible to say that the variables other than these are effective in the decision of the producers whether to have soil analysis or not.

It was determined that the age of the producers had a positive effect on the soil analysis at the 1% significance level. An increase in the age of the producer by one year increased the probability of getting a soil analysis by 1.106 times or 10.6%.

It was determined that the education period had a positive effect on the status of having soil analysis at the 10% significance level. A one-unit increase in education time increased the probability of having a soil analysis by 11.8%. In the studies carried out by Işık *et al*. (2009) and Abay *et al*. (2017), it was concluded that the education period of the producers positively affected the level of benefiting from agricultural supports. Tan *et al*. (2017) determined that the education level of the producers had a positive effect on the benefit of organic farming support and in the study conducted by Ağır and Akbay (2018), it was determined that the education level of the producers had a positive effect on the benefit from the beef cattle support. In the study carried out by Haroll Kokoye *et al*. (2018), it was determined that the tendency of the producers to have soil analysis increased as the education level of the producers increased.

It was determined that agricultural experience had a negative effect on soil analysis at the 5%significance level. The negative sign of the coefficient of the agricultural experience variable indicated that there was a negative relationship between agricultural experience and soil analysis, and as the agricultural experience of the producers increased, the tendency of the producers to have soil analysis decreases by 1.074 (1/0.931) times or 7.4%. It can be said that experienced operators try to maintain the current situation, while less experienced operators attach more importance to innovations. In the study conducted by Agır and Akbay (2018), it was determined that the livestock experience of the producers had a negative effect on the benefit of the beef cattle support.

It was determined that the number of people in the family had a positive effect on soil analysis at the 5% significance level. A one-unit increase in the number of households increased the probability of having a soil analysis 1.365 times.

The total size of the land cultivated by the producers positively affected the soil analysis at the 1% significance level. A one-unit increase in the size of the land increased the probability of soil analysis by 1.003 times. When evaluated in general, the pricing structure of soil analysis support depending on the size of the enterprise caused the producers to have soil analysis. Tan *et al*. (2017) determined that the size of the land cultivated by the producers had a positive effect on the benefit of organic farming support. Haroll Kokoye *et al*. (2018) determined that the size of the land had a positive effect on the soil analysis.

The activity types of the producers affected the situation of having soil analysis at 10% significance level and negatively. It was seen that the tendency of producers dealing with only vegetative production to have soil analysis increased. This situation can be interpreted as the producers, who are engaged in animal husbandry as well as plant production, spend most of their time in animal husbandry activities and cannot spare time for innovations related to plant production. The fact that the producers are experienced in taking soil samples positively affected the situation of having soil analysis at 1% significance level, as expected.

Table 11. Logistic regression analysis results.
Çizelge 11. Lojistik regresyon analiz sonuçları.

Variables	β	SE	Wald	DF	P	exp (β)
Constant	-6.813	1.537	19.639	1	0.000***	0.001
Age	0.101	0.034	9.003	1	0.003***	1.106
Education period	0.111	0.061	3.282	1	0.070*	1.118
Agricultural experience	-0.072	0.031	5.289	1	0.021**	0.931
Number of family members	0.311	0.143	4.705	1	0.030**	1.365
Total land size	0.003	0.001	11.027	1	0.001***	1.003
Irrigated land size	0.001	0.003	0.155	1	0.694	1.001
Non-agricultural income	0.144	0.388	0.137	1	0.711	1.155
Type of activity	-0.734	0.423	3.010	1	0.083*	0.480
Encountering risks in agriculture in the last three years	-0.433	0.387	1.250	1	0.264	0.649
Experience in taking soil samples	1.416	0.513	7.609	1	0.006***	4.120

β: Coefficient, SE: Standard error, DF: Degrees of freedom, P: Significance level, Exp (β): Odds ratio
***1%, **5%, *significant at 10% significance level

Artificial Neural Networks Analysis Results

In the designed artificial neural network model, 140 data out of a total of 200 data were used for the number of sample training and 60 data for the number of sample tests (Table 12). In the literature, the distribution of the data set as 70% training, 30% test or 80% training and 20% test data is accepted, and it is seen that the obtained model is appropriate.

"Hyperbolic Tangent Function" is used as the activation function of artificial nerve cells in the hidden layer and output layer in the program. There are 10 artificial neurons in the first layer, which is the input layer, and these artificial neurons represent the independent variables. The created model has one hidden layer and seven elements. In the output layer, there are 2 artificial nerve cells representing the levels of the dependent variable (with or without analysis) (Table 13).

Table 12. Operation summary.
Çizelge 12. İşlem özeti.

	Number	%
Number of sample trainings	140	70.00
Number of sample tests	60	30.00
Valid	200	100.00
Outsider	0	
Total	200	

Table 13. Artificial neural network model.
Çizelge 13. Yapay sinir ağı modeli.

Input layer	Independent variables	1. Age 2. Education period 3. Agricultural experience 4. Number of family members 5. Total land size 6. Irrigated land size 7. Non-agricultural income 8. Type of activity 9. Encountering risks in agriculture in the last 3 years 10. Experience in taking soil samples
Hidden layer	Number of hidden layers	1
	Number of partitions in the hidden layer	7
	Activation function	Hyperbolic tangent
Output layer	The dependent variable	Soil analysis
	Number of output layer units	2
	Rescaling method of dependent variables	Standardized
	Activation function	Hyperbolic tangent
	Error function	Sum of squares

Layers of the artificial neural network are shown in Figure 2. There are independent variables in the input layer, one hidden layer and seven elements are seen. In the output layer, there is a dependent variable.

The findings obtained from the analysis of the artificial neural network and the classification of the producers according to the status of having soil analysis are given in Table 14. Of the 57 producers in the training set of the artificial neural network model that did not have soil analysis, 38 were classified correctly, 19 were incorrectly classified, and the correct classification ratio was found to be 66.67%. Of the 83 producers who had soil analysis, 74 were classified correctly, 9 were incorrectly classified, and the correct classification ratio was determined as 89.16%. The overall correct classification ratio of the model was found to be 80%. Of the 23 producers who did not have soil analysis in the test set, 12 were classified correctly, 11 were incorrectly classified, and the correct classification ratio was found to be 52.17%. Of 37 producers who had soil analysis, 33 were classified correctly and 4 were incorrectly classified, and the correct classification ratio was determined as 89.19%. The overall correct classification ratio was found to be 75%. When the classification results for the training and test sets were examined, it was seen that the artificial neural network created gave better results, especially in the classification of the producers who had soil analysis.

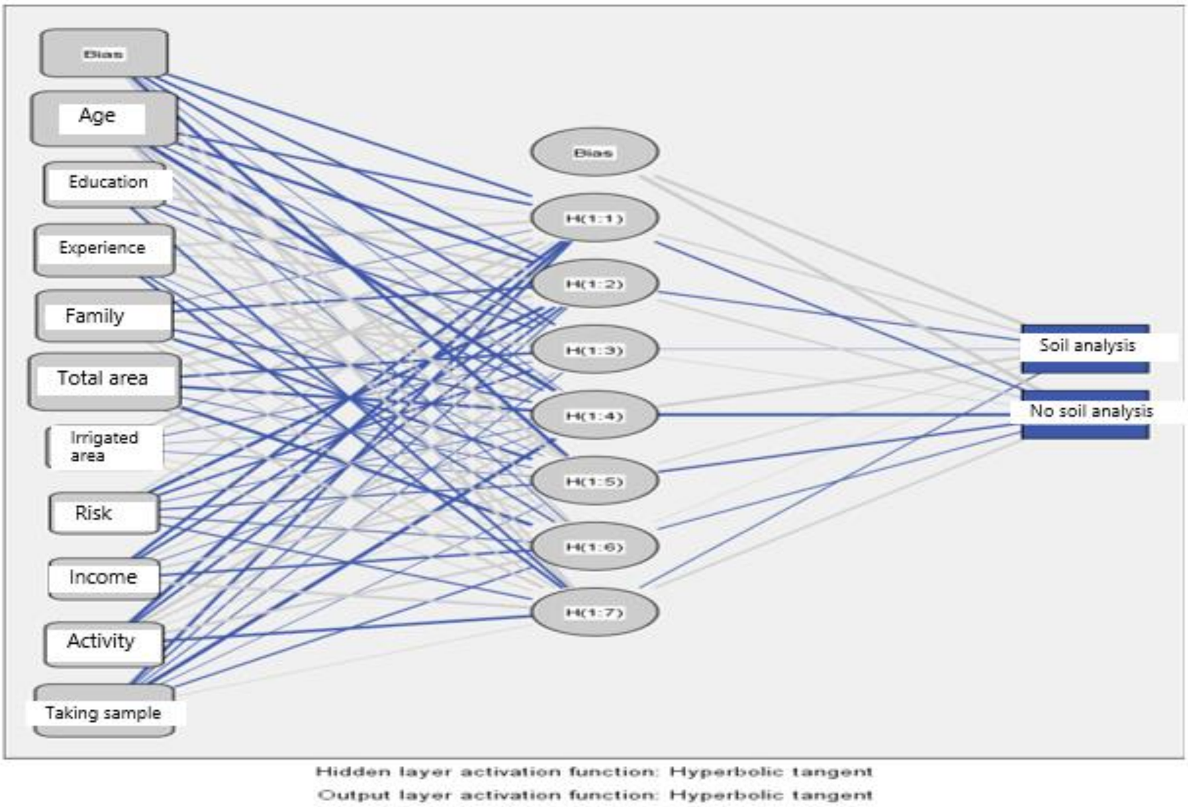

Figure 2. Layers of the neural network model.
Şekil 2. Yapay sinir ağı modeline ait katmanlar.

Table 14. Classification results obtained as a result of the artificial neural network model.
Çizelge 14. Yapay sinir ağı modeli sonucu elde edilen sınıflandırma sonuçları.

Sample	Real/observed state	Predicted state No	Predicted state Yes	Correct classification percentage
Education	No	38	19	66.67
	Yes	9	74	89.16
	Total	33.57	66.43	80.00
Test	No	12	11	52.17
	Yes	4	33	89.19
	Total	26.67	73.33	75.00
Total	No	50	30	62.50
	Yes	13	107	89.17
	Total	31.50	68.50	80.67

After the classification performance of the network was determined, the importance degrees of the independent variables were determined as % according to the weights that connect the artificial nerve cells in the network and are given in Table 15. Figure 3 shows the significance levels of the input (independent) variables.

When Table 15 and Figure 3 are examined, it is seen that the most important input variable (independent variable) for the artificial neural network created to classify the producers according to their soil analysis was "total land size (100%)". These input variables were respectively "age (88.04%)", "agricultural experience (76.63%)", "experience in taking soil samples (74.46%)", "number of family members (70.11%)", "education (38.59%)". ", "type of activity (34.78%)", "size of irrigated land (28.26%)", "non-agricultural income (16.85%)" and "experience with risk in agriculture in the last three years (16.30%)".

Accordingly, it can be stated that the most important determinants of soil analysis were the total land size and age, and the variables that had the least effect on soil analysis are non-agricultural income and risk exposure in agriculture in the last three years.

Table 15. The degree of effect of independent variables on the result.
Çizelge 15. Bağımsız değişkenlerin sonuca etki dereceleri.

Independent variables	Importance level	Normalized significance (%)
Age	0.162	88.04
Education period	0.071	38.59
Agricultural experience	0.141	76.63
Number of family members	0.129	70.11
Total land size	0.184	100.00
Irrigated land size	0.052	28.26
Non-agricultural income	0.031	16.85
Type of activity	0.064	34.78
Encountering risks in agriculture in the last 3 years	0.030	16.30
Experience in taking soil samples	0.137	74.46

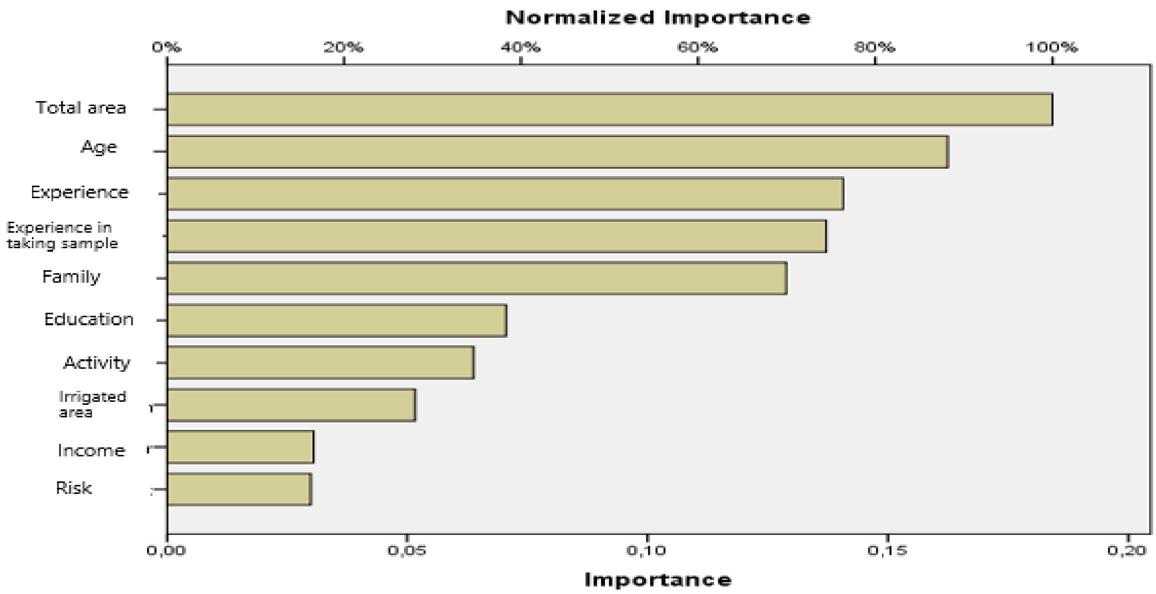

Figure 3. Significance of independent variables.
Şekil 3. Bağımsız değişkenlerin önem dereceleri.

The performances of logistic regression analysis and artificial neural network analysis methods were compared using the classification tables obtained by both methods. As a result of the artificial neural network analysis, separate classification tables were obtained for each set. In the calculation of the overall accuracy percentage, the sets were combined, the assignment values in the same cells were collected and the overall correct classification percentage was obtained. In Table 16, the correct classification percentages obtained with both analyzes are given comparatively.

When Table 16 is examined, it was seen that artificial neural network analysis gave better results for the classification of producers who had soil analysis, and logistic regression analysis for the classification of producers who did not have soil analysis. The overall correct classification ratio was 77% in logistic regression analysis and 80.67% in artificial neural network analysis. It was seen that the classification percentages obtained by both methods were quite close to each other.

According to the results of logistic regression analysis and artificial neural network analysis, the variables that determine the status of soil analysis are listed according to their importance and given in Table 17. It was seen that the results obtained by both methods were quite close to each other.

Table 16. Comparison of artificial neural network (ANN) and logistic regression analysis (LRA) classification percentages.
Çizelge 16. Yapay sinir ağı (YSA) ve lojistik regresyon analizi (LRA) sınıflandırma yüzdelerinin karşılaştırılması.

Real/observed state	Predicted state				Correct classification percentage	
	No		Yes			
	LRA	ANN	LRA	ANN	LRA	ANN
No	56	50	24	30	70.00	62.50
Yes	22	13	98	107	81.70	89.17
Total percentage of correct classification					77.00	80.67

It can be interpreted that artificial neural network analysis can be used as an alternative method to logistic regression analysis, since the classification rates are very close to each other and the degree of influence of the independent variables on soil analysis is almost the same.

Table 17. Logistic regression analysis and comparison of artificial neural networks according to independent variables.
Çizelge 17. Bağımsız değişkenlere göre lojistik regresyon analizi ve yapay sinir ağlarının karşılaştırılması.

Order of importance	Logistic regression analysis	Artificial neural networks
1	Total land size	Total land size
2	Age	Age
3	Agricultural experience	Agricultural experience
4	Experience in taking soil samples	Experience in taking soil samples
5	Number of family members	Number of family members
6	Education period	Education period
7	Type of activity	Type of activity
8	Encountering risks in agriculture in the last three years	Irrigated land size
9	Irrigated land size	Non-agricultural income
10	Non-agricultural income	Encountering risks in agriculture in the last three years

CONCLUSION

In this study, the factors affecting the status of soil analysis in Edirne and Tekirdağ provinces were analyzed. It was determined that the probability of having a soil analysis increased positively with the total size of the land, experience in taking soil samples, age, family size and education period. It has been concluded that the producers dealing with only vegetable production are more likely to have soil analysis. It has been determined that the producers who have soil analysis are more educated than the producers who do not have the analysis, and the size of the land they have cultivated is higher.

The fact that the lands of the producers who do not have soil analysis are smaller than those who have soil analysis can be considered as one of the reasons that prevent the producers who do not have soil analysis from benefiting from soil analysis support. Since the small and fragmented lands require the producers to have a separate soil analysis for each land, it is possible to interpret that the producers did not have soil analysis due to the increase in costs.

Animal husbandry activity is higher in the producer group that does not have soil analysis compared to the producer group that has analysis. Different training programs can be put into practice for producers who continue their production mainly on livestock. Because such enterprises do not care about their agricultural activities other than livestock activities, and as a result, they do not seek to benefit from soil analysis and supports. This negative thought must be broken.

It is thought that giving weight to extension studies on fertilizer and soil analysis in the research area and informing the producers more about soil sampling by privately authorized soil analysis laboratories together with the laboratories of the Ministry of Agriculture and Forestry in the region will increase the dissemination and adoption of soil analysis. Due to the lack of soil analysis, the producers who produce products with low yield and quality should be informed about this issue and necessary publication studies should be carried out.

CONFLICT OF INTEREST

There is no conflict of interest between the authors.

DECLARATION OF AUTHOR CONTRIBUTION

Başak Aydın: Conducting surveys, literature review, statistical analysis and interpretation, article writing
Erol Özkan: Conducting surveys
Emel Kayalı: Conducting surveys
Volkan Atav: Conducting surveys
Mehmet Ali Gürbüz: Conducting surveys
İlker Kurşun: Conducting surveys
İhsan Engin Kayhan: Conducting surveys

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