Journal of Tekirdag Agricultural Faculty
Tekirdağ Ziraat Fakültesi Dergisi

Mart/March 2024, 21(2)
Başvuru/Received: 08/10/22
Kabul/Accepted: 26/12/23
DOI:10.33462/jotaf.1186095

http://dergipark.gov.tr/jotaf
http://jotaf.nku.edu.tr/

ARAŞTIRMA MAKALESİ **RESEARCH ARTICLE**

Determination of Agricultural Mechanization Level in Kahramanmaraş with Poisson Regress by District

Kahramanmaraş İlinde Tarımsal Mekanizasyon Düzeyinin İlçelere Göre Poisson Regresyon ile Belirlenmesi

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Abstract

In this study, agricultural mechanization level indicators of the districts of Kahramanmaraş between the years 2012-2021 were calculated. A model has been established for this. While the dependent variable in the model is the agricultural areas planted in the districts according to the years, the independent variables are the number of tractors in the districts according to the years and other determined tools, equipment and machines. Poisson regression test was used, there was 25.022 chi-square probability relationship between the planted agricultural areas in Kahramanmaraş districts between 2012 and 2021, with the number of tractors in the districts and other determined equipment by years. At the level of agricultural mechanization, it was determined that there was a 3.32 decrease in the average number of tractors per 1000 hectares of land in Kahramanmaraş districts between 2012 and 2021, and a decrease of 12.45 in the number of specific equipment per tractor over the years. Among this decrease, it was thought that reasons such as climate change, input costs and job change were among the main reasons for leaving agriculture. In the comparison made from 2012 to 2021, the number of tractors in all districts increased by 54.18%, while the number of tractor equipment was also observed. An increase of 46.11% was observed. In addition, as a result of the trend analysis value applied, it was concluded that the average absolute percentage errors in the districts were 4.10443, the average number of tractors per 1000 hectares by years, and the number of specific equipment per tractor in the districts according to the years was 1.96718, which is a good estimation.

Keywords: Agricultural land, Tractor, Agricultural mechanization

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Atıf: Gök, İ., Şahin, M., Tolun, T. (2024). Kahramanmaraş İlinde tarımsal mekanizasyon düzeyinin ilçelere göre Poisson regresyon ile belirlenmesi. *Tekirdağ Ziraat Fakültesi Dergisi,* 21(2): 285-296.
Citation:Gök, İ., Şahin, M., Tolun, T. (2024). Determination of agricultural mechanization level in Kahramanmaraş with Poisson regress by district. *Journal of Tekirdag Agricultural Faculty,* 21(2): 285-296.

Öz

Bu çalışmada Kahramanmaraş ilinin ilçelerinin 2012-2021 yılları arasındaki tarımsal mekanizasyon düzeyi göstergeleri hesaplanmıştır. Bunun için bir model kurulmuştur. Modelde bağımlı değişken yıllara göre ilçelerinde ekilen tarım alanları olur iken, bağımsız değişkenlerde yıllara göre ilçelerdeki traktör sayısı ve belirlenmiş diğer aletlerdir. Poisson regresyon testinin kullanıldığı bu alanda Kahramanmaraş ilinin ilçelerinin 2012-2021 yılları arasında Kahramanmaraş ilçelerinde ekilen tarım alanlarının, yıllara göre ilçelerdeki traktör sayısı ve belirlenmiş diğer aletleri ile arasında 25.022 ki-kare olabilirlik oranında bir ilişki vardır. Tarımsal mekanizasyon düzeyinde 2012-2021 yılları arasında Kahramanmaraş ilçelerinde yıllara göre 1000 hektar alana düşen ortalama traktör sayısında 3.32 oranında, yıllara göre traktör başına düşen belirli ekipman sayısında da 12.45 oranında bir azalma olduğu belirlenmiştir. Bu azalmanın arasında iklim değişikliği, girdi maliyetleri, iş değişikliği gibi nedenlerden dolayı tarımı bırakmanın temel nedenleri arasında yer aldığı düşünülmüştür. Ayrıca uygulanan trend analiz değerinin sonucunda ortalama mutlak yüzdesel hatalar ise ilçelerin yıllara göre 1000 hektar alana düşen ortalama traktör sayısı 4.10443, ilçelerin yıllara göre traktör başına düşen belirli ekipman sayısı da 1.96718 olarak iyi bir tahmin gerçekleştirildiğinin sonucuna ulaşılmıştır.

Anahtar Kelimeler: Tarım arazisi, Traktör, Tarımsal mekanizasyon

1. Introduction

Agricultural sector is an economic and social business line with its impact on livelihood and labor force, its contribution to general national income, and the raw materials it provides to the industry in Turkey.

In order to meet the needs of the rapidly increasing human population, a better quality and more measured production area in the agricultural sector working areas is one of the main goals of agricultural production in today's agriculture. This goal makes it inevitable to use technology to accelerate and improve agricultural production. Within the production work areas, agricultural mechanization covers a special area. Agricultural mechanization studies should be used in production in order to obtain higher quality and higher efficiency in unit area and unit time. Agricultural mechanization methods are divided into two basic clusters as power and machines used in the job site. Tractors, which are called force machines in the field of agricultural mechanization, can give power to agricultural-construction machines that do not have the ability to move themselves in various situations in order to fulfill their mobility (Sümer et al., 2003; Sümer et al., 2004).

Agricultural mechanization, use of advanced technological networks in the agricultural sector; It is an important production method that allows widespread use of inputs such as irrigation, fertilization, soil cultivation and maintenance (Korucu et al., 2015). Agricultural mechanization level can show awareness from region to region in terms of both economic and technical levels. Determination of its level with the help of signs of agricultural mechanization; It is important in terms of comparing and interpreting the agricultural mechanization levels of countries, regions and provinces. The most basic power source used in the operation of the fields is the tractor. For this reason, the tractor used by the landowners in the land operation is one of the most important factors in determining the agricultural mechanization levels of the regions. The agricultural mechanization level, which is based on the widely used tractor, is the tractor power per the planted land for production, the number of tractors per 1000 hectares, the production area per one tractor and the number of equipment per one tractor (Sabancı et al., 2003). Agricultural lands; Various studies have been conducted on the size, yield, and average productivity per 1 hectare area (Kök, 1993; Lüle et al., 2012; Akar et al., 2012; Bilim et al., 2014; Bozkurt, 2016; Oğuz et al., 2017; Aslantürk and Altuntaş 2018). According to these studies, to determine the signs of agricultural mechanization and to determine the mechanization effect, based on the size of the agricultural land planted in the districts of Kahramanmaraş between the years 2012-2021, the number of tractors and the determined tractor equipment, and as a result of the results obtained, the mechanization level from the region to the region between the determined periods was made by making comparisons within the districts. detecting the change that may occur.

2. Materials and Methods

2.1. Material

The data of this research was obtained from the Turkish Statistical Institute (TUIK, 2021). According to the data obtained from TUIK, tractor horsepower is 35-50 horsepower, 51-70 horsepower, 70 and more horsepower, lug tractor plow, arc plow and cultivator, which are estimated to be widely used in the equipment of the tractor, and fruits in the planted agricultural lands, Size of agricultural land planted between 2012-2021 in Afşin, Andırın, Dulkadiroğlu, Ekinözü, Elbistan, Göksun, Nurhak, Onikisubat, Pazarcık, Türkoğlu and Çağlayancerit districts of Kahramanmaraş province, based on beverage and spicy plants, vegetable fields and cereals and other herbal products areas. A database was created about the specified tractor equipment and the number of tractors. A model has been established to determine the level of mechanization. While the dependent variable in the model is the agricultural areas planted in the districts according to the years, the independent variables are the number of tractors in the districts and other determined tools according to the years. It was tested with the poisson distribution method in the SPSS program and a comparison was made between the districts as a result of the years and data determined. Agricultural land cultivated by years in all districts between 2012-2021 *Table 1.A* and it is given in *Table 1.B.*

The total processed parcel size in the districts in 2012 is 2275517 m2, in 2013 3236923 m2, in 2014 3168249 m2, in 2015 3272680 m2, in 2016 3015063 m2, in 2017 3012018 m2, in 2018 3059753 m2, in 2019 3183214 m2, in 2020 3275806 m2 and In 2021, it was determined to be 3218535. In addition, when the total processed parcel size in the districts in 2012 and the total processed parcel size in the districts in 2021 are compared, an increase in the total parcel size processed in the districts was observed by 41.44%.

Table 1.A. Total processed parcel size in districts by year.

Districts	Total Parcel Size Processed by Years				
	2012	2013	2014	2015	2016
Afşin	465279	571975	591262	585041	520283
Andırın	123581	139869	133982	137441	137897
Dulkadiroğlu	-	260721	278840	270480	271755
Ekinözü	54880	57287	57913	59476	53050
Elbistan	651569	789037	675844	812548	768263
Göksun	432367	395509	408389	409696	401786
Nurhak	22151	21111	19785	20110	17812
Onikişubat	-	285647	287291	282687	283001
Pazarcık	339190	492012	495116	483087	365206
Türkoğlu	131039	185061	177950	170392	157967
Çağlayancerit	55461	38694	41877	41722	38043

***Table 1.B. Total processed parcel size in districts by year*.**

Districts	Total Parcel Size Processed by Years				
	2017	2018	2019	2020	2021
Afşin	515353	495761	524733	542292	534596
Andırın	141226	184605	193800	195221	193722
Dulkadiroğlu	280649	296847	305961	320840	258641
Ekinözü	42304	46613	42722	48429	50093
Elbistan	742876	714372	813482	813605	808605
Göksun	402286	401382	383421	394269	393365
Nurhak	21622	21875	22521	23812	28297
Onikişubat	281186	281788	272667	302150	296269
Pazarcık	356573	387593	360641	365816	357829
Türkoğlu	184275	184486	218148	221055	237495
Çağlayancerit	43668	44431	45118	48317	59623

In this research, the total number of tractors used in agricultural lands cultivated in all of the districts between 2012 and 2021 is given in *Table 2*.

Table 2. The total number of tractor equipment in the districts by years.

Districts	Total Number of Tractor Equipment by Years.									
	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Afşin	2810	2820	2830	2830	2900	2910	2960	3030	3030	3030
Andırın	1618	1625	1625	1635	1635	1685	1685	1691	1691	1724
Dulkadiroğlu	-	1828	2180	1920	1924	1975	2230	2260	2375	2430
Ekinözü	183	185	187	187	187	187	191	194	202	202
Elbistan	6550	6500	6500	6510	7500	7500	7450	7600	8210	9400
Göksun	1445	1455	1480	1490	1504	1521	1521	1530	1537	1544
Nurhak	195	201	201	196	205	212	219	222	227	228
Onikişubat	-	1352	1390	1390	1400	1401	1413	1424	1443	1514
Pazarcık	2428	2428	2428	2428	2430	2438	2438	2440	2440	2440
Türkoğlu	920	940	997	1018	1029	1115	1137	1152	1171	1205
Çağlayancerit	294	294	294	294	308	313	312	312	308	308

The total number of tractor equipment in the districts in 2012 was determined to be 16443, 19628 in 2013, 20112 in 2014, 19868 in 2015, 21022 in 2016, 21257 in 2017, 21556 in 2018, 21855 in 2019, 22634 in 2020 and 24025 in 2021. In addition, when the total number of tractor equipment in all districts in 2012 and the total number of tractor equipment in all districts in 2021 are compared, an increase in the total number of tractor equipment was observed by 46.11%.

2.2. Method

The aim of this study is to determine the degree of impact between the number of tractors and other determined tools, which are thought to be connected to the agricultural areas processed in the districts of Kahramanmaraş between the years 2012-2021. In this, the poisson distribution, which is a statistical analysis method, was used.

2.2.1. Poisson regression

Poisson regression is a mathematical analysis that determines the random degree of a data set, is useful in making the data sets created for analysis fit the institutional curve, and is used in the stage of executing certain predictions from the main data sets (Gerlough and Schuhl, 1955). It is applied to the problems that have occurred in the explanatory variables detected in the cases that have emerged in the period sections that are desired to be analyzed. Model; It sets out by estimating that the logarithm of possible numbers is a linear function of the explanatory variables, since they contain discontinuous and non-negative countable data. Special explanatory variables can be mentioned as the logarithm of the degrees of certain numbers before and after a one-unit increase that may occur in the explanatory variable as soon as all other explanatory variables are assumed to be constant (Köleoğlu, 2006). There are times when the answer variable takes a non-continuous value such as 0,1,2,…,n, but is not categorical. The model with continuous and non-categorical response variables associated with rare events is called the Poisson regression model based on certain assumptions. This model, called the Poisson regression model, is generally used to analyze counting data (Akın, 2002). Since the model is an exponential model, even if it is a negative situation that it causes difficulty and complexity in the interpretation of the coefficients of the model, linear regression analysis is a model that can be alternated in events consisting of the counting data of the answer variable (Deniz, 2005). Poisson regression model; In multiplicative models containing approximate data, when there is a conditional dependence between the explanatory variables, it provides an advantage to those who work because it is an elastic model (Lloyd, 1999). The Poisson regression model is the most used model after the logistic regression model. The most striking feature of this model is that there is an equality between the variance and the mean. However, in many applications it is not possible to achieve this equality.

In the Poisson distribution; If the obtained variance is less than the obtained mean, it is called under-dispersion, and if the obtained variance is greater than the obtained mean, it is called over-dispersion. The dependent variable Y, which is defined as the number of related cases in the Poisson regression;

$$X_1, X_2, \cdots, X_n \qquad \text{(Eq. 1)}$$

If independent variables are given, it is assumed to obtain the Poisson distribution. Thus, it is assumed that there is a linear factor hypothesis derived from the independent variables of the logarithm of μ, which is the Poisson mean (SAS, 2005; Yeşilova et al., 2006). Poisson regression model according to the function in the subject;

$$Log(\mu) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_m X_m \qquad \text{(Eq.2)}$$

given in the form. in the model μ becomes an exponential factor of the independent variables. $\mu'y$ü,

$$\mu = \exp(\beta_0 + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_m X_m) \qquad \text{(Eq.3)}$$

can be written as

The Poisson distribution is a type of distribution that can determine the number of events or situations that are likely to occur in a specified place or volume in a specified period. This distribution was introduced by a French mathematician in the 18th century, and he named this distribution the poisson. In the following times, it has taken its current form in the research and analysis of different scientists (Gürsakal, 1997).

The Poisson distribution formula is:

$$P(y;\ \mu) = \frac{\mu^{y} e^{-\mu}}{y_i} \qquad \text{y=0,1,2…} \qquad \text{(Eq.4)}$$

İn equality y_i, the number of occurrences of expected event events, and μ_i' i is the distribution parameter. Well $E(y_i) = \mu_i$ is in the form.

μ_i'in Poisson regression model is obtained when it is dependent on the explanatory variables. $\mu - i$ generally $\mu_i = e^{x \cdot \beta}$ can be obtained as a supplement. Here x is in the position of the explanatory variable vector. β' a indicates the parameter vector to be evaluated. The approximate value of the Poisson distribution is:

$$\mu_i = E(\frac{y_i}{x_i}) = \exp(x_i\beta) \quad \text{(Eq. 5)}$$

given in the form. In the statistics branch, the above-mentioned model is referred to as the linear logarithmic model. In the Poisson distribution, the approximate variance is equal.

$$\mu_i = E(\frac{y_i}{x_i}) = V(\frac{y_i}{x_i}) \quad \text{(Eq. 6)}$$

The state of equality between the mean and the variance is called equal spread. However, in the analysis, the counting variables indicate overdispersion as their variances are larger than the mean in most periods. Since the

number of analyzed zero values is overdispersed, the poisson regression model causes situations or events such as unobserved heterogeneity if it exceeds the obtained zero values (Kibar, 2008).

The overdispersion problem occurring in the model is not likely to affect the predictions made in the coefficient or coefficients. However, it has the possibility to have an effect on the estimated standard error area in the model, and within this, it increases the reliability level of the model (AL-Ghirbal and AL-Ghamdi, 2006).

2.2.2. Trend analysis

It is the representation of the long-term fundamental trend in a time series with a curve or a straight line (Yavuz, 2016). In the trend analysis method, the trend equation that best describes the time series is determined and predictions are made for the next times. It can be applied with trend analysis method estimation, moving average analysis method, semester analysis method and least squares analysis method. However, in order to obtain the equation of the trend line, it is necessary to observe various types of equations (logarithmic, exponential, etc.) apart from the least squares analysis method (Witt and Witt, 1992).

3. Results and Discussion

In this research, first of all, a model was established in the districts of Kahramanmaraş as a result of the data set obtained from TUIK between the years 2012-2021, the dependent variable is the agricultural areas planted in the districts according to the years, the number of tractors in the districts according to the years in the independent variables and the other determined equipments, and the hypotheses of the model are:

H0: There is no relationship between the agricultural lands planted in Kahramanmaraş districts between 2012-2021, the number of tractors in the districts by years and other specified equipment.

H1:There is a relationship between the agricultural lands planted in Kahramanmaraş districts between 2012-2021, the number of tractors in the districts by years and other specified equipment.

model:

$$Y_{it=}\beta_0 + \beta_1 X_{1it} + \beta_2 X_{2it} + u_{it} \quad \text{(Eq. 7)}$$

Yit: The size of the agricultural areas planted in Kahramanmaraş districts between 2012-2021 by years.

X1it: Number of tractors found in Kahramanmaraş districts between 2012-2021 by years.

X2it: The number of specific tractor equipment found in Kahramanmaraş districts by years between 2012-2021.

is in the form.

And poisson regression analysis was done by using spss program.

Between the years 2012-2021, the number of tractors found in Kahramanmaraş districts according to the years is 30, as a result of the years specified in the range of 0 to 500 in the districts, and this determined range explains 27.8%. Tractor assets as a result of the years specified in the range of 501 to 1000 are 22, and this specified range explains 20.4%. As a result of the years specified in the range of 1001-1500, the tractor asset is 26 and this specified range explains 24.1%. Tractor assets as a result of the years specified in the range of 1501-2000 are 20, and this specified range accounts for 18.5%. Tractor assets as a result of the years specified in the range of 2501-3000 are 4 and this explains 3.7% of the specified range. The tractor asset as a result of the years specified in the range 3001-3500 is 3, and this specified range explains 2.8%. The tractor asset as a result of the years specified in the range 3501-4000 is 3, and this specified range explains 2.8%.

Table 3. Categorical variable outcome of X1 poisson regression

Categorical Variable Information		
X1	**N**	**Percent**
0-500	30	%27.8
501-1000	22	%20.4
1001-1500	26	%24.1
1501-2000	20	%18.5
2501-3000	4	%3.7
3001-3500	3	%2.8
3501-4000	3	%2.8
Total	108	%100

Table 4. Categorical variable outcome of x2 poisson regression

Categorical Variable Information		
X2	**N**	**Percent**
0-1000	33	%30.6
1001-2000	40	%37.0
2001-3000	22	%20.4
3001-4000	3	%2.8
6001-7000	4	%3.7
7001-8000	4	%3.7
8001-9000	1	%0.9
9001-10000	1	%0.9
Total	108	%100

Between the years 2012-2021, the number of tractors found in Kahramanmaraş districts by years is 33, as a result of the years specified in the range of 0 to 1000 in the districts, and this determined range explains 30.6%. As a result of the years specified in the range of 1001 to 2000, the tractor asset is 40, and this specified range explains 37%. The number of tractors as a result of the years specified in the 2001-3000 range is 22, which explains 20.4% of the specified range. Tractor assets as a result of the years specified in the range of 3001-4000 are 3, and this specified range explains 2.8%. Tractor assets as a result of the years specified in the range 6001-7000 are 4 and this explains 3.7% of the specified range. Tractor assets as a result of the years specified in the range 7001-8000 are 4 and this explains 3.7% of the specified range. Tractor assets as a result of the years specified in the range 8001-9000 are 1 and this explains 0.9% of the specified range. The tractor asset as a result of the years specified in the range 9001-10000 is 1 and this explains 0.9% of the specified range.

As stated in Table 5., since the probability value is less than 0.05, the null hypothesis is rejected. In other words, in the established model, there is a 25.022 chi-square probability relationship between the agricultural areas planted in Kahramanmaraş districts between 2012 and 2021, with the number of tractors in the districts by years and other specified equipment.

Table 5. Poisson regression chi-square likelihood result

Chi-Square Likelihood Ratio	Degrees of Freedom	Probability
25.022	7	0.001

In addition, at the agricultural mechanization level, the average number of tractors per 1000 hectares of districts by years *Table 6* and the number of specific equipment per tractor in the districts by years is given in *Table 7*.

The average number of tractors per 1000 hectares between the years 2012-2021 in all districts by years; It was determined that it was 3.38 in 2012, 3.94 in 2013, 4.49 in 2014, 4.54 in 2015, 4.88 in 2016, 4.74 in 2017, 4.54 in 2018, 4.50 in 2019, 4.24 in 2020 and 4.36 in 2021. In addition, when the average number of tractors per 1000

hectares of land in 2012 is compared with the average number of all districts by years and the average number of tractors per 1000 hectares of land in 2021, it has been determined that the average number of all districts decreases by 3.32%. Among the reasons for the decrease compared to these years, climate change, input costs, job change were among the main reasons for leaving agriculture. In addition, the trend analysis result of the average number of tractors per 1000 hectares of districts by years is given in *Figure 1*.

Table 6. Average number of tractors per 1000 hectares of districts by years

District	Average Number of Tractors Per 1000 Hectares by Years.									
	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Afşin	3.32	2.72	2.63	2.66	3.01	3.04	3.19	2.97	2.85	2.86
Andırın	10.89	9.63	10.05	9.95	9.92	9.75	7.46	7.17	7.12	7.19
Dulkadiroğlu	-	2.96	4.42	4.62	4.60	4.49	4.37	4.34	4.22	5.45
Ekinözü	2.00	1.92	1.98	1.93	2.16	2.71	2.55	2.90	2.99	3.05
Elbistan	4.45	3.80	4.43	3.69	4.16	4.33	4.65	4.36	4.37	4.77
Göksun	1.94	2.14	2.10	2.13	2.19	2.26	2.27	2.38	2.31	2.30
Nurhak	7.90	8.19	8.99	9.69	10.61	8.92	9.18	9.14	7.18	6.11
Onikişubat	-	4.56	7.22	7.34	7.33	7.37	7.36	7.61	6.90	7.39
Pazarcık	4.84	3.33	3.31	3.40	4.51	4.64	4.28	4.61	4.54	4.68
Türkoğlu	4.76	3.41	3.70	3.96	4.46	4.01	4.01	3.41	3.48	3.72
Çağlayancerit	0.50	0.72	0.66	0.67	0.76	0.66	0.65	0.70	0.68	0.53

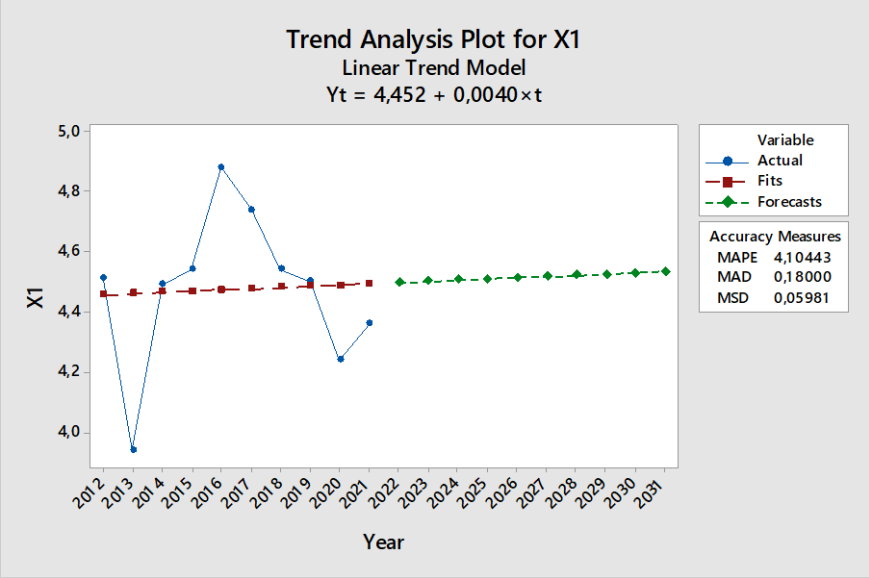

Figure 1. Trend analysis of the average number of tractors (X1) per 1000 hectares of districts by years

Mean absolute percentile errors (MAPE) measure how much the values estimated by this measure deviate from the true values. From this point of view, a low MAPE value means a better estimation has been made. In *Figure 1*, since the MAPE value is 4.10443, it is concluded that a good estimation has been made.

All district averages of the number of specific equipment per tractor in the districts between 2012-2021; It was determined that it was 2.57 in 2012, 2.41 in 2013, 2.32 in 2014, 2.29 in 2015, 2.31 in 2016, 2.34 in 2017, 2.34 in 2018, 2.24 in 2019, 2.23 in 2020 and 2.25 in 2021. In addition, it has been determined that the number of specific equipment per tractor in the districts in 2012 compared to the average number of all districts and the number of specific equipment per tractor per year in the districts in 2021, compared to the average number of all districts, decreased by 12.45%. Among the reasons for the decrease compared to these years, climate change, input costs, job change were among the main reasons for leaving agriculture.

In addition, the trend analysis result of the number of specific equipment per tractor in the Districts by years is given in *Figure 2*.

Table 7. The number of specific equipment per tractor in the districts by years

District	Average Number of Certain Equipment Per Tractor by Years.									
	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Afşin	1.81	1.81	1.81	1.81	1.84	1.85	1.86	1.94	1.95	1.98
Andırın	1.20	1.20	1.20	1.19	1.19	1.22	1.22	1.21	1.21	1.23
Dulkadiroğlu	-	2.36	1.76	1.53	1.53	1.56	1.71	1.69	1.75	1.72
Ekinözü	1.66	1.68	1.62	1.62	1.62	1.62	1.60	1.56	1.39	1.32
Elbistan	2.25	2.16	2.16	2.17	2.34	2.32	2.24	2.14	2.30	2.43
Göksun	1.72	1.71	1.72	1.70	1.70	1.66	1.66	1.67	1.68	1.70
Nurhak	1.11	1.16	1.12	1.10	1.08	1.09	1.08	1.07	1.32	1.31
Onikişubat	-	1.03	0.66	0.66	0.67	0.67	0.68	0.68	0.69	0.69
Pazarcık	1.47	1.47	1.47	1.47	1.47	1.47	1.46	1.46	1.46	1.45
Türkoğlu	1.47	1.48	1.51	1.50	1.45	1.50	1.53	1.54	1.51	1.36
Çağlayancerit	10.50	10.50	10.50	10.50	10.62	10.79	10.75	9.75	9.33	9.62

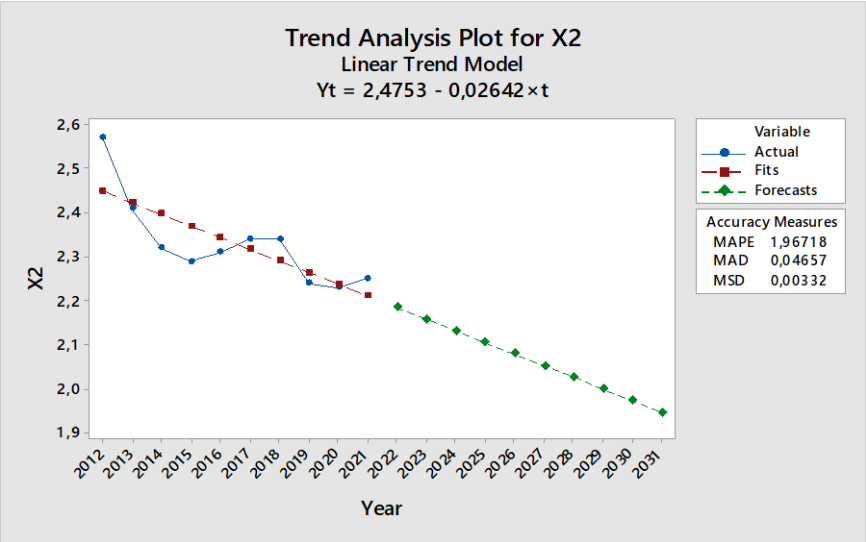

Figure 2. Trend analysis of the number of specific equipment per tractor (X2) of the districts by years

Mean absolute percentile errors (MAPE) measure how much the values estimated by this measure deviate from the true values. From this point of view, a low MAPE value means a better estimation has been made. As the MAPE value is 1.96718 in *Figure 2*, it is concluded that a good estimation has been made.

Agricultural lands in various regions of Turkey; Various studies have been carried out on the size, yield, and average yield per 1 hectare area. While the average tractor horsepower falling was 2.1-246.6, it was determined that the number of tools or machines falling on a tractor changed as 2,4-17.8 (Koçtürk and Onurbaş, 2007). As a result of a study conducted in the Eastern Mediterranean in Turkey, it was determined that the average tractor horsepower is 47.83 kW and the annual working time of a tractor is 600 hours (Aybek and Senel, 2009). According to the results of a research conducted in Eğirdir district of Isparta province, the number of tractors per farm was 0.79, agricultural machinery was 4.70 and equipment per tractor was 5.17. In addition, it has been determined that the average tractor power is 39.92 kW, the annual tractor operating hours are 380.65 and the production of horticultural crops on 45.22% of the lands, and the apple area takes the first place with a 43.65% share in the crop pattern (Gökdoğan and Bayhan 2011). As a result of a study conducted in the province of Kırklareli in Turkey, 833 machine equipment support from 23 different types of machines was provided within the scope of 50% grant between 2007 and 2012, and it was determined by the research that both the renewal of old machines and the use of new technological machines were made possible in the region (Baran and Akbayrak, 2013). As a result of a study conducted in Kahramanmaraş, the total number of tractors in Kahramanmaraş between 2008-2013 is 10561-12165 and the average tractor power is 41.5-40.59 kW. The production area values are 366 251-359 578 ha and the number of agricultural tools-machines is 48 734-62 848. Mechanization level indicator values of Turkey were determined as 1.98-2.37 kW/ha, 44.02-52.23 tractor/1000 ha,

22.71-19.15 ha/tractor and 5.28-5.09 tool-machine/tractor (Korucu et al., 2015). As a result of a study conducted in Denizli, it was determined that the average tractor horsepower was 35.93 kW, the average number of tools and machinery per tractor was 4.5, and the average number of tractors per 1000 hectares was 82.74 (Doruk, 2016). As a result of a study conducted in Muş province, the average tractor horsepower is 40 kW, the average tractor horsepower per 1000 hectares of land is 2.65 kW, the average number of tractors per 1000 hectares is 65.6, and the number of tools and machines per tractor is determined as 4.80 (Akar and Çelik, 2017). As a result of a study conducted in Turkey and the Thrace region and the provinces of Edirne, Kırıkkale and Tekirdağ, the number of tractors per 1000 hectares between 2008 and 2017 was 27.9% in Turkey, 3.7% in the Thrace region, 13.9% in Edirne and 6.1% in Kırklareli. While there is an increase, there is a decrease of 5.8% in Tekirdağ and according to the trend analysis, it has been determined that the tractor horsepower per 1000 hectares of land is expected to be 3.01 kW in 2023 in the Thrace region (Abdikoğlu, 2019). As a result of a study conducted in Dereköy neighborhood of Biga district of Çanakkale province in Turkey, it has been determined that agricultural mechanization and production inputs have decreased significantly due to the decrease in the number of parcels and the increase in the size of parcels with consolidation, and at the same time, all the inputs spent for production, including the depreciation expenses of the tractor, have decreased at a high rate. (Irmaklı and Aydın, 2022).

4. Conclusions

The aim of this research is to determine the signs of agricultural mechanization and to determine the effect of mechanization based on the total land size, number of tractors and determined tractor equipment in the districts of Kahramanmaraş between the years 2012-2021. is to determine the change that may occur in the level of mechanization to the region.

The sample of this study was obtained from the Turkish Statistical Institute (TUIK). According to the data obtained from TUIK, tractor horsepower is 35-50 horsepower, 51-70 horsepower, 70 and more horsepower, lug tractor plow, arc plow and cultivator, which are estimated to be widely used in the equipment of the tractor, and fruits in the planted agricultural lands, Size of agricultural land planted between 2012-2021 in Afşin, Andırın, Dulkadiroğlu, Ekinözü, Elbistan, Göksun, Nurhak, Onikisubat, Pazarcık, Türkoğlu and Çağlayancerit districts of Kahramanmaraş province, based on beverage and spicy plants, vegetable fields and cereals and other herbal products areas. A database was created about the specified tractor equipment and the number of tractors. For the estimation results obtained in the research, poisson regression analysis and trend analysis methods were used. According to the estimation results, there is a 25.022 chi-square probability relationship between the agricultural areas planted in Kahramanmaraş districts between 2012 and 2021, with the number of tractors in the districts by years and other specified equipment. At the level of agricultural mechanization, it was determined that there was a 3.32 decrease in the average number of tractors per 1000 hectares of land in Kahramanmaraş districts between 2012 and 2021, and a decrease of 12.45 in the number of specific equipment per tractor over the years. Among this decrease, it was thought that reasons such as climate change, input costs and job change were among the main reasons for leaving agriculture. In addition, as a result of the trend analysis value applied, it has been concluded that the average absolute percentage errors in the districts are 4.10443, the average number of tractors per 1000 hectares by years, and the number of specific equipment per tractor in the districts is 1.96718, according to the years.

The reasons for not obtaining full good results in the districts of Kahramanmaraş as a result of the data obtained from TUIK are that the specified time interval was kept short and the criteria under the preference sub-title were chosen more in the data obtained. . In order to avoid these and similar problems in future article or thesis research, the specified period should be kept wider, and regions or regions dealing with agriculture should be preferred.

Conflicts of Interest

We declare that there is no conflict of interest between us as the article authors.

Authorship Contribution Statement

Concept: İsmail GÖK, Mustafa ŞAHİN and Tolga TOLUN; Design: İsmail GÖK, Mustafa ŞAHİN and Tolga TOLUN; Data Collection or Processing: İsmail GÖK and Mustafa ŞAHİN; Statistical Analyses: İsmail GÖK and Mustafa ŞAHİN; Literature Search: İsmail GÖK and Tolga TOLUN; Writing: İsmail GÖK, Mustafa ŞAHİN and Tolga TOLUN .

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