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THE ANALYSIS OF THE CURRENT SITUATION OF WHEAT PLANTED AREAS IN THE TIGRIS BASIN AND THE CHANGE OVER YEARS (1991-2015)

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Abstract

The Southeastern Anatolia Region has two basins, being the Tigris Basin and the Lower Euphrates Basin. According to the data for 2015, 9.5% of the wheat production in Turkey is performed in the provinces (Diyarbakır, Mardin, Siirt, Batman, Şırnak) in the Tigris Basin which is the subject of the study. Wheat production in the agricultural lands of the region stands out in terms of the indicators of droughts related to both geographical restrictions and global warming. Climatic changes resulting from the global warming are one of the most important factors affecting agricultural production. In this regard, the assessment of precipitation values originating from climatic changes enables us to have an opinion on wheat production in the Tigris Basin in the future. It is considered that the potential for wheat planting may increase due to the appropriate climatic conditions in the Tigris Basin and available productive lands. The mapping of the changes in precipitation and yield values of wheat planted areas by transforming them into digital data is possible thanks to current information technologies. In this study, it is aimed to identify the change of wheat planted areas in the provinces in the Tigris Basin for last 25 years, the condition of available lands and their efficiency in meeting the needs for wheat. In this context, Geographical Information Systems (GIS) and statistical analyses were used. The climatic data of the Tigris Basin for many years (annual precipitation) and the yield of wheat planted areas and the values of cultivated areas between the years of 1991-2015 were used for the study. Accordingly, Geographical Information Systems (GIS) were entered into the database and interpreted by being associated with the statistical analyses.

Key words**:** *wheat, GIS, Tigris Basin, precipitation*

INTRODUCTION

The wheat produced in almost all regions of the world and Turkey is an important agricultural product in terms of concerning a large producer group and constituting the raw material for bread which is the staple food of people. The contribution of cereals to the national economy is versatile. These contributions appear in the use of agricultural lands, agricultural production, nourishment of people, domestic and foreign trade and national income (Kızılaslan, 2004) [4].

Wheat as an important agricultural product for Turkey leads in the cereal group of agricultural products. Nowadays, most of the countries in the world accept wheat as a strategic product and apply their policies in this direction.

Turkey is one of the countries that will be mostly affected by climatic changes related to global warming. Different regions will be affected by possible climatic changes in different ways and at different levels. The Southeastern Anatolia Region under the threat of desertification due to rising temperature will be affected more when precipitation is inadequate (Özturk, 2002) [5].

While wheat can be grown in every region of Turkey, it is commonly produced especially in the Central Anatolia Region. Thus, the Central Anatolia Region is placed on the top with the 36% share in bread wheat production in 2013. Central Anatolia is followed by the Marmara Region with 15% and the Southeastern Anatolia Region with 14%. The Eastern Anatolia and Aegean Regions have the least share in production with 7%. The

Southeastern Anatolia Region is in the first place in durum wheat production with 46%, the Central Anatolia Region (28%) is in the second place, the Aegean Region (13%) is in the third place (Anonymous, 2013) [1].

When the soil assets and productivity in Turkey are considered, wheat production seems as an income-generating business in rural areas which reduces the unemployment. It seems that increasing the areas of wheat production and promoting the establishment of wheat-input food industries in the region may decrease the flow rate of rural to urban migration (for economic reasons) and increase the working potential for the Tigris Basin. Therefore, the projects in the Tigris Basin carried out for social purposes aim to provide employment. Recently, both development agencies have presented projects and the Ministry of Agriculture have provided producer support in the Southeastern Anatolia Region.

In a study conducted by Sönmez et al. in 2007[7], it was aimed to develop a sustainable land management plan and soil conservation plan by benefiting from the remote perception and geographical information systems technology instead of classical methods based on geodetic computation techniques. The basic soil characteristics of the lands were distinguished at the series and phase level, the current land use forms were introduced and the regional land ability classes were formed in a study conducted in Antalya, Altınova for this purpose by considering the Soil Conservation and Land Use Act.

It is an important obligation to do certain planning related to the use and management of lands and soils in terms of the conservation of both agricultural and non-agricultural lands (urban settlement, areas suitable for industry and trade) and soils and providing the continuity of productivity. One of these plannings is the Land Ability Classification which is an international technical classification system and indicates the relative suitability of the lands with various characteristics for different uses. Such a classification is created both directly on the basis of land studies and with the interpretation of the basic soil maps prepared with suitable methods (Soil Survey Staff, 1993; Dinç et al., 1997) [3,6]. The planning of agricultural production with classical methods gives its place to the methods performed with geographical information systems and remote perception which enable the examination in a shorter time and with more visual maps. Since GIS is a method which makes it possible to examine all factors together in countries such as Turkey which have numerous microclimates among the macroclimates and various slope, topographic and soil structures from the step conditions to the forest, it is inevitable to use the maps created with GIS technologies in planning.

Cereal production is performed on 106,5 million da in Turkey. While wheat is produced in 67% of this area, barley is produced in 24%, corn is produced in 6% of it. These products are followed by rye (1.3%), paddy (1.1%), oat (0.8%), triticale (0.3%) and other cereal products (einkorn, canary grass, panicum, sorghum, mixture at the rate of 0.1%) (Anonymous, 2016) [2].

When the data for 2015 within the boundaries of Diyarbakır province are examined, it is revealed that wheat is produced in an area of 3,867,141 da and when this amount is compared with the data for 1991 (2,626,420 da), it is indicated that there is an increase at the rate of 47.2%. When the wheat planting rates in the Tigris Basin are examined by the provinces, it is seen that Diyarbakır province has the largest production area (50%). Mardin province is at the second place with 26%, Batman province is at the third place with 10%, Şırnak province is at the fourth place with 9% and Siirt province is at the fifth place with 5%.It is considered that the fact that the results of the study can reveal the current situation in the region and the analyses to be carried out in this context will contribute to the development rate of the basin in the rural aspect, production amount and realization of the industrial deficit of the basin

MATERIALS AND METHODS

The study is conducted in the Southeastern Anatolia Region in Turkey and covers Diyarbakır, Mardin, Batman, Siirt and Şırnak provinces of the Tigris Basin (Figure 1).

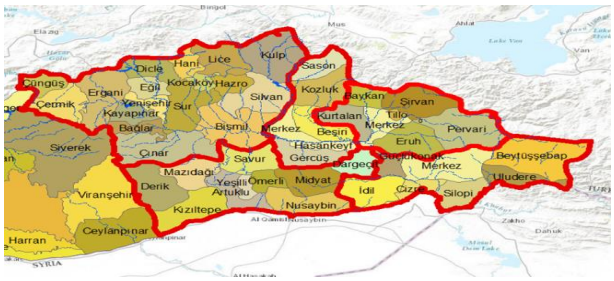

Fig. 1. Districts of the Tigris Basin

It is important to identify the amount of wheat production in the basin for many years (1991-2015) to be able to determine the change of wheat production lands over the years in this study conducted in cooperation with Siirt University, Faculty of Agriculture, Department of Agricultural Economics and Department of Biosystem Engineering. The available wheat production lands (da), the amount of production (ton) and the yield (kg/da) values between the years of 1991 and 2015 acquired from the system of the Turkish Statistical Institute (TSI) were used for the Tigris Basin which is the subject of the study. Our study consists of two stages. The first one of these stages is the evaluation of the precipitation and yield values of the last 25-year wheat production in the Tigris Basin by using GIS techniques and the yield values (kg/da) of the production areas for the last 25 years and the change of the production areas (da) in 5-year periods for 5 different provinces were presented with GIS techniques. All of these acquired data constitute the main material of the study. The satellite images for 2014 in ArcMAP environment were used as a basic determining criterion in GIS system in this study. The questioning and analysis parts of the Geographical Information Systems were benefited from. The wheat production areas and amounts were evaluated in the Geographical Information Systems environment and the change over the years was mapped. In this context, the study area was digitized in the GIS environment as a polygon being provincial borders in the first place. For this purpose, ArcMAP 10.0 software and WGS 84 coordinate reference system were used. All boundaries were divided as a separate layer on the basis of provinces to make the examinations of each province independently from the other provinces. A database (attribute data) was created by entering the wheat production areas provided from the TSI system into these layers prepared. At the second stage of our study, the precipitation values for 1991-2015, production areas, the amount of production and yield values were entered into SPSS environment and statistical analyses were made. The levels or grades of the relationship between the independent and dependent variables were measured with the help of the correlation analysis. The coefficient acquired as a result of the correlation analysis has a value varying between -1 and +1. While the coefficient takes a value of 0 or close to 0 when there is no interaction or little interaction between the variables, it takes the value of 1 if there is a full and strong interaction between the variables and it takes the value of -1 if there is a reverse and full interaction. The correlation coefficient is usually indicated with letter "r". The affecting way and strength of the yield of the variables were analyzed for each province in the basin, and the correlation coefficients between the precipitation and yield values were calculated. In addition to this, the yield, precipitation, production area and the amounts of production of each term were compared with the 25-year averages of the basin by separating into 5-year periods in Excel program and the rates of decrease and increase were identified and interpreted

RESULTS AND DISCUSSIONS

When the findings in the study area were compared, it was revealed that Diyarbakır province had a significant place both are ally and in terms of the amounts of production. When the precipitation data of Diyarbakır province were examined, it was seen that precipitation decreased at the rate of 10,45% in the last 10 years according to the 25-year precipitation averages, however, wheat planted areas and yield increased. It was discovered that wheat production and yield had the lowest values between the years of 1996-2000 (Figure 2).

Table 1. The Precipitation-Yield Correlation in Diyarbakır Province

		Rain-fed	Yield
Rain-fed	Pearson Correlation	1	0.053
	Sig. (2-tailed)		0.800
	N	25	25
Yield	Pearson Correlation	0.053	1
	Sig. (2-tailed)	0.800	
	N	25	25

In this context, when Table 1. was examined, it was indicated that the fact that wheat production and yield values decreased below the average by years was not only related to the change in precipitation values.
Accordingly, since the value of r=0,053 obtained by entering the precipitation and yield values in the correlation analysis carried out in SPSS program is close to 0, it is possible to conclude that there is a weak correlation between the variables, in other words, precipitation over the years which constitute the subject of the study does not affect the yield of wheat (Fig. 2).

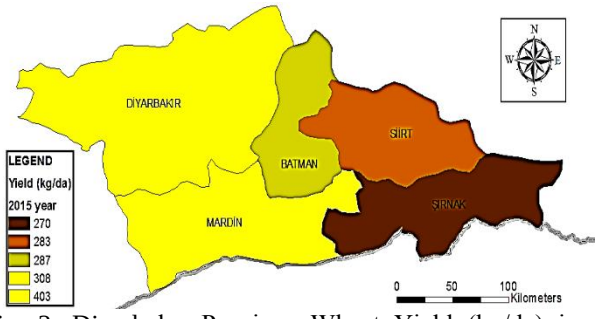

Fig. 2. Diyarbakır Province Wheat Yield (kg/da) in 2015

Although precipitation is known as the major factor affecting the yield of wheat, it is considered that factors such as seed, cultural struggle, fertilization, etc. are effective in the improvement of the conditions and the increase in the yield (Table 2).
Mardin is the second biggest province in the basin in terms of production area (Fig. 3) and potential While a decrease of 3.67% is seen in the amount of precipitation according to the average of 25 years between the years of 1999-2000 in Mardin, it is considered that the decrease of 110% in the yield amount is a result of the irregular precipitation regime and both global economic crisis and devaluation experienced in our country between the mentioned years.

Table 2. The Change of the Wheat Production Potential in Diyarbakır Province over the Years

Diyarbakir				
Years	Rain-fed (%)	Planting Area (%)	Productio n(%)	Yield (%)
1991-1995	9.92	-19.45	-42.05	-16.15
1996-2000	-2.87	-16.29	-61.12	-33.37
2001-2005	1.63	-0.72	-0.15	3.35
2006-2010	-3.4o	5.48	7.37	4.04
2011-2015	-7.05	20.13	37.39	23.81

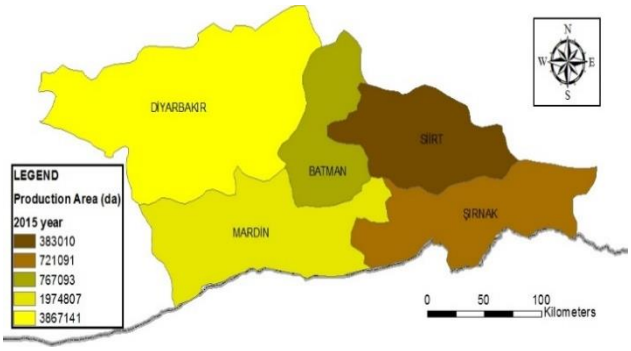

Fig. 3. Mardin Province Production Area (da) in 2015

The crisis experienced between the years of 1999-2000 caused an approximately 50-60% increase in the cost of fuel which had the biggest share in agricultural production and producers could not harvest and in this regard it was considered that the values of wheat production and yield decreased or there might be some mistakes in the data entry (Table 3).

Table 3. The Precipitation-Yield Correlation in Mardin Province

		Yield	Rain-fed
Yield	Pearson Correlation	1	0.006
	Sig. (2-tailed)		0.978
	N	25	25
Rain-fed	Pearson Correlation	0.006	1
	Sig. (2-tailed)	0.978	
	N	25	25

When the precipitation-yield correlation in Table 4 which verifies the decrease in the yield amount is examined, it can be expressed that the correlation is too weak with the value of r=0,006 and in this context, the precipitation between the years of 1991-2015 which are the subject of the study does not affect the yield of wheat.
It was concluded that the 17.14% decrease in the yield amount together with the 16.28% increase according to the average of 25 years in the amount of precipitation between the years of 1991 and 1995 in Batman province

originated from the fact that precipitation did not occur in the period when wheat needed water, quality seeds were not used and there was no cultural struggle in the mentioned years.

Table 4. The Change of the Wheat Production Potential in Mardin Province over the Years

Mardin				
Years	Rain-fed (%)	Planting Area (%)	Production (%)	Yield (%)
1991-1995	13.89	-20.29	-69.38	-34.81
1996-2000	-3.67	-3.58	-96.39	-80.45
2001-2005	-2.62	-6.56	-3.34	7.14
2006-2010	-14.16	-5.45	3.16	10.88
2011-2015	2.3	24.04	47.37	33.55

Moreover, according to the data recorded between the years of 2011-2015, there was a 39.01% increase in the yield.

It is considered that a relatively higher recorded increase in the yield is related to the fact that new agricultural technologies (harvest mechanization, fertilization, plant protection, etc.) started to be used by producers (Table 5).

Table 5. The Precipitation-Yield Correlation in Batman Province

		Yield	Rain-fed
Yield	Pearson Correlation	1	0.179
	Sig. (2-tailed)		0.392
	N	25	25
Rain-fed	Pearson Correlation	0.179	1
	Sig. (2-tailed)	0.392	
	N	25	25

The r value was calculated to be 0.179 as a result of the precipitation-yield correlation (Table 6). This value indicates that even if it is weak there is a positive interaction between the precipitation and yield in Batman province.

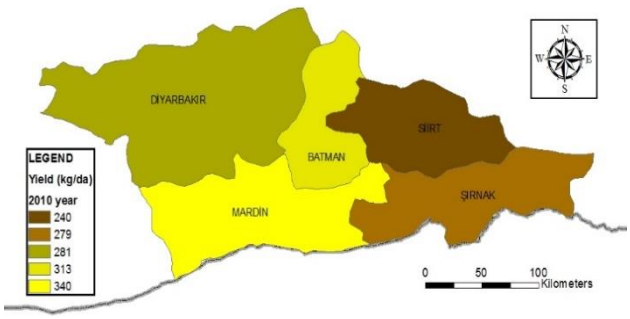

Fig. 4. Batman Province Yield (kg/da) in 2010

Table 6. The Change of the Wheat Production Potential in Batman Province over the Years

Batman				
Years	Rain-fed (%)	PlantingArea (%)	Production (%)	Yield (%)
1991-1995	16.28	-26.2	-53.28	-17.14
1996-2000	-9.41	-17.49	-48.4	-21.17
2001-2005	-3.4	-0.8	-4.42	0.2
2006-2010	-8.27	8.74	13.64	3.75
2011-2015	0.09	21.17	35.82	21.87

When the wheat planted areas in Şırnak province are compared by years, a 55,31% increase was calculated between the rates between the years of 2011 and 2015 and the rates between the years of 1991 and 1995 (Fig. 5).

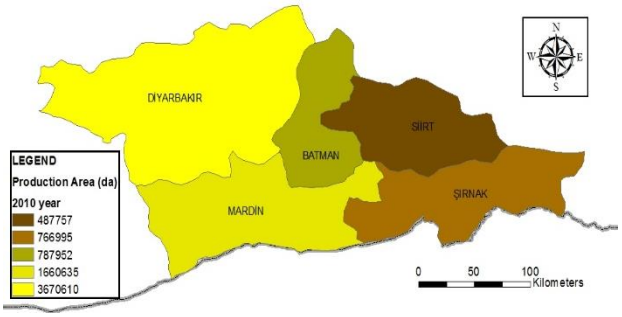

Fig. 5. Şırnak Province Production Area (da) in 2010

It is possible to say that this increase resulted from the fact that producers increased the planting areas to take an advantage of government aids and to meet the market demand for wheat. Moreover, it can be said that the increase in the production areas results from the fact that the inputs in the wheat production are less when compared to other agricultural products and the product is acquired more easily. It is considered that the producers of flour plants were directed to the cultivation of wheat in the last 10 years in the city center and county towns of Şırnak (Table 7). When the precipitation-yield correlation in Şırnak province is examined, the fact that the value of r=-0,281 is negative indicates that there is an inverse proportion between the yield and precipitation. The fact that the amount of precipitation increases is an indicator of a decrease in the yield. However, it is concluded that the fact that the annual precipitation is low especially during the tillering of wheat or grain filling may affect

this analysis negatively (Table 8).

Table 7. The Precipitation-Yield Correlation in Şırnak Province

		Rain-fed	Yield
Rain-fed	Pearson Correlation	1	-0.281
	Sig. (2-tailed)		0.173
	N	25	25
Yield	Pearson Correlation	-0.281	1
	Sig. (2-tailed)	0.173	
	N	25	25

Table 8. The Change of the Wheat Production Potential in Şırnak Province over the Years

Şırnak				
Years	Rain-fed (%)	PlantingArea (%)	Production (%)	Yield (%)
1991-1995	18.95	-31.37	-76.15	-29.01
1996-2000	-11.5	-40.37	-87.78	-26.79
2001-2005	2.39	-3.2	5.9	12.18
2006-2010	-13.11	19.52	24.19	9.2
2011-2015	-4.09	23.94	34.11	16.39

In the evaluation on the basis of the precipitation averages for 25 years in Siirt province, although the annual precipitation tended to decrease at the rate of 15.24% in last 10 years, a 45.48% increase occurred in the rates of the wheat yield and there was a 42,65% increase in the planted areas (Fig. 6).
Moreover, while there were negative decreases in the amount of wheat production in Siirt province between the years of 1991 and 2005, it was identified that this situation indicated a 74,95% positive increase in the last 10 years (Table 9).
When the precipitation-yield correlation in Siirt province is considered, it is possible to say that since the value of r=-0,029 is close to 0, even if it is negative, the interaction is too weak, in other words, the connection between the amount of precipitation and the yield of wheat is too weak (Table 10).

Table 9. The Precipitation-Yield Correlation in Siirt

		Rain-fed	Yield
Rain-fed	Pearson Correlation	1	-,029
	Sig. (2-tailed)		,890
	N	25	25
Yield	Pearson Correlation	-,029	1
	Sig. (2-tailed)	,890	
	N	25	25

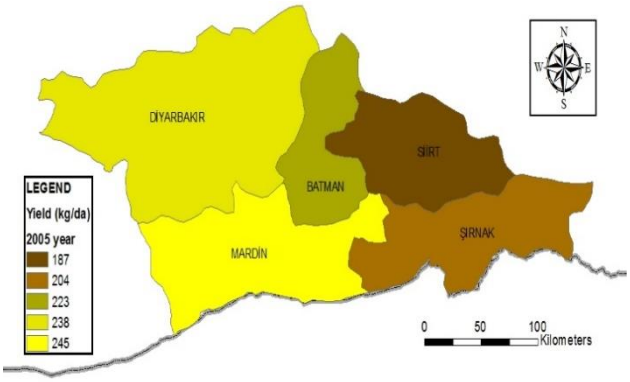

Fig. 6. Siirt Province Wheat Yield (kg/da) in 2005

Table 10. The Change of the Wheat Production Potential in Siirt Province over the Years

Siirt				
Years	Rain-fed (%)	PlantingArea (%)	Production (%)	Yield (%)
1991-1995	18.04	-10.47	-46.74	-25.87
1996-2000	-13.34	-31.82	-85.99	-32.99
2001-2005	3.72	-30.4	-73.56	-25.46
2006-2010	-9.5	29.4	34.74	10.4
2011-2015	-5.74	13.25	40.21	35.8

It seems that the arithmetic average of the amount of precipitation between the years of 1991 and 2015 in Mardin province is 508 mm/year and the average yield amount for 25 years is 256 kg/da. Despite the 10% increase in the amount of the annual precipitation in 1991, there was a 30% decrease in the yield amount.
It is considered that this situation resulted from the fact that certified seeds were not used, the annual precipitation did not occur in the vegetation period or from the producer mistakes (wrong fertilization, defects in harvest techniques, etc.). The amount of precipitation over the years is below the average of the basin especially in 2008 according to the regional average. The drought experienced around the world in 2008 can be accepted as a reference to this situation. (Fig.7).
The deviations in the precipitation regime together with the decrease formed in the precipitation averages by years in relation to global warming and climatic changes are the other factors that should be considered. If the deviations in the precipitation regime and the decrease in the amount of precipitation continue, wheat production in the study area

will be affected negatively.

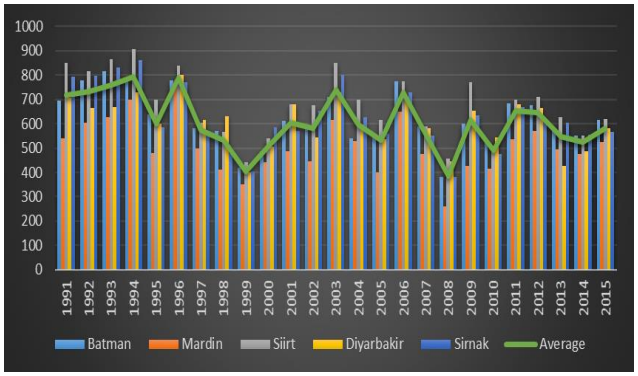

Fig.7. The Precipitation Values (mm/year) in the Tigris Basin between the Years of (1991-2015)

It is indicated that Diyarbakır province has the largest production area in the Tigris Basin. Between the years of 1991 and 2015, there was a 26% decrease in the wheat production area especially between the years of 2004 and 2008. It is considered that this decrease resulted from the lack of precipitation in the mentioned years. Then in 2009, while a 12,38% increase was recorded in the wheat production areas of the basin together with the increase of the total amount of precipitation, there was a 77.9% increase in the yield.

When the yield values in the Tigris Basin are examined by the years, it stands out that the change is positive. The facts that the producers using certified seeds are supported in the agricultural production and the level of the awareness of the farmers in the region increases are among the primary reasons for this situation.

In this context, it can be stated that the wheat yield values showed a 35% increase between the years of 1991 and 2015 in question (Fig.8).

When especially the year of 2013 is evaluated, it is seen that the relationship between the amount of the annual precipitation and yield is reverse. While the amount of precipitation was below the average of many years in 2013, there was not a significant decrease in the yield, moreover, there was a little increase.

It is possible to say that this inverse proportion resulted from the irregularity of the precipitation regime in that year, in other words, the wheat plant received precipitation in the months of April and May when it especially needed water (Fig.8.).

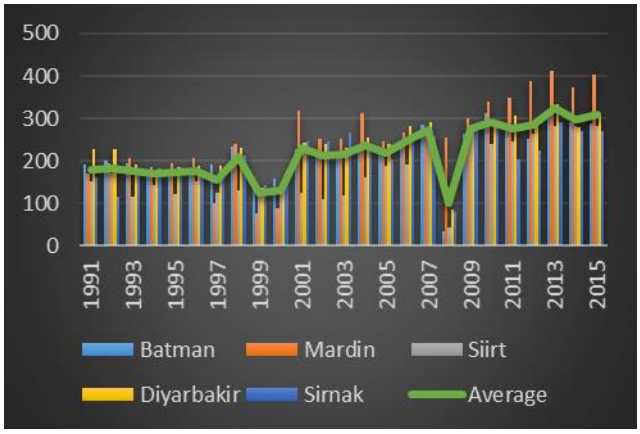

Fig.8. The Wheat Yield Values of the Tigris Basin between the years of 1991 and 2015 (kg/da)

CONCLUSIONS

When the period between the years of 1991 and 2015 in the Tigris Basin is examined, it is discovered that wheat planting areas, the amount of production and the yield values tended to increase especially in the last 10 years, however, the amount of the annual precipitation decreased on the basis of the basin. On the basis of this information, it is concluded that the amount of the annual precipitation does not affect the production alone but it is one of the components affecting the production. In the period of the mentioned 25 years, the lowest amount of precipitation was identified to be 260 mm/year in 2008 for Mardin; 380 mm/year for Batman; 455 mm/year for Siirt; 445 mm/year for Diyarbakır; 380 mm/year for Şırnak and the result of this situation is reflected as the loss of wheat yield in the Tigris Basin. There was the same decrease in the wheat production values in the basin between the years of 1998 and 1999.

It is seen that the wheat production areas in the Tigris Basin increased over the years due to the fact that agricultural support promotes the wheat production, wheat input food industrial facilities are supported in the region as a result of government policies, quality and certified seeds are used, the awareness of the producers has increased, etc.

There were increases in the production and yield as a result of the fertilization in the right

place, in the right time and in the right quantity together with the improvements in the agricultural techniques used to increase the yield values in a unit of area. The soil analysis support of the Ministry of Food, Agriculture and Livestock together with the diesel fuel, fertilizer and certified product supports caused the producers to be directed to more sensitive agricultural techniques in the wheat production, in other words, they take care of agricultural production and the amount of the products acquired from a unit of area increases.

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