A Closer Look at the Statistical Data: The Tractor Count Increases as the Agricultural Production Value Decreases for Turkey

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Abstract: FAO claims that the World population will increase by 2.3 billion people by the year 2050 that practically means more food and more energy demand. Agriculture is an energy-intensive industry. Nearly 30% of the world's total energy production is utilized by agriculture and related sectors. Energy consumption per-capita is accepted as an indicator of development and prosperity. Mechanization levels in agriculture are believed to be the key factor for total productivity. Tractors are the key mechanization units that operate in agricultural activities. Statistics show that in past years tractor numbers of Turkey have shown a great increase every year, however, some other statistics show a decrease in total agricultural production value. A simple co-efficient is proposed in this study calculated by dividing total production value to tractor count. Study shows that although tractor numbers are rising, agricultural production value is decreasing and the co-efficient for 2010 was 0.075, and it gradually decreased to 0,052 in the year 2016. Simplistic forecasting of tractor numbers showed that there might be nearly 1.6M tractors by the year 2030. Statistical data from TUIK and FAO shows tractor count increases but total agricultural production value decreases.
Keywords: tractor, agricultural production, coefficient, forecasting, agricultural energy

İstatistiksel Verilere Daha Yakından Bakış: Türkiye İçin Tarımsal Üretim Değeri Düştükçe Traktör Sayısı Artmaktadır

Abstract: FAO, Dünya nüfusunun 2050 yılına kadar pratik olarak daha fazla gıda ve daha fazla enerji talebi anlamına gelen 2,3 milyar kişi artacağını iddia ediyor. Tarım, enerji yoğun bir endüstridir. Dünyadaki toplam enerji üretiminin yaklaşık% 30'u tarım ve ilgili sektörler tarafından kullanılmaktadır. Kişi başına enerji tüketimi, kalkınma ve refahın bir göstergesi olarak kabul edilmektedir. Tarımda mekanizasyon düzeylerinin toplam verimlilik için anahtar faktör olduğuna inanılmaktadır. Traktörler, tarımsal faaliyetlerde faaliyet gösteren kilit mekanizasyon üniteleridir. İstatistikler, geçmiş yıllarda Türkiye'nin traktör numaralarının her yıl büyük bir artış gösterdiğini, ancak diğer bazı istatistiklerin toplam tarımsal üretim değerinde bir düşüş gösterdiğini göstermektedir. Toplam üretim değerinin traktör sayısına bölünmesiyle hesaplanan bu çalışmada basit bir katsayı önerilmiştir. Araştırma, traktör sayılarının artmasına rağmen, tarımsal üretim değerinin düştüğünü ve 2010 yılı için katkının 0.075 olduğunu ve 2016 yılında kademeli olarak 0,052'ye düştüğünü göstermektedir. TUIK ve FAO'dan elde edilen istatistiksel veriler traktör sayısında artış olduğunu, ancak toplam tarımsal üretim değerinin düştüğünü göstermektedir
Key words: Özetin bir satır altına mümkünse başlıkta bulunmayan, çalışmanın içeriği ile doğrudan ilişkili ve dizinlenmeyi kolaylaştıracak en fazla 5 anahtar sözcük yazılmalıdır.

1. Introduction

This study emphasizes on the question " Does the increase in total tractor count end up with higher agriculture production value?". Do farmers across country just purchase these brand new tractors because they just can, thanks to the globalizing world and economy makes accessing easy

to loans. Agricultural operations should sustain a clear and replenishable way of methodology to fight poverty and environmental hazards. World population's pressure on resources is forcing agricultural sector to become even more intensive. Agricultural branches seem relatively traditional and technological acceleration factor for agriculture rather seems not as rapid as other industrial branches. When agricultural techonolgy is the subject, most of key figures are biogenous and development for these biogenous factors do not rapidly occur as they do in mechanics, electronics, information technology. However much agriculture sector has access to technology, the production is still going to be dependant on biotic factors like soil, seasons, sunlight, climate. Related agricultural operations could be enhanced with energy intensive applications. Altough agriculture operations are generally not a direct user of electricity, the food sector currently accounts for around 30 percent of the world's total energy consumption (Sims and Dubois, 2011) Producing 70 percent more food for an additional 2.3 billion people by 2050 and adapting to climate change are the main challenges world agriculture will face next. (Food and Agriculture Organization of the United Nations 2009). Agricultural field operations are largely dependent on tractor power that consumes fuel. There are many parameters in field operations that affect the fuel consumption of a tractor, such as soil texture, climate, relative humidity, tractor type (two- or four-wheel drive), tractor size and tractor implement relationship. Therefore, tractor fuel consumption is not constant and varies from one to another situation (Nielsen and Sorensen, 1993). To increase efficiency of agricultural production; it is necessary to increase machine working efficiency. (Taylor, 1980). Whether the production is in field or in greenhouses using energy efficiently will contribute to value and quality of products. (Saltuk, 2018; Saltuk, 2019) Turkey without adequate oil resources, has to spend hundreds of billions of dollars to import fuel, to sustain every sector, fuel (energy) consumption as it is in agriculture is the largest input of overall costs. Also, energy prices determine and fluctuate the final consumer prices of agricultural products. Energy, has the largest share in Turkey's total imports. In year 2019, total oil imports increased by 14.32% compared to 2018 and became 3,642,373,873 tons. (EPDK, 2019) That's why quantity of tractors matter for a country importing the most of oil, motor vehicles, tractors, lubricants, spare parts and similar operation units. No doubt that Turkey is a country of agriculture, where agriculture vastly longs from east to west, south from north with variable agricultural products. (Ekinci et al., 2020) These agricultural activities require mostly non-renewable fossil-based fuels. (Ekinci et al., 2005). According to the Union of Turkish Agricultural Chambers; In the year 2000, number of tractors used in agriculture was 941.835, this number increased by 38.7 percent in the past 17 years and reached 1306736 units. (UTAC, 2019).

It is beyond suspicion that this increase in number of tractors is directly proportional with fuel consumption. Even though reports from the Nebraska Tractor Test Laboratory (NTTL) show improved fuel efficiency during the past 20 years. A 4.8% decrease in average annual specific volumetric fuel consumption (Grisso et al., 2004), comparing to 38.7 percent increase in tractor count for Turkey, still the need for fuel is increasing. It is a mountain to climb to calculate the exact fuel consumption value of tractors since it depends on many factors can be made an open-ended list like horse power, age, operating conditions, operator's ability, tire condition and pressure, maintenance, attached equipment, drawbar power, soil type and so forth.

2.   Material and Method

2.1.   Material

2.1.1 General concept of this study

This study aims to understand wheather increasing numbers of tractors as well increase agricultural production values in U.S dollars or not. To seek an answer, this study utilizes TUIK and FAO statistics and tries to zoom-in these numbers.

2.1.2 TUIK Data on increasing numbers of tractors

TUIK, Turkish Statistical Institute gathers data on various topics countrywide and publishes them public. Agricultural equipment and machinery statistics is one of these topics. According to TUIK data by the year 2018 there was 1306736 tractors in Turkey with an increasing trend by each year. Authorities claimed that this is a new record. (TUIK 2020 and TZOB 2019).

Table 1. Tractor count between years 2013 and 2018 in Turkey

HP (Horse Power)	Single Axle				Two Axles				Palletized	Total
	1-5	5 +	1-10	11-24	25-34	35-50	51-70	70 +		
2013	10.889	42.476	5.937	20.153	71.165	493.462	451.292	118.000	186	1.213.560
2014	14.383	51.492	6.247	20.906	69.223	493.914	461.399	125.536	200	1.243.300
2015	14.856	54.604	6.252	21.181	68.074	491.828	468.060	135.297	206	1.260.358
2016	15.736	57.131	6.448	21.274	66.825	489.621	475.665	140.699	132	1.273.531
2017	16.589	59.061	6.432	20.527	65.866	492.343	493.660	152.133	125	1.306.736
2018	17.129	60.707	6.554	20.886	66.104	493.134	505.087	162.425	113	1.332.139

Table 1, shows that number of tractors is increased by 118,579 between 2013 and 2018 in a five-year period, which means 118,579 more units to operate and fuel. There are some studies in

literature, trying to explain the cause and criteria behind tractor purchasing behavior for Turkey (Cankurt and Miran, 2010; Sağlam and Çevik, 2012; Aytuğ and Karadibak, 1998; Cankurt, 2008); but it is still not clear whether these purchases of tractors fit for purpose or not. No country-wide current literature found to mention in this study. Although energy matter is the ultimate problem of our time and upcoming years it is understandable that a study to properly understand and give recommendations country-wide about tractor selection and operation is beyond limits of individual efforts.

The efficiency and success of field operations with a tractor is directly related to the attached machine's power demand. If the tractor cannot output adequate power for the operated machine, or the machine operated is too small to load the tractor, work performance decreases and fuel consumption increases. A small tractor for a big field and a big tractor for a small land is also problematic. World-wide recognized ASABE standards claim that in developed countries annual tractor utilization is 800-1000 h/annually.(ASAE, 1995). There are studies in literature reporting annual tractor operating hours under 1000 h/annually from various regions of Turkey (Sağlam and Çetin 2017; Aybek and Hurşitoğlu; Mutlu 2011). But While current tractor presence is increasing constantly with low working hours, it is stated by TZOB that the level of mechanization Turkey is far behind from the EU; The number of equipment per tractor for EU is 10, and it is 5.2 for Turkey. Area per tractor in our country is 26 hectares, this number is 11.3 hectares for the EU. While there are 45 tractors per 1,000 hectares in Turkey, this number is 57 in the EU. (TZOB, 2019)

2.2 Forecasting the future numbers of tractors

To better cope with the increasing numbers, a simple MS Office Excel Forecast is employed to the past data from Table 1 that runs Exponential Smoothing (ETS) algorithm. This is a very popular scheme to produce a smoothed Time Series. Whereas in Single Moving Averages the past observations are weighted equally, Exponential Smoothing assigns exponentially decreasing weights as the observation get older. In other words, recent observations are given relatively more weight in forecasting than the older observations. In the case of moving averages, the weights assigned to the observations are the same and are equal to 1/N. In exponential smoothing, however, there are one or more smoothing parameters to be determined (or estimated) and these choices determine the weights assigned to the observations (NIST 2013). Confidence interval is 95%.

Naturally these numbers just might represent an example and future tractor numbers may vary on many factors like politics, economy, technology. prices. Still, formed by a trusted and common software Table 2, might portray the future numbers.

Table 1 Forecast Table for Total Tractor Count 2018-2030

Year	Total	Forecast (Total)	Lower Confidence Limit	Upper Confidence Limit
2013	1213560			
2014	1243500			
2015	1260358			
2016	1273531			
2017	1306736			
2018	1332139	1332139	1332139	1332139
2019		1349233	1339227	1359239
2020		1371846	1361840	1381853
2021		1394460	1384453	1404466
2022		1417073	1407066	1427079
2023		1439686	1429679	1449693
2024		1462300	1452293	1472307
2025		1484913	1474906	1494920
2026		1507526	1497518	1517534
2027		1530139	1520131	1540148
2028		1552753	1542744	1562762
2029		1575366	1565357	1585376
2030		1597979	1587969	1607990

Table 2 shows that between years 2013 and 2018, tractor numbers have always increased. By the year 2030 presence of tractors is going to be nearly 1.597.979 units. Even if this forecast fails to hit the bull's eye , no doubt that tractor numbers will still increase somehow. Table 2 is interpreted into a graphic in Figure shown below. This situation might pose a threat for economy, environmental targets and from other aspects since this study will further present that agricultural production value is not increasing as the tractor count does.

2.3. Number of Tractors and agricultural production value for Turkey

The question to ask is; Does the increase in tractor count constantly trigger an increase in total value of agricultural production as well. To get the agricultural production values of Turkey in Millon Dollars by years, FAO (Food and Agriculture Organization) service FAOSTAT is accessed. The address of website is http://www.fao.org/faostat/en/#data. The data FAO offers is open to

public and free. No registration is needed. Value of Agricultural Production is selected from main screen and "Gross Production Value (Current million US$)" is selected from the next page for the years 2000-2016, The latest available data year is 2016. Figure 1 shows a detailed description about obtaining the data.
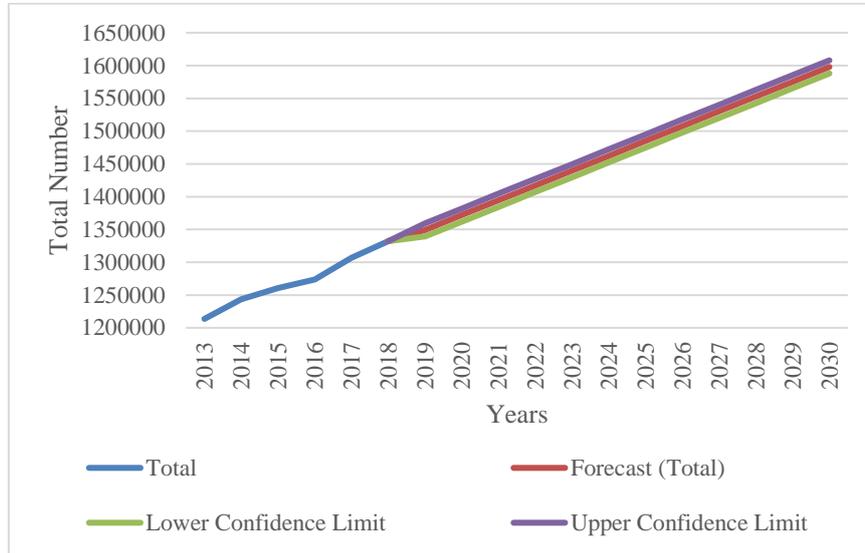

Figure 1 Forecast graphic between years 2013-2030

Figure 2 Accessing the FAO data for total agricultural production value in US Dollars for Turkey

Generated statistical data from FAOSTAT is given in Table 3 and shows clearly that the value of production has not increased constantly in years, fluctuating between years and furthermore the data is tending to decrease between years 2011 and 2016, from 80.7 billion U.S Dollars to 66.7 billion U.S Dollars.

Table 2 Value of production in million US dollars for Turkey

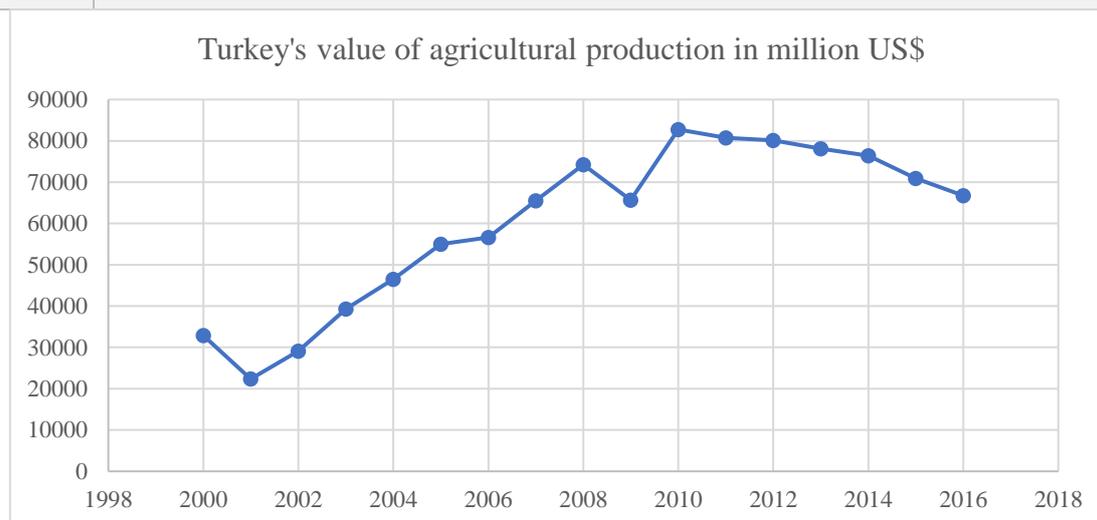| Year	Value of Production in Million US$
2000	32933
2001	22352
2002	29097
2003	39334
2004	46482
2005	54993
2006	56648
2007	65543
2008	74227
2009	65662
2010	82748
2011	80733
2012	80113
2013	78083
2014	76444
2015	70900
2016	66717

Figure 3. Turkey's value of agricultural production in million US Dollars between years 2000-2016

Figure 3 shows that agricultural production value for Turkey has been decreasing year by year since 2010. Agricultural production is the solely confidential wealth generating branch for Turkey. Relating this agricultural production value directly with a certain unique condition takes further inspection however the decrement is constant and since it is related with many factors commenting whether it is increasing or not from 2016 to this day. Fresh data is needed between years 2016-2020 since it is not yet published by FAO.

3. Results and Discussion

To elaborate agricultural production value and tractor count together ; a coefficient is proposed in table 4 below. This coefficient consists of a simple approach where "Production value" in million dollars is divided by ` Total Tractor Count `

$$Coefficient = \frac{Production\ Value\ in\ million\ U.S\ Dollars}{Total\ Tractor\ Count}$$

Table shows that these coefficient numbers are fluctuating, neither increasing nor decreasing by years, this situation matters since this coefficient shows the value added to production value by number of tractors.

Table 3. Comparative table for number of tractors and production value for Turkey

Year	Total Tractor Count	Production Value in million U.S Dollars.	Production Value/Tractor Count
2001	948.416	22.352	0.023
2002	970.083	29.097	0.029
2003	997.620	39.334	0.039
2004	1.009.065	46.482	0.046
2005	1.022.365	54.993	0.053
2006	1.037.383	56.648	0.054
2007	1.056.128	65.543	0.062
2008	1.070.746	74.227	0.069
2009	1.073.538	65.662	0.061
2010	1.096.683	82.748	0.075
2011	1.125.001	80.733	0.071
2012	1.178.253	80.113	0.067
2013	1.213.560	78.083	0.064
2014	1.243.300	76.444	0.061
2015	1.260.358	70.900	0.056
2016	1.273.531	66.717	0.052

Table 4 presents the data of tractor count and agricultural production values togetherWhile forming this table, a simple new approach is proposed to get a coefficient by just dividing production value to total tractor count for each year. The agricultural production value is taken as a thousand number and tractor numbers are taken as million as they are seen in table below. The reason behind making calculations between years 2001 and 2016 is data for these years are available and intersecting in both TUIK and FAO databases, since tractor count is gathered from TUIK and total agricultural production data is obtained from FAO.
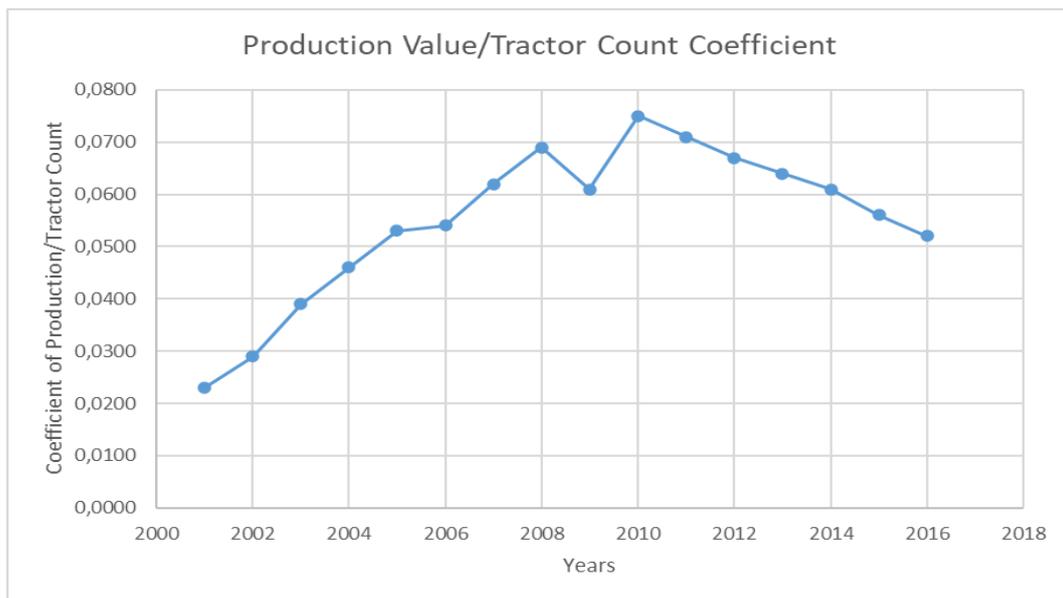

Figure 4 Production value/tractor count coefficient value by years

"Production value/Tractor count" ratio in Figure 4 shows no stable increment by years, far from doing so, the co-efficient constantly trends to decrease. That could mean, more tractors, even more fuel consumption and overall. In further studies, with an enhanced statistics work or data science benefited, the perfect or near-perfect co-efficient of these variables could be detected and used by authorities or researchers to make further policies or instructions.

4. Conclusion

Collocutors should kindly keep in mind that this paper is just an experimental pathway for further studies and doesn't hold any strong claims about the relation number of tractors and agricultural production values. But again, the data barely indicates that enriching the tractor presence with new amounts of units, does not necessarily result in increasing amounts of agricultural production value, furthermore new tractors could mean more imports or just idle machine force or environmental

hazards maybe extra CO_2 emissions. Further studies needed to better understand the motivation behind purchasing tractors. Instructions and regulations are suggested by authorities for those who purchase new tractors. Buying new units of tractors may not be beneficial for agricultural production value. However statistical data portraits a general view and could be falliable since it is not possible to validate these numbers subject to this study with field inventory analysis. This study doesn't exhibit that agricultural industry in Turkey is shrinking or decreasing in terms of production or quality. The purpose of this study is to draw attention to increasing numbers of tractors. Authorities might kindly consider examining the presence of agricultural machinery in general terms to maintain sustainibilty and economic goals while having a servicable tractor park. It is kindly reminded that agricultural values are affected by many of World's current events.

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