

# Evaluation of Agricultural Machinery Presence and Usage Activities in Tokat

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**Abstract.** In this study, the area of influence of agricultural machinery in Tokat, its districts and the size of the cultivated area were compared. Required number of machineries was evaluated. Thus, the machines were divided into seven groups (Soil Tillage Machinery, Sowing and Planting Machinery, Maintenance and Fertilization Machinery, Plant Protection Machinery, Harvesting Machinery, Combine Harvester, Tractors). Data on the number of cultivated areas and agricultural machinery were taken from the Turkish Statistical Institute. The number of machines, daily working time, annual workable days, effective working capacity, and machine impact area for each machine were calculated separately. Based on this data, the number of machines that should be in each district was determined. As a result, it was determined that the number of Subsoiler, Combi Harrow, Stone Collecting Machinery, Rotary Cultivator, Soil levelling Machinery, Rotary Tiller, Seedling Planting Machinery, Arc Opening Plough, Manure Spreading Machinery, Baler, and Combine Harvester is insufficient in the province of Tokat. It was determined that other machines in the groups were more than necessary. Baler had the highest deficit, while tractor had the highest surplus. The importance of planning in enterprises and the machines that should be prioritized in the production of industrialists have been revealed.

## 1 Introduction

Agricultural mechanization has come to a remarkable position for sustainable agricultural production to reach advanced levels in terms of quality and quantity [1]. Agricultural mechanization enables faster production in larger areas, indirect increase in yield and use of new production technologies [2].

Agricultural mechanization and the level of mechanization may vary according to countries depending on cultivation, environment and economic conditions. It is important for the producers in our country to adapt to this rapidly developing field in the world. In determining the level of mechanization, the status of the tractor park, its relationship with agricultural machinery and its density in the unit agricultural area are the most important indicators. It is important to take the right and necessary steps to improve these indicators. In this way, yield and quality in agricultural production will increase [3].

It may be possible to increase yield in production by planning mechanization in accordance with the agricultural structure of a region. In this sense, it is very important to choose the right equipment. It is also necessary to know the size and number of farms, production techniques, cropping patterns, soil and climate characteristics [4, 5].

Since the average data to be taken from very large areas may cause mistakes in mechanization planning, it is a correct approach to make evaluations in smaller areas. For this reason, it would be a more realistic approach to make planning by going from the enterprise to the country in general [6].

35.83% (360.835 ha) of the surface area of Tokat is agricultural land, 12.12% (122.106 ha) is meadow and pasture land, 44.12% (444.341 ha) is forest land and 7.93% (79.918 ha) is other land. Of the agricultural land, 69.73% is arable agriculture, 4.30% is vegetable agriculture, 8.63% is fallow land, 2.96% is fruit agriculture, 1.83% is vineyard agriculture, 0.05% is undercover agriculture, 0.01% is ornamental plant agriculture, 0.67% is poplar and willow land, and 11.82% is non-arable land [7]. While field agriculture comes to the forefront in Tokat, it is also noteworthy that there is a high proportion of non-arable land.

The aim of the study is to determine whether the number of agricultural machines in Tokat and its districts is sufficient by comparing the functional efficiency of each agricultural machine with the cultivation areas.

## 2 Material and Method

The presence of agricultural machinery, planted and harvested areas in Tokat province and its districts were

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obtained from the Turkish Statistical Institute (TUIK) [7].

Within the scope of the study, agricultural implements and machinery commonly used by business owners in Tokat province and its districts were evaluated. The agricultural tools and machines used were categorized in 7 classes.

- Soil Tillage Machinery,

(Mouldboard Plow, Disc Harrow, Toothed Harrow, Subsoiler, Combi Harrow, Cultivator, Roller, Stone Collecting Machinery, Soil Levelling Machinery, Rotary Cultivator, Rotary Tiller),

- Sowing and Planting Machinery,

(Combined Seed Drill, Seedling Planting Machinery, Pneumatic Planting Machinery, Potato Planting Machinery),

- Maintenance and Fertilization Machinery,

(Arc Opening Plough, Manure Spreading Machinery, Chemical Centrifugal Fertilizer Spreader, Tractor Drawn Hoeing Machinery),

- Plant Protection Machinery,

(PTO driven Sprayer, Motorized Garden Sprayer),

- Harvesting Machinery,

(Baler, Corn Forage Harvester, Hay Rake, Sugar Beet Harvester Machinery, Potato Harvester, Tractor Drawn Mower),

- Combine Harvester

- Tractors.

The machine impact area calculation for each agricultural machinery group was calculated with the help of equation (1) [8, 9].

$$A = F_{ef} * n * t * g \tag{1}$$

A : Machine impact area (da year<sup>-1</sup>)

F<sub>ef</sub> : Effective working capacity (da h<sup>-1</sup>)

n : Number of machines (units)

t : Daily working time (h days<sup>-1</sup>)

g: Number of annual workable days (days per year)<sup>-1</sup>

The effective working capacity of the machine was calculated with the help of equation (2) [10].

$$F_{ef} = b * V * k \tag{2}$$

b : Machine working width (m)

V : Forward speed (km h<sup>-1</sup>)

k : Time-use coefficient (%)

The required number of agricultural machinery/ agricultural machinery group (RNM) was calculated by proportioning the areas of influence of the machines to the areas cultivated/sown/harvested [9].

$$RNM = A / F_{ef} \tag{3}$$

RNM : Required Number of Machines

A : Cultivated Area (da)

## 3 Results and Discussion

### 3.1 Soil Tillage Machinery

The need status of the machines in the soil tillage machinery group for Tokat in general and its districts is given in Table 1.

**Table 1.** The need for soil tillage machines in Tokat

Machinery	Almus	Artova	Başsiflik	Erbaa	Merkez	Niksar	Pazar	Resadiye	Sulusaray	Turhal	Yesilyurt	Zile	Tokat	
Moldboard Plow	M	545	450	99	1.706	2.500	1.076	660	582	400	1.393	370	2.775	12.556
	R	38	48	11	92	131	118	31	50	38	125	33	234	949
	D	507	402	88	1.614	2.369	958	629	532	362	1.268	337	2.541	11.607
Disc Harrow	M	11	181	1	4	150	42	281	0	7	143	170	888	1.878
	R	13	16	4	31	45	40	11	17	13	43	12	79	324
	D	-2	165	-3	-27	105	2	270	-17	-6	100	158	809	1.554
Toothed Harrow	M	360	73	60	1300	878	1075	80	583	14	210	59	260	4.952
	R	10	13	3	25	35	32	9	14	11	34	9	63	258
	D	350	60	57	1275	843	1043	71	569	3	176	50	197	4.694
Subsoiler	M	0	3	0	10	28	15	20	0	5	7	7	190	285
	R	22	27	7	52	74	67	18	29	22	71	19	132	540
	D	-22	-24	-7	-42	-46	-52	2	-29	-17	-64	-12	58	-255
Combi Harrow	M	0	0	22	0	2	0	30	1	0	5	1	99	160
	R	15	18	5	35	49	45	12	19	15	47	13	88	361
	D	-15	-18	17	-35	-47	-45	18	-18	-15	-42	-12	11	-201
Cultivator	M	287	260	14	151	1960	112	288	3	260	755	135	1800	6.025
	R	9	12	3	22	31	28	8	12	9	30	8	55	227
	D	278	248	11	129	1929	84	280	-9	251	725	127	1745	5.798
Roller	M	9	47	0	30	168	76	38	12	23	51	60	35	549
	R	10	13	3	24	34	31	8	13	10	32	9	60	247
	D	-1	34	-3	6	134	45	30	-1	13	19	51	-25	302
Stone Collecting Machinery	M	1	1	0	2	4	2	1	1	3	1	6	23	23
	R	30	38	9	73	103	94	25	40	30	99	26	185	752
	D	-29	-37	-9	-71	-99	-92	-24	-39	-29	-96	-25	-179	-729
Rotary Cultivator	M	7	2	0	26	214	49	80	3	12	68	2	53	516
	R	24	30	7	58	83	75	20	32	24	79	21	149	602
	D	-17	-28	-7	-32	131	-26	60	-29	-12	-11	-19	-96	-86
Soil Levelling Machinery	M	0	11	0	26	50	37	2	0	1	20	5	13	165
	R	19	23	6	45	63	58	15	25	19	61	16	113	463
	D	-19	-12	-6	-19	-13	-21	-13	-25	-18	-41	-11	-100	-298
Rotary Tiller	M	0	1	0	6	18	0	40	0	0	22	1	43	131
	R	22	28	7	53	76	69	18	29	22	73	20	136	553
	D	-22	-27	-7	-47	-58	-69	22	-29	-22	-51	-19	-93	-364

M: Number of Machines, R: Required Number of Machines, D: Difference

Moldboard plow, toothed harrow and cultivator (except Resadiye) were found to be in excess in all districts. Rotary Cultivator and Rotary Tiller were found to be lack in all districts except Pazar. This situation indicates that traditional tillage is widespread in Tokat agriculture.

The fact that the excess of disc harrow is highest in Zile district may be due to the fact that it is the district where sunflower agriculture is most common.

It was determined that there is a lack of stone collecting machinery and soil levelling machinery in all districts of Tokat. This situation is due to the fact that most of the stone collecting machinery in Tokat are allocated to the producers by the Tokat Directorate of Agriculture and Forestry through rental method.

Subsoiler was found to be missing in all districts except for Pazar and Zile. It is thought that the lack is due to inadequacy of information.

### 3.2 Sowing and Planting Machinery

The need status of the machines in the sowing and planting machinery group for Tokat in general and its districts is given in Table 2.

In the Niksar district, where tobacco is cultivated, seedling planting machinery was determined to be sufficient in the planted area, while in the Erbaa district, it was determined that there was a need for six machinery. The lack of machinery in Erbaa district is because the seedling planting process is done by manpower.

**Table 2.** The need for sowing and planting machinery in Tokat

Machinery		Almus	Artova	Başçiftlik	Erbaa	Merkez	Niksar	Pazar	Reşadiye	Sulusaray	Turhal	Yeşilyurt	Zile	Tokat
Seedling Planting Machinery	M	-	-	-	26	-	1	-	-	-	-	-	-	27
	R	-	-	-	32	-	1	-	-	-	-	-	-	33
	D	-	-	-	-6	-	0	-	-	-	-	-	-	-6
Combined Seed Drill	M	28	70	0	39	183	63	80	2	49	138	136	323	1.111
	R	26	29	8	62	81	84	7	39	24	82	16	164	622
	D	2	41	-8	-23	102	-21	73	-37	25	56	120	159	489
Potato Planting Machinery	M	0	5	15	5	20	128	0	0	1	0	6	5	185
	R	3	6	16	13	9	28	1	4	1	5	2	2	90
	D	-3	-1	-1	-8	11	100	-1	-4	0	-5	4	3	95
Pneumatic Planting Machinery	M	2	4	-	5	9	10	45	0	3	17	7	80	182
	R	2	8	-	9	19	13	12	1	5	18	7	33	127
	D	0	-4	-	-4	-10	-3	33	-1	-2	-1	0	47	55

M: Number of Machines, R: Required Number of Machines, D: Difference

It was determined that there is a lack in the Combined Seed Drill in Başçiftlik, Erbaa, Niksar, and Reşadiye districts, while there is excess in others. It is seen that broadcast sowing is done in the districts where it is needed.

It was determined that the potato planting machine was surplus for Merkez, Niksar, Yeşilyurt, and Zile, sufficient for the Sulusaray district, and lack for others.

It was calculated that the potato planting machinery is more than needed in the Merkez, Niksar, Yeşilyurt, and Zile districts, sufficient for the Sulusaray district and insufficient for others.

It was determined that pneumatic planting machinery was sufficient in the Almus and Yeşilyurt districts, excessive in the Pazar and Zile districts, and lack in others.

### 3.3 Maintenance and Fertilization Machinery

The need status of the machines in the maintenance and fertilization machinery group for Tokat in general and its districts is given in Table 3.

**Table 3.** The need for maintenance and fertilization machinery in Tokat.

Machinery		Almus	Artova	Başçiftlik	Erbaa	Merkez	Niksar	Pazar	Reşadiye	Sulusaray	Turhal	Yeşilyurt	Zile	Tokat
Arc Opening Plough	M	8	0	0	12	94	121	28	2	7	115	1	14	402
	R	24	12	1	62	97	56	41	8	8	62	14	86	471
	D	-16	-12	-1	-50	-3	65	-13	-6	-1	53	-13	-72	-69
Manure Spreading Machinery	M	0	0	0	3	10	5	8	0	7	3	1	2	39
	R	13	16	4	35	45	40	12	17	13	41	12	77	325
	D	-13	-16	-4	-32	-35	-35	-4	-17	-6	-38	-11	-75	-286
Chemical Centrifugal Fertilizer Spreaders	M	48	250	0	88	160	163	210	18	26	200	155	800	2.118
	R	2	3	1	6	8	7	2	3	2	7	2	13	56
	D	46	247	-1	82	152	156	208	15	24	193	153	787	2.062
Tractor Drawn Hoeing Machinery	M	5	18	0	16	125	14	105	0	47	69	73	253	725
	R	3	8	1	14	27	18	18	1	5	25	6	38	164
	D	2	10	-1	2	98	-4	87	-1	42	44	67	215	561

M: Number of Machines, R: Required Number of Machines, D: Difference

The lack of arc plough was detected in all districts except Niksar. The reason for the lack of the machine may be due to the widespread use of pressurized irrigation systems in the agricultural areas of Tokat.

It was calculated that manure spreading machinery is missing in all districts of Tokat. Farm manure is commonly distributed by manpower or by using a leveling shovel throughout Tokat, which has limited the use of the manure spreading machinery.

It was calculated that there is a surplus in chemical centrifugal fertilizer spreaders in all districts except Başçiftlik district.

As for the tractor drawn hoeing machinery, it was calculated that there were surplus machines in all districts except Başçiftlik, Niksar and Reşadiye districts.

### 3.4 Plant Protection Machinery

The need status of the machines in the plant protection machinery group for Tokat in general and its districts is given in Table 4.

**Table 4.** The need for plant protection machinery in Tokat.

Machinery		Almus	Artova	Başçiftlik	Erbaa	Merkez	Niksar	Pazar	Reşadiye	Sulusaray	Turhal	Yeşilyurt	Zile	Tokat
PTO driven Sprayer	M	7	165	0	247	420	85	125	10	20	145	43	718	1.985
	R	5	12	4	17	21	20	6	13	9	19	9	36	171
	D	2	153	-4	230	399	65	119	-3	11	126	34	682	1.814
Motorized Garden Sprayer	M	21	3	0	94	254	63	0	5	1	93	0	23	557
	R	1	1	1	7	10	5	3	2	1	4	1	6	42
	D	20	2	-1	87	244	58	-3	3	0	89	-1	17	515

M: Number of Machines, R: Required Number of Machines, D: Difference

It was calculated that there is a lack of PTO driven sprayers in Başçiftlik and Reşadiye districts, and motorized garden sprayers in Başçiftlik, Pazar and Yeşilyurt districts, and surplus in all other districts.

### 3.5 Harvesting Machinery

The need status of the machines in the harvesting machinery group for Tokat in general and its districts is given in Table 5.

**Table 5.** The need for harvesting machinery in Tokat

Machinery		Almus	Artova	Başçiftlik	Erbaa	Merkez	Niksar	Pazar	Reşadiye	Sulusaray	Turhal	Yeşilyurt	Zile	Tokat
Baler	M	6	10	2	9	44	2	26	8	8	24	16	38	193
	R	66	63	27	170	197	245	24	105	48	189	50	423	1.607
	D	-60	-53	-25	-161	-153	-243	2	-97	-40	-165	-34	-385	-1.414
Com Forage Harvester	M	25	4	0	13	120	58	77	1	9	37	7	39	390
	R	5	3	0	4	21	39	12	1	2	27	11	17	142
	D	20	1	0	9	99	19	65	0	7	10	-4	22	248
Hay Rake	M	40	37	50	1	235	0	105	13	2	47	23	40	593
	R	17	10	2	7	25	9	4	3	5	9	13	5	109
	D	23	27	48	-6	210	-9	101	10	-3	38	10	35	484
Sugar Beet Harvester Machinery	M	0	15	0	2	3	8	27	0	0	3	41	30	129
	R	3	17	0	2	23	3	2	0	13	6	18	11	98
	D	-3	-2	0	0	-20	5	25	0	-13	-3	23	19	31
Potato Harvester	M	0	6	0	6	11	149	62	0	0	0	15	6	255
	R	2	3	16	13	8	31	1	4	1	4	2	2	87
	D	-2	3	-16	-7	3	118	61	-4	-1	-4	13	4	168
Tractor Drawn Mower	M	267	60	20	46	153	85	31	68	22	58	73	43	926
	R	27	16	4	11	41	14	6	5	8	14	21	8	175
	D	240	44	16	35	112	71	25	63	14	44	52	35	751

M: Number of Machines, R: Required Number of Machines, D: Difference

In all districts of Tokat except Pazar, lack of baler was calculated. Corn forage harvester was determined to be sufficient for Reşadiye, lack for Yeşilyurt and surplus in all other districts. While the sugar beet harvester machinery was sufficient in Erbaa district, it was calculated that Almus, Artova, Merkez, Sulusaray and Turhal districts were lack and the remaining districts had surplus machines. Potato harvester was found to be lack in Almus, Başçiftlik, Erbaa, Yeşilyurt, Sulusaray and Turhal districts and surplus in other districts. In tractor drawn mower, it was calculated that there is surplus in all districts.

### 3.6 Combine Harvester

The need status of combine harvester for Tokat in general and its districts is given in Table 6.

**Table 6.** The need for combine harvester in Tokat.

Machinery		Almus	Artova	Başçiftlik	Erbaa	Merkez	Niksar	Pazar	Reşadiye	Sulusaray	Turhal	Yeşilyurt	Zile	Tokat
Combine Harvester	M	0	2	0	2	33	0	11	0	2	26	3	45	124
	R	6	16	8	37	26	48	13	22	12	41	11	93	333
	D	-6	-14	-8	-35	7	-48	-2	-22	-10	-15	-8	-48	-209

M: Number of Machines, R: Required Number of Machines, D: Difference

Combine harvester lack was calculated in all districts except the Merkez district. The seasonal need for harvesters is met by harvesters coming from other provinces.

### 3.7 Tractors

The need for tractors in Tokat in general and its districts is given in Table 7.

**Table 7.** The need for tractors in Tokat.

Machinery		Almus	Artova	Başçiftlik	Erbaa	Merkez	Niksar	Pazar	Reşadiye	Sulusaray	Turhal	Yeşilyurt	Zile	Tokat
Tractor	M	964	546	236	2.079	5.396	1.440	605	656	274	1.666	430	2.690	16.682
	R	14	18	6	62	75	67	19	21	14	64	15	125	500
	D	950	528	230	2.017	5.321	1.373	586	635	260	1.602	415	2.565	16.482

M: Number of Machines, R: Required Number of Machines, D: Difference

It was calculated that there are surplus tractors in all districts of Tokat. The reason for this can be said to be that tractor ownership is seen as a social status and used in construction and transportation works.

## 4 Conclusion

The lack or excess of machinery in the province of Tokat, where field, garden, and fruit agriculture are practiced, is due to inadequate machinery planning. It is important in terms of contributing to the production of idle machines by means of machine contracting or leasing [11] and making transfers from the districts with excess machinery to the districts where machinery deficiency is detected, making the use of common machinery widespread and enabling mechanized agriculture in districts with machinery lack. The results will also guide agricultural machinery manufacturers and producers.

## References

1. H.Ü. Evcim, A. Değirmencioglu, Ö.E. Gülден, İ. Aygün, *Economic Environ. Studies*, **12** (4), 459-466 (2012)
2. M. Özgüven, U. Türker, A. Beyaz. *Gazi Osman Pasa University Journal of Faculty of Agriculture*, **27** (2), 89-100 (2010)
3. Ö.E. Gülден, Ö. Ertugrul, A. Değirmencioglu. *Comptes rendus de l'Acade'mie bulgare des Sciences*, **72** (8), 1144 (2019)
4. A. Işık, İ. Akıncı, A. Sabancı. *Selection of Agricultural Machinery Suitable for GAP Region and Park Demand in 2000s*. 16th National Congress on Agricultural Mechanization, 5-7 September, Book of Proceedings, 45-54, Bursa (1995)
5. C. Yıldız, Y. Erkmén, *Journal of Atatürk University Faculty of Agriculture*, **35** (1-2), 59-63 (2004)
6. Ü. Evcim. *Izmir: Ege University Faculty of Agriculture Publications* (1990)
7. TUIK. *Turkish Statistical Institute* (2021)
8. C. Yildiz, İ. Öztürk, Y. Erkmén. *Determination of Erzurum province Agricultural Tools and Machinery Map with Geographic Information Systems*. TMMOB Chamber of Mapping and Cadastral Engineers National Geographic Information Systems Congress, Karadeniz Technical University, Trabzon (2007)

9. A. Yıldırım. *Evaluation of the Utilization Activities of Agricultural Machinery in Konya Province with Geographic Information Systems*. Unpublished Master's Thesis. Selçuk University Institute of Science and Technology, Department of Agricultural Machinery and Technology Engineering, Konya (2019)

10. H. Dinçer. Journal of Atatürk University Faculty of Agriculture, ½ (1970)

11. O. Gümüş. Ege University Institute of Science and Technology, Department of Agricultural Machinery, Izmir (2006)