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Evaluation of Agricultural Machinery Presence and Usage Activities in Konya Districts by Geographical Information Systems.

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ABSTRACT

The negative effects of global climate change continue to be an element of pressure on agricultural production in Turkey as in many other countries. In a changing climate, the necessity of more efficient and sustainable agricul-tural production in the world is paramount to feed an increasing population. Currently agricultural machines, which minimally disturb the soil, produce less waste and consume less energy, are being used. The most important factor in this process is the change and transformation in agricultural machinery used in agricultural production.

In the province of Konya, production is still carried out with traditional agricultural machinery. The size of the land and the density of agricultural production are not taken into consideration in the purchase and use of agricultural machinery.

In this study, the impact area of the agricultural machines/machinery groups in the districts of Konya will be calculated, compared with the size of the cultivated areas and their efficiency will be evaluated. At the same time, by using Geographical Information Systems (GIS), the presence of agricultural machinery and the impact areas of machine groups in the districts of Konya will be mapped.

This study, which is conducted for the first time in Konya province, will provide a guide in determining which agricultural machinery/machinery groups are overbought, used below capacity, or insufficient in Konya dis-tricts.While there is a surplus in almost every machine group, the largest number of machines is in the soil tillage and seed bed preparation machine group (64,733 units), the largest impact area belongs to the plantcare and fertilizer machine group (611,808,657 da year -1), and the most surplus is seen in the soil tillage and seed bed preparation machinery group (62,707 units in excess). In the case of harvesting machines, their number is found to be inadequate (335 units of shortage).

1. Introduction

Agriculture is the starting point of food chain, which we define as the primary production. Sustainable agriculture involves the production of adequate and high quality foodstuffs in a cost efficient manner as well as systems and practices that improve the protection of agricultural land, farmers, the environment and natural agricultural resources.

In our country's agricultural production, the cost of agricultural inputs is continuously increasing. Among costs, the machinery inputs occupy the first place. Approximately 35% of production inputs are mechanization inputs. Despite this high cost share, mechanization is perceived as less important than seed, fertilizer, pesticide and fuel costs. However, when one considers the fact that the fuel is a mechanization input, the importance of mechanization becomes evident. The mechanization input is ignored because saving the day rather than efficiency is prioritized. However, the mechanization tools that have old technology greatly reduce the product efficiency (Özgüven et al., 2010). For this reason, renewal of machines with timely and correct decisions reduces the operating costs and makes the enterprise more efficient. Working with agricultural machinery that are used beyond their mechanical and economical depreciation period, leads to appalling economic losses to our country's agricultural sector. In addition to economic losses, the use of depreciated machinery leads to environmental pollution well above

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the limits and also poses a major risk to life and property safety (İleri, 2018).

The demand for the tractors is quite high due to the number of agricultural enterprises in our country, the habit of using tractors in daily life and socio-economic reasons. The old tractors that have completed their economic life cause 30% more fuel consumption than the new ones. Nearly half of the current tractor pool (43%) is composed of tractors that have completed their mechanical life and these tractors are known to consume 30% more fuel (1,620 L) than the new ones. The monetary equivalent of this (2018 average diesel price is 5.93 TL L-1) is approximately 9,600 TL per year (Anonymous, 2019b). They cause 1,400 TL increase in maintenance and repair costs and 150 hours of worktime loss in 1 year. They pollute the air up to 10 times more and create at least 7 dbA more noise while running. It has been determined that working with depreciated machinery causes deterioration of product quantity and quality. It also leads to deterioration of human health and decreased work efficiency due to increased noise emission and to loss of life and property due to increased accident risk. (Evcim, 2008)

The amount of wheat harvested with combine harvesters is considered to be approximately 80% of total product. In our country, if we assume that half of this machinery-harvested product (8 million tonnes of wheat which corresponds to half of 80 % of 20 million tonnes of total wheat production per year) is harvested using depreciated combines that are at least 10 years old (60 % of total combine harvester pool is depreciated), then the 1% preventable grain loss caused by these machinery is 80 thousand tons of wheat, which corresponds to approximately 108 million TL in 2019 prices. This amount covers only the product loss. Work, quality and increased operating costs should be calculated separately.

Acquisition of machines that are not needed, and using worn-out machines that have completed their economical depreciation period, increase the costs significantly. Most producers are not aware of this cost. Therefore, it is important to have sufficient num-ber of machines, which are also adequate in terms of power. Moreover, agricultural machinery should not be used beyond their mechanical and economical de-preciation period (Anonymous, 2016).

In this study, the number of existing machinery in the districts of Konya and the impact areas of the agricultural machinery at the district level were compared with the cultivated areas and mapped. In this study, the number of tractors, harvesters and other agricultural machinery, which have not completed the economic life were used. The purpose of the study is to determine whether agricultural machinery is over-bought or not sufficient for current production levels by comparing the functional efficiency of each agri-cultural machine with the crop cultivation areas.

2. Materials and Methods

The agricultural machinery presence, the cultivated areas and harvested areas were determined using official statistics published by Turkey Statistical Institute in Konya and its districts (Anonymous, 2017).

There are 75 types of agricultural machinery in Konya. In this study, the machines that are found in the farmers' machine park but have lost their use or are not widely used (wooden plough, threshing sled, churn, etc.) are not taken into account in the calcula-tions. Agricultural machines were examined in 7 groups and combine harvesters were evaluated as a separate group apart from other harvesting machines.

These are;

1. Soil Tillage and Seed Bed Preparation Machines (Arc Opening Plow, Sub-soiler, Disc type stubble Plow, Disc Harrow, Disc Tractor Plow, Toothed Harrow, Harrow-drill combination, Stubble Plow, Tractor Plow, Cultivator, Roller, Rotary tiller, Set Making Machine, Stone Collecting Machine, Rotary Cultivator, Soil Levelling Machine)

2. Sowing Planting Machines (Stubble Sowing Machine, Combine Grain Sowing Machine, Potato Planting Machine, Pneumatic Sowing Machine, Tractor Sowing Machine, Universal Sowing Machine (Including Mechanical Beet Drum Seeder)

3. Plant Husbandry and Fertilization Machines (Manure spreading machine, Animal and Tractor operated Hoeing Machine, Chemical Fertilizer Distributor)

4. Agricultural Pest Control Machines (Atomizer, PTO driven Sprayer, Motorized Sprayer, Pull type Motor Sprayer and Pollinator Combine Atomizer, Pollinator)

5. Harvesting Machines (Baler Machine, Combine Beet Harvesting Machine, Combine Potato Harvesting Machine, Maize Silage Machine, Hay Rake, Sugar Beet Harvester, Potato Harvester, Stalk Shredder, Tractor Drawn Mower)

6. Combine Harvesters

7. Tractors

In the calculation of the impact areas of agricultural machinery, the machines having completed their economic life have been excluded from the evaluation. In agricultural machinery, the economic life is widely accepted as ten years. According to this, it was accepted that 50% of agricultural machinery and 47% of tractors (Özgüven et al., 2010) completed their economic life. Since the contracting system is widely used in combine harvesters; all existing harvesters is included in the calculations (Yılmaz and al., 2006).

In the calculation of working widths of the agricultural machinery, agricultural tools and machinery manufacturers' catalogs in the province of Konya and other provinces of Turkey were used in addition to the average working widths based on (Ozden and Soğancı, 1996).

The annual number of workable days of agricultural machinery is calculated by using meteorological data

of districts (Anonymous, 2019a). In the calculation, daily average temperature, daily total precipitation, 10 cm soil temperature and daily average relative humidity values, which are an important criterion for harvesting and harvesting machines, were obtained for each district from the 8th Regional Directorate of Meteorology for the 2007-2018 period. These criteria are common variables used for soil processing, plantcare and pest control, harvesting and threshing in different studies and are taken from Kuşçu (2008).

Group I: Soil Processing and Sowing Activities

TAVE i	> 5 °C
PRE i	< 2.5 mm
PRE i + PRE i-1	< 3.5 mm
PRE i + PRE i-1 + PRE i-2	< 4.0 mm
TSOI i	> 0.0 °C

II. Group: Plantcare and Pest Control Activities

TAVE i	> 5 °C
PRE i	< 0.5 mm
TSOI i	> 5.0 °C

III. Group: Haversting and Blending Activities

TAVE i	> 15 °C
PRE i	< 0.0 mm
PRE i-1	< 2.0 mm
RH i	< 60

Here;

TAVE i	Average temperature on day i (°C)
PRE i	Total precipitation on day i (mm)
PRE i-1	Total precipitation on the day before day i (mm)
PRE i-2	Total precipitation on day i-2 (mm)
TSOI i	Soil temperature at 10 cm below surface (°C)
RH i	Average relative humidity values on day i (%)

After calculating the number of workable days for the whole year according to the meteorological data, the following periods during which the agricultural activities are carried out were taken into account (Ada and al., 2010; Arıoğlu and al., 2006; Bozdemir, 2017; Sade and al., 2007):

• For soil processing and planting, 15 March - 30 April, 15 September - 31 October

• For plantcare and pest control procedures, 15 February - 14 April, 1 May - 14 July, 15 October -14 November

• For harvesting and threshing, the interval between 01 July and 30 November were used.

The number of workable days calculated according to meteorological data has been reduced considering the above periods.

The annual number of workable days calculated by this method is shown in Table 1.

In the calculation of the district level usage period of the tractors, Agricultural Cost System (TAMSIS) 2017 data of the Ministry of Agriculture and Forestry were used. TAMSIS is a system of production costs calculated separately for each product produced in the district based on interviews with farmers at the district level. For fuel costs, TAMSIS data, which are determined separately for each product, are used.

Fuel cost had been converted to liters (Anonymous, 2019b).

Hourly fuel consumption (l h^{-1}) of the tractors in the district according to the power (BG) average was calculated by using Yavuzcan and Vatandaş, (1986).

The total amount of annual fuel are divided into the calculated values to calculate the annual working hours. Daily working time was assumed to be 8 h day^{-1}.

The annual number of workable days for tractors calculated by this method is shown in Table 1

Table 1
Workable Days per year for Agricultural Machinery (days).

District	Soil Processing and Sowing Machines	Plantcare Fertilization and Pest Control Machines	Harvesting Machines	Combine Harvesters	Tractors
Ahırlı	53	74	81	75	73
Akören	68	72	92	75	98
Akşehir	59	48	71	75	72
Altınekin	71	78	97	83	105
Beyşehir	55	41	80	85	128
Bozkır	59	74	90	83	134
Cihanbeyli	80	56	93	84	148
Çeltik	71	80	93	73	62
Çumra	76	60	92	93	123
Derbent	56	54	69	67	91
Derebucak	45	60	74	65	129
Doğanhisar	58	64	63	64	67
Emirgazi	70	81	98	89	152
Ereğli	65	67	91	90	86
Güneysınır	59	70	87	77	123
Hadim	47	46	61	87	22
Halkapınar	66	83	93	84	75
Hüyük	69	66	84	72	189
Ilgın	72	47	85	73	68

Table 1(Continuation)
Workable Days per year for Agricultural Machinery (days).

Kadınhanı	76	49	81	82	161
Karapınar	72	62	91	87	223
Karatay	74	82	92	83	101
Kulu	72	59	83	83	182
Meram	74	60	79	81	61
Sarayönü	73	40	79	80	315
Selçuklu	71	33	79	78	73
Seydişehir	46	39	69	82	94
Taşkent	56	62	70	77	147
Tuzlukçu	66	69	86	62	105
Yalıhüyük	54	76	89	77	106
Yunak	61	46	78	83	119
Konya	64	61	83	79	107

Source: Author's compilation of data obtained from 8th Regional Directorate of Meteorology for the 2007-2018 peri-od.

The daily working time of the effective work success of agricultural machinery was taken as 8 h day^{-1}.

The forward speed in working with agricultural machinery and their time-utilization coefficients, that are used in the calculation of the effective working capacity of agricultural machinery are taken from (Özmerzi et al., 2004).

Equation (1) is used in the calculation of the effective working capacity of the agricultural machinery.

Effective working capacity (da h^{-1}) = Machine working width (m) x Forward speed (km h^{-1}) x Time-use coefficient (%)……..……(1)

While calculating the agricultural machinery working widths, average values are found by scanning the catalogs of the companies that produce agricultural machines in Konya and in other cities and by using (Özden and Soğancı, 1996).

Forward speed and time utilization coefficients in working with agricultural machinery are based on (Özmerzi et al., 2004).

Based on the number, effective working capacity, daily working time (8 hours) and the number of working days per year of agricultural machines, the annual impact area are calculated for 7 different machine groups in each district of Konya. The these calculations were given in equation (2).

Machine impact area (da year^{-1}) = number of machines (pcs) x effective working capacity (da h^{-1}) x daily working time (h day^{-1}) x number of annual workable days (day year^{-1})..... (2)

For each group of machines, the impact areas (da) calculated according to Equation 2 are converted into circular areas in each district and the radius (m) of this area is calculated. Similarly, the area planted according to the agricultural production in the district was considered as a circle and the radius of these areas was also determined (Yıldız et al., 2007).

For this, the following formula is used.

$$r = \sqrt{A/\pi} \quad \text{……. ……..(3)}$$

Here;

r: Calculated Area Radius (m)

A: Area (m^2)

π: 3,1416

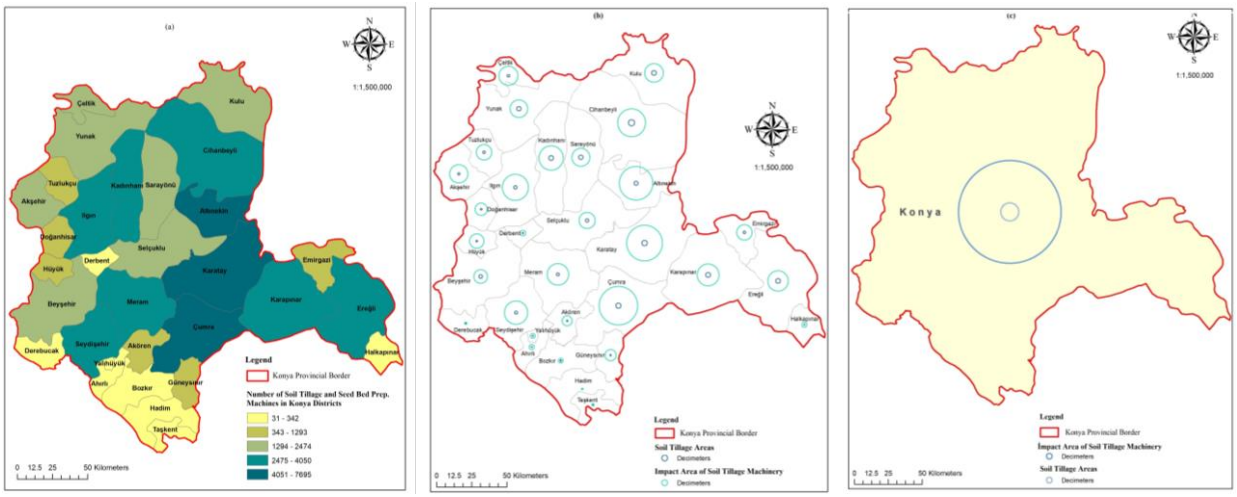
Using equation (2) the impact areas of the machinery groups are calculated. Then, using equation (3) machine impact areas and cultivated areas are transformed into circular form. Using these data, the impact areas of the machines are compared with planted areas. The number of required machinery was calculated based on the size of planted areas. The adequacy or surplus of agricultural machines were determined according to above calculations and comparisons.

For each machine group, two different maps were created at the district level. The first map shows the numbers of the existing machine group, and the second map shows the impact areas of the machine groups and the planted areas as circular areas to allow for comparison.

3. Results and Discussion

Soil Tillage and Seed Bed Preparation Machines:

The number of soil tillage and seed bed preparation machines in the districts of Konya province, and the circular sizes of machine group impact areas and cultivated areas in Konya at the district and province scale are given in Figure 1. Table 2 shows the cultivated areas and the impact areas of soil tillage and seed bed preparation machines..



(a) (b) (c)

Figure 1
(a) Number of soil tillage and seed bed preparation machines in Konya districts, (b) Representation of machine group impact areas and cultivated areas as circular sizes in Konya districts. (c) Representation of machine group impact area and cultivated area as circular sizes in Konya province.

Table 2
Impact Areas of Soil Tillage and Seed Bed Preparation Machines and Cultivated Areas.

District	Number of Agricultural Tools and Machines(units)	Impact area of the To-ols/machines (da year $^{-1}$)	Impact Radius of the Group (m)	Cultivated Area (da)	Cultivated Area Radius (m)	Necessary Number of tools/Machines Based on Culti-vated Area (units)	Difference in Number of tools/machines (Necessary-Existing)
Çumra	7,695	60,351,661	138,602	1,100,034	18,712	141	-7,554
Karatay	6,428	51,288,394	127,772	1,286,503	20,236	162	-6,266
Altınekin	6,155	45,534,970	120,392	649,907	14,383	88	-6,067
Cihanbeyli	4,050	31,742,016	100,518	1,548,905	22,204	198	-3,852
Seydişehir	3,313	21,837,893	83,374	354,342	10,620	54	-3,259
Ilgın	3,270	27,746,784	93,979	531,473	13,007	63	-3,207
Kadınhanı	3,181	23,840,653	87,113	899,923	16,925	121	-3,060
Karapınar	2,919	19,648,512	79,084	999,737	17,839	149	-2,770
Meram	2,711	18,543,926	76,829	405,361	11,359	60	-2,651
Ereğli	2,761	16,853,876	73,244	893,597	16,865	147	-2,614
Yunak	2,474	12,411,597	62,855	840,146	16,353	168	-2,306
Akşehir	2,313	13,641,791	65,896	262,507	9,141	45	-2,268
Çeltik	2,202	14,778,338	68,586	318,078	10,062	48	-2,154
Kulu	2,083	13,957,459	66,654	935,087	17,252	140	-1,943
Sarayönü	2,082	13,181,289	64,774	888,258	16,815	141	-1,941
Beyşehir	1,781	7,481,364	48,799	570,487	13,476	136	-1,645
Selçuklu	1,626	10,470,796	57,732	484,820	12,423	76	-1,550
Emirgazi	1,293	9,642,696	55,402	287,995	9,575	39	-1,254
Tuzlukçu	1,201	9,492,226	54,968	271,353	9,294	35	-1,166
Hüyük	1,105	8,579,681	52,259	173,009	7,421	23	-1,082
Doğanhisar	1,095	6,088,051	44,021	147,360	6,849	27	-1,068
Güneysınır	968	5,263,508	40,932	112,655	5,988	21	-947
Akören	648	4,285,523	36,934	139,093	6,654	22	-626
Ahırlı	342	1,067,293	18,432	45,805	3,818	15	-327
Derbent	312	1,219,098	19,699	83,142	5,144	22	-290
Bozkır	228	973,642	17,605	95,213	5,505	23	-205
Yalıhüyük	178	910,613	17,025	32,810	3,232	7	-171
Halkapınar	164	1,045,546	18,243	39,881	3,563	7	-157
Derebucak	64	220,320	8,374	24,728	2,806	8	-56
Taşkent	60	220,954	8,386	11,666	1,927	4	-56
Hadim	3k1	103,325	5,735	2,878	957	1	-30
Konya	64,733	452,423,791	379,487	14,159,429	67,135	2,026	-62,707

When we examine Figure 1 and Table 2, we observe that district with the maximum number of machines in the soil tillage and seed bed preparation machines group is Çumra (7,695) and it constitutes 12% of total number in the province. In terms of the number of machines in this group, Karatay (6,428) is the second and Altınekin (6,155) in the third.

The districts with the least machinery in this group are Hadim (31 units), Taşkent (60 units) and Derebucak (64 units).

Accordingly, Çumra, Karatay and Altınekin districts occupy the top three positions in the ranking of impact areas of the soil tillage and seed bed preparation machinery group. Hadim, Derebucak, Taşkent districts occupy the bottom three positions in this regard.

When we compare the machine group impact areas and cultivated areas, it was determined that 7,554 units of soil tillage and seed bed preparation machines in Çumra, 6,266 units in Karatay and 6,067 units in Altınekin district are overbought. In this group, it is evident that there is a surplus in the number of machines in comparison to the cultivated areas. In Konya, the total number of surplus in the soil tillage and seed bed preparation machines is 62,707 units.

Sowing Planting Machines:

The number of sowing and planting machines in the districts of Konya and the circular sizes of machine group impact areas and cultivated areas in Konya at the district and provincial scale are given in Figure 2. Table 3 shows the cultivated areas and the impact areas of sowing and planting machines

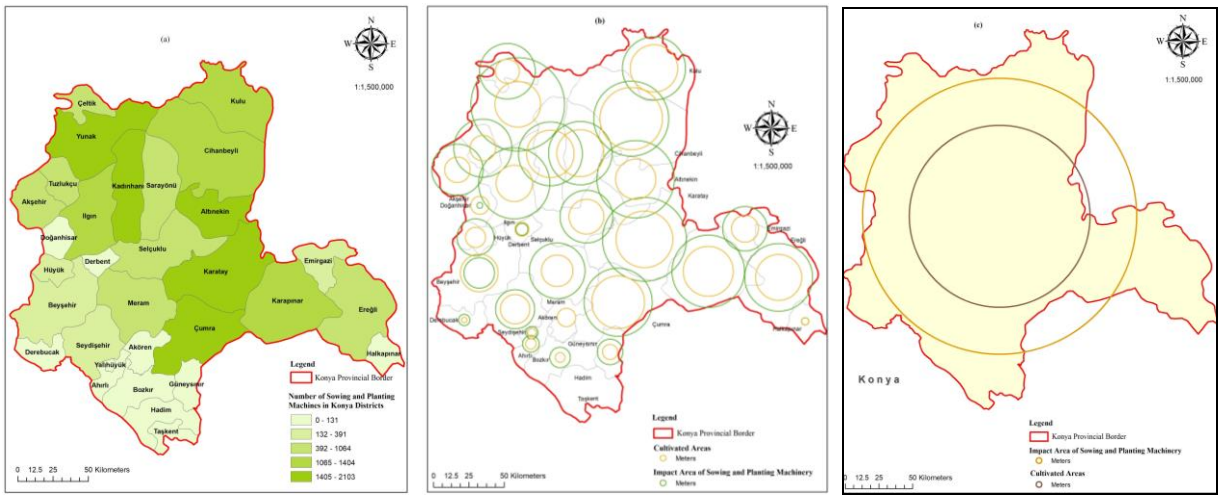


Figure 2
(a) Number of sowing and planting machines in Konya districts, (b) Representation of machine group impact areas and cultivated areas as circular sizes in Konya districts. (c) Representation of machine group impact area and cultivated area as circular sizes in Konya province.

Table 3
Impact Areas of Sowing and Planting Machines and Cultivated Areas

District	Number of Agricultural Tools and Machines (units)	Impact Area of the Tools/Machines (da year $^{-1}$)	Impact Radius of the Group (m)	Cultivated Area (da)	Cultivated Area Radius (m)	Necessary Number of Tools/Machines Based on Cultivated Area (units)	Difference in Number of Tools/Machines (Necessary-Existing)
Yunak	2,103	3,469,634	33,233	826,802	16,223	502	-1,601
Altınekin	2,058	2,391,970	27,593	647,321	14,354	557	-1,501
Karatay	1,981	2,783,982	29,769	1,283,413	20,212	914	-1,067
Ilgın	1,343	2,008,659	25,286	520,459	12,871	348	-995
Çeltik	942	1,235,580	19,832	232,586	8,604	178	-764
Kadınhanı	1,666	1,616,155	22,681	894,062	16,870	922	-744
Karapınar	1,380	2,075,781	25,705	991,795	17,768	660	-720
Çumra	1,691	1,839,010	24,194	1,100,034	18,712	1,012	-679
Tuzlukçu	806	1,336,521	20,626	263,263	9,154	159	-647
Akşehir	750	1,054,206	18,318	262,507	9,141	187	-563
Kulu	1,204	1,585,256	22,463	895,834	16,886	681	-523
Meram	767	1,235,759	19,833	398,091	11,257	248	-519
Ereğli	913	1,830,558	24,139	836,393	16,317	418	-495
Sarayönü	1,064	1,602,298	22,584	878,469	16,722	584	-480
Cihanbeyli	1,404	2,231,045	26,649	1,548,905	22,204	975	-429
Selçuklu	705	1,112,816	18,821	481,936	12,386	306	-399

Table 3 (Continuation)
Impact Areas of Sowing and Planting Machines and Cultivated Areas

Emirgazi	391	787,149	15,829	287,995	9,575	144	-247
Hüyük	331	544,782	13,168	162,322	7,188	99	-232
Seydişehir	378	607,926	13,911	347,741	10,521	217	-161
Güneysınır	111	262,719	9,145	92,616	5,430	40	-71
Bozkır	86	170,170	7,360	39,613	3,551	21	-65
Doğanhisar	170	164,388	7,234	131,390	6,467	136	-34
Yalıhüyük	59	60,861	4,401	29,333	3,056	29	-30
Ahırlı	46	109,789	5,912	45,705	3,814	20	-26
Derebucak	21	50,982	4,028	11,850	1,942	5	-16
Halkapınar	23	22,227	2,660	23,042	2,708	24	1
Akören	131	136,590	6,594	138,413	6,638	133	2
Derbent	38	58,231	4,305	79,810	5,040	53	15
Beyşehir	342	369,110	10,839	570,487	13,476	529	187
Konya	22,749	32,604,363	101,874	14,159,429	67,135	9,880	-12,869

Source: The agricultural machinery presence, the cultivated/planted areas are from Turkey Statistical Institute (anonymous, 2017). Other variables are calculated by the authors based on equation (1), equation (2) and equation (3).

When we examine Figure 2 and Table 3, we observe that district with the maximum number of machines in the sowing and planting machines group is Yunak; with 2,103 units, which constitutes 9% of total number of sowing and planting machines in the province. Altınekin (2,058 units) is the second and Karatekin (1,981) is the third.

The districts with the least number of machines in this group are Derebucak (21 units), Halkapınar (23 units) ve Derbent (38 units).

When the districts with the most and least number of sowing and planting machines are examined; we observe that sowing and planting machines are concentrated mostly in the districts that have large agricultural lands where farmers engage in field crop cultivation, whereas the number of sowing and planting machines are fewer in the districts where the land structure is small and fragmented.

The impact areas of sowing and planting machines were compared at the district scale. According to the calculations; the cultivated area in Yunak district is 826,802 da, while the impact area of sowing and plating machines is 3,469,634 da. The number of machines should have been 502 based on the size of the cultivated areas (826,802 da). Therefore 1,601 units of 2,103 existing machines in the district constitute a surplus. In the evaluation of the machine group impact areas, Altınekin is the second with 1,501 units of surplus machines and Karatay is the third (1,067 units).

Plantcare and Fertilization Machines:

The number of plantcare and fertilization machines in the districts of Konya province, and the circular sizes of machine group impact areas and cultivated areas in Konya at the district and province scale are given in Figure 3. Table 4 shows the cultivated areas and the impact areas of plantcare and fertilization machines.

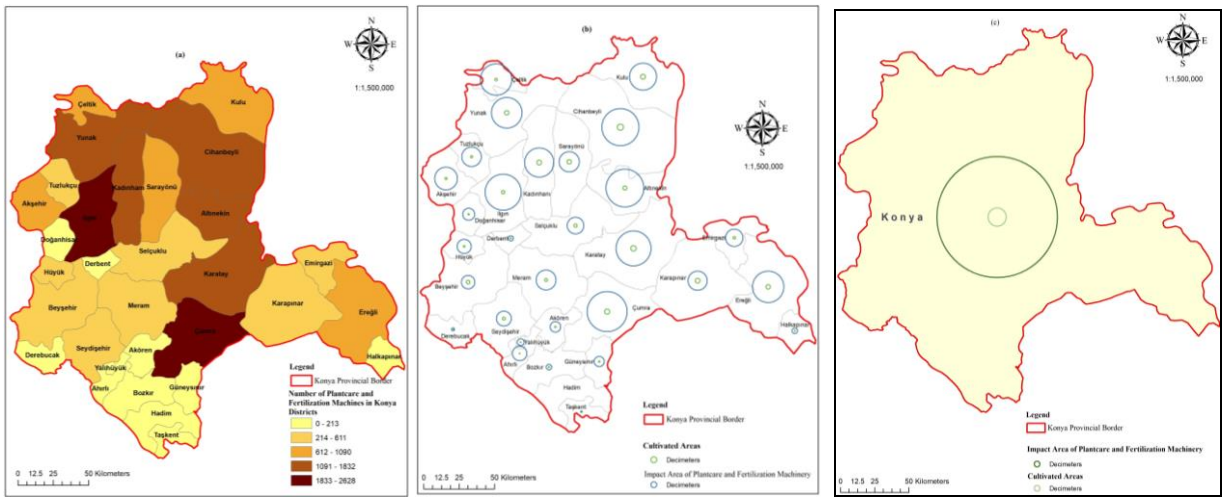


Figure 3
(a) Number of plantcare and fertilization machines in Konya districts, (b) Representation of machine group impact areas and cultivated areas as circular sizes in Konya districts. (c) Representation of machine group impact area and cultivated area as circular sizes in Konya province.

Table 4
Impact Areas of Plantcare and Fertilization Machines and Cultivated areas.

District	Number of Agricultural Tools and Machines (units)	Impact area of the Tools/machines (da year^{-1})	Impact Radius of the Group (m)	Cultivated Area (da)	Cultivated Area Radius (m)	Necessary Number of tools/Machines Based on Cultivated Area (units)	Difference in Number of tools/machines (Necessary-Existing)
Çumra	2,628	63,562,656	142,241	1,100,034	18,712	46	-2,582
Ilgın	2,097	51,569,829	128,122	520,459	12,871	22	-2,075
Cihanbeyli	1,832	54,289,805	131,457	1,548,905	22,204	53	-1,779
Yunak	1,590	37,636,832	109,454	826,802	16,223	35	-1,555
Altınekin	1,558	56,210,669	133,762	647,261	14,354	18	-1,540
Karatay	1,408	48,774,387	124,601	1,283,413	20,212	38	-1,370
Kadınhanı	1,363	34,226,382	104,377	894,062	16,870	36	-1,327
Ereğli	1,090	39,152,978	111,637	836,393	16,317	24	-1,066
Çeltik	938	38,988,544	111,402	317,812	10,058	8	-930
Akşehir	938	20,490,547	80,761	262,507	9,141	13	-925
Kulu	904	29,158,083	96,339	895,834	16,886	28	-876
Sarayönü	771	16,449,888	72,361	878,469	16,722	42	-729
Selçuklu	611	10,892,086	58,882	481,936	12,386	28	-583
Meram	550	15,706,224	70,707	398,091	11,257	14	-536
Karapınar	556	14,901,179	68,871	991,795	17,768	38	-518
Seydişehir	447	8,901,984	53,231	347,741	10,521	18	-429
Tuzlukçu	416	14,941,978	68,965	263,263	9,154	8	-408
Beyşehir	322	7,118,617	47,602	570,487	13,476	26	-296
Emirgazi	292	11,814,401	61,324	287,995	9,575	8	-284
Hüyük	260	7,944,130	50,286	162,322	7,188	6	-254
Ahırlı	213	8,231,523	51,188	45,805	3,818	2	-211
Doğanhisar	167	5,809,869	43,004	131,390	6,467	4	-163
Akören	125	4,560,134	38,099	139,093	6,654	4	-121
Güneysınır	111	4,230,744	36,697	92,616	5,430	3	-108
Yalıhüyük	48	2,002,022	25,244	29,333	3,056	1	-47
Bozkır	48	1,337,446	20,633	55,886	4,218	3	-45
Derbent	38	1,126,138	18,933	79,810	5,040	3	-35
Halkapınar	29	1,320,962	20,505	31,401	3,162	1	-28
Derebucak	14	356,544	10,653	23,970	2,762	1	-13
Taşkent	3	102,077	5,700	11,666	1,927	1	-2
Konya	21,367	611,808,657	441,298	14,159,429	67,135	495	-20,872

Source: The agricultural machinery presence, the cultivated/planted areas are from Turkey Statistical Institute (anonymous, 2017). Other variables are calculated by the authors based on equation (1), equation (2) and equation (3).

When Figure 3 and Table 4 are examined, we observe that the district with the most machinery presence in the group of plantcare and fertilization machines is Çumra. Plantcare and fertilization machines in Çumra district constitute 12% of the total number in the province. The least number of plantcare and fertilization machines are in Taşkent and Derebucak districts. Within the group which includes manure spreading machine, animal and tractor-pulled hoeing machine and chemical fertilizer distributor, the number of chemical fertilizer distributor is the highest with 18,550 units in total, animal and tractor-pulled hoeing machine is the second with 2,662 units in total, and manure spreading machine is in the third place with 155 units.

The number of plantcare and fertilization machines is higher in districts that have large agricultural areas and engage in field crop cultivation such as Çumra, Ilgın and Cihanbeyli. The numbers are fewer in the districts such as Taşkent, Derebucak and Halkapınar, which have less agricultural land and where fruit and vegetable growing is common.

Within the plantcare and fertilization machines group, the number of chemical fertilizer distributor is the highest, followed by animal and tractor-pulled hoeing machine and manure spreading machine respectively.

When we examine the required number of plantcare and fertilization machines, calculated by comparing the impact radii and cultivated area radius, we can determine that for Çumra district, which has the highest number of plantcare and fertilization machines, 46 units of plantcare and fertilization machines would be sufficient. Therefore, we can conclude that out of the total number of 2,678 units in the district, 2,632 units are in excess.

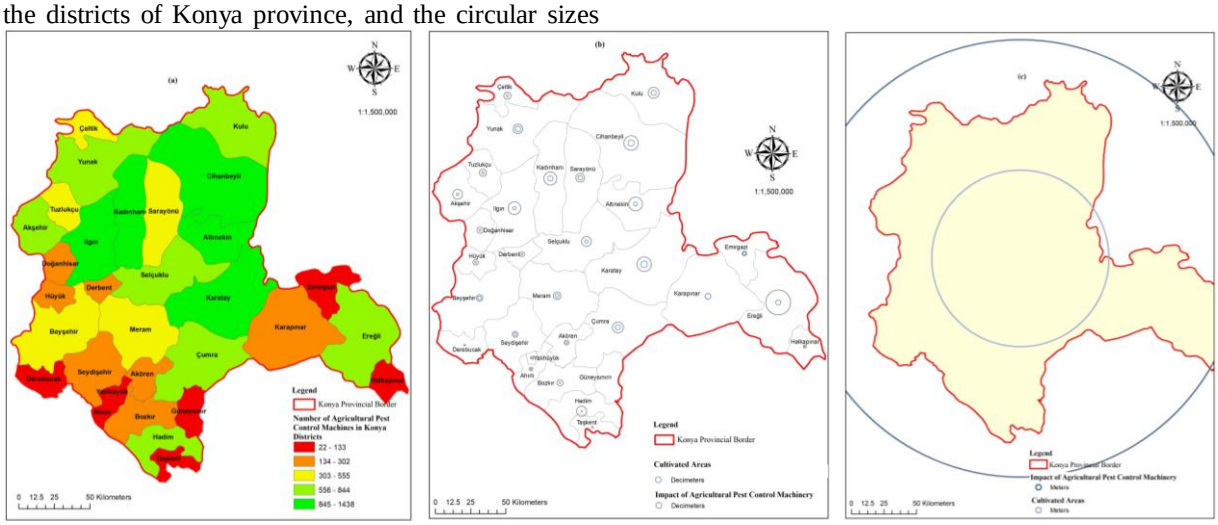
In the group of plantcare and fertilization machines, Ilgın is the second district with the most machinery presence compared to the cultivated areas, and 22 plantcare and fertilization machines are sufficient for the cultivated areas, however, it is observed that 2,097 units have been acquired and 2,075 units are redundant.

According to the effect of machine group domain, it is determined that there are 2 and 13 surpluses in

Taşkent and Derebucak districts which have the least machine group respectively.

Agricultural Pest Control Machines:

The number of agricultural pest control machines in the districts of Konya province, and the circular sizes of machine group impact areas and cultivated areas in Konya at the district and province scale are given in Figure 4. Table 5 shows the cultivated areas and the impact areas of agricultural pest control machines.



(a) (b) (c)

Figure 4
(a) Number of agricultural pest control machines in Konya districts, (b) Representation of machine group impact areas and cultivated areas as circular sizes in Konya districts. (c) Representation of machine group impact area and cultivated area as circular sizes in Konya province.

Table 5
Impact Areas of Agricultural Pest Control Machines and Cultivated areas

District	Number of Agricultural Tools and Machines (units)	Impact area of the Tools/machines (da year^{-1})	Impact Radius of the Group (m)	Cultivated Area (da)	Cultivated Area Radius (m)	Necessary Number of tools/Machines Based on Cultivated Area (units)	Difference in Number of tools/machines (Necessary-Existing)
Cihanbeyli	1,438	8,566,168	52,218	1,588,982	22,490	267	-1,171
Altınekin	1,262	7,525,856	48,944	649,907	14,383	109	-1,153
Karatay	1,437	8,321,529	51,467	1,799,108	23,931	311	-1,126
Ilgın	1,121	6,479,502	45,415	531,473	13,007	92	-1,029
Kadınhanı	1,200	7,012,096	47,244	1,072,475	18,476	184	-1,016
Hadim	755	4,095,780	36,107	79,482	5,030	15	-740
Çumra	843	4,748,214	38,877	1,108,580	18,785	197	-646
Akşehir	687	4,026,183	35,799	292,714	9,653	50	-637
Kulu	810	4,803,625	39,103	1,152,087	19,150	195	-615
Ereğli	644	24,945,199	89,108	1,154,597	19,171	30	-614
Selçuklu	663	3,834,428	34,936	484,820	12,423	84	-579
Yunak	844	3,754,400	34,570	1,191,449	19,474	268	-576
Sarayönü	555	3,204,958	31,940	888,258	16,815	154	-401
Meram	462	2,410,928	27,702	578,415	13,569	111	-351
Çeltik	367	2,097,087	25,836	318,078	10,062	56	-311
Tuzlukçu	350	2,082,933	25,749	271,353	9,294	46	-304
Bozkır	294	1,622,816	22,728	95,213	5,505	18	-276
Doğanhisar	302	1,685,549	23,163	153,172	6,983	28	-274
Beyşehir	350	1,872,728	24,415	580,481	13,593	109	-241
Seydişehir	258	1,486,451	21,752	354,342	10,620	62	-196
Hüyük	220	1,244,526	19,903	173,009	7,421	31	-189
Derbent	172	971,131	17,582	83,142	5,144	15	-157
Akören	169	955,646	17,441	140,614	6,690	25	-144
Ahırlı	92	550,160	13,233	53,991	4,146	10	-82
Yalıhüyük	75	412,516	11,459	32,810	3,232	6	-69
Halkapınar	72	415,730	11,504	39,881	3,563	7	-65

Table 5 (Continuation)
Impact Areas of Agricultural Pest Control Machines and Cultivated areas

Emirgazi	133	795,340	15,911	408,652	11,405	69	-64
Karapınar	274	1,480,367	21,707	1,245,782	19,913	231	-43
Taşkent	30	114,587	6,039	21,203	2,598	6	-24
Güneysınır	53	315,006	10,013	192,521	7,828	33	-20
Derebucak	22	94,505	5,485	24,728	2,806	6	-16
Konya	512	89,725,750	168,999	14,619,579	68,217	2,600	-13,354

Source: The agricultural machinery presence, the cultivated/planted areas are from Turkey Statistical Institute (anonymous, 2017). Other variables are calculated by the authors based on equation (1), equation (2) and equation (3).

When Figure 4 and Table 5 are examined, it is seen that the districts of Cihanbeyli (1,438 units), Karatay (1,437 units) and Altınekin (1,262 units) are in the top three positions in terms of the presence of agricultural pest control machinery group whereas Derebucak (22 units), Taşkent (30 units) and Güneysınır (53 units) districts occupy the last three ranks.

Within the in the agricultural pest control machinery group, the number of PTO driven sprayers is the highest with 1,430 units in the Cihanbeyli district, and 1,250 units in each of the Altınekin and Karatay districts, whereas the number of Pull type Motor Sprayer and Pollinator Combine Atomizer is the least with 1 units in each of the Yunak, Yalıhüyük and Doğanhisar districts.

At the Konya provincial level, in terms of the presence of agricultural pest control machines, the number of PTO driven sprayers is the highest with 13,019 units, followed by motorized sprayer with 2,053 units, and atomizers with 606 units. At the fourth rank is Pull type Motor Sprayer and Pollinator Combine Atomizer with 216 units, followed by 60 pollinators.

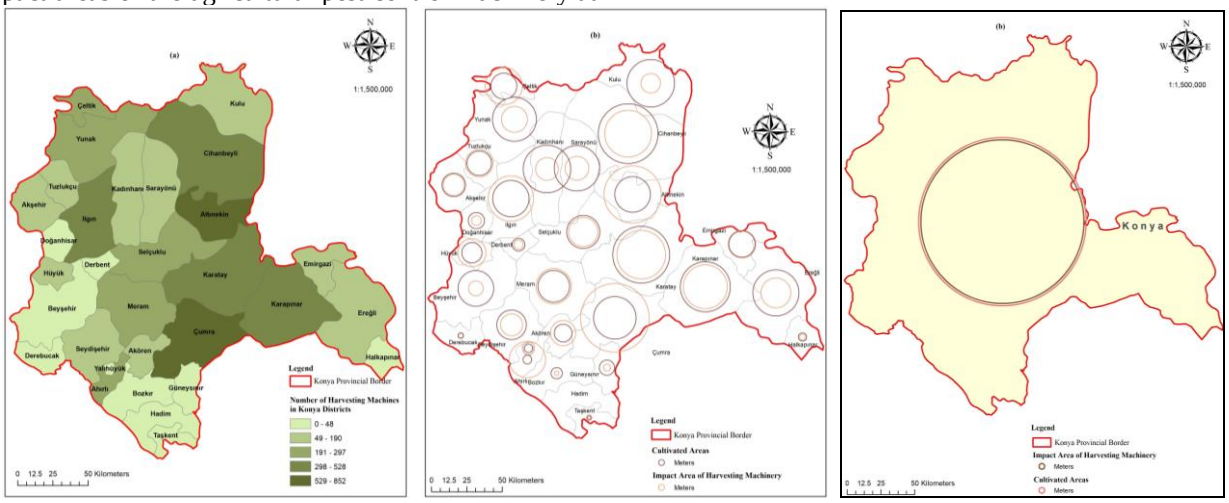
When we compare the cultivated areas and the impact areas of the agricultural pest control machinery at the district level, the disttict with the highest machine group impact area is Ereğli (24,945,199 da) and according to the calculated impact area, 30 units of agricultural pest control machinery would be sufficient for the cultivated areas in Ereğli district, therefore the remaining 614 units of agricultural machinery are redundant.

In comparing the cultivated areas with the impact area of the machinery group, 1,171 units in Cihanbeyli district, 1,153 units in Altınekin district and 1,126 units of agricultural pest control machinery in Karatay district are found to be redundant.

Derebucak (16 units), Güneysınır (20 units) and Taşkent (24 units) districts occupy the lowest ranks in terms of the surplus in the agricultural pest control machinery group.

Harvesting Machines:

The number of harvesting machines in the districts of Konya province, and the circular sizes of machine group impact areas and planted areas in Konya at the district and province scale are given in Figure 5. Table 6 shows the cultivated areas and the impact areas of harvesting machines.



(a) (b) (c)

Figure 5
(a) Number of harvesting machines in Konya districts, (b) Representation of machine group impact areas and cultivated areas as circular sizes in Konya districts. (c) Representation of machine group impact area and cultivated area as circular sizes in Konya province.

Table 6
Impact Areas of Harvesting Machines and Cultivated Areas.

District	Number of Agricultural Tools and Machines (units)	Impact area of the Tools/machines (da year^{-1})	Impact Radius of the Group (m)	Cultivated Area (da)	Cultivated Area Radius (m)	Necessary Number of tools/Machines Based on Cultivated Area (units)	Difference in Number of tools/machines (Necessary-Existing)
Altınekin	852	1,294,666	20,300	506,303	12,695	334	-518
Çumra	800	1,855,448	24,302	720,699	15,146	311	-489
Ahırlı	297	521,541	12,885	31,074	3,145	18	-279
Ilgın	528	811,453	16,071	520,459	12,871	339	-189
Çeltik	256	548,019	13,208	269,067	9,255	126	-130
Akören	128	252,190	8,960	123,193	6,262	63	-65
Meram	287	495,972	12,565	398,091	11,257	231	-56
Hüyük	87	314,275	10,002	162,322	7,188	45	-42
Tuzlukçu	150	299,335	9,761	237,339	8,692	119	-31
Yalıhüyük	31	60,746	4,397	29,333	3,056	15	-16
Emirgazi	180	298,875	9,754	277,076	9,391	167	-13
Taşkent	9	12,970	2,032	5,498	1,323	4	-5
Derebucak	8	9,511	1,740	12,060	1,959	11	3
Halkapınar	9	13,487	2,072	29,371	3,058	20	11
Derbent	24	34,425	3,310	63,732	4,504	45	21
Akşehir	126	183,136	7,635	222,399	8,414	154	28
Bozkır	6	8,054	1,601	50,980	4,028	38	32
Güneysınır	15	20,781	2,572	92,616	5,430	67	52
Doğanhisar	34	40,118	3,574	106,726	5,829	91	57
Selçuklu	221	336,868	10,355	437,471	11,800	287	66
Karapınar	452	759,172	15,545	991,795	17,768	591	139
Seydişehir	190	191,787	7,813	347,741	10,521	345	155
Karatay	495	935,144	17,253	1,283,413	20,212	680	185
Ereğli	150	355,921	10,644	836,393	16,317	353	203
Beyşehir	48	86,364	5,243	506,992	12,704	282	234
Cihanbeyli	382	865,827	16,601	1,413,119	21,209	624	242
Sarayönü	150	224,655	8,456	810,000	16,057	541	391
Yunak	229	265,393	9,191	770,116	15,657	665	436
Kulu	94	150,563	6,923	895,834	16,886	560	466
Kadınhanı	174	205,079	8,080	894,062	16,870	759	585
Konya	6,412	11,451,777	60,376	12,048,374	61,928	6,747	335

Source: The agricultural machinery presence, the cultivated/planted areas are from Turkey Statistical Institute (anonymous, 2017). Other variables are calculated by the authors based on equation (1), equation (2) and equation (3).

In Figure 5 and Table 6, in the group of harvesting machines, Altınekin has the highest number of machinery with 852 machines, which constitutes 13.2% of all harvesting machines in the province. In the second place is Çumra (800 units), followed by Ilgın (528 units) district.

In the harvesters group, Bozkır (6 units), Derebucak (8 units) and Taşkent (9 units) districts are listed as the districts with the least machine presence.

Within the group of harvesting machines at the district scale, Altınekin ranks first with 550 sugar beet harvesters, Cihanbeyli district is the second with the presence of 300 combine sugar beet harvesters, and Ilgın is the third with tractor drawn mower machines.

In the 6,412 units harvesting group machines throughout Konya, there are 1.654 sugar beet harvesters, 1,274 grass rakes and 1,164 tractor drawn mowers.

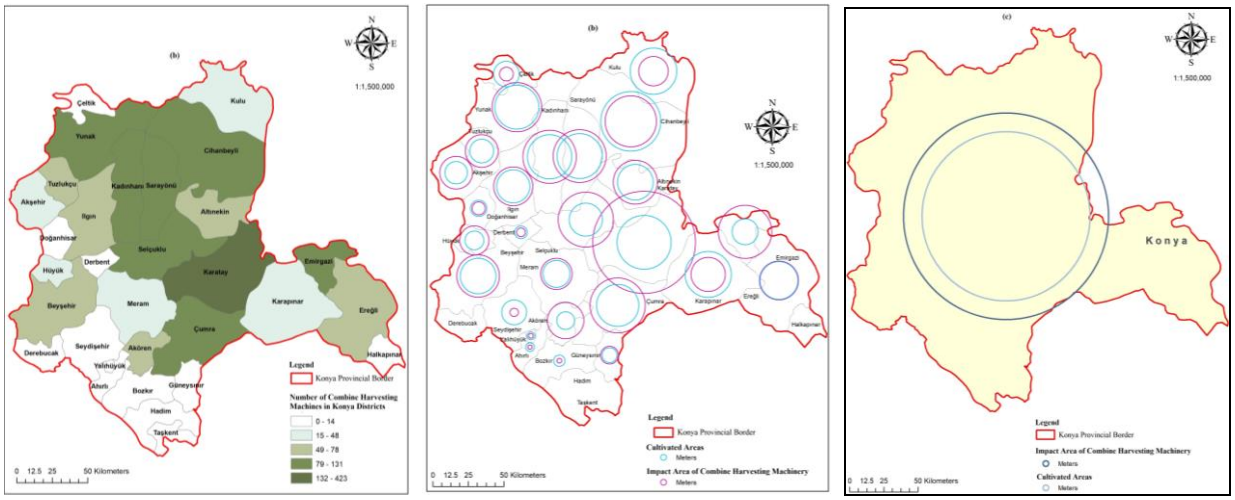
In this group, the combine potato harvesting machine (70 units), stalk chopper (153 units) and potato harvester (229 pieces) are the machines with least presence.

In the harvesting machines group, if we compare the cultivated areas and the impact areas of the agricultural machinery at the district level, 334 harvesting machines are found to be sufficient for the cultivated areas in Altinekin district, while 518 machines were obtained in excess. Although the 311 machines would be sufficient for the cultivated areas in Çumra district, it was found that 489 machines were acquired in surplus, while 18 machines were sufficient in the Ahırlı district and 279 more machines had been acquired.

In this group of machinery, according to the machine machine impact areas, 174 harvesting machines in Kadınhanı district can only be sufficient for 23% of the cultivated areas and 585 more machines are needed. 466 more harvesting machines in Kulu and 436 more in Yunak are needed as well.

Combine Harvesters:

The number of combine harvesters in the districts of Konya province, and the circular sizes of machine group impact areas and planted areas in Konya at the district and province scale are given in Figure 6. Table 7 shows the cultivated areas and the impact areas of combine harvesters.



(a) (b) (c)

Figure 6
(a) Number of combine harvesters in Konya districts, (b) Representation of machine group impact areas and cultivated areas as circular sizes in Konya districts. (c) Representation of machine group impact area and cultivated area as circular sizes in Konya province.

Table 7
Impact Areas of Combine Harvesters and Cultivated Areas

District	Number of Agricultural Tools and Machines (units)	Impact area of the Tools/machines (da year^{-1})	Impact Radius of the Group (m)	Cultivated Area (da)	Cultivated Area Radius (m)	Necessary Number of tools/Machines Based on Cultivated Area (units)	Difference in Number of tools/machines (Necessary-Existing)
Karatay	423	4,128,818	36,252	1,146,707	19,105	118	-305
Selçuklu	131	1,201,637	19,557	437,471	11,800	48	-83
Emirgazi	107	1,119,905	18,881	268,126	9,238	26	-81
Akören	59	520,380	12,870	123,196	6,262	14	-45
Çumra	110	1,203,048	19,569	708,799	15,021	65	-45
Kadınhanı	116	1,118,611	18,870	776,734	15,724	81	-35
Sarayönü	118	1,110,144	18,798	805,200	16,009	86	-32
Tuzlukçu	59	430,181	11,702	227,324	8,506	32	-27
Altınekin	78	761,342	15,567	505,203	12,681	52	-26
Akşehir	48	423,360	11,609	197,360	7,926	23	-25
Hüyük	40	338,688	10,383	139,479	6,663	17	-23
Beyşehir	72	719,712	15,136	506,992	12,704	51	-21
Yunak	98	956,558	17,449	770,116	15,657	79	-19
Ilgın	70	600,936	13,831	440,312	11,839	52	-18
Meram	41	390,550	11,150	288,239	9,579	31	-10
Güneysınır	14	126,773	6,352	86,758	5,255	10	-4
Ereğli	57	603,288	13,858	569,285	13,461	54	-3
Ahırlı	1	8,820	1,676	31,074	3,145	4	3
Yalıhüyük	1	9,055	1,698	27,367	2,951	4	3
Bozkır	1	9,761	1,763	50,980	4,028	6	5
Derbent	4	31,517	3,167	63,732	4,504	9	5
Doğanhisar	9	67,738	4,643	106,726	5,829	15	6
Çeltik	9	77,263	4,959	260,107	9,099	31	22
Seydişehir	3	28,930	3,035	243,604	8,806	26	23
Karapınar	45	460,404	12,106	845,618	16,406	83	38
Cihanbeyli	105	1,037,232	18,170	1,413,119	21,209	144	39
Kulu	36	351,389	10,576	853,559	16,483	88	52
Konya	1,855	17,836,039	75,348	11,944,889	61,662	1,243	-612

Source: The agricultural machinery presence, the cultivated/planted areas are from Turkey Statistical Institute (anonymous, 2017). Other variables are calculated by the authors based on equation (1), equation (2) and equation (3).

When Figure 6 and Table 7 are examined, the highest number of combine harvesters among the districts of Konya is found in Karatay with 423 units, which constitutes 22.8% of the combine harvesters in the province of Konya. However, in terms of areas harvested by combine harvester, Karatay district is the

second and has a share of 9.6%. Although Selçuklu district comes in the second place with 131 harvesters in terms of the presence of combine harvesters, the areas harvested by combine harvesters constitute 36% of the impact area of combine harvesters.

In Ahırlı, which has the least harvesting capacity, there is 1 combine harvester and can cover only 28% of the areas harvested by combine harverters.

There are no combine harvesters in Derebucak, Hadim, Halkapınar and Taşkent. In these districts, agricultural production is predominantly based on fruit and vegetable cultivation. Field crops produced in small and fragmented land are harvested either by combine harvesters from other districts or by other methods.

In the districts of Konya, when the impact areas of combine harvesters are compared with the cultivated areas, it is seen that in the Karatay district where the maximum number of harvesters is present, the existing harvesters can cover for 3.6 times the cultivated area and 118 harvesters would be sufficient for this district according to the calculated impact area. It is noteworthy that 305 of the 423 harvesters were overbought.

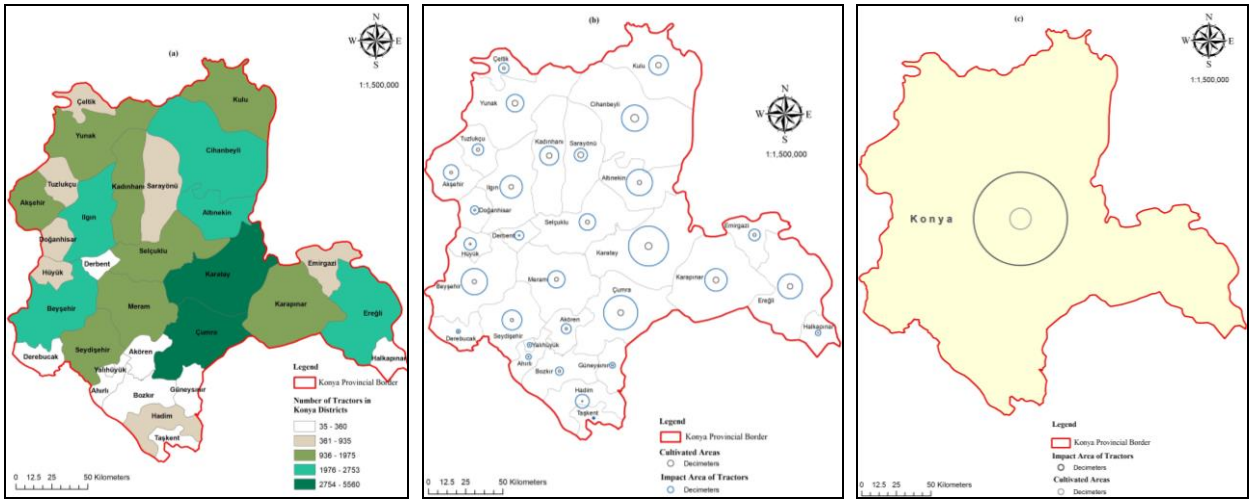
Kulu district, where farmers mostly produce grains, is found to be the most lacking district in terms of the presence of combine harvesters. The existing machinery pool in the Kulu district, with respect to their impact area, can only be sufficient for 36% of the areas harvested by combine harvester. According to the size of areas harvested by combine harvester, there should be 88 harvesters in this district, while only 36 units are available and 52 more combine harvesters are required.

Cihanbeyli is the second in the ranking of districts where the need for combine harvesters is highest. Although this district is the first province in Konya in terms of cultivated areas; the existing number of combine harvesters can only be sufficient for 73% of the cultivated areas and 39 more combine harvesters are needed in this district.

According to the impact areas of combine harvesters, the districts where most combine harvesters are acquired are Karatay (305 units), Selçuklu (83 units) and Emirgazi (81 units).

Tractors:

The number of tractors in the districts of Konya province, and the circular sizes of machine group impact areas and planted areas in Konya at the district and province scale are given in Figure 7. Table 8 shows the cultivated areas and the impact areas of tractors.



(a) (b) (b)

Figure 7
(a) Number of tractors in Konya districts, (b) Representation of machine group impact areas and cultivated areas as circular sizes in Konya districts. (c) Representation of machine group impact area and cultivated area as circular sizes in Konya province.

Table 8
Impact Areas of Tractors and Cultivated Areas

District	Number of Agricultural Tools and Machines(units)	Impact area of the Tools/machines (da year^{-1})	Impact Radius of the Group (m)	Cultivated Area (da)	Cultivated Area Radius (m)	Necessary Number of tools/Machines Based on Cultivated Area (units)	Difference in Number of tools/machines (Necessary-Existing)
Karatay	5,560	71,879,680	151,261	1,286,503	20,236	100	-5,460
Çumra	3,975	62,582,400	141,140	1,108,580	18,785	70	-3,905
Ereğli	2,753	30,305,024	98,216	893,597	16,865	81	-2,672
Ilgın	2,547	22,169,088	84,004	531,473	13,007	61	-2,486
Altınekin	2,531	34,016,640	104,057	649,907	14,383	48	-2,483
Beyşehir	2,328	38,141,952	110,186	580,481	13,593	35	-2,293
Cihanbeyli	2,367	44,840,448	119,470	1,588,982	22,490	84	-2,283
Seydişehir	1,975	23,763,200	86,972	354,342	10,620	29	-1,946
Karapınar	1,834	52,349,696	129,087	999,737	17,839	35	-1,799
Meram	1,714	13,382,912	65,268	405,361	11,359	52	-1,662
Akşehir	1,495	13,777,920	66,224	292,714	9,653	32	-1,463
Selçuklu	1,485	13,875,840	66,459	484,820	12,423	52	-1,433
Kulu	1,465	34,128,640	104,228	1,152,087	19,150	40	-1,425
Kadınhanı	1,454	29,964,032	97,662	899,923	16,925	44	-1,410
Yunak	1,269	19,329,408	78,439	840,146	16,353	55	-1,214
Hadim	935	2,632,960	28,950	76,979	4,950	27	-908
Çeltik	878	6,967,808	47,095	318,078	10,062	40	-838
Sarayönü	656	26,449,920	91,756	888,258	16,815	22	-634
Hüyük	551	13,329,792	65,138	173,009	7,421	7	-544
Doğanhisar	516	4,425,216	37,531	147,360	6,849	17	-499
Tuzlukçu	482	6,478,080	45,410	271,353	9,294	20	-462
Emirgazi	425	8,268,800	51,303	288,652	9,585	15	-410
Akören	360	4,515,840	37,913	140,614	6,690	11	-349
Derbent	307	3,575,936	33,738	83,142	5,144	7	-300
Bozkır	256	4,390,912	37,385	95,213	5,505	6	-250
Ahırlı	195	1,822,080	24,083	53,991	4,146	6	-189
Güneysınır	185	2,912,640	30,449	112,655	5,988	7	-178
Halkapınar	151	1,449,600	21,481	39,881	3,563	4	-147
Yalıhüyük	86	1,166,848	19,272	32,810	3,232	2	-84
Derebucak	52	858,624	16,532	24,728	2,806	1	-51
Taşkent	35	658,560	14,478	21,203	2,598	1	-34
Konya	40,821	310,651,547	314,457	14,619,579	68,217	1,921	-38,900

Source: The agricultural machinery presence, the cultivated/planted areas are from Turkey Statistical Institute (anonymous, 2017). Other variables are calculated by the authors based on equation (1), equation (2) and equation (3).

According to Figure 7 and Table 8, the first three districts with the highest number of tractors are Karatay district with the presence of 5,560 units, Çumra district with 3,975 units and Ereğli district with 2,753 units.

The last ranks are occupied by Taşkent district with 35 units, Derebucak district is one rank above with 52 units and Yalıhüyük with 86 tractors.

When we analyze the presence of tractors in Konya districts in terms of power distribution, we observe that those districts which have large agricultural lands and mainly engage in field crop cultivation like Karatay, Çumra, Cihanbeyli, etc. have high-power tractors, whereas in districts that mostly commonly grow vegetables and fruits like Hadim, Ereğli, Beyşehir etc. farmers prefer less powerful and usually single-axle tractors.

The impact area of 5,560 tractors in the Karatay district was calculated as 71,879,680 da. According to this impact area, while 100 tractors were sufficient for the cultivated areas of Karatay district (1,286,503 da), 5,460 more tractors were acquired. It can be said that there are 3,905 excess units in Çumra, which is in the second place, and 1,799 excess tractors in Karapınar district, which is in third place.

In comparing the impact area of the tractor with with the cultivated area, Taşkent district is in the last place with 34 excess units, Derebucak has 51 excess units and Yalıhüyük district has 84 tractors in excess.

Among the 7 machine groups identified throughout Konya, the largest number of machines is in the soil tillage and seed bed preparation machine group, the largest impact area belongs to the plantcare and fertilizer machine group, and the most surplus is seen in the soil tillage and seed bed preparation machinery group. In the case of harvesting machines, their number is found to be inadequate.

In this study, the usability of geographical information systems in the field of agricultural machinery is demonstrated and the research is designed at the district level for richer detail. Both of these factors required comprehensive work. With this study, in 31

districts of Konya province, cultivated areas and the impact areas of agricultural machinery categorized in 7 groups were converted into maps by using ArcGis 10.4 program.

At the district level, it was found that the most surplus was in the group of soil tillage and seed bed preparation machines, with 7,554 excess units in Çumra, 6,266 units in Karatay and 6,067 units in Altınekin district. Again at the district level, the most deficiency was observed in the group of harvesting machines in the districts of Kadınhanı, Kulu, Yunak, Sarayönü, Cihanbeyli, Beyşehir and Ereğli.

When individual machines forming the groups are examined at the district level; the 5,460 tractors in Karatay, 3,905 tractors in Çumra, and 3,546 moldboard type tractor ploughs in Çumra are in excess, whereas 2,149 more balers in Cihanbeyli district, and 1,706 more balers in Karatay district are needed along with 1,674 more atomizers in Cihanbeyli district and 1,346 more atomizers in Karatay district.

In Konya province overall surplus in agricultural machinery groups are 62,707 units in the soil tillage and seed bed preparation machines, 38,900 units in tractors, 20,872 units in the plantcare and fertilization machinery group, 13,354 units in the agricultural pest control machinery group, 12,869 units in the sowing and planting machines and 612 units in combine harvesters. In the group of harvesting machines, there is a need for 335 more machines.

At the provincial level, among the individual machines forming the groups, the surplus is 20,463 moldboard type tractor ploughs, 18,106 chemical fertilizer distributors and 10,574 PTO driven sprayers; whereas the shortage is 17,711 balers, 14,842 atomizers and 8,403 pneumatic seeders.

As a result of this study conducted in Konya at both provincal and district level, we can conclude that although there is an unused mechanization capacity in all machine and machine groups in general; there is also a significant gap in Konya districts with respect to machines such as stubble sowing machine, subsoiler, stone collecting machine, manure spreading machine, stalk shredder machine, and baler machine which support novel environment-friendly approaches and have recently been introduced to the machine pool.

The main finding of the study is that there is a generalized inert mechanization capacity in terms of both the agricultural machinery groups and individual machines forming the groups in Konya districts. This inert mechanization capacity, which is quite substantial in Konya districts, leads to higher investment costs in machinery capital in enterprises. Therefore, encouraging the joint use of machinery or contracting can be proposed as a solution.

It is important to develop policies to encourage the acquisition of machines such as baler, atomizer, pneumatic seed drill, stubble sowing machine, subsoiler, stone collecting machine, manure spreading machine and shredder machine, which are found to be lacking in numbers in Konya province. Moreover, it is vital to plan for the elimination of the deficiencies in mechanization tools used in irrigated agricultural areas, which are expected to increase in the near future after all stages of operation of the Konya Plain Project (KOP) are completed.

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