



## Machinery Levels of Black Carrot-Producing Agricultural Enterprises in Ereğli and Karapınar Towns of Konya Province\*\*

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### ABSTRACT

The primary objective of the present study was to generate a database for mechanization levels of black carrot-producing agricultural enterprises in Konya region. Sample villages were selected purposefully, and 37 enterprises were visited to apply face-to-face questionnaires. Present findings revealed that land size per enterprise was 1124.6 da, average number of plots was 10.2, total number of plots was 379 and average plot size was 78.8 da. About 62.69% of total cultivated lands was used for black carrot production and it was respectively followed by irrigated wheat farming (15.39%), tomato cultivation (7.09%) and irrigated barley farming (6.61%). With regard to mechanization level of the present enterprises, number of tractors per enterprise was 2.81, average tractor power was 68.65 kW, number of tools and machines per tractor was 6.52, mass of tool-machine per tractor was 9.45 tons, average engine power per unit area was 1.72 kW ha<sup>-1</sup>, number of tractors per 1 000 ha land area was 24.99 and cultivated land per tractor was calculated as 40.01 ha.

### 1. Introduction

Black carrot is largely consumed in Turkey. Black carrot is not consumed much as fresh vegetable, it is mostly used as fermented juice. Carrot is a root-crop. Central Anatolia region and especially Konya province is the greatest carrot producer of Turkey. Yellow carrot is produced in Kaşınhanı town of Konya and black carrot is commonly produced in Ereğli and Karapınar towns of Konya. Reliable data are not available for the carrot production of the region.

It was estimated that companies had growers performed black carrot cultivation for concentrate juice production over 40 thousand da land area of the region in 2018 and purchased about 160 thousands of black carrot (130 thousand tons for concentrate and 30 thousand tons for turnip) and such a quantity corresponded about 40 thousand decares.

Black carrot contains 26.40 mg (100 ml)<sup>-1</sup> ascorbic acid (Kırca 2004). Turnip juice produced from black carrot is a fermented product and has an appetizing characteristic (Canbaş and Deryaoğlu 1993). Turnip juice also contains lactic acid. Lactic acid gives a sour taste to turnip juice, facilitates mineral use of the body and regulates pH of digestive system. It is a peptic and refreshing product (Miişoğlu 2004). Black carrot has a quite high antioxidant activity and it is a good source of anthocyanin pigment. It is a remarkable product with a high anthocyanin content (1750 mg kg<sup>-1</sup>) and special quality parameters (Kırca et al 2006). Anthocyanins are the most natural food dyes providing shiny red color to foodstuffs and commonly used as an alternative to synthetic colorants (Bridle and Timberlake 1997, Giusti and Wrolstad 2003). Black carrot concentrate is also used as a natural fabric dye.

Agricultural structures of the regions are generally assessed through number of agricultural enterprises, land sizes of these enterprises, number of plots of each enterprise, credit supply, household share, number, age, gender and education of workers of enterprises. Agricultural mechanization levels should also be put forth in such assessments.

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In previous studies, mechanization levels of carrot (yellow) producing enterprises of Konya province (Yokuş et al 2015), Çumra town of Konya province (Keleş and Haciseferoğulları 2016), enterprises of Şanlıurfa-Harran plain (Bozkurt and Aybek 2016), enterprises of Muş plain (Akar and Çelik 2017), Kırklareli province (Kayhan et al 2017), Malatya province (Aslantürk and Altuntaş 2018), sunflower-producing enterprises of Çorum province (Altuntaş and Bal 2018) and Karaman province (Kirpitçi et al 2018) were investigated.

Among the agricultural inputs of black carrot production, mechanization investments constitute a significant place. Therefore, structure and mechanization characteristics of the producer enterprises should be well analyzed for planned and properly mechanization investment in carrot production. There aren't any studies in literature about mechanization levels of black carrot-producing enterprises. Thus, in this study, tractor and agricultural machinery inventories and agricultural mechanization levels of agricultural enterprises were determined.

## 2. Materials and Methods

Four districts (villages) of Ereğli and Karapınar towns of Konya province were selected as the research sites of the present study. Black carrot is produced in these villages (Kuzukuyu and Beyören districts of Ereğli town and Akören and Oymalı districts of Karapınar town. Black carrot-producing agricultural enterprises of these districts constituted the research population. About 90% of regional production come from these four villages. Therefore, these villages (Kuzukuyu, Beyören, Oymalı and Akören) were selected purposefully. Questionnaire forms were applied to enterprise managers through face-to-face meetings in November and December of 2018.

Interviews were made with the local authority (mukhtar) of these villages and 2018 Farmer's Registration System records were assessed and ultimately 75 black carrot-producing agricultural enterprises were determined. While selecting these enterprises, enterprises with small land sizes and different enterprises of the same family were not taken into consideration. Full-count method was applied to these enterprises. However, some enterprises rejected to participate into the survey and some were not able to be found in their places. Therefore, questionnaires were applied to 37 black carrot-producing agricultural enterprises. Resultant data were also supported with observation technique. Total sowing area of black carrot-producing agricultural enterprises of the region is around 40 000 da. Sowing area of questionnaire-applied 37 enterprises is 26 090 da corresponding to 65% of total sowing area of the region.

Annual total fuel consumptions were used for better assessment of annual tractor operational durations of the enterprises. Engine power and specific fuel consumption of the enterprise tractors were also taken into consideration and the following equations were used in relevant calculations (Işık and Atun 1998):

$$AOD = AFC / (SFC \times LR \times P_m) \quad (1)$$

AOD : Annual operational duration (h year<sup>-1</sup>),  
 AFC : Annual total fuel consumption (L year<sup>-1</sup>),  
 SFC : Specific fuel consumption (LkWh<sup>-1</sup>),  
 LR : Tractor loading rate, taken as 0.40,  
 P<sub>m</sub> : Tractor engine power (kW).

SPSS software was used for statistical analyses of survey data. Frequency, percentiles and mean values were used in data analysis.

## 3. Results and Discussion

### General characteristics

Of the participant enterprises, 43.2% were doing this business for ≥21 years, 21.6% for 16-20 years, 16.2% for 6-10 years, 16.2% for 11-15 years and 2.7% for 1-5 years. In general, present enterprises were quite experienced in black carrot production.

Ages of enterprise owners varied between 25 -61 years with an average age of 43.6 year. As compared to average farmer's age of International Labor Organization (ILO) (58 years), average age of enterprise owners was low (Evcim et al 2015).

Of the participant enterprise owners, 51.4% had primary school education, 10.8% had secondary school education, 29.7% had high school education and 8.1% had university education. Survey results revealed that households contributed to agricultural productions in 91.9% of the enterprises and did not have any contributions in 8.1% of the enterprises.

Total sowing area of the present enterprises was 41 610 da corresponding to a land size of 1 124.6 da per enterprise. Total sowing area of the enterprises varied between 40 – 500 da and land size was mostly (8.1%) 200 da. Number of plots varied between 1- 32 with an average value of 10.2. Total number of plots was 379 and average plot size was 78.8 da.

Plant production status of black carrot-producing enterprises is provided in Table 1. Black carrot production was performed on 62.69% of total sowing area. It was respectively followed by irrigated wheat farming (15.39%), tomato cultivation (7.09%) and irrigated barley farming (6.61%). Apart from these products, maize (2.64%), alfalfa (2.27%), potato (1.20%), silage maize (1.17%) and sugar beet (0.73%) were cultivated by the present enterprises.

Table 1  
Plant production over the agricultural fields

Type of crop	Sowing area (da)	Yield (kg da <sup>-1</sup> )	Total number of Enterprises	Frequency (%)
<u>Irrigated farming</u>				
Black carrot	26 090	4 028.4	37	62.69
Wheat	6 405	788.2	20	15.39
Barley	2 750	599	12	6.61
Silage maize	486	5714	7	1.17
Alfalfa	944	1 800	13	2.27
Kernel maize	1 100	1 500	2	2.64
Tomato	2 950	10 899	9	7.09
Potato	500	4 500	1	1.20
Sugar beet	305	9 333	3	0.73
<u>Dry farming</u>				
Barley	80	250	1	0.19

#### Tractor inventory of the enterprises

Total number of tractors of black carrot-producing enterprises was 104, thus the number of tractors per enterprise was 2.81. Number of tractors varied between 1-7 and 27% of enterprises had 1-3 tractors, 18.95% had 4 tractors, 16.2% had 2 tractors and 5.4% had 5-7 tractors.

Distribution of tractor model years are presented in Figure 1. Of available tractors, 12.5% was 2013 model, 10.6% was 2016 model, 8.7% was 2014 and 2015 model, 6.7% was 2017 model, 5.8% was 2012 model,

4.8% was 1998 and 2011 model and 3.8% was 2018 model. Tractor models varied between 1969 - 2018 and average tractor model was 2007. In other words, average age of tractors was 12 years. The ratio of 10-years old tractors was 66.5%. In Turkey, there were 1 254 190 rubber-tired two-axial tractors with different power groups in 2018 and average tractor age was over 25 years (TUIK 2019; Anonymous 2019). Average tractor age in present study was lower than the country average.

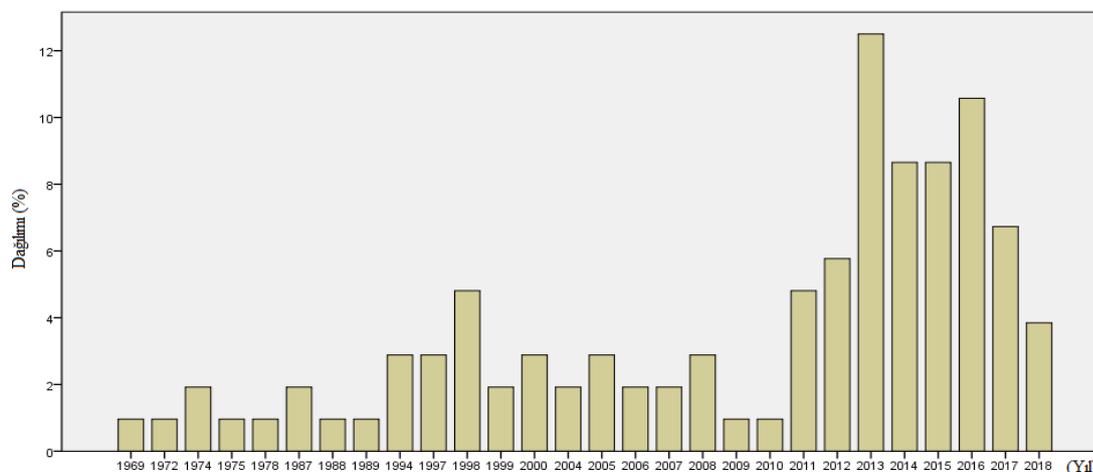


Figure 1  
Distribution of tractor models

In Turkey, about 30 companies are in tractor market with about 40 brands. Therefore, there different brands of different companies in tractor parks of the enterprises. Of these tractors, 29.8% was New Holland, 24% was Massey Ferguson, 18.3% Tümosan, 16.3% Fiat, 2.9% John Deere, 1.9% Ford, Erkunt and Hattat and about 1% was Kubato, Deutz and Claas Arion (Figure 2).

Average tractor power was 68.63 kW. Average tractor power of Turkey is 44.2 kW (60 BG) (Anony-

mous, 2019). Power distribution of present tractors is provided in Table 2. About 63.46% of tractors had a power of between 40.1 - 70 kW. Evcim et al (2015) reported that 10% of Turkish tractor park had a power of greater than 51.5 kW. In present study, 76.92% of tractors had a power of greater than 50.1 kW. Present tractor powers and power distribution values were quite greater than the average of Turkey

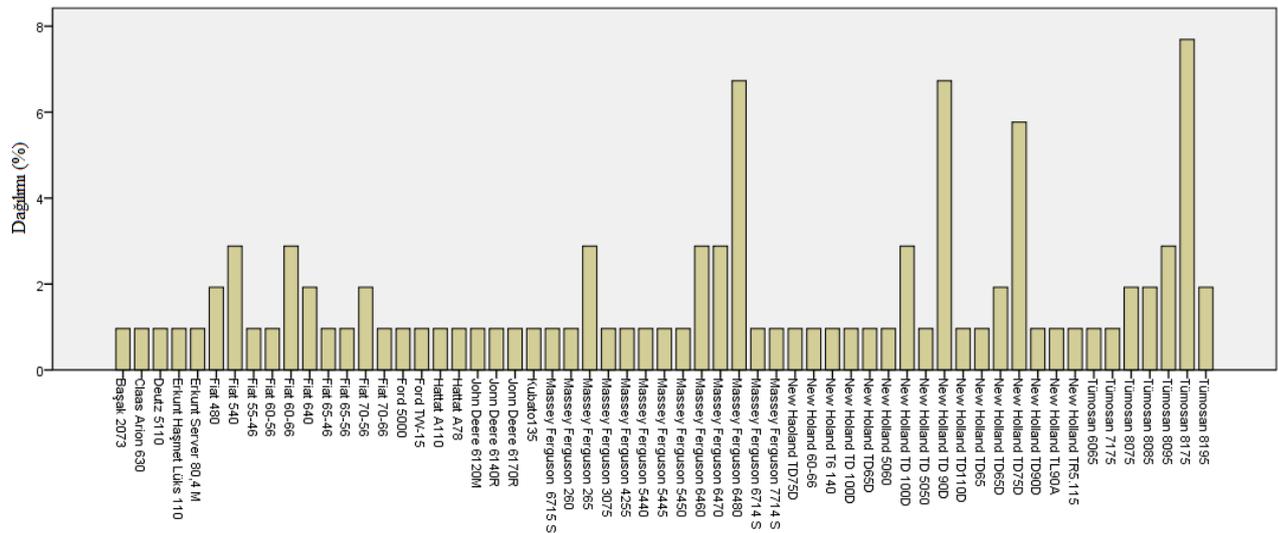


Figure 2  
Distribution of tractor brands

Table 2  
Power distribution of tractors of the enterprises

Power (kW)	Number of tractors	Percentage (%)	Average power of the groups (kW)
35-40	4	3.85	35.29
40.1-50	20	19.23	45.73
50.1-60	26	25.00	55.29
60.1-70	20	19.23	65.93
70.1-80	7	6.73	75.20
80.1-90	9	8.65	84.56
90.1-100	2	1.92	97.44
100.1-110	6	5.77	105.52
110.1-120	5	4.81	113.2
121.1-130	5	4.81	122.8
Total	104	100	-

#### Annual operational duration of tractors

Annual fuel consumptions of the enterprises were determined. Among the annual fuel consumptions, fuel consumed by the diesel vehicles and trucks were not able to be clearly identified. Therefore, 12 enterprises with a truck were not taken into consideration and fuel consumptions of 55 tractors of only 25 enterprises were taken into consideration. Annual operational durations of the tractors varied between 147.7 - 1 189.9 h with an average value of 657.2 h year<sup>-1</sup>. Annual operational duration of tractors in Çumra town was reported as 532.5 h year<sup>-1</sup> (Keleş and Haciseferoğulları 2016). High operational hours of black carrot-producing enterprises were attributed to large land size of the enterprises and contracting services for harvest-like mechanization practices.

#### Agricultural machinery inventory

Number of agricultural machines, common types, number of machines per tractor and enterprise are provided in Table 3.

There was a total of 678 agricultural tool - machine in present enterprises. Number of tool-machines per

tractor was calculated as 6.52 and number of tool-machines per enterprise was calculated as 18.32.

Distribution of the most common agricultural tool and machines of the enterprises were as follows: 116 trailer, 68 moldboard plough, 42 centrifuge-type fertilizer distributor, 43 vertical and horizontal-shaft rototiller, 40 pulverizator, 32 hoeing machine without fertilizer, 32 hoeing machine with fertilizer, 29 horizontal weeding machine, 25 silage machine and 22 cultivator. Number of these machines per enterprise was respectively calculated as 3.14, 1.84, 1.08, 1.14, 0.86, 0.72, 0.78, 0.68 and 0.59. The other tools and machines followed these previous ones.

The black carrot-producing enterprises of Ereğli and Karapınar towns also produce cereals, feed crops and tomato. Moldboard plough and conventional soil tillage are commonly used in production of these commodities. Such a case can clearly be inferred from the number of moldboard ploughs in machine parks. Conventional soil tillage in black carrot production requires intensive tillage and thus generates soil compaction.

Just based on production chain of black carrot, among the conservation soil tillage machines, there were 47 rototillers (25 horizontal-shaft and 18 vertical-shaft) and they were used in seedbed preparations. Of the moldboard ploughs, 10.3% (7 ploughs) were rotary-type and 4 of them had 4 bodies and two of them had 2 bodies. Sandy soil texture of the region generally generates soil compaction problems.

Sowing was performed with pneumatic precise vegetable sowing machines in almost half (46%) of the enterprises. About 70% of precise sowing machines were local brands and the other vegetable sowing ma-

chines were imported. Combined cereal sowing machines and pneumatic precise sowing machines were used in sowing of the other products and number of such machines per enterprise was 0.41 and 0.22.

The enterprises without a pneumatic precise vegetable sowing machine generally purchased the service of pneumatic machines.

Enterprises cut carrot leaves with a hay silage machine, clean carrot heads with a horizontal chopper and collect leaves with hay rakes and number of such machines per enterprise was 0.68, 0.78 and 0.57, respectively

Table 3

Number of agricultural machines, common types and number of machines per tractor and enterprise

Agricultural machines	Number	Type / capacity	Range	Common type	Common type ratio (%)	Machine/tractor	Machine / Total mass enterprise (kg)
Moldboard plough	68	Body	3-6	4 bodies	60.65	0.65	1.84
Subsoiler + chisel blaster	14	Leg	5-13	9 legs	28.57	0.13	0.38
Cultivator	22	Leg	9 - 17 legs	13 legs	40.90	0.21	0.59
Horizontal shaft rototiller	25	Blade	54 - 84 blades	72 blades	48.00	0.24	0.68
Vertical shaft rototiller	18	Blade	16 - 32 blades	24 blades	55.56	0.17	0.49
Ridge making machine	23	Unit	4 units	4 units	100	0.22	0.62
Hoeing machine with fertilizer	29	Unit	5-7 units	5 units	65.51	0.28	0.78
Hoeing machine without fertilizer	32	Leg	4	4	100	0.31	0.86
Trailer	116	Capacity	3-10 tons	8 tons	68.10	1.11	3.14
Pneumatic vegetable planting machine	17	Row	4 rows	4 rows – mechanical	100	0.16	0.46
Centrifuge-type fertilizer distributor	40	Tank capacity	250-1000 L	1 000 L	42.5	0.38	1.08
Pulverizator	42	Tank capacity	600-2 000 L	1 000 L	57.14	0.40	1.14
Silage machine	25	Number of blades	21	21	100	0.24	0.68
Hay rake	21	Unit	3-8	5	42.85	0.20	0.57
Horizontal straw chopper	29	Number of blades	24	24	100	0.28	0.78
Suspended-type carrot harvester	18	Two-row	2 rows	2 rows	100	0.17	0.49
Pull-type carrot harvester	19	Number of rows	1-2	2	57.90	0.18	0.51
Self-propelled carrot harvester	4	Two-row	2 rows	2 rows	100	0.04	0.11
Combined cereal harvester	15	Row	16-32	20 rows	33.33	0.14	0.41
Mechanical carrot planting machine	1	Row	4 rows triple	4	100	0.01	0.03
Maize silage machine	7	Row	1-2 rows	1 row	85.71	0.06	0.19
Roller	4	Operational width (m)	2.5-3.5	3 m	50.00	0.04	0.11
Pneumatic precise sowing machine	8	Unit (fertilizer)	4-6	4 units	62.50	0.08	0.22
Feed mixer and distributor	12	Tank capacity	6-12 m <sup>3</sup>	8 m <sup>3</sup>	41.67	0.12	0.32
Rotary drum mower	8	Operational width	1.35-1.90	1.65	62.5	0.08	0.22
Disk mower	3	Number of disks	6 disks	6 disks	100	0.03	0.08
Double serrate blade mower	5	Number of blades	22	22	100	0.05	0.14
Baler	8	Rectangular and roll	Rectangular and roll	Rectangular	87.50	0.08	0.22
Front loader	15	Tank capacity	0.58-0.72 m <sup>3</sup>	0.72 m <sup>3</sup>	66.67	0.14	0.41
Rear loader	5	Number of lifts	1-2	Double lift (0.28 m <sup>3</sup> )	80.0	0.05	0.14
Leveling blade	21	Operational width	2-3 m	2.4 m	52.38	0.20	0.57
Solid fertilizer distributor	4	Capacity	6.5-15 m <sup>3</sup>	10 m <sup>3</sup>	50.00	0.04	0.11
Fixed milking facility*	14	Number of heads	7-20	10 heads	42.86	-	-
Truck*	23	Capacity	20 – 30 tons	20 tons	69.56	-	-
Beko loader*	4	Front loader and scraper	-	-	-	-	--
<b>Total</b>	<b>678</b>						<b>982 717</b>

\*Number and mass were not included in calculations

In black carrot harvest, 10.8% of the enterprises were using self-propelled harvesters, 51.4% were using pull-type harvesters and 48.6% were using suspended-type harvesters. All of the self-propelled harvesters and 94.7% of pull-type harvesters were imported. Suspended-type harvesters were local brands and some enterprises commonly use them for pull-out and boxing of black carrots.

Trailers are commonly used to transport pulled out black carrots to washing facilities. Therefore, number of trailers per tractor (1.11 trailers) and enterprise (3.14 trailers) had the greatest ratios.

Table 4

Agricultural mechanization level of black carrot-producing enterprises

Mechanization criteria	Value
Number of enterprises	37
Cultivated land (ha)	4161
Number of tractors	104
Number of tractors per enterprise	2.81
Number of tool-machines per enterprise	18.32*
Average tractor power (kW)	68.63
Power per enterprise (kW enterprise <sup>-1</sup> )	192.89
Number of machines per tractor	6.52*
Cultivated land per tractor (ha tractor <sup>-1</sup> )	40.01
Machine mass per tractor (ton tractor <sup>-1</sup> )	9.45
Tractor power per unit of cultivated land (kW ha <sup>-1</sup> )	1.72
Number of tractors per 1 000 ha of cultivated land [(tractor (1 000 ha) <sup>-1</sup> ]	24.99

It was reported in previous studies for Kadınhanı and Çumra towns of Konya province, number of tractors per enterprise was respectively 0.81 and 1.0, number of tool-machines per tractor was 11.50 and 14.92, tractor power per enterprise was 39.92 and 60.89 kW, average tractor power was 49.06 and 58.70 kW, machine mass per tractor was 6.43 and 10.77 tons, average engine power per unit area was 1.91 and 4.08 kW ha<sup>-1</sup>, number of tractors per 1 000 ha cultivated land was 38.91 and 69.47 and cultivated land per tractor was 25.69 and 14.39 ha (Yalmançı 2008; Keleş and Haciseferoğulları 2016). It was reported in another study conducted with sunflower-producing enterprises of Çorum province that average tractor power of enterprises was 44.78 kW, number of tool-machines per tractor was 5.2, average power per unit area was 3.99 kW ha<sup>-1</sup> and cultivated land per tractor was 10.78 ha (Bal and Altuntaş 2018). The present tractor power per unit of cultivated land and number of tractors per 1 000 ha cultivated land were greater and the other parameters were lower than those earlier ones. Lower values were attributed to recently performed land consolidation in Akören village, thus intensive production and greater land size of enterprises (112.5 ha enterprise<sup>-1</sup>).

For Turkey in general, number of tractors per 1 000 ha cultivated land is 45, cultivated land per tractor is 26 ha, tractor power per unit area is 1.68 kW ha<sup>-1</sup>, number of tool-machines per tractor is 5.2, machine mass per tractor is 4.2 tons and average tractor power is 44.2 kW (60 BG) (Anonymous, 2019). As compared to these values, present number of tractors per 1 000 ha was

#### Indicators of agricultural mechanization levels

Indicators of mechanization levels for black carrot-producing enterprises are provided in Table 4. Number of tractors per enterprise was 2.81, number of tool-machines per enterprise was 18.32, average tractor power was 68.63 kW, tractor power per enterprise was 192.89 kW, number of machines per tractor was 6.52, cultivated land per tractor was 40.01 ha tractor<sup>-1</sup>, machine mass per tractor was 9.45 tons, tractor power per unit of cultivated land was 1.72 kW ha<sup>-1</sup> and number of tractors per 1 000 ha cultivated land was 24.99.

lower and the other parameters were greater than country averages.

#### 4. Conclusion

The present study was conducted to determine agricultural mechanization characteristics of black carrot-producing agricultural enterprises. A database was generated with the aid of present data for mechanization planning of enterprises. Present parameters should be updated regularly to provide contributions to enterprise economies. For mechanization planning, some other variables such as climate data, time factors, energy needs of agricultural machines should be added to present database. In this way, optimum capacity tractors and machines suitable for enterprise sizes should be supplied to enterprises.

Land size of present enterprises were remarkable (112.5 ha enterprise<sup>-1</sup>). Over the black carrot-producing lands, land consolidation was performed only in Akören village. Land consolidation hasn't been performed in the other three villages. Therefore, number of plots varied between 1 – 32 with an average value of 10.2. Total number of plots was 379 and average plot size was 78.8 da. Such a case makes the purchase of expensive agricultural machines difficult and also limits the size of agricultural tools and machines. Such small plots increase agricultural inputs and unit costs. Therefore, land consolidation works should be accelerated in the region.

Average age of available tractors was 11 years. Such a value is lower than county (Turkey) average (25 years). It should be pointed out that data on tractor park and mechanization indicators were generally greater than country averages.

Further research is recommended about the average ages and economic lives of agricultural machines. Machines should be so selected as to comply with the tractor powers. Ratio of imported sowing and harvest machines is also remarkable. Such ratios should be reduced through manufacture and purchase of local brands. Number of different tool and machines for tomato, feed crops and cereals was sufficient in number and diversity.

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