

# Spatial Distribution of Local Sheep Breeds in Antalya Province

Serife Gulden Yilmaz, Suleyman Karaman

**Abstract**—Sheep breeding is important in terms of meeting both the demand of red meat consumption and the availability of industrial raw materials and the employment of the rural sector in Turkey. It is also very important to ensure the selection and continuity of the breeds that are raised in order to increase quality and productive products related to sheep breeding. The protection of local breeds and crossbreeds also enables the development of the sector in the region and the reduction of imports. In this study, the data were obtained from the records of the Turkish Statistical Institute and Antalya Sheep & Goat Breeders' Association. Spatial distribution of sheep breeds in Antalya is reviewed statistically in terms of concentration at the local level for 2015 period spatially. For this reason; mapping, box plot, linear regression are used in this study. Concentration is introduced by means of studbook data on sheep breeding as locals and total sheep farm by mapping. It is observed that Pırlak breed (17.5%) and Merinos crossbreed (16.3%) have the highest concentration in the region. These breeds are respectively followed by Akkaraman breed (11%), Pırlak crossbreed (8%), Merinos breed (7.9%) Akkaraman crossbreed (7.9%) and Ivesi breed (7.2%).

**Keywords**—Antalya, sheep breeds, spatial distribution, local.

## I. INTRODUCTION

SMALL ruminant breeding is important in terms of employment of the rural sector in Turkey. It is also very important to meeting both the demand of red meat consumption and the availability of industrial raw materials.

Turkey is one of the leading countries in the world in terms of small ruminant breeding due to its geographical and ecological characteristics [3]. Furthermore, Turkey is one of the most important genetic resources because of genetic background development by several civilizations in Anatolia [7]. The amount of small ruminant was 41 million 329 thousand in 2016, and it decreased 1.4% by comparison with 2015. In Turkey, most of the sheep are local breed [6]. While the amount of sheep in Turkey was 28.5 million in 2000, it decreased to 21.8 million in 2009 with 24% [13]. Although the amount of sheep increased in the following years, the decrease rate was 21% in last 25 years. Moreover, it was observed that the amount of sheep was 30 million 983 thousand in 2016 and it decreased %1.7 by comparison with previous year. Total milk production in 2016 decreased to 18 million 489 thousand tonnes with 0.9% by comparison with previous year. Also, 6.3% of total milk production was obtained from sheep in 2016. In addition, wool production increased 5.6% in 2016

according to 2015 [15]. The amount of sheep in West Mediterranean Region was 2.6% of total sheep amount in Turkey in 2013. Ivesi, Akkaraman, Pırlak, Sakiz breeds and crossbreeds and Central Anatolian Merino breed are mostly raised in this region [4]. The amount of sheep in Antalya increased to 440 thousand 373 with 50.7% from 1991 to 2016 [14], [15].

Conservation and development of local sheep breeds are important in terms of using as genetic material. Local breeds are important genetic resource for the development of new genotypes with the purpose of increase the resistance to several factors and conservation of yield capacity in harsh and insufficient environmental conditions [11].

In Turkey, local sheep breeds are very important in terms of genetic variation and they need to be taken under protection due to danger of extinction. Thus, this study provides a new perspective to develop a policy about protection of animal genetic resources. Moreover, spatial distribution of local sheep breeds in Antalya was evaluated in terms of concentration.

## II. SHEEP BREEDING, FORAGE, AND CLIMATE RELATIONS

When registered sheep breeding enterprises of Antalya Sheep and Goat Breeders' Association are observed in terms of district basis, it is seen that Korkuteli, Manavgat, Elmalı and Serik districts have high concentration of distribution (Fig. 1).

High quality and yield of meadow-rangelands are important for feeding of sheep, decrease of forage costs, and providing good quality of meat and milk products. Antalya has 2 087 426 hectares total area, and 7.34% of this area is meadow-rangelands. Furthermore, there is no sufficient meadow-rangelands in Turkey, therefore, feeding of sheep need to be supplied with hay, compound and concentrated feeds in addition to grazing [2]. The largest meadows in Antalya are in Korkuteli, Elmalı, Gündoğmuş, Akseki and Alanya districts respectively, and it can be said that sheep breeding can be increased in these districts [1] (Fig. 1).

When the the distribution of meadow areas in Antalya is observed, it is seen that the highest concentration is in Elmalı district, and it is followed by Korkuteli, Manavgat, Alanya and Kaş districts (Fig. 2).

In Antalya, Ibradı had the highest precipitation in last ten years, and it was followed by Akseki, Manavgat, Gündoğmuş and Alanya districts (Fig. 3).

It was observed that sheep production is big in high concentrated meadow areas, and it is small in high precipitation and mountainous areas.

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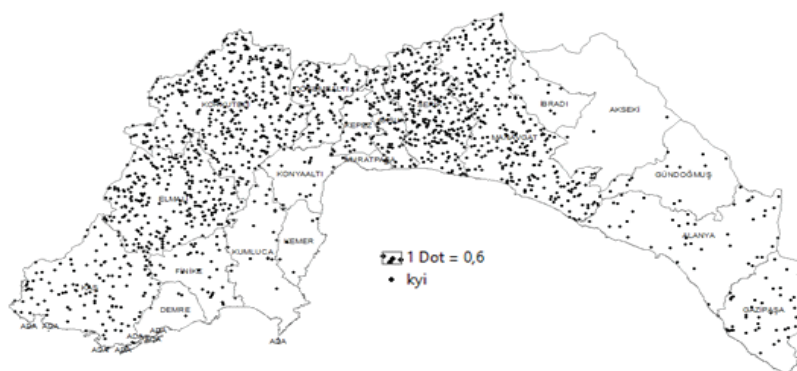


Fig. 1 The distribution of sheep breeding enterprises in Antalya Province

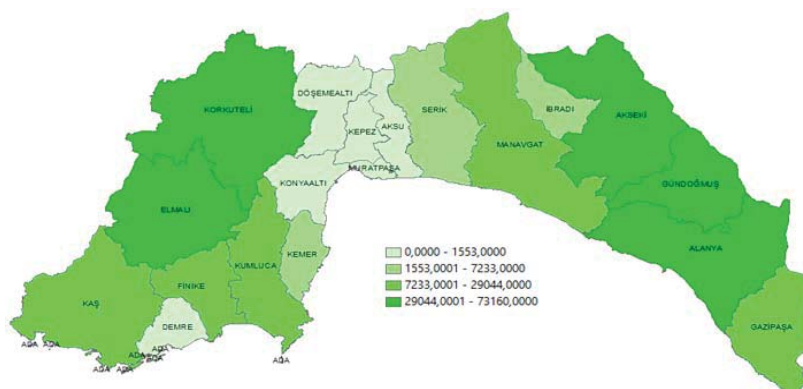


Fig. 2 Spatial distribution of meadows (ha)

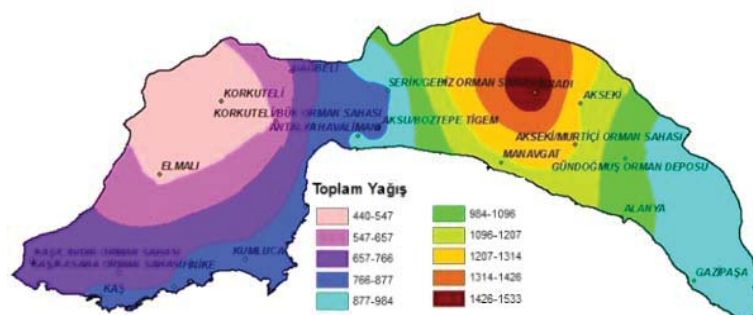


Fig. 3 Total precipitation in last ten years in Antalya Province

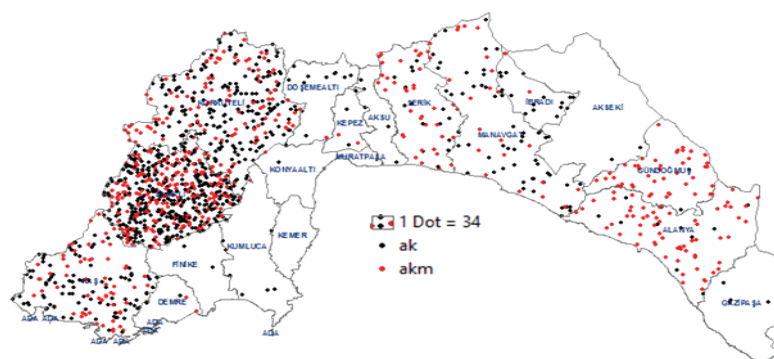


Fig. 4 Spatial distribution of Akkaraman breed and crossbreed

### III. MATERIALS AND METHODS

#### A. Material

The data about sheep breeding enterprises and sheep breeds were obtained from statistics of Ministry of Food, Agriculture and Livestock, and studbook of Sheep & Goat Breeders' Association. In this studbook, there are registrations of 26 sheep breeds belong to Antalya location. The other data related to sheep breeding were obtained from Agricultural Structure and Production statistics of Turkish Statistical Institute.

#### B. Method

The spatial distribution of sheep breeds (10 breeds) and crossbreeds that are highly found in sheep breeding enterprises in Antalya Province in 2015, was analysed with mapping, box plot and linear regression. Each method that were used for evaluation of statistics about sheep breeds and crossbreeds, are explained below in detail.

##### 1. Spatial Distribution

The spatial distribution of sheep breeds and crossbreeds were introduced with maps by ArcGIS (ver.10) software. Sheep breeds and crossbreeds were introduced together in maps, and spatial distribution of both of them was revealed.

##### 2. Box Plot

Box plot gives information about the figure of variable distribution. In other words, it enables to visualising of symmetry and distribution of sample data. Moreover, extreme values and outliers can be introduced visually by box plot. It separated data set to 5 parts consisting of the lowest value, lower quartile of the distribution (25% of cumulative distribution–Q1), median (Q2), higher part (75% of cumulative distribution – Q3) and the highest value. Median is represented by the line that is in the center of the box plot. Box plot shows also outliers that is described as minimum and maximum values (1.5 or 3 that are generated randomly by GeoDa) of the difference between first and third quartiles. For instance, lower outlier can correspond to a low value,  $[Q1 - 1.5 * (Q3 - Q1)]$  and higher outlier is described as a high value  $[Q3 + 1.5 * (Q3 - Q1)]$ . The thin line that is in the upper part of the box plot, is defined as whisker. It represents 1.5 times default criterion of the difference between first and third quartiles.

##### 3. Linear Regression

Linear regression analysis was done in terms of sheep breed. The amount of sheep crossbreed was considered for each sheep breed as dependent variable due to sheep crossbreed is depend on sheep breed. The amount of sheep breed is used as explanatory variable in the regression analysis. Scatter plot between two variables, coefficient values, t statistics and marginal probability were given in the regression analysis.

##### 4. Spatial Index

Spatial index was used to express change of local sheep breeds according to space more understandable and simple.

When spatial index is created, arithmetic mean is calculated and the amount of sheep breed in each location is divided to arithmetic mean and multiplied by 100 [12]. Any value in the spatial index represents of situation of the amount of sheep breed belongs to the *i* location according to the mean.

### IV. RESULTS

#### A. Akkaraman

Akkaraman is one of the local sheep breed in Turkey, and it is available to breed in semi-arid climate that is dry and hot in summers, cold and snowy in winters. Akkaraman breed is resistant to harsh environmental conditions, diseases and long walking. This breed also is chosen because of it can be fed in poor meadows, can be raised in poor meadows that is not rugged, and it has high meat and milk yield [5], [8].

When the Fig. 3 is observed, it is seen that this breed is raised more in midland and high parts of Mediterranean Region.

11% of total sheep amount in Antalya is Akkaraman breed and 7.8% of it is Akkaraman crossbreed. 42% of Akkaraman sheep is crossbreed. Akkaraman breed is found 9 times more in Elmalı, 4 times more in Korkuteli, 2 times more in Kaş and 23% more in Manavgat district by comparison with the average. Akkaraman crossbreed is found 7 times more in Elmalı, 3 times more in Korkuteli, 2 times more in Kaş and Alanya, %43 more in Gündoğmuş and %19 more in Serik district by comparison with the average (Table I).

Akkaraman breed has the highest concentrations in Elmalı and Korkuteli districts, and they are followed by Kaş and Manavgat districts. Akkaraman crossbreed has the highest concentrations in Elmalı, Korkuteli, Alanya and Kaş districts (Fig. 4).

Distribution and outliers of Akkaraman breed and crossbreed are introduced by box plot in Fig. 5. While, Akkaraman breed is not found in some locations, the highest amount (12450) of it is found in Elmalı district. 25% of spatial data of Akkaraman breed are more than 414. There are 4 outliers in the box plot of Akkaraman breed. In other words, Akkaraman breed is found in different levels in 4 different locations. While Akkaraman crossbreed is not found in some locations, the highest amount of it is found in Elmalı and Korkuteli districts. 25% of spatial data of Akkaraman crossbreed are more than 118. Akkaraman crossbreed is found in extreme levels in 6 different locations. Spatial variation of Akkaraman breed is 43% more than spatial variation of Akkaraman crossbreed. Sheep amount is more variable in the locations, where Akkaraman breed is found in.

Akkaraman crossbreed is obtained by crossbreeding of Akkaraman breed and other sheep breeds. So, there is a relation with Akkaraman breed and Akkaraman crossbreed. The increase in amount of Akkaraman crossbreed is depend on distribution of Akkaraman breed. 90% of the increase in amount of Akkaraman crossbreed is caused by changes on the amount of Akkaraman breed; however, only 10% is independent variable with uncertain reasons. Variability of Akkaraman breed is statistically significant at 1% level. When the amount of Akkaraman breed increases 1 unit, Akkaraman

crossbreed increases 0.57 units. In other words, spatial Akkaraman breed in a large extent. distribution of Akkaraman crossbreed is depend on

TABLE I  
SPATIAL INDEX OF SHEEP BREEDS AND CROSSBREED

	Ak Karaman	Ak Karaman Crossbreed	İvesi	İvesi Crossbreed	Merinos	Merinos Crossbreed	Kıvırcık	Kıvırcık Crossbreed	Pırlıt	Pırlıt Crossbreed
Demre	5	5	0	13	0	48	0	0	0	0
Gazipaşa	9	0	35	369	7	33	0	0	0	0
Finike	7	0	2	81	8	19	8	86	0	0
Kaş	207	193	243	75	102	28	122	3	0	0
Kemer	0	0	0	0	5	5	14	21	0	0
Alanya	28	206	1	3	33	150	1	20	0	1
Kumluca	15	1	0	0	52	18	163	67	0	0
Muratpaşa	0	0	0	0	15	18	0	0	0	4
Konyaaltı	3	0	0	0	30	10	0	0	0	0
Elmalı	845	695	313	403	185	182	10	149	35	130
Gündoğmuş	5	143	0	24	6	13	0	0	0	2
Kepez	8	6	3	16	27	27	14	145	51	77
Aksu	9	1	0	1	16	26	0	7	282	1
Döşemealtı	29	5	1	0	122	45	16	94	134	57
İbradı	38	11	0	0	4	25	0	12	35	6
Serik	37	119	4	10	69	260	175	8	17	339
Akseki	6	0	0	0	5	12	0	0	6	0
Korkuteli	425	344	786	311	496	343	385	40	288	136
Manavgat	123	70	12	92	719	636	192	650	152	447
Ortalama	100	100	100	100	100	100	100	100	100	100
	Pırlak	Pırlak Crossbreed	Sakız	Sakız Crossbreed	Tahirova	Tahirova Crossbreed	Mor Karaman	Mor Karaman Crossbreed	Anadolu Merinosu	Anadolu Merinosu Crossbreed
Demre	0,2	0,0	0,0	26,0	0,0	0,0	0,0	0,0	0,0	0,0
Gazipaşa	0,0	2,6	7,0	21,7	0,0	0,0	0,0	0,0	0,0	0,0
Finike	4,7	27,6	14,7	28,0	0,0	0,0	3,3	3,4	1,5	128,8
Kaş	25,5	1,0	196,8	50,1	77,6	58,8	0,4	29,0	328,7	448,3
Kemer	0,4	3,6	47,7	0,2	0,0	0,0	0,0	0,0	279,0	193,5
Alanya	8,3	4,4	6,2	44,3	3,1	47,1	15,5	377,5	125,6	14,2
Kumluca	2,5	2,2	155,0	20,5	0,0	0,0	4,1	0,0	2,9	0,0
Muratpaşa	4,4	14,7	2,3	1,2	0,0	0,0	0,0	0,0	0,0	38,4
Konyaaltı	12,8	0,7	55,4	147,4	0,0	0,0	0,0	0,0	8,8	0,0
Elmalı	90,0	26,6	327,4	396,1	686,7	123,5	79,2	11,9	43,8	170,8
Gündoğmuş	1,5	1,6	3,5	16,6	19,4	0,0	5,2	123,5	0,0	73,3
Kepez	31,3	110,4	49,2	100,0	7,1	0,0	0,4	0,0	77,4	7,1
Aksu	206,0	24,6	4,6	6,0	0,0	0,0	40,2	54,5	0,0	10,7
Döşemealtı	172,4	66,2	62,4	55,0	4,1	0,0	4,1	17,9	5,8	0,0
İbradı	27,7	2,3	127,9	83,6	86,7	90,2	0,0	0,0	0,0	0,0
Serik	298,0	1029,6	105,4	9,7	5,1	15,7	102,8	197,7	125,6	3,6
Akseki	12,0	23,0	36,8	0,0	0,0	0,0	2,2	0,9	0,0	0,0
Korkuteli	522,1	149,8	471,1	722,2	51,0	111,8	997,0	120,1	100,8	11,4
Manavgat	380,3	308,8	126,7	71,5	59,2	252,9	45,7	163,6	0,0	0,0
Ortalama	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0

#### B. İvesi

İvesi breed has high adaptability to different environmental conditions, dry and cot climates, and can walk long distances. Thus, this breed is available for raising in midland and high parts of Mediterranean Region like Akkaraman breed [5], [8].

7% of total sheep amount in Antalya is İvesi breed, and 5% of it is İvesi crossbreed. 42% of total amount of İvesi sheep is crossbreed. İvesi breed is found 8 times more in Korkuteli, 3 times more in Elmalı and 2 times more in Kaş district by comparison with the average. İves crossbreed is found 4 times more in Elmalı and Gazipaşa, and 3 times more in Korkuteli

district by comparison with the average (Table I).

İvesi breed has high concentration especially in Korkuteli district as is seen in Fig. 6. Breeding of İvesi breed is more in Korkuteli, Elmalı and Kaş districts. It is also observed that breeding of İvesi crossbreed is more in Elmalı, Gazipaşa, Korkuteli and Manavgat districts respectively.

Distribution and outliers of İvesi breed and crossbreed are introduced by box plot in Fig. 7. İvesi breed is not found in 9 locations, and it is found in 7 locations in a low level. The highest amount (9799) of İvesi breed is found in Korkuteli. There are 3 outliers in the box plot of İvesi breed. In other

words, Ivesi breed is found in different levels in 3 different crossbreed are more than 145. Ivesi crossbreed is found in locations. While Ivesi crossbreed is not found in 7 locations, extreme levels in 5 locations. Spatial variation of Ivesi breed is the highest amount of Ivesi crossbreed is found in Elmalı, 99% higher than Ivesi crossbreed. Sheep amount is more Gazipaşa and Korkuteli districts. 25% of spatial data of Ivesi variable in the locations, where Ivesi breed is found in.

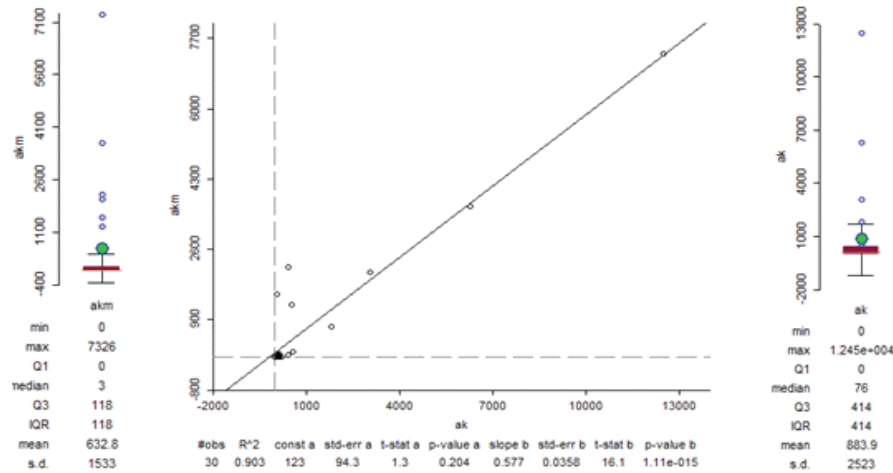


Fig. 5 Regression analysis and box plot of Akkaraman breed and crossbreed

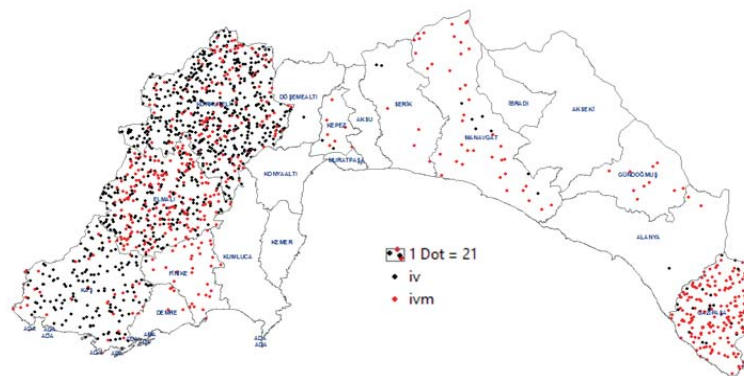


Fig. 6 Spatial distribution of Ivesi breeds and crossbreed

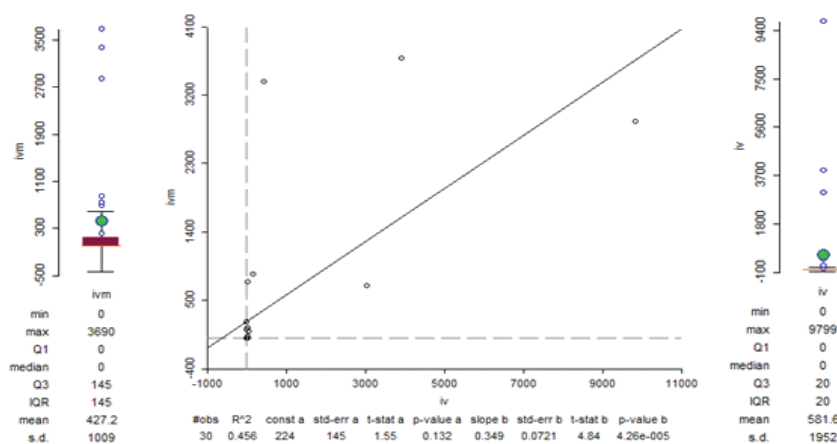


Fig. 7 Regression analysis and box plot of Ivesi breed and crossbreed

There is linear relationship between the amount of Ivesi breed and crossbreed. 46% of the increase in amount of Ivesi



crossbreed is caused by changes on the amount of Ivesi breed; however, 54% is independent variable with uncertain reasons. Variability of Ivesi breed is statistically significant at 1% level. When Ivesi breed increases 1 unit, Ivesi crossbreed increases 0,35 unit. In other words, spatial distribution of Ivesi crossbreed is depend on Ivesi breed in a low extent. Because, farmers might chose Ivesi crossbreed due to adaptability to the region.

#### C. Merino Sheep

Merino breed that has high wool yield, is more preferred in low rugged meadows. Local breeds are crossbred with Merino with the purpose of increase meat and wool yield. For instance; Karacabey Merino Sheep was obtained by crossbreeding with Kivırcık and German Wool Merino Sheep, and, Central Anatolian Merino Sheep was obtained by crossbreeding of German Mutton Merino Sheep and Akkaraman. These breeds have high meat and wool yield, adapted to terrestrial climate, and are resistant to diseases [8].

67% of Merino sheep is crossbreed. Merino breed is found 7 times more in Manavgat, 5 times more in Korkuteli, 2 times more in Elmalı and 22% more in Döşemealtı district by comparison with the average. Merino crossbreed is found 6 times more in Manavgat, 3 times more in Korkuteli and Serik, 2 times more in Elmalı and 50% more in Alanya district by comparison with the average (Table I).

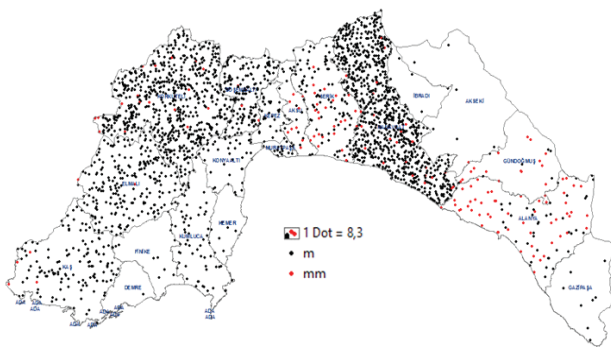


Fig. 8 Spatial distribution of Merino breeds and crossbreed

Merino breed is 5<sup>th</sup> most raised sheep with 7.9% in Antalya. Merino breed has the highest concentration in Manavgat district, and it is followed by Korkuteli, Elmalı and Döşemealtı districts. Merino crossbreed is the second most raised sheep in Antalya with 16.3%. Merino crossbreed has the highest concentration in Manavgat district; moreover, it has high concentration in Korkuteli and Serik districts also (Fig. 8).

Distribution and outliers of Merino breed and crossbreed are introduced by box plot in Fig. 9. While Merino breed is not found one location, it is found in 6 locations in a low level. The highest amount (7265) of Merino breed is found in Manavgat district. There are 3 outliers in the box plot of Merino breed. In other words, Merino breed is found in different levels in 3 different locations. Merino crossbreed is found in extreme levels in 5 locations. Spatial variation of Merino breed is 19% more than spatial variation of Merino

crossbreed. Sheep amount is more variable in the locations, where Merino breed is found in.

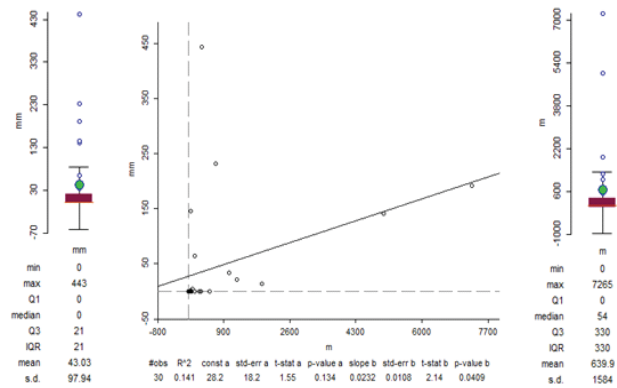


Fig. 9 Regression analysis and box plot of Merino breed and crossbreed

There is linear relationship between the amount of Merino breed and crossbreed. 14% of the increase in amount of Merino crossbreed is caused by changes on the amount of Merino breed, however, 86% is independent variable with uncertain reasons. Variability of Merino breed is statistically significant at 5% level. When Merino breed increases 1-unit, Merino crossbreed increases 0,02 unit. Merino breed is more spatially distributed than Merino crossbreed. Merino crossbreed is more distributed than Merino breed in Alanya and Serik districts. Spatial distribution of Merino crossbreed is depending on Merino breed in a low extent.

#### D. Kivırcık

Kivırcık breed has high meat and milk yield, high adaptability and strong body. This breed is resistant to harsh environmental conditions, and it can walk long distance even in a rugged terrain [5], [8]. 53% of Kivırcık sheep is crossbreed. Kivırcık breed is found 4 times more in Korkuteli, 2 times more in Manavgat and Serik, 63% more in Kumluca and 22% more in Kaş district by comparison with the average. Kivırcık crossbreed is found 7 times more in Manavgat, 49% more in Elmalı and 45% more in Kepez district by comparison with the average (Table I).

Kivırcık breed has the highest concentration in Korkuteli district, and it is followed by Manavgat and Serik districts. Kivırcık crossbreed is found in Manavgat district at the most; furthermore, it has high concentrations in Elmalı and Kepez districts (Fig. 10).

Distribution and outliers of Kivırcık breed and crossbreed are introduced by box plot in Fig. 11. While Kivırcık breed is not found in 8 locations, it is found in 6 locations in a low level. Korkuteli and Manavgat districts have the highest amount of Kivırcık breed. There are 5 outliers in the box plot of Kivırcık breed. In other words, Kivırcık breed is found in different levels in 5 different locations. Kivırcık crossbreed is found in extreme levels in 3 locations. Spatial variation of Kivırcık crossbreed is 45% more than spatial variation of Kivırcık breed. Sheep amount is more variable in the locations, where Kivırcık crossbreed is found in.

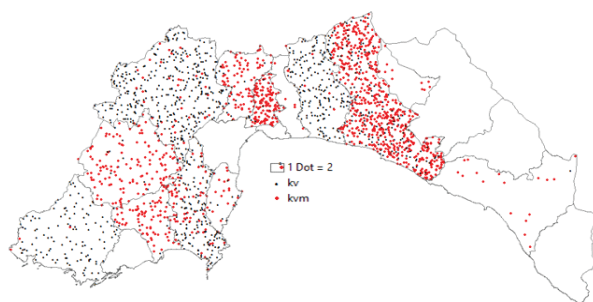


Fig. 10 Spatial distribution of Kıvrık breeds and crossbreed

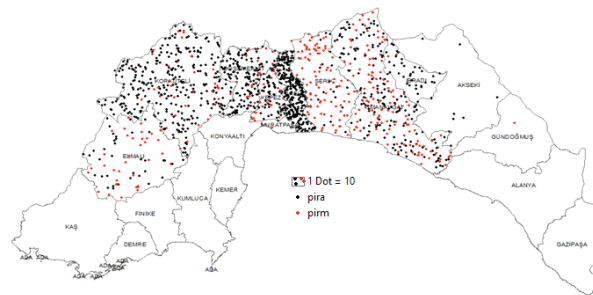


Fig. 12 Spatial distribution of Pırlak breeds and crossbreed

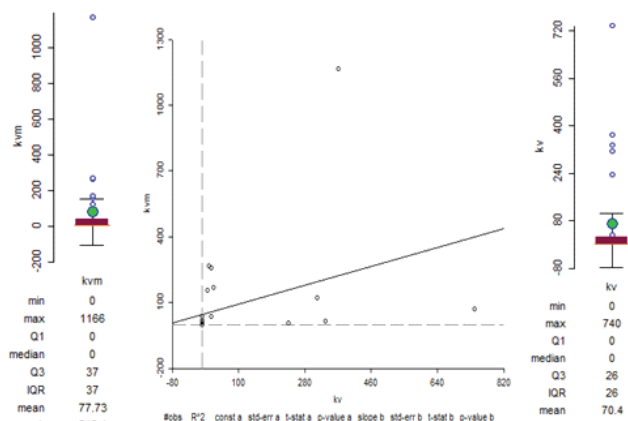


Fig. 11 Regression analysis and box plot of Kıvrık breed and crossbreed

As a result of linear regression analysis between Kıvrık breed and crossbreed, it was observed that 13% of the increase in amount of Kıvrık crossbreed is caused by changes on the amount of Kıvrık breed, however, 87% is independent variable with uncertain reasons. Variability of Kıvrık breed is statistically significant at 5% level. When Kıvrık breed increases 1 unit, Kıvrık crossbreed increases 0.48 unit. Kıvrık breed is more spatially distributed than Kıvrık crossbreed. Kıvrık crossbreed is more distributed than Kıvrık breed in Finike, Elmalı, Kepez and Manavgat districts.

#### E. Pırlak

Pırlak breed is resistant to harsh environmental conditions and diseases. It is mostly raised by family farms as small herds and, moreover, its meat is delicious [5]. 4.4% of total sheep amount in Antalya is Pırlak breed, and 1.4% of it is Pırlak crossbreed. Only 25% of Pırlak sheep is crossbreed. Pırlak breed is found 3 times more in Korkuteli and Aksu, 52% more in Manavgat and 34% more in Döşemealtı district by comparison with the average. Pırlak crossbreed is found 5 times more in Manavgat, 3 times more in Serik, 36% more in Korkuteli and 30% more in Elmalı district by comparison with the average (Table I). Pırlak breed has the highest concentration in Korkuteli and Aksu districts, and, Manavgat district follows that. Pırlak crossbreed is found in Manavgat and Serik districts at the most (Fig. 12).

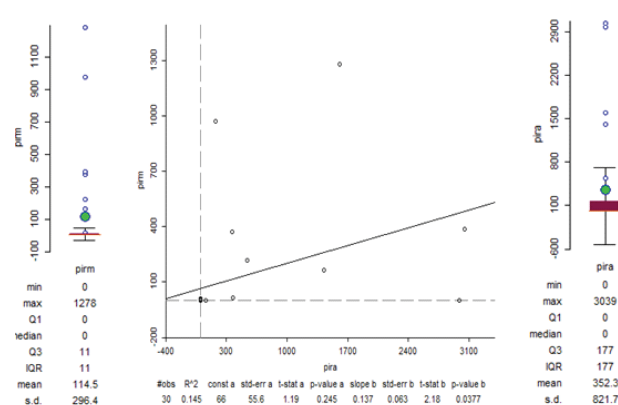


Fig. 13 Regression analysis and box plot of Pırlak breed and crossbreed

Distribution and outliers of Pırlak breed and crossbreed are introduced by box plot in Fig. 13. While Pırlak breed is not found in 10 locations, it is found in 2 locations in a low level. It is found in Korkuteli and Aksu districts at the most. There are 4 outliers in the box plot of Pırlak breed. In other words, Pırlak breed is found in different levels in 4 different locations. Pırlak crossbreed is found in extreme levels in 6 locations. Spatial variation of Pırlak crossbreed is 26% more than spatial variation of Pırlak breed. Sheep amount is more variable in the locations, where Pırlak crossbreed is found in.

As a result of linear regression analysis between Pırlak breed and crossbreed, it was observed that 15% of the increase in amount of Pırlak crossbreed is caused by changes on the amount of Pırlak breed, however, 85% is independent variable with uncertain reasons. Variability of Pırlak breed is statistically significant at 5% level. When Pırlak breed increases 1 unit, Pırlak crossbreed increases 0.14 unit. Pırlak breed is more spatially distributed than Pırlak crossbreed. Pırlak crossbreed is more distributed than Pırlak breed in Serik and Elmalı districts.

#### F. Pırlak

Pırlak is dual-purpose sheep breed, has delicious meat. It is resistant to harsh environmental conditions and diseases, and have high adaptability to dry and hot climates. Moreover, this breed is raised as nomadic [5], [8].

31% of Pırlak sheep is crossbreed. Pırlak breed is found 5 times more in Korkuteli, 4 times more in Manavgat, 3 times more in Serik, 2 times more in Aksu and 72% more in Döşemealtı district by comparison with the average. Pırlak

crossbreed is found 10 times more in Serik, 3 times more in Manavgat and 50% more in Korkuteli district by comparison with the average (Table I).

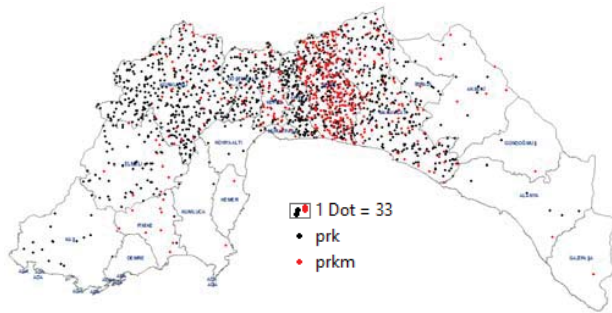


Fig. 14 Spatial distribution of Pırlak breeds and crossbreeds

While Pırlak breed is the most raised sheep with 17.5% in Antalya, Pırlak crossbreed is the 4<sup>th</sup> with 8%. Pırlak breed has the highest concentration in Korkuteli district, and it is followed by Manavgat and Serik districts. Concentration of Pırlak crossbreed is the highest in Serik district (Fig. 14).

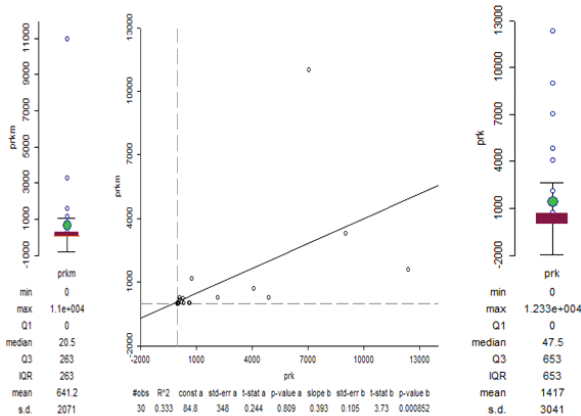


Fig. 15. Regression analysis and box plot of Pırlak breed and crossbreed

Distribution and outliers of Pırlak breed and crossbreed are introduced by box plot in Fig. 15. While Pırlak breed is not found in 1 location, it is found in 4 locations in a low level. It is found in Korkuteli, Manavgat, Serik and Aksu at the most. There are 5 outliers in the box plot of Pırlak breed. In other words, Pırlak breed is found in different levels in 5 different locations. Pırlak crossbreed is found in extreme levels in 4 locations. Spatial variation of Pırlak crossbreed is 108% more than spatial variation of Pırlak breed. Sheep amount is more variable in the locations, where Pırlak crossbreed is found in.

As a result of linear regression analysis between Pırlak breed and crossbreed, it was observed that 33% of the increase in amount of Pırlak crossbreed is caused by changes on the amount of Pırlak breed, however, 67% is independent variable with uncertain reasons. Variability of Pırlak breed is statistically significant at 1% level. When Pırlak breed increases 1 unit, Pırlak crossbreed increases 0,39 unit. Pırlak

breed is more spatially distributed than Pırlak crossbreed. Pırlak crossbreed has higher concentration than Pırlak breed in Serik, Kepez and Finike districts.

#### G.Sakız

Sakız breed shows early development. It has very high fertility and milk yield, and delicious meat. This breed has low adaptability and poor herd instinct. Breeding of Sakız sheep in harsh terrestrial climatic conditions is not suitable. Moreover, it is used in the crossbreeding of local breeds, which have a low yield [5], [8], [9].

69% Sakız sheep is crossbreed. Sakız breed is found 5 times more in Korkuteli, 3 times more in Elmalı, 2 times more in Kaş and 55% more in Kumluca district by comparison with the average. Sakız crossbreed is found 7 times more in Korkuteli, 4 times more in Elmalı and 47% more in Konyaaltı district by comparison with the average (Table I).

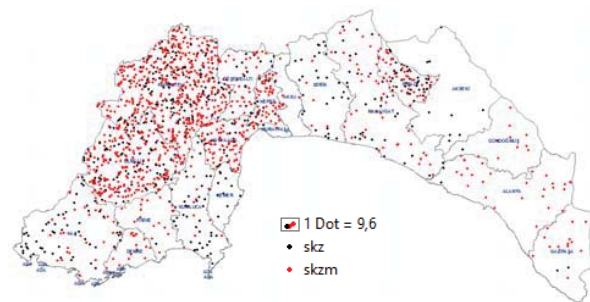


Fig. 16 Spatial distribution of Sakız breeds and crossbreeds

Sakız breed has the highest concentration in Korkuteli, Elmalı and Kaş districts in Antalya Province. Sakız crossbreed has higher amount and concentration than Sakız breed in Antalya, and Sakız crossbreed has the highest concentration in Korkuteli and Elmalı districts (Fig. 16).

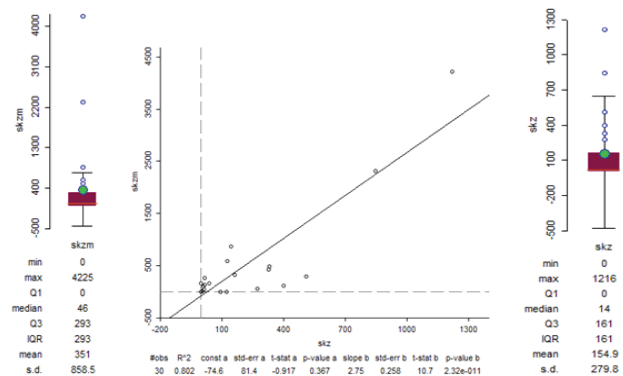


Fig. 17 Regression analysis and box plot of Sakız breed and crossbreed

Distribution and outliers of Sakız breed and crossbreed are introduced by box plot in Fig. 17. While Sakız breed is not found in 1 location, it is found in 7 locations in a low level. The highest amount of it is found in Korkuteli, Elmalı and Kaş districts. There are 2 outliers in the box plot of Sakız breed.



In other words, Sakız breed is found in different levels in 2 different locations. Sakız crossbreed is found in extreme levels in 3 locations. Spatial variation of Sakız crossbreed is 64% more than spatial variation of Sakız breed. Sheep amount is more variable in the locations, where Sakız crossbreed is found in.

As a result of linear regression analysis between Sakız breed and crossbreed, it was observed that 80% of the increase in amount of Sakız crossbreed is caused by changes on the amount of Sakız breed; however, 20% is independent variable with uncertain reasons. Variability of Sakız breed is statistically significant at 1% level. When Sakız breed increases 1 unit, Sakız crossbreed increases 2,8 unit. Sakız crossbreed is more spatially distributed than Sakız breed. Sakız crossbreed has higher concentration than Sakız breed in Korkuteli, Kepez and Elmalı districts.

#### H. Tahirova

Tahirova was obtained by crossbreeding of Doğu Friz x Kivırcık, it is dual-purpose sheep and especially used by milk producers [10]. It has high fertility and multiparous characteristic, and raised in family farms. It can be raised in not too poor meadows with good practices [5]. Tahirova breed is found in Elmalı district at the most with 7 times more than the average. Tahirova crossbreed is found 3 times more in Manavgat, 23% more in Elmalı and 12% more in Korkuteli district by the comparison with the average (Table I).

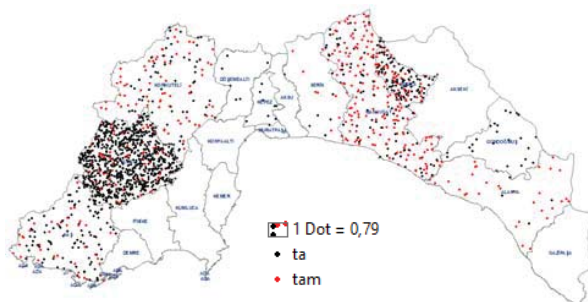


Fig. 18 Spatial distribution of Tahirova breed and crossbreed

Tahirova breed has the highest concentration in Elmalı district, and it is followed by Ibradi and Kaş districts. Tahirova crossbreed has the highest concentration in Manavgat district, it has also high concentration in Elmalı and Korkuteli districts (Fig. 18).

Distribution and outliers of Tahirova breed and crossbreed are introduced by box plot in Fig. 19. While Tahirova breed is not found in 9 locations, it is found in 4 locations in a low level. It is found in Elmalı and Ibradi districts at the most. There are 3 outliers in the box plot of Tahirova breed. In other words, Tahirova breed is found in different levels in 3 different locations. Tahirova crossbreed is found in extreme levels in 7 locations. Spatial variation of Tahirova breed is 139% more than spatial variation of Tahirova crossbreed. Sheep amount is more variable in the locations, where Tahirova breed is found in.

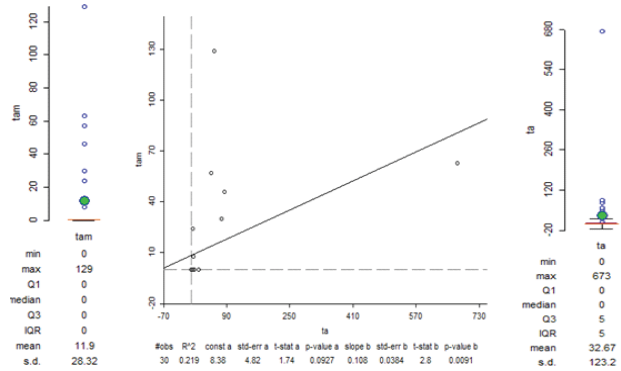


Fig. 19 Regression analysis and box plot of Tahirova breed and crossbreed

As a result of linear regression analysis between Tahirova breed and crossbreed, it was observed that 22% of the increase in amount of Tahirova crossbreed is caused by changes on the amount of Tahirova breed, however, 78% is independent variable with uncertain reasons. Variability of Tahirova breed is statistically significant at 1% level. When Tahirova breed increases 1 unit, Tahirova crossbreed increases 0,11 unit. Tahirova breed is more spatially distributed than Tahirova crossbreed. Tahirova crossbreed has higher concentration than Tahirova breed in Manavgat and Korkuteli districts.

#### I. Morkaraman

Morkaraman is a dual-purpose sheep breed; it is resistant to harsh environmental conditions, cold and snowy weathers and diseases. Breeding of Morkaraman sheep can be done in not so rugged and poor meadows [5], [8]. Morkaraman breed is found in Korkuteli district at the most with 10 times more than the average, and it is followed by Serik district. Morkaraman crossbreed is found 4 times more in Alanya, 2 times more in Serik and 63% more in Manavgat district by comparison with the average (Table I).

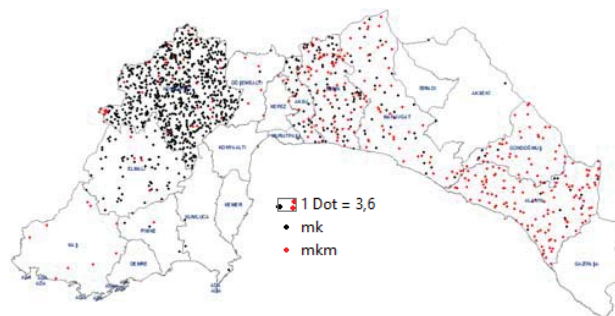


Fig. 20 Spatial distribution of Morkaraman breeds and crossbreed

Morkaraman breed has the highest concentration in Korkuteli district. Morkaraman crossbreed has the highest concentration in Alanya district, and it has also high concentration in Serik and Manavgat districts (Fig. 20).

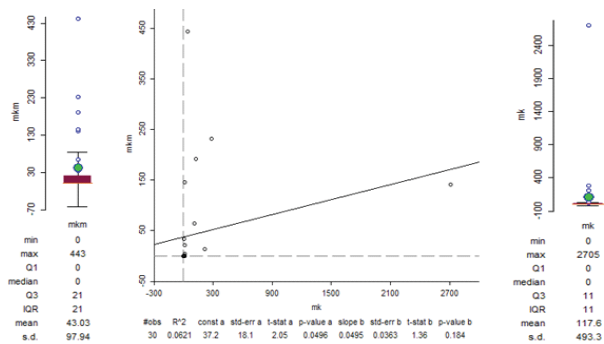


Fig. 21 Regression analysis and box plot of Morkaraman breed and crossbreed

Distribution and outliers of Morkaraman breed and crossbreed are introduced by box plot in Fig. 21. While Morkaraman breed is not found in 6 locations, it is found in 7 locations in a low level. The highest amount of it is found in Korkuteli, Elmalı and Serik districts. There are 3 outliers in the box plot of Morkaraman breed. In other words, Morkaraman breed is found in different levels in 3 different locations. Morkaraman crossbreed is found in extreme levels in 4 locations. Spatial variation of Morkaraman breed is 192% more than spatial variation of Morkaraman crossbreed. Sheep amount is more variable in the locations, where Morkaraman breed is found in.

Morkaraman breed is more spatially distributed than Morkaraman crossbreed. Morkaraman crossbreed has higher concentration than Morkaraman breed in Alanya, Gündoğmuş and Manavgat districts.

#### J. Anatolian Merino Sheep

Anatolian Merino Sheep was obtained by crossbreeding of German Mutton Merino Sheep and Akkaraman breed. This breed is raised for meat and wool. It has high adaptability to different environmental conditions, terrestrial climate and long walking [5], [8]. 67% of Anatolian Merino Sheep is crossbreed. Anatolian Merino breed is found 3 times more in Kaş and Kemer, 25% more in Alanya and Serik districts by comparison with the average. Anatolian Merino crossbreed is found 4 times more in Kaş, 2 times more in Kemer and Elmalı and 28% more in Finike district by comparison with the average (Table I).

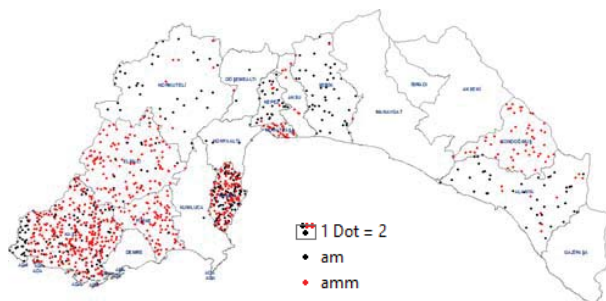


Fig. 22 Spatial distribution of Anatolian Merino breeds and crossbreed

Anatolian Merino breed has the highest concentration in Kaş and Kemer districts. Anatolian Merino crossbreed has higher concentration than Anatolian Merino breed in Antalya Province. Anatolian Merino crossbreed has the highest concentration in Kaş, Kemer, Elmalı and Finike districts. (Fig. 22).

Distribution and outliers of Anatolian Merino breed and crossbreed are introduced by box plot in Fig. 23. While Anatolian Merino breed is not found in 8 locations, it is found in 6 locations in a low level. The highest amount of it is found in Kemer, Alanya and Kaş districts. There are 5 outliers in the box plot of Anatolian Merino breed. In other words, Anatolian Merino breed is found in different levels in 5 different locations. Anatolian Merino crossbreed is found in extreme levels in 5 locations. Spatial variation of Anatolian Merino crossbreed is 30% more than spatial variation of Anatolian Merino breed. Sheep amount is more variable in the locations, where Anatolian Merino crossbreed is found in.

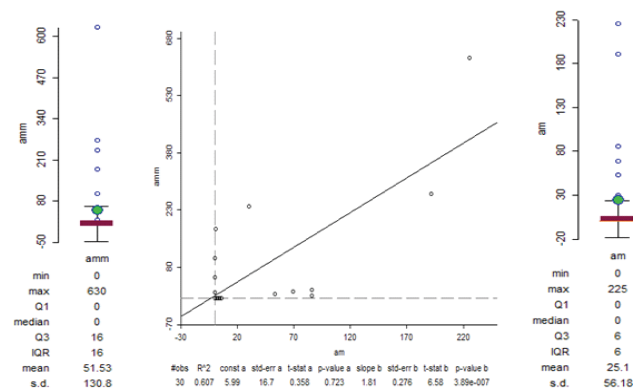


Fig. 23 Regression analysis and box plot of Anatolian Merino breed and crossbreed

As a result of linear regression analysis between Anatolian Merino breed and crossbreed, it was observed that 61% of the increase in amount of Anatolian Merino crossbreed is caused by changes on the amount of Anatolian Merino breed; however, 39% is independent variable with uncertain reasons. Variability of Anatolian Merino breed is statistically significant at 1% level. When Anatolian Merino breed increases 1-unit, Anatolian Merino crossbreed increases 1,8 unit. Anatolian Merino crossbreed is more spatially distributed than Anatolian Merino breed. Anatolian Merino crossbreed has higher concentration than Anatolian Merino breed in Finike, Kaş, Kemer, Gündoğmuş and Elmalı districts.

#### V. CONCLUSIONS

The highest sheep amount in Antalya Province belongs to Pırlak breed (17.5%), Merinos crossbreed (16.3%), Akkaraman breed (11%), Pırlak crossbreed (8%), Merions breed (7.9%), Akkaraman crossbreed (7.9%) and Ivesi breed (7.2%) respectively. When the spatial distribution of breeds is observed in terms of districts, Akkaraman breed and crossbreed have the highest concentration in Elmalı district. It is because of Akkaraman breed and crossbreed are resistant to

harsh environmental conditions, cold and diseases have high adaptability to poor meadows, poor nutrition and care, different climate conditions and terrestrial climate. Moreover, Tahirova breed has the highest concentration in Elmalı district, because it is resistant to diseases, has high adaptability to terrestrial climate and has high milk yield. Ivesi, Pırlak, Pırt and Morkaraman breeds that have high adaptability to dry and hot climates, different environmental conditions, and Sakız breed that has high fertility and milk yield, and has low climate adaptability, have high concentration in Korkuteli district.

Moreover, Merino breed and crossbreed that have high fertility, high meat and milk yield, is good on steppe climate that is low precipitation, Kıvrıkcık crossbreed that is resistant to harsh environmental conditions, has adaptability to maquis shrublands, high, moist and cold climates, and Pırt crossbreed that is resistant to harsh environmental conditions, diseases and long walking, and can be raised as nomadic, have high concentration in Manavgat district.

Furthermore, Pırlak crossbreed is concentrated in Serik district because it is suitable for low rugged meadows. Anatolian Merino breed and crossbreed are concentrated in especially highlands (Kalkan and Gömbe highlands) of Kaş district at the most, because these breed and crossbreed have high adaptability to low rugged and poor meadows, terrestrial climate and different environmental conditions. Breeding of these sheep breeds and crossbreeds increase in the districts of Antalya Province with adaptability practises from time to time; moreover, local people have breeding habits. These situations are effective on the concentration of the sheep breeds and crossbreed in the districts of Antalya Province.

Sheep crossbreed is obtained by crossbreeding of sheep breeds. Thus, there is a relation with sheep breeds and crossbreeds. According to linear regression analysis, the spatial distribution of Akkaraman, Sakız and Anatolian Merino crossbreeds are depend on distribution of their breeds. However, the spatial distribution of Ivesi, Merino, Kıvrıkcık, Pırt, Pırlak, Tahirova and Morkaraman crossbreeds are depend on uncertain reasons. These uncertain reasons can be indicated as bringing sheep breed and crossbreed from different location, choosing sheep crossbreed due to adaptability to the location, unconscious behaviours for renewing of sheep herd and maintaining of current situation of sheep herd.



Fig. 24 Sheep grazing in the highlands in Antalya Province

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