The Present Situation of Guarding Dog Usage Opportunities in Livestock Production of Turkey for Wolf Damages

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Abstract. *One of the most important problems of the small ruminant sector is economic losses due to predators. The problem is mostly caused by wild predators and manifests itself, especially by the damage caused to sheep and goat flocks, while the presence of these very same predators is absolutely necessary for the ecological system. Because sheep flocks generally graze in the pasture at night, guarding them from wild predators is an important aspect of pasture-based sheep farming. For this purpose, livestock guarding dogs have been used primarily against predators such as foxes, wolves, bears, coyotes, hyenas, and big cats. In this study, a specific research survey form was developed and used to determine predator damage and the current status of shepherd dog use. Sheep and goat flocks were randomly selected from 12 different provinces where the research was implemented. Among the farms included in the research, 40.4% of them breed sheep, 52.5% breed goats, and 7.1% breed both sheep and goats. The flock size varies between 100 to 500 heads, and the breeding system is traditionally based on pasture, with some flocks being bred as nomadic herds on plateaus or pastures during summer. Among the provinces included in this research, the average number of wolf attacks and the number of animal casualties were 6.01 ± 0.704 and 12.17 ± 1.329, respectively, and the differences between provinces were statistically significant ($P < 0.05$, $P < 0.01$). The average of the total economic damage caused by wolf attacks on sheep and goat herds was determined to be 2299.7 ± 235.2 US$ and losses between provinces differed significantly ($P < 0.01$).*

Introduction

One of the most important problems of the small ruminant sector is economic losses due to predators. The problem is mostly caused by wild predators and manifests itself, especially by the damage caused to sheep and goat flocks, while the presence of these very same predators is absolutely necessary for the ecological system. For this reason, the interest in the losses caused by wild predators (wolf, bear, jackal, lynx, hyena, dingo, coyote, etc.) to pasture-based animal production is increasing day by day (Kellert et al., 1996; Mech, 1999). The level of economic loss caused by predators in small ruminant production is not trivial. In the USA alone, wild predators constitute 34% of all causes of livestock deaths (Browns et al., 1997; McNeal, 2001). In 2004, the casualties in US farms due to predator damage amounted to 155.000 heads, corresponding to 18.3 million US dollars in economic value (Jones, 2004). For this reason, controlling predator damage in small ruminant flocks is one of the most important factors that will ensure the profitability of sheep and goat farming operations.

Different methods are used to protect and control sheep, goats, and other farm animals from wild predator attacks. These approaches can be categorized as passive (non-lethal) and active (lethal) methods, although they may not be suitable for all livestock breeders (Rollins et al., 2004). Therefore, when determining the most effective livestock protection program, it is of great importance to effectively combine herd husbandry practices with an integrated approach in terms of protection from wild predator attacks. In addition, one must be careful to ensure that the protection methods chosen for predator control do not cause stress among the animals in the flock. Sizewise, sheep and goats are the easiest targets for wild predator attacks, and, among all livestock species, they are also the most exposed to attacks by predators (Frezard and Le Pape, 2003).

The most common protection methods implemented in sheep and goat flocks fall under the passive control category, which do not kill wild predators, and are more acceptable and preferred for preserving the ecosystem (Connover and Kessler, 1994; Gilsdorf et al., 2002). Passive methods are successful if the farming of sheep and goats is conducted in a problem-free and healthy environment while not directly eradicating the wild animal population in the region. Some passive methods include environmental controls such as using livestock guarding dogs (LGDs), having ewes and does giving births in shelters, keeping herds in sheltered corrals at night, scaring predators using scarecrows, traps, electric or traditional fence systems, utilizing sound-making deterrents equipment, and many more.

Apart from these methods, guarding or protective animals such as donkeys and llamas are widely used in some countries (Taşkın et al., 2011). Conversely, lethal methods for wild predator control are used when passive methods are not very effective or losses

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in sheep and goat herds continue to increase. Lethal methods include foot or leg traps, live cages or traps, firearms, and the use of chemicals such as M-44 (sodium cyanide) (Taşkın et al., 2011). The basis of the use of active (lethal) control methods is that they reduce the number of wild predators close to sheep and goat farms (Anonymous, 2005). Despite the excessive killing of wild predators such as jackals and wolves, however, these predators need to be able to reproduce to continue their species and protect their existence in the natural world. Because sheep flocks generally graze in the pasture at night, guarding them from wild predators is an important issue of pasture-based sheep farming. For this purpose, LGDs have been used primarily against predators such as foxes, wolves, bears, coyotes, hyenas, and big cats (Smith et al., 2000). Livestock guarding dogs most likely emerged in Mesopotamia and in surrounding regions, which had well-developed small sheep and goat farms (Landry, 1999).

Livestock guarding dogs, as one of the passive fighting methods, are medium to large-sized dogs kept with livestock to protect the latter from predators. They have been bred for thousands of years to protect sheep and other domesticated livestock from predators and thieves (Smith et al., 2000; Gehring et al., 2010). Livestock guarding dogs are believed to be the ancestors of today's mastiffs, which lived on the high Tibetan plateaus in prehistoric times (Guardamagna, 1995). Traditionally, LGDs have also been used to guard cattle in other parts of Europe and Asia, although this practice is less common compared with the use of LGDs to protect sheep. Coppinger et al. (1988a) reported that LGDs reduced predator losses by 60%, whereas Green and Woodruff (1988) confirmed this result with a 82% reduction, supporting the idea of LGD economic benefits to breeders. In their study with 160 breeders in the US state of Colorado, Andelt and Hopper (2000) reported that 84% of LGDs were used excellently or well, 13% were used moderately, and 3% were inadequately used. In addition, other researchers working on the subject have determined that the success rates of protecting flocks with dogs in reducing economic losses vary between 11% and 93%, with rates usually reaching 70% in short-term studies (Green and Woodruff, 1988; McGrew and Blakesley, 1982; Rust et al., 2013).

Livestock guarding dogs are also used effectively to protect goat herds, and although it is not a common practice, other social animals such as llamas, alpacas, and ostriches are also used for protection from wild predators in some countries (Landry, 2000). In an assessment made among approximately 50 LGD dog breeds from various countries for the protection of livestock animals (Landry, 2000), Pyrenees (France, Spain), Kangal-Anatolian shepherd dog (Turkey), Komondor (Hungary), Maremma (Italy) and Sharplanina (Serbia- and former Yugoslavia) were among the most common breeds (Andelt, 2004; Coppinger et al., 1988b; Green and Woodruff, 1988; Landry, 2000; Van Bommel, 2010). The effectiveness of LGDs is influenced by many features, especially their behavioural and physical features, including those body structure, body condition, ability to smell, courage, vision and hearing ability.

The aim of this study was to investigate wolf predator damage in sheep and goat flocks in Turkey and the current use of herd protection or shepherd dogs, which is one of the non-lethal (passive control) methods to protect these herds from predators, develop a solution to the problems in the field, and contribute to the very limited literature on the subject.

Materials and methods

Development of the survey form and animal material

Sheep and goat flocks were randomly selected from 12 different provinces where the research was implemented (Fig. 1). The flock size varies between 100 to 500 heads, and the breeding system is traditionally based on pasture, with some flocks being bred as nomadic herds on plateaus or pastures during summer. Usually both meat and milk are produced in these flocks. Additional feeding is provided during winter, in line with the financial resources of the farmer, and for this purpose, grains such as barley, wheat, etc. are used. Animal health services are covered by the Ministry of Agriculture District Offices and private veterinary clinics.

In this study, a specific research survey form was developed and used to determine predator damage and the current status of LGD use. The survey form consists of 11 questions and farmers were asked the following questions: to i) determine the number of wolf attacks on their flocks, ii) the number of animals killed in these attacks, and iii) the extent of damage (economic loss) done. To determine the type of measure taken by farmers against wolf attacks, they were asked to answer one of four options, which were (1) the use of shepherd dogs, (2) the use of firearms, (3) the use of scarecrows, and (4) other methods. To measure the effectiveness of these methods against wolves, farmers were asked to report the number of dogs they had, and their answers were evaluated at the province and farm levels. Turkey is known for having very famous dog breeds possessing important genetic resources in the guarding dog class. Therefore, producers were also asked to report the breed of their LGDs, such as (1) Kangal, (2) Akbaş and (3) others, to determine which breeds of dogs were used to protect their herds. A question was also included in the survey to determine the yearly economic cost of rearing and keeping LGDs. Farmers were asked whether or not they vaccinated their dogs to examine the importance they attached to the health of their dogs. The survey form also included questions about whether farmers acquired their LGDs through cash purchase, from their neighbours' farms and friends, or from their own pack of dogs, and about the number of shepherds used in their herds.

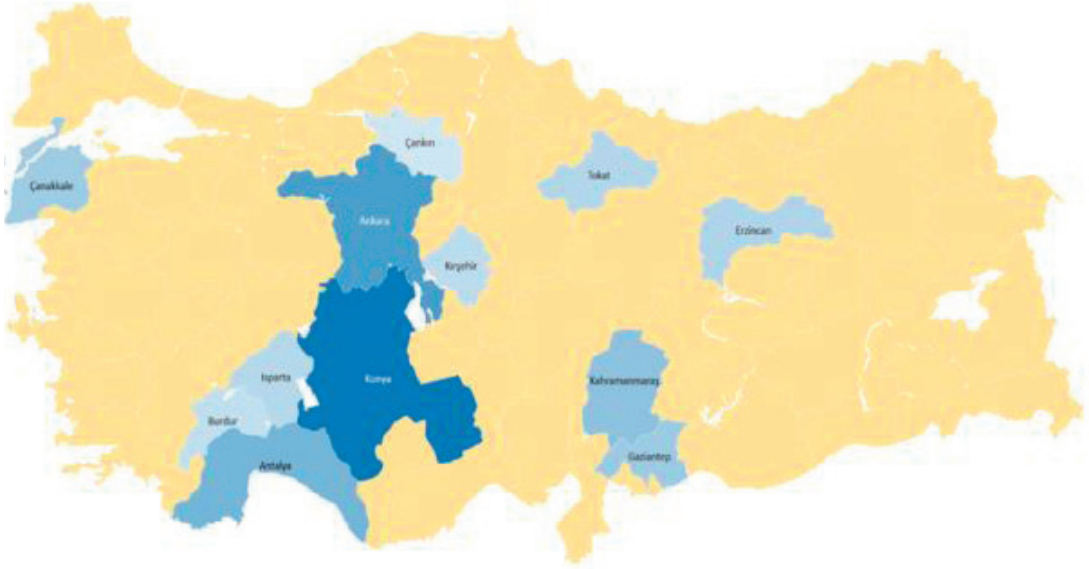

Fig. 1. Provinces where the study was conducted

Finally, to capture the producers' expectations from the government in their struggle against wolves, the survey form included (1) whether or not gun licenses should be given, (2) whether captured wolves should be released into nature, (3) whether LGDs should be provided to farmers, (4) whether livestock loss insurance should be provided free to farmers, (5) whether wolf hunting should be allowed, and (6) all the above options. Damage to the flock due to wolf attacks and annual LDG expenses were evaluated in Turkish Lira by converting them to current US dollars at the date of the study (Anonymous, 2022) using the exchange rate of the Central Bank of the Republic of Turkey.

The study was carried out in 368 sheep and goat farms included in the National Community-Based Small Ruminant Breeding Project (NCSRP) in 12 provinces (Table 1). The total number of small ruminants (sheep and goats) in the provinces studied in 2022 was 10 958 205 heads, constituting 19.48% of the total number of small ruminants in Turkey (Anonymous, 2022). Among all farms included in the research, 40.4% of them breed sheep, 52.5% breed goats, and 7.1% breed sheep and goats together. The farms where the survey was conducted were selected using a simple random sampling method, and farms with shepherd dog ownership were included in our sample, following the methodology of Güneş and Arıkan (1988). Each of the sheep and goat farms in our sample was visited separately, and survey forms were filled out during face-to-face meetings with livestock farmers and employees. Evaluations and face-to-face interviews of farms were conducted by the same person in each province and completed within the same day. The status of the different sheep and goat farms was analyzed through the use of descriptives (percentages, averages, standard error, minimum, and maximum). All statistical analyses were computed in Microsoft Office Excel 2010 for Windows and SPSS 14.01 (SPSS Inc., Chicago, IL, USA) where we used a one-way ANOVA and Duncan test to compare subsample means.

Results and discussion

The results obtained regarding the precautions taken against wolf attacks by sheep and goat farms within our scope, the dog breeds they used, methods of procuring their dogs, health and vaccination practices for shepherd dogs, the number of shepherds, and the breeders' expectation from the government are summarized in Table 2. Thereby, the precautions taken by sheep-goat farms against wolves, information about the livestock guarding dogs they used to protect their flocks from predators, the number of shepherds, and breeders' expectations from the government were determined.

Table 1. Number of animals in the province studied (Anonymous, 2022)

Number	Provinces	Sheep	Goat
1	ANKARA	1 680 217	333 259
2	ANTALYA	645 755	763 147
3	BURDUR	209 431	147 945
4	**ÇANAKKALE**	577 047	248 043
5	**ÇANKIRI**	163 848	22 743
6	ERZİNCAN	535 642	61 672
7	GAZİANTEP	620 099	231 291
8	ISPARTA	307 194	204 856
9	KIRŞEHİR	384 857	32 676
10	KONYA	2 770 980	275 489
11	KAHRAMANMARAŞ	601 216	450 933
12	TOKAT	467 040	74 722

Table 2. The precautions taken against wolves, some characteristics of livestock guarding dogs, the number of shepherds on farms and expectations from the state

Factors	Variables		Results, %
What precautions are taken against wolves?	Dog		62.6
	Firearms		28.9
	Scarecrow, etc.		2.1
	Other		6.4
What dog race/breed do you have?	Anatolian shepherd (Kangal)		32.9
	Akbaş		9.8
	Other		57.3
Are dogs vaccinated?	Yes		82.3
	No		17.7
How are dogs acquired?	Cash buying		25.4
	From neighbours		54.4
	From own pack of dogs		20.2
How many shepherds do you have?	Owner	72	19.6
	1	138	37.5
	2	103	28.0
	3	30	8.2
	4	14	3.8
	5 >	11	2.9
What is your expectation from the government in your struggle against wolves?	Gun licence		8.8
	No trapped wolf release		44.7
	Provide a free guarding dog		14.1
	Free insurance		11.1
	Wolf hunting should be legal		16.1
	All of the above		5.2

Table 3. The number of wolf attacks on sheep and goat farms

Factors	Province	N	Mean	Std. Error	Min	Max	*P*
Number of wolf attacks	Ankara	61	7.18 ^{abc}	2.374	0	100	*
	Antalya	29	10.34 ^{ab}	2.439	0	50	
	Burdur	41	5.27 ^{bc}	1.016	0	35	
	Çanakkale	32	13.59 ^{a}	5.520	0	150	
	Çankırı	18	1.17 ^{c}	0.345	0	6	
	Erzincan	23	6.00 ^{abc}	1.593	0	30	
	Gaziantep	31	1.74 ^{c}	0.250	1	8	
	Isparta	28	7.07 ^{abc}	1.739	1	40	
	Kırşehir	21	1.57 ^{c}	0.321	0	6	
	Konya	42	5.55 ^{bc}	0.790	1	25	
	Kahramanmaraş	20	1.90 ^{c}	0.228	0	4	
	Tokat	22	4.82 ^{bc}	1.033	0	18	
	Total	368	6.01	0.704	0	150	

* $P < 0.05$ a, b, c: Values within a column with different superscripts differ ($P < 0.05$).

Among the provinces included in our research, the average number of wolf attacks (Table 3) and the number of animal casualties (Table 4) were 6.01 ± 0.704 and 12.17 ± 1.329, respectively, and differed between provinces ($P < 0.05$, $P < 0.01$). The average of total economic loss caused by wolf attacks on sheep and goat herds (Table 5) was determined to be 2299.68 ± **235**.176 US dollars, and the losses differed between provinces ($P < 0.01$).

The average number of guarding dogs within a flock and their corresponding expenses (Table 6) were 4.76 ± 0.188 heads, and 256.07 ± 236.306 US dollars, respectively, and the differences in the number of guarding dogs and related expenses were different between the provinces ($P < 0.01$).

Precautions against wolves and preferred dog breeds

As a choice method for protecting their flocks against wolf attacks, 62.6% of the surveyed farmers used LGDs, 28.9% used firearms, 2.1% used scarecrows and 6.4% used other methods (Table 2, Fig. 2). These results indicate that the use of LGDs, which is among the predominant active methods used

Table 4. The number of animal casualties in flocks due to wolf attacks on sheep and goat farms

Factors	Province	N	Mean	Std. Error	Min	Max	*P*
Number of animal casualties	Ankara	61	14.26 ^{abc}	3.300	0	130	**
	Antalya	29	15.97 ^{abc}	5.187	0	150	
	Burdur	41	24.63 ^{a}	5.388	0	150	
	Çanakkale	32	19.09 ^{ab}	9.481	0	300	
	Çankırı	18	5.11 ^{bc}	1.765	0	25	
	Erzincan	23	8.04 ^{bc}	2.869	0	60	
	Gaziantep	31	7.81 ^{bc}	1.431	1	30	
	Isparta	28	18.11 ^{ab}	4.011	2	75	
	Kırşehir	21	1.00 ^{c}	.276	0	4	
	Konya	42	5.79 ^{bc}	1.022	0	30	
	Kahramanmaraş	20	4.90 ^{bc}	1.172	0	20	
	Tokat	22	6.18 ^{bc}	1.444	0	22	
	Total	368	12.17	1.329	0	300	

** $P < 0.01$ a, b, c: Values within a column with different superscripts differ ($P < 0.01$).

Table 5 Least square averages of the total economic losses caused by wolf attacks on sheep and goat flocks by province

Factors	Province	N	Mean	Std.Error	Min	Max	*P*
Total economic loss (US$)	Ankara	61	1679.24^{bcd}	360.755	0.00	13756.61	**
	Antalya	29	2829.78^{bc}	696.178	0.00	19841.27	
	Burdur	41	7468.06^{a}	1334.139	0.00	39682.54	
	Çanakkale	32	2523.56^{bcd}	1254.079	0.00	39682.54	
	Çankırı	18	787.77^{cd}	270.615	0.00	3968.25	
	Erzincan	23	1247.41^{bcd}	397.231	0.00	7936.51	
	Gaziantep	31	1279.23^{bcd}	237.163	158.73	4761.90	
	Isparta	28	3420.73^{b}	661.154	396.83	13227.51	
	Kırşehir	21	215.42^{d}	64.937	0.00	793.65	
	Konya	42	1058.83^{bcd}	185.403	0.00	5291.01	
	Kahramanmaraş	20	874.34^{bcd}	210.903	0.00	3174.60	
	Tokat	22	1366.04^{bcd}	414.747	0.00	8465.61	
	Total	368	2299.68	235.176	0.00	39682.54	

** : P < 0.01; a, b, c, d: Values within a column with different superscripts differ significantly ($P < 0.01$).

Table 6. Least square averages of the number of livestock guarding dogs in sheep and goat farms and expenditures on livestock guarding dogs by province

Factors	Province	N	Mean	Std.Error	Min	Max	*P*
Number of dogs	Ankara	61	6.92^{ab}	3.964	1	20	**
	Antalya	29	3.07^{de}	1.602	0	6	
	Burdur	41	5.49^{bc}	2.226	2	11	
	Çanakkale	32	5.31^{bc}	3.771	0	14	
	Çankırı	18	3.72^{cde}	1.904	0	8	
	Erzincan	23	2.30^{e}	1.295	0	5	
	Gaziantep	31	2.29^{e}	0.938	1	4	
	Isparta	28	3.86^{cde}	2.138	1	10	
	Kırşehir	21	4.29^{cd}	2.493	1	11	
	Konya	42	7.86^{a}	5.677	0	25	
	Kahramanmaraş	20	2.15^{e}	0.933	0	4	
	Tokat	22	3.77^{cde}	1.850	0	8	
	Total	368	4.76	3.605	0	25	
Dog expenses (head/year in US$)	Ankara	61	276.09^{bc}	223.886	39.68	793.65	**
	Antalya	29	245.12^{bc}	179.341	0.00	661.38	
	Burdur	41	707.83^{a}	190.383	158.73	1058.20	
	Çanakkale	32	286.67^{b}	257.549	0.00	1058.20	
	Çankırı	18	230.01^{bc}	82.934	52.91	330.69	
	Erzincan	23	181.27^{cd}	155.913	0.00	661.38	
	Gaziantep	29	122.03^{de}	83.442	0.00	476.19	
	Isparta	28	218.25^{bc}	101.347	105.82	529.10	
	Kırşehir	21	71.81^{e}	28.996	26.46	132.28	
	Konya	42	205.47^{bcd}	125.480	52.91	661.38	
	Kahramanmaraş	20	55.56^{e}	16.950	26.46	79.37	
	Tokat	22	119.95^{de}	60.900	0.00	264.55	
	Total	366	256.07	236.306	0.00	1058.20	

** $P < 0.01$; a, b, c, d, e: Values within a column with different superscripts differ significantly ($P < 0.01$).

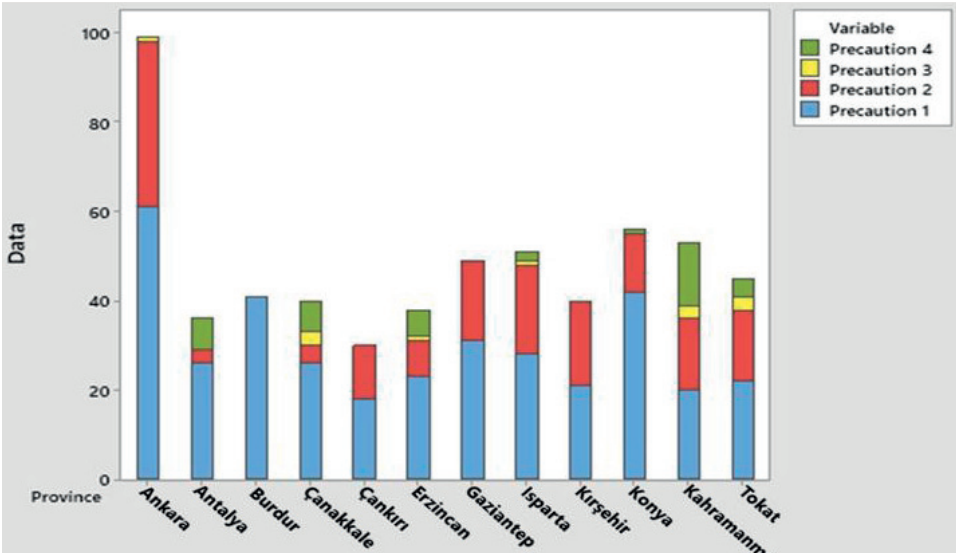

Fig. 2. Different precautions taken against predators and their distribution

Precaution 1: livestock guarding dogs; Precaution 2: firearms; Precaution 3: scarecrows; Precaution 4: other methods

against predators worldwide, is also the preferred strategy adopted by farmers in Turkey. Smith et al. (2000) reported that LGDs reduce predatory damage in flocks by 11–100%. Breitenmoser et al. (2005), Gehring et al. (2010), Shivik (2006), and Smith et al. (2000) reported that the use of LGDs, along with non-lethal methods such as fencing and shepherd protection, is a prominent approach to reduce human and wildlife conflicts.

In response to predator attacks, results from our research show that the most preferred LGD breeds by the farmers were Kangal (Anatolian shepherd dog; 32.9%) and Akbaş (9.8%), but other breeds of dogs constituted 57.3% of all LGDs used in sheep and goat farms (Table 2, Fig. 3). Provinces with the highest use of Kangal and Akbaş breeds were Burdur and Ankara, respectively (Fig. 3).

The Kangal or Anatolian Shepherd is a genetic dog breed with immense popularity for small livestock farmers in Anatolia, especially in the Sivas province of Turkey, but also with global recognition. The origin of the Kangal in Anatolia can be traced to earlier than 6000 years ago, and this dog possesses an innate capacity of showing herd protection behavior independently of the shepherd. Several large "shepherd" or livestock guardian dog breeds were historically selectively bred to protect sheep and goat flocks in the Balkans, Anatolia, and the Caucasus regions (Gündemir et al., 2023). The Kangal breed herd protection ability is instinctively high and does not require any training. The Kangal breed possesses a short and dense coat and is adapted to the steppe climate of Anatolia where summers are hot and winters are cold. As a unique LGD with highly sensitive visual and olfactory features, the Kangal successfully fulfils its duty of protection against predators on most continents and countries such as South Africa and Namibia. For instance, in the Wild Cheetah Management Project (WCMP) implemented in South Africa in 2005 to reduce the damage caused by cheetahs to small ruminant flocks, Kangal dogs reduced predatory damage by 73%, with 93% of farmers recommending their use. The main reasons behind the choice of the Kangal breed in the WCMP program are the dog's large size, short hair coat, and ability to move freely and independently (Binge, 2017). The CCF (Cheetah Conservation Fund) LGD programme is centred around the breeding of LGDs in Namibia and the placement and follow-up of LGDs with farmers that were interested in participating in the programme. The selected dog breeds (i.e., Anatolian shepherd and Kangal dog) originated in Turkey and have guarded livestock from local predators, such as the brown bear (Ursus arctos), red fox (Vulpes vulpes), and grey wolf (Canis lupus), as well as other damage-causing species such as wild boar (Sus scrofa) for thousands of years (Marker et al., 2020).

The widespread purpose of Kangal breeding in Turkey is to protect livestock from predators, especially wolves in rural areas, and to use the dog as a guard or protection dog in residential areas (Akyazi et al., 2018). Due to their characteristics, they are preferred by small livestock farmers over other breeds of shepherd and guard dogs in both Turkey and abroad. Other than the Kangal dog, one of the most common LGDs in Turkey is the Akbaş shepherd dog. The Akbaş is bred in Sivrihisar, Afyon, Eskisehir

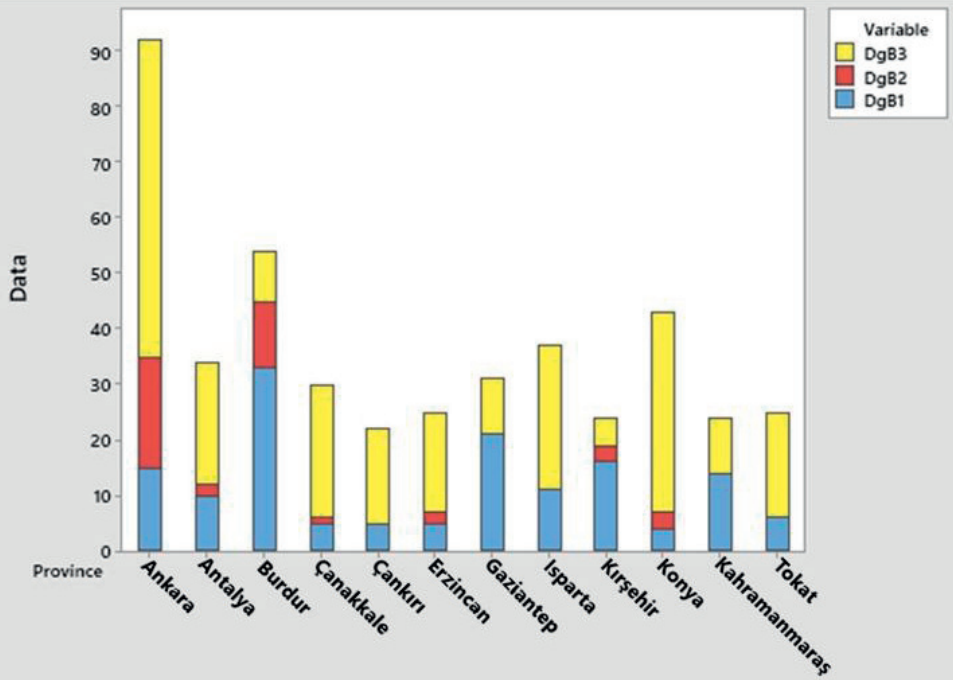

Fig. 3. Dog breeds (DgB) preferred by farmers

DgB1: Kangal, DgB2: Akbaş, DgB3: Other

and Ankara provinces, and it is similar to the Kangal in terms of instinctively protecting the herd without a need for warning (Anonymous, 2009). Compared with the Kangal, its courage and aggression against predators is high, but its adaptability and aggression towards humans are low. After the Pyrenees breed, it is considered to be one of the breeds with the least amount of aggression towards the herd, which it protects and, altogether, it is one of the breeds preferred by many animal breeders both in Turkey, Africa, and America.

Van Bommel (2010) reported that the Kangal and Akbaş breeds were traditionally used in Turkey to protect livestock from wolves, foxes, jackals, bears, wild boars and wild dogs, hence helping shepherds very effectively in herd protection. It has also been reported that when nomadic livestock farmers go to high plateaus and long journeys, LGDs are widely used, and they ensure the safety of the herds. The Kangal and the Akbaş are at the forefront among Pyrenees, Komondor Maremma, Kuvasz and other dog breeds due to their high ability to stay with the herd (Green and Woodruff, 1988).

Dog health and vaccination status

A particular goal of the research was to determine the level of awareness and behaviour regarding the care of dogs, especially vaccination (rabies vaccination, distemper and parvovirus) and health issues. Our results show that 82.3% of the farmers' dogs were vaccinated (Table 2), denoting the importance that sheep and goat farmers attach to dog health. In addition to the task they perform, shepherd dogs are both traditionally and culturally important, especially in Anatolia and, in recent years, the level of awareness about LGDs has improved. The dog vaccination status by province is shown in Fig. 4.

Dog procurement methods

Sheep and goat breeders address their need for shepherd dogs in different ways. A significant proportion of farmers, especially those who have been breeding sheep or goats for many years, generally raise their own shepherd dogs and mate their own female dogs with the most preferred males, thus providing young puppies for their own use. Our survey shows that 25.4%, 54.4% and 20.2% of farmers preferred the methods of procuring dogs through exchange of money, from friends, and their own pack of dogs, respectively (Table 2, Fig. 5). It is understood that the most common method of dog procurement among the farmers is procurement from each other and friends, and this result indicates that farmers attach more value to their social relations with other sheep and goat farmers compared with their own economic concerns. Marker et al. (2005) also suggest other measures that could be implemented to encourage farmers to use shepherd dogs, such as government subsidies to partially finance the purchasing and breeding among producers, shepherd dog fairs and exhibitions, as well as actions by non-governmental organisations.

Number of shepherds per farm

During the last decade, shepherding on farms in Turkey has become a profession that is not preferred by the younger population due to the development of the economy and socio-cultural reasons. This new reality contrasts with the traditional habits of Turkish farms filling their shepherd vacancy through

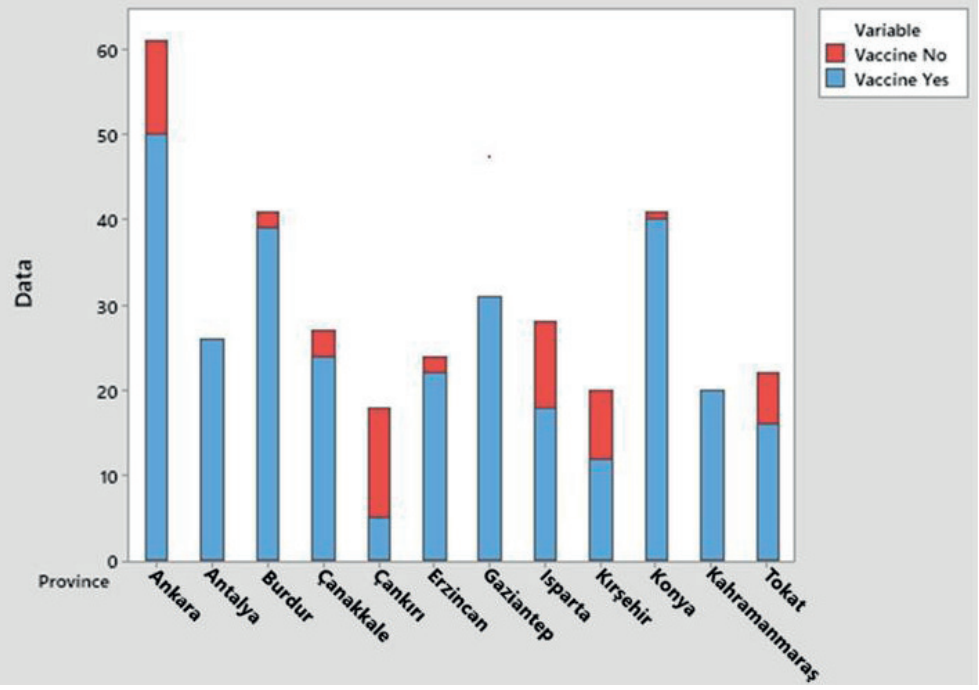

Fig. 4. Distribution of vaccination status of dogs by province

members of their own households. The problems encountered in the shepherd labour market in Europe also apply to Turkey, where the younger population (under 30 years of age) refuses to be employed as shepherds. Currently, nearly 90% of the population employed as shepherds in Turkey are refugees and asylum seekers, and they encounter a variety of problems due to legal infrastructure and working conditions. According to our study, the share of enterprises with no shepherd (self), or with 1, 2, 3, 4, 5, or more shepherds were 19.6%, 37.5%, 28.0%, 8.2%, 3.8% and 2.9%, respectively (Table 2). These results indicate that in Turkey small ruminant farmers generally prefer 1 or 2 shepherds for herd management. The number of shepherds required by businesses may vary depending on the kidding and lambing season of the animals and their feeding in summer and winter. At the same time, flock size is also an important factor affecting the number of shepherds needed. Sheep or goat owners generally allocate 1 shepherd for a herd of 250 to 300 animals. During the lambing and kidding season, a temporary assistant shepherd is employed, or the owner satisfies this need for extra labor from household members. Mosalagae and Mogotsi (2013) reported that similar problems were experienced in both developed and developing countries. It may be recommended to aggregate small flocks into larger flocks to solve this problem and employ shepherds to work in these larger herds. For example, a solution might be to protect a large flock of sheep and goats with 2 to 3 shepherds and at least 2 to 3 good LGDs.

Farmers' expectations from the government in their struggle against predators

Small livestock owners continue their production activity by protecting their sheep and goats against predators using traditional methods. In the current system, the economic consequences of compensating predator damage in the absence of animal insurance (predator incident insurance is limited to 2 attacks) are non-negligible. Sheep and goat farmers do not have a very effective and productive organizational structure, resulting in having to deal with these occurrences individually, without assistance. Our results show that the top three expectations of sheep and goat owners from the government in their fight against wolves (Table 2, Fig. 6) are that wolves should not be released to the ecosystem (44.7%), wolf hunting should be allowed (16.1%), and shepherd dogs should be given free of charge (14.1%). In Turkey, there is no specific policy that addresses the impact and damage to animal production by wildlife. For this reason, when attacked by wolves, farmers generally resort to the following measures: i) fighting methods that kill or cripple wolves, or ii) farmers may intervene in wildlife conservation areas close to their farms, or they may withdraw from livestock production activities. Graham et al. (2004) stated that these retaliatory reactions by producers are contrary to the public and political intentions of wildlife management. Moral et al. (2016) suggest implementing public policies that encourage the use of LGDs by farmers, as it is beneficial to the small livestock production system, and because the use of LGDs is the method where wild predators are least affected.

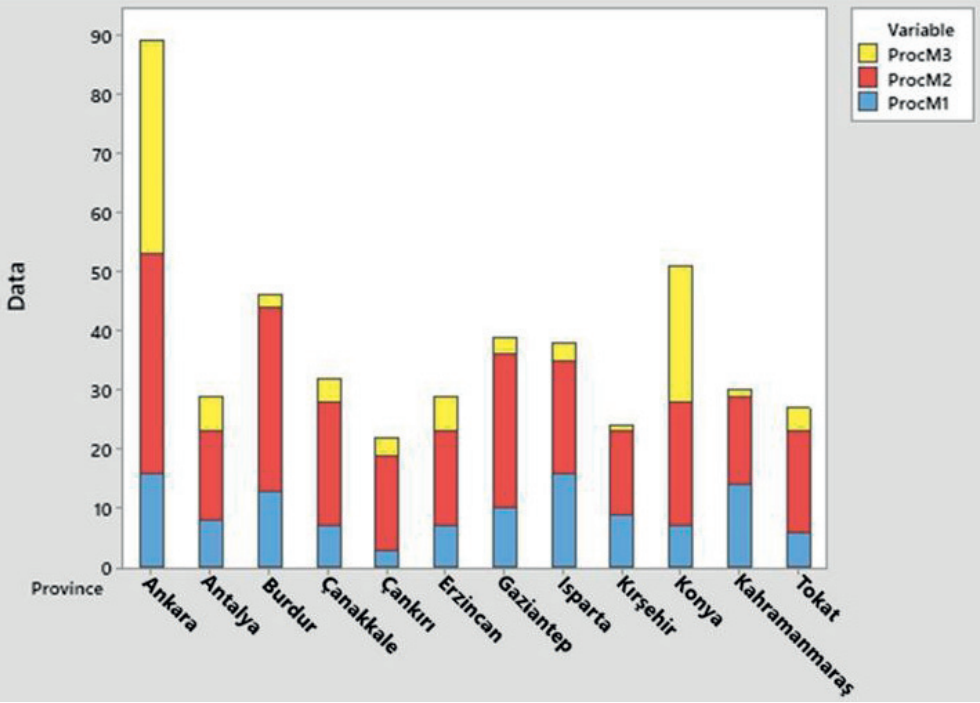

Fig. 5. Distribution of dog procurement methods (PrcM) by province

ProcM1: Cash buying, ProcM2: From friends, ProcM3: From own pack of dogs

Number of wolf attacks on sheep and goat farms

The average number of wolf attacks in sheep and goat farms (Table 3) was 6.01 ± 0.704 and differed between provinces ($P < 0.05$). The highest numbers of wolf attacks were 13.59 ± 5.520 and 10.34 ± 2.439, observed in Çanakkale and Antalya provinces, respectively, and the lowest numbers of occurrences were 1.17 ± 0.345 and 1.57 ± 1.469 in Çankırı and Kırşehir provinces, respectively. The larger number of attacks in Çanakkale and Antalya could be attributed to the presence of denser forests and mountainous terrain, relative to the other provinces surveyed. In addition to LGDs being ineffective in such geographical areas, it can be argued that LGDs might be the underlying cause of wolf attacking dogs and small livestock in mountainous areas, dense maquis and forest areas.

The average number of sheep and goats that perished due to wolf attacks (Table 4) was found to be 12.17 ± 1.329 and differed between provinces ($P < 0.01$). The highest numbers of small ruminant casualties due to wolf attacks were 24.63 ± 5.388 and 19.09 ± 9.481 heads in Burdur and Çanakkale provinces, respectively, and the lowest numbers were 1.00 ± 0.276 heads and 4.90 ± 1.172 heads in Kırşehir and Kahramanmaraş provinces, respectively. Although the preferred protection method against predators is the use of shepherds and shepherd dogs, most wolf attacks and flock casualties occurred when shepherds and dogs were accompanying small herds. Therefore, this finding supports the idea that the practices used against wolf attacks are ineffective and that simply having shepherds and guard dogs near small ruminants is not sufficient to provide the desired level of protection. Redden et al. (2015) state that domestic animals, especially small ruminants, are highly susceptible to attacks from various wild and domestic animals, hence flock protection dogs with appropriate behaviour and training can minimize predator damage to farm animals. Ogada et al. (2003) and Abade et al. (2014) reported that LGDs are trained not to chase predatory animals, but rather to warn shepherds of danger, and even in that case, utilization of LGDs can reduce predator-related losses by up to 63%.

Economic losses from predator attacks

Within the provinces of interest, the average economic loss per farm due to wolf attacks (Table 5, Fig. 7) was calculated to be 2299.68 ± **235**.176 US$, and was different between provinces ($P < 0.01$). The highest economic loss due to wolf attacks was calculated as 7468.06 ± 1334.139 US$ and 3420.73 ± 661.154 US$ in Burdur and Isparta provinces, respectively, and the least amount of economic loss was calculated as 215.42 ± 64.937 US$ and 787.77 ± 270.615 US$ in Kırşehir and Çankırı provinces, respectively.

Controlling predator damage in sheep and goat flocks is one of the most important factors for the profitability of the business. In a study conducted in the USA in 2004, the damage caused by wild predators to goat farms was estimated to be 155.000 heads, corresponding to a monetary equivalent of approximately 18.3 million US$ (Jones, 2004). Coppinger et al. (1988a), based on reports collected from producers in the United States, reported reduced feral predator attacks by 64%, and that,

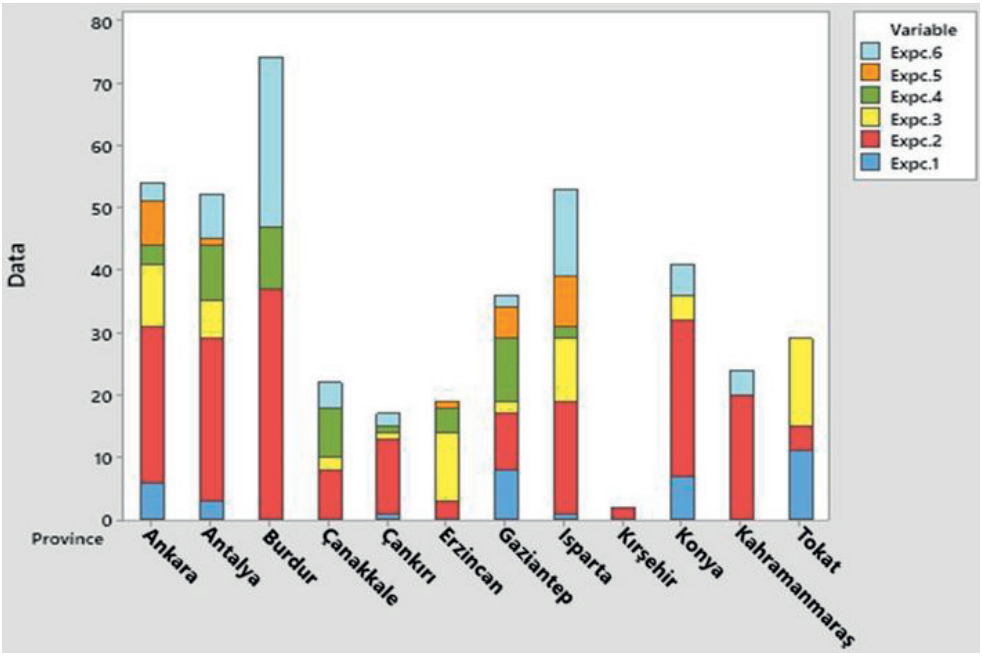

Fig. 6. Farmers' expectations (Expc) from the government in their struggle against predators

Expc.1: Gun licence; Expc. 2: No wolves released; Expc.3: Provide a free guarding dog; Expc.4: Free insurance; Expc.5: Wolf hunting should be legal; Expc.6: All of the above

within one year, livestock losses fell to zero in 53% of farms implementing an LGD program. Andelt and Hopper (2000) reported a smaller number of lambs lost to predators for sheep producers with LGDs in a survey conducted in Colorado. Additionally, the same survey found that producers without LGDs lost almost six times more lambs than those with LGDs, and 84% of the 160 producers surveyed reported that LGDs were excellent or very successful in reducing predation of their sheep. Furthermore, Marker et al. (2005), in studies conducted between 1994 and 2002 to determine the effectiveness of dogs in Namibian small ruminant farms, reported LGDs being very effective in reducing livestock losses.

Number of dogs per farm and dog expenses

Although sheep and goat farmers seem to think that their LGDs are sometimes ineffective against wolves, they continue to use LGDs, believing that sheep and goat losses and even attacks on shepherds would be even higher without LGDs. The average number of dogs per farm (Table 6) was 4.76 ± 3.605, and it was different among provinces ($P < 0.01$). The provinces of Konya and Ankara have the highest number of LGDs for protection against wolf attacks on sheep herds, respectively, 7.86 ± 0.876 and 6.92 ± 3.964. Conversely, the provinces of Kahramanmaraş and Gaziantep have the least number of LGDs, respectively, 2.15 ± 0.209 and 2.29 ± 0.168.

The number of dogs required for the most effective protection against predators in small ruminant herds varies depending on the size of the pasture, the number of animals, the topography of the region, the number and species of predators, the presence or absence of fences, and the protective behaviour of LGDs. Generally, one LGD per 100 sheep is recommended. Conversely, herds of 1000 heads or larger rarely have more than 6 LGDs (Redden et al., 2015). In Turkey, the number of dogs kept in sheep and goat farms varies depending on the interest of farmers and shepherds in LGDs, as well as whether or not the land is densely forested or maquis, and the predatory potential of the region. Due to the increase in feeding and vaccination costs associated with dog ownership in recent years, however, farmers have been displaying a tendency to reduce the number of LGDs in their farms.

In the present study, the average cost spent on dogs (Table 6) used to protect sheep and goat flocks from wolf attacks was 256.07 ± 12.318 US$, and it differed between provinces ($P < 0.01$). The highest expenditure on LGDs was calculated as 707.83 ± 29.733 and 286.67 ± 45.529 US$, in Burdur and Çanakkale provinces, respectively, and the lowest expenditure was 55.56 ± 3.790 US$ and 71.81 ± 6.327 US$ in Kahramanmaraş and Kırşehir provinces, respectively. Considering that each lamb entails a cost of 80 to 110 US$ to the producer, the relative cost of an LGD is very low. These results can be explained by the fact that sheep and goat farmers generally prefer traditional methods for feeding their dogs and ignore the associated vaccination and medication costs. In the provinces where this research was conducted, there is an overall tendency of trying to reduce farm expenses by spending the least on LGDs. Redden et al. (2015) report that the estimated first-year cost for a new LGD is at least 1000 USD, with subsequent annual costs of approximately 500 US$ in Texas, USA. In addition, in Namibia, Marker et al. (2005) reported that in 2003, farmers' costs generally reached 130 US$ for both male and female LGD offspring, including the cost of neutering. In comparison, when small ruminant farmers in Turkey purchase LGDs for the first time, the costs are quite low, as they meet their needs from friends or their own pack of dogs. Conscious breeders pay 500–700 US$ for quality dogs over time or exchange their dogs for rams or sheep at this price. In Turkey, Kangal and

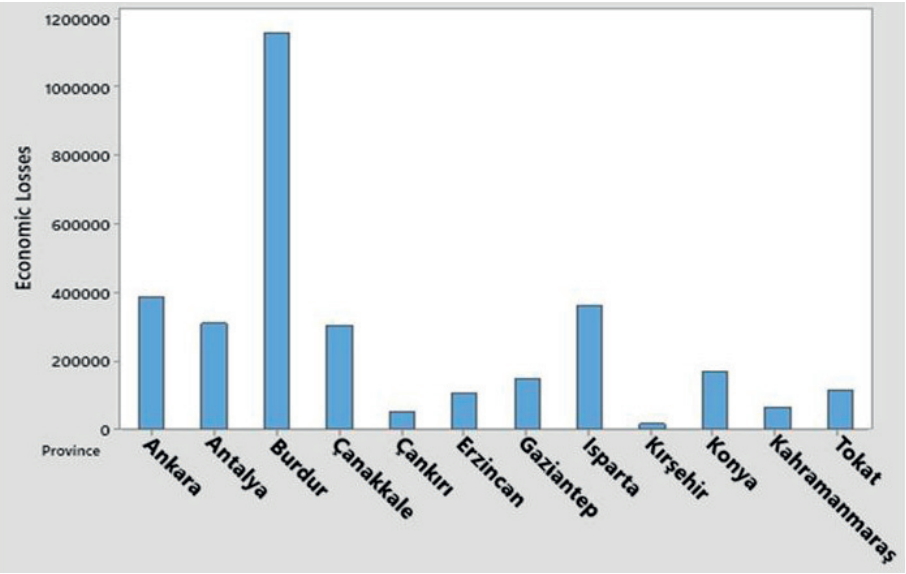

Fig. 7. Economic losses from predator attacks (US$)

Akbaş shepherd dogs are bred in public and private enterprises to supply LGDs, and although they are sold to farmers or individuals who request them for a monetary payment, these enterprises are quite inadequate to meet the aggregate demand of livestock producers in Turkey.

Conclusion

This study was carried out to alleviate the lack of information on the general situation of damage caused by wolves to small livestock farms in Turkey and on the use of livestock guarding dogs. The use of LGDs to minimize predator losses is one of the best options, and it is recommended to use local dog breeds that have adapted to Turkey's geography and livestock populations and have received a certain level of training. In this sense, motivating the use of Kangal and Akbaş LGDs will be one of the most effective solutions. In addition, the integration of herd management dogs, such as Border Collies, etc., into the flocks alongside native Turkish dog breeds that will serve as livestock guardians should be evaluated. Such a strategy will not only reduce the amount of workload and number of shepherds required, but it will also bring a new understanding and relief to the country's sheep and goat breeding.

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Conflict of interests

The authors declare no conflict of interest.

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