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Reduction in Livestock Losses following placement of Livestock Guarding Dogs and the impact of herd species and dog sex

*Stacey-Lee Leijenaar[1], Deon Cilliers[2], Katherine Whitehouse-Tedd[2,3]

[1]Centre for Wildlife Management, University of Pretoria, South Street, Pretoria, 0081, South Africa
[2]Cheetah Outreach, Quinan house, Paardevlei, De Beers Street, Somerset West, Western Cape, 7137, South Africa.
[3]Environment and Protected Areas Authority, Sharjah, United Arab Emirates.

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Livestock guarding dogs have been placed on South African farms by the not-for-profit organisation, Cheetah Outreach Trust, since 2005, and have been proven to be an efficient form of non-lethal predator control against jackal, caracal, leopards, cheetahs and other predators found in South Africa. However, the impact that herd species (sheep, goat, cattle or mixed) or the sex of the dog may have on the observed reduction in livestock losses following placement of a livestock guarding dogs has not been investigated. To address this, the reduction in livestock losses following placement of an Anatolian livestock guarding dogs was measured in two South African provinces over a nine year period and data simultaneously collected on herd type and dog sex. Dogs comprised of 78 males and 49 females. Farms consisted of 68 sheep, 37 goats, 23 cattle, and two exotic game farms. Effectiveness was measured as the difference between farmer-reported livestock losses before and after the placement of a dog and was calculated as percentage change in stock loss after introduction of a livestock guarding dog according herd species and dog sex. This study determined the impact of herd type or dog sex on the difference between livestock loss before versus after livestock guarding dogs placement. This study indicates that the use of this breed of livestock guarding dog is an effective means of reducing perceived livestock losses due to predation, regardless of dog sex, and may be used with equal effectiveness with a range of herd species.

Key words: Livestock guarding dog, non-lethal predator control, livestock losses, Cheetah Outreach Trust, South Africa.

INTRODUCTION

Carnivore conservation is often problematic as the objectives of conservationists are frequently contradictory to agriculturalists [1]. Conflict existing between predators and farmers has been found to be the most frequently occurring form of human-wildlife conflict [2]. Many carnivore species are regarded as pests by farmers due to their impact on agricultural activities. A study conducted in Namibia attributed 47.6% of cheetah, *Acinonyx jubatus,* mortality to persecution by humans on farmland [3]. The population of cheetah in South Africa is relatively small; as a result, mitigation of existing human-predator conflict is crucial [1]. Worldwide it has been shown that the severity of livestock-predator conflict is commonly linked to the level (not style) of husbandry, where by level of husbandry refers to input (capital and labour) per unit of land or animal, and style refers to the different husbandry methods employed (such as form of predator control or grazing strategy). Intensive husbandry has been shown to lead to fewer losses than extensive husbandry [2]. Due to the success of predator control programmes many farmers have recently returned to extensive farming practices, which, along with the recovery of a number of predator species, leave livestock vulnerable to predation once again.

The role of predators and their relationships in an ecosystem must be recognised. Poorly managed

*Corresponding Author's E-mail: lee_stace@yahoo.com; Tel.: +2782 719 5780.

predator control programmes can have a number of negative cascading ecological effects. Eradication of apex predators can lead to an increase in mesopredator populations (i.e. predators not occupying the top trophic level, such as jackal, *Canis mesomelas,* and caracal,*Caracal caracal*) [1,4]. Other issues, which may arise, include an increase in wild herbivore populations due to decreased predation [5]. Subsequent perturbations to the inter-ecosystem predator and prey dynamics can compromise habitat quality with consequences for both animal and human populations. In order to reduce conflict between livestock farmers and wild predators, Livestock Guarding Dogs (LGD), including breeds such as Anatolian shepherds and Great Pyrenees, are raised and habituated with a flock or herd from six to eight weeks of age [6-8]. The success of a guard dog programme in Namibia by the Cheetah Conservation Fund [6] led to the trial and launch of a similar project by Cheetah Outreach and the De Wildt's Wild Cheetah Management Project in 2005 in South Africa. A number of carnivores species in South Africa require conservation support; for example, the sub-Saharan cheetah is classed as vulnerable and other species such as African wild dog, *Lycaon pictus,* are endangered [9]. Many carnivore populations in South Africa exist outside of protected areas and modifications to their habitats by agriculture associated with expanding human settlement and increasing population size, can increase the frequency and intensity of wildlife conflict situations [3]. According to Bergman *et al*. [10] predation is responsible for losses totalling ZAR 1.4 billion (USD116.3 Million) per year. The financial implications of these losses are thought to drive the retaliatory actions of farmers against wild carnivores [10].

Anatolians have been used in other parts of the world for thousands of years as a means of livestock protection. Use has occurred in the arid Anatolian Plateau region of Turkey. The climate in these areas share similarities with many areas in South Africa including the two provinces included in this study, having very hot summers and cold winters. The coat of this breed allows effective cooling and insulation due to length of coat, coarseness of hair and colour. The physicality (size, strength, excellent sense of smell and good eye sight and hearing) as well as personality attributes (high levels of familiarity and dedication to those with which it is bonded) makes this breed effective at guarding livestock [7]. Livestock guarding dogs have been shown to reduce predation from 11-100%, with many studies reporting higher end figures [6,11-13]. Indeed, LGD in the current study site have been shown to reduce livestock losses by 68–100% [1]. This method of non-lethal predator control therefore has the potential not only to be beneficial from a conservation point of view but from an agricultural productivity point of view as well. Increased productivity and thus profit occurs as pastures can be more efficiently utilized, there is the potential to increase the size of the herd, and livestock condition may also be enhanced as a result [7]. Although a number of studies have looked at LGD use in sheep, cattle, goats and other livestock types such as swine [14], little attention has been paid to whether herd type impacts the ability of the LGD to effectively protect the herd or flock. In this case herd type refers to livestock species being categorised as sheep, goat, cattle, and exotic game or mixed. Rust *et al*. [1] determined no effect of herd type post-LGD placement but did not investigate the impact of herd type on percentage of change (i.e. before *versus* after placement). Attributes such as aggression are not desirable behaviours in livestock and are therefore frequently selected against in breeding programmes. A sizeable diversity exists in behavioural patterns in domestic animals as well as extensive differences in the physiological mechanisms responsible for these behaviours [15]. Therefore the degree to which these anti-predator behaviours have been reduced may differ between different domestic livestock species resulting in differing levels of vulnerability to predation for different species [16]. Innate herd specific behaviours may have some bearing on aspects such as level of bonding and as such the use of LGD may be better suited to some species more so than others.

Type of livestock influences the type of predator most likely to attack, larger predators are known for taking larger domestic species (e.g. lions and tigers take a greater proportion of cattle), whereas smaller predators (such as leopard and cheetah) take a greater proportion of sheep, goats and other small to medium livestock [17]. Therefore the interaction between type of livestock being farmed and type of predator dominant in area could impact the level of success once a LGD has been introduced. Graham *et al*. [2] found that predators were reported to kill 0.02-2.6% of livestock but up to 9% of game species annually [2]. Therefore, the possibility exists that farming wild game species carries more risk of livestock losses due to predation, compared to other livestock farming. Hence, a successful method to mitigate losses in a diverse range of herd types is imperative in this farming context. Sex of dog may be another factor that influences a guard dog's behaviour (such as chasing game/livestock and aggressiveness) and as such could impact effectiveness of reducing livestock losses. Pal *et al*. [18] examined the agonistic behaviour of free-ranging dogs (*Canis familiaris*) in India in relation to season, sex and age, and found overall levels of aggression were highest among adult females, whereas submissive behaviour was highest in juvenile males. In this case season, sex and age were shown to have a significant effect on the agonistic behaviour of free-ranging dogs. However a much earlier study [19] on the use of livestock guarding dogs found that there was no significant difference in success rate between male and female dogs. This lack of difference was shown for all nine breeds (including 56 Anatolians) investigated in the study. Furthermore, no significant difference in success was found between dogs that were intact and those that had been neutered, however no information was available regarding number or sex of dogs sterilized versus intact, nor at what age sterilization occurred or whether it was before or after dogs had been employed as a LGD [19]. Therefore, further research needs to be undertaken to determine whether the practice of sterilizing guard dogs has the potential to increase the success of LGDs. Additional studies [20,21] support the notion that sterilization may have potential benefits if it reduces sex distinctive behaviours such as wandering by males, but also removes potential issues such as pregnancy and whelping in female dogs. These benefits would likely be advantageous in the context of LGD efficacy.

The Cheetah Outreach LGD programme has mainly been employed with sheep and goat farmers, but dogs have increasingly been used with cattle and exotic game species. Likewise, the placement of both male and female dogs occurs randomly according to puppy availability. Therefore, this study aimed to compare the success of LGD in reducing livestock losses in sheep, goat, cattle, exotic game or mixed herds in the North West and Limpopo provinces of South Africa. A second objective was to determine whether the sex of dog impacts the observed reduction in livestock losses.

MATERIALS AND METHODS

Study Animals

Data on livestock losses (animals lost from the herd due to perceived predation) was obtained for 135 farms using 139 dogs. Only single dog-farms were included but a greater number of dogs versus farms were included since dogs were occasionally replaced on a farm over time, for various reasons such as property ownership changes. Data on farmer-perceived livestock losses before and after placement of a LGD was collected between 2005 and 2014. Dogs were all Anatolian Shepherds from reputable breeders with proven working lines. Puppies were placed with their intended flock between six and eight weeks of age. Up to sixteen weeks each puppy was left with eight to ten weaned lambs. Subsequently the puppies were introduced to the rest of their intended flock and accompanied them into the grazing areas, with close monitoring of the dog by the farmer and Cheetah Outreach for up to one year. Training of all dogs in this study was performed by the farmers in accordance with instructions from Cheetah Outreach (Farmer's Anatolian Manual, available at http://www.cheetah.co.za/an_project.html).

Dogs comprised of 78 males, 49 females, and 12 dogs for which sex data could not be obtained as the farmers had only provided dog names, which could be sexually ambiguous. All dogs were sterilized at seven months of age. This was done by a qualified veterinarian on the farm where the dog has been placed in order to minimise time away from the herd or flock. Farm types consisted of 68 sheep, 37 goats, 23 cattle, and two exotic game farms (Springbok). Mixed livestock herds (n = 5) consisted of only sheep and goats. One dog was moved from a flock of sheep to a herd of exotic game during the study period. Dogs were placed on farms throughout Limpopo and North West provinces in South Africa (Figure 1). This data was used to investigate percentage improvement in livestock loss between different herd types and according to the sex of dog.

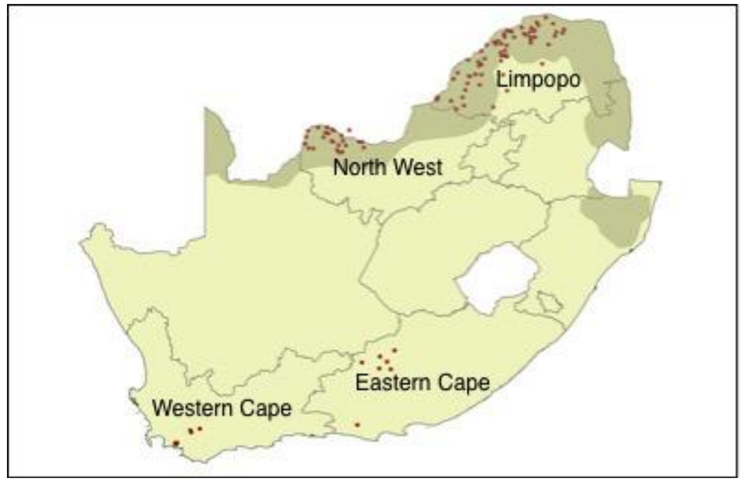

Figure 1: Livestock Guarding Dog placements (indicated by red dots) in South Africa (map courtesy of Cheetah Outreach).

Data Collection

During the first year of placement puppies were monitored on a monthly basis by Cheetah Outreach staff. Between ages one and three years dogs were monitored biannually. Thereafter, dogs were monitored on a yearly basis. Farmers are interviewed (face to face where possible or telephonically) according to the monitoring schedule mentioned above and were initially provided with a farm information questionnaire prior to the introduction of the dogs in the programme. The farmer indicated number of stock losses and herd type on this initial questionnaire. Stock loss data provided by Cheetah Outreach for the period 2005-2011 was previously analysed by Rust *et al*. [1]. The current study uses the same dataset, with the addition of new data obtained in 2012- 2014. All data collected between 2005 - 2014 was used to investigate the impact of sex of dog and herd type on percentage change in livestock loss before and after LGD placement (in contrast to Rust *et al*. [1] who used only post-placement data to investigate the influence of herd type).

Data Analysis

None of the data collected satisfied the criteria for a

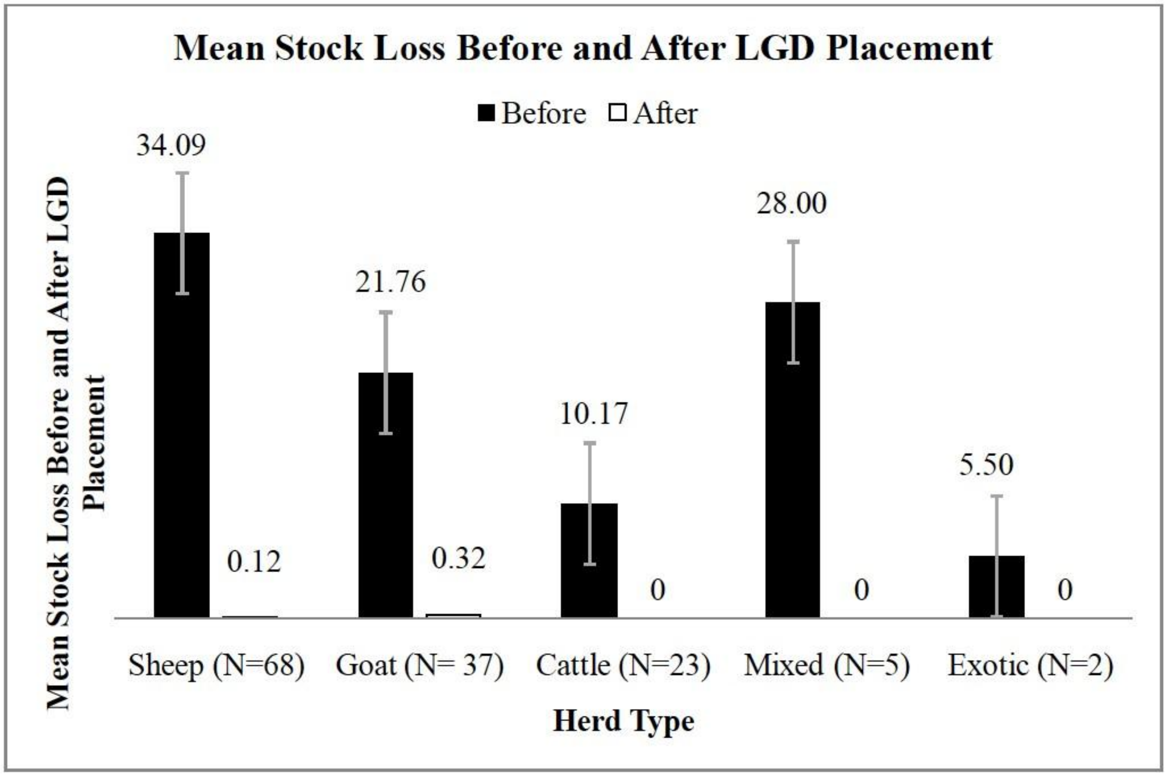

Figure 2: Mean number of livestock lost according to herd type. Black bars represent mean losses before placement of a LGD; white bars represent mean losses after placement of a LGD. No losses occurred after placement of a LGD for cattle, mixed or exotic game herds. Bars represent mean ±standard error of the mean.

normal distribution (Shapiro-Wilk Test: <0.0001 for all). Therefore analysis consisted of non-parametric independent samples test in SPSS v. 22 (SPSS Inc., Chicago, Illinois, U.S.A). Percentage change in stock loss after introduction of a livestock guarding dog was calculated as follows:

[(Number of livestock lost to predators before the dog -
Number of livestock lost to predators after the dog) X 100
Number of livestock lost to predators before the dog]

A Kruskal-Wallis test was used to compare percentage change in stock loss after introduction of a livestock guarding dog according to herd species. A Mann-Whitney U test was used to compare percentage change in stock loss after introduction of a livestock guarding dog according to dog sex. The level of significance was set at $p < 0.05$.

RESULTS

Out of the 135 farms evaluated only 10 farms (7.41%) continued to experience some losses due to predation after a LGD was introduced for the period 2005–2014 (Figure 2). No difference in reduction of stock loss between herd types was detectable (Figure 3). There was no significant difference between sexes for mean overall improvement in livestock losses after dog introduction (98.50% ±0.61 for males, 99.52% ±0.28 for females).When sex of dog was compared within each herd type, both male and female dogs had a percentage improvement of 100% for cattle, mixed and exotic game herds. There was no significant difference in percentage improvement of stock loss between males and females in sheep herds (98.42% ± 0.89 for males, 99.49% ± 0.36 for females) nor in goat herds (97.53% ± 1.43 for males, 99.17% ± 0.83 for females).

DISCUSSION

This study has demonstrated that herd type (livestock species) and dog sex had no impact on the percentage reduction in livestock loss following placement of a LGD on South African farms. Similarly, Rust *et al*. [1] found no difference in predation levels of the different farmed species during LGD placement, and our results confirm that this lack of effect was not concealing a difference in the relative improvement experienced by farmers following a LGD placement. However, sample sizes were small for cattle, mixed herds, and particularly for exotic game species (n=2). This may explain the minor differences apparent in the change in livestock loss

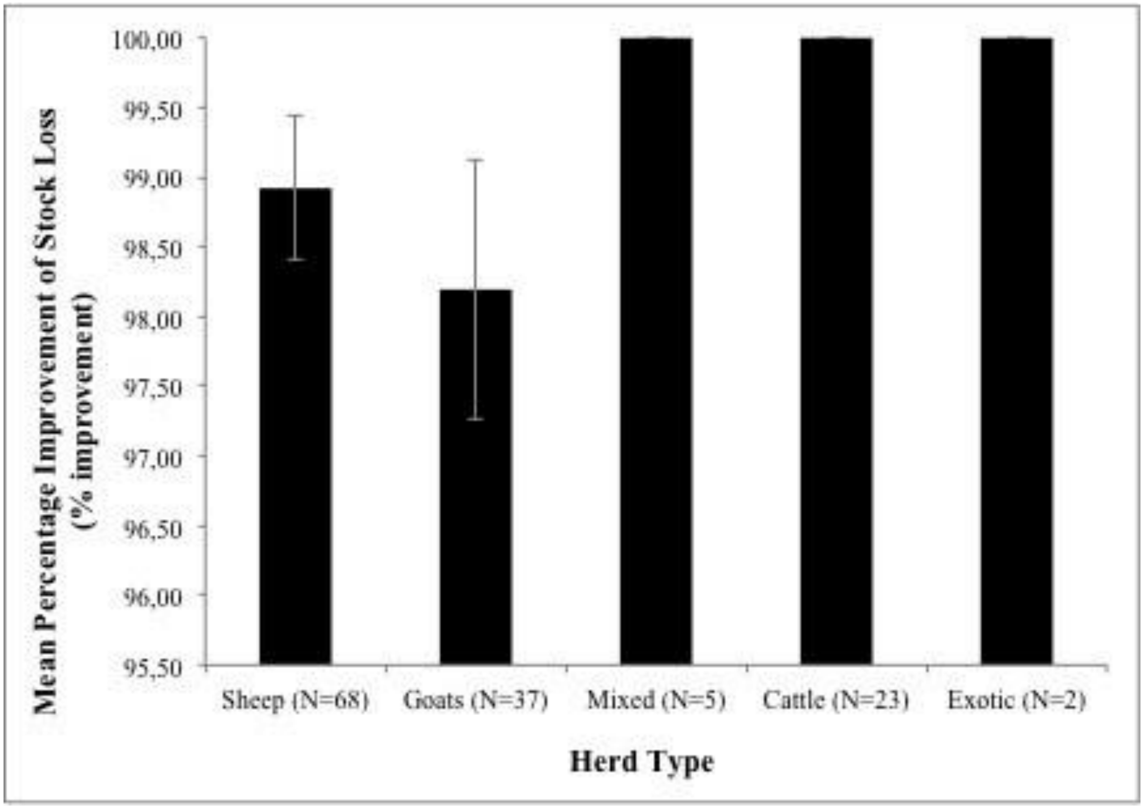

Figure 3: A bar graph showing the mean percentage improvement in stock losses after the introduction of a livestock guarding dog into different herd types. Bars represent mean ± standard error of the mean.

calculated for these herd types, compared to sheep and goat herds, for which data was available for larger samples (n > 30). It is therefore unlikely that any real difference exists between herd species in the degree of protection conferred by a LGD and, as such, Anatolian LGDs can be considered a versatile method of non-lethal predator control in the context of South African farming.

The placement of a LGD with exotic game herds is a relatively novel application of this predator control method in South Africa and is still being tested and fully evaluated. Whilst our data is insufficient to draw conclusions from in regards to the efficacy of this application, the current study findings are encouraging and further testing with atypical livestock species is warranted. This study relies on farmers choosing to participate. This means that farms used may not necessarily be representative of farms and farming practices in South Africa. Although habitat type was similar across study sites, confounding factors such as husbandry practices, stocking rates, predator densities and initial level of predation, which have all been found to impact farmer-predator conflict, were not consistent across farms (unpublished data, Cheetah Outreach Trust). However on an individual basis, alternative predator control methods existed both prior to, and after the introduction of the guard dogs. Percentage change was determined from pooled before and after data for each herd type or dog sex to reduce the impact of these confounding factors. However, future studies are hence warranted with larger datasets that would permit grouping of data according to the use and type of alternative predator control methods, so as to more precisely determine the effect of the dog placement independently. Additionally a comparison between farms in the same area without LGD placements, exposed to the same type and level of surrounding predator populations, could be beneficial in gaining a sound and comprehensive evaluation of the impact LGDs.

Farmers may not keep accurate records of loss numbers and as such numbers given should be considered estimates. Additionally when referring to periods before the introduction of livestock guarding dog, answers to questions posed in the questionnaire relied on the farmers' recollection of events and numbers of livestock affected (livestock losses were given for the year preceding placement of the dog). Information therefore takes on the form of a testimonial. It is however in the interest of participating farmers to provide accurate data. Due to the opportunistic nature of many predators and the influence of prey size on predation risk, cattle are less likely to be targeted as prey, particularly by smaller predators such as cheetah [22,23]. Whilst the deterrent effect of a dog is expected to be consistent regardless of prey species, when a guarding device is added to an already risky or potentially costly prey (e.g. cattle), this combination may reflect the crossing of some theoretical threshold in a predator's prey preferences. As such, predators faced with such a combination of risk factors could avoid these types of predation opportunities altogether, which could explain the 100% decrease in predation levels seen in cattle herds post LGD-placement in this study. In contrast, it is feasible that a difference existed in the number of cattle versus sheep or goat farms in the area, and that reduced availability of cattle in the area subsequently reduced predation via decreased opportunity. Since data was only available for farms utilising LGDs, it is unknown whether cattle were disproportionately available to predators in the area. However, despite there being fewer herds of cattle than sheep or goats included in the study population, losses prior to LGD placement were similar between cattle and sheep or goat flocks. This indicates that predation opportunity could also be expected to have been similar. Therefore, the 100% improvement in stock losses seen for cattle farms post LGD-placement is more likely to reflect a change in predator preference.

An unexpected and incidental finding of this study was the successful relocation of a dog between herd types. Previously it has been stated that once bonded with a specific herd type, it is not advisable to move the dog and place it with a different herd type [7,24,25]. However, at least one dog was successfully transferred between herds of different species with no loss of efficacy in the current study. This provides further evidence in support of the versatility of this breed of guarding dog. Further research is necessary in order to determine whether other dogs could be moved to a different herd type and retain efficacy in reducing livestock losses. Sex of dog did not significantly impact the ability of a dog to reduce livestock losses. All puppies in this programme are spayed or neutered at seven months of age, which may contribute to sex specific behaviour and/or undesirable behaviour being reduced. In companion animals a gonadectomy is often requested specifically to reduce normal breeding behaviour and is frequently a recommended treatment for behavioural problems in dogs such as aggression and roaming. Sexually dimorphic behaviours, which are at least to some extent mediated by sex hormones are the ones most commonly affected by a gonadectomy, ovariectomy or an ovariohysterectomy. It has even been suggested that neutering may possibly improve the trainability and at tentativeness of male dogs [20,21]. It is therefore feasible that the lack of inter-sex difference in change in livestock loss following LGD placement reflects the practice of sterilising LGDs, and supports this as a beneficial management strategy.

Management Implications

The notion that herd type does not impact the reduction in livestock loss following placement of an LGD is an important one. Farmers, in South Africa in particular, have the option of not only farming with traditional species such as sheep, goats and cattle but can focus on wildlife utilisation by producing game meats as an alternative. A number of farmers in South Africa have altered their operation to include game species with domestic livestock or are exclusively farming wild species [5,26]. The ability of an LGD to bond and protect different species opens up the possibility that they can be used to reduce livestock losses due to predation for game farmers as well. Whilst the results of the current study require further testing with an increased sample size, the high percentage improvement in stock survival seen for the two game farms is particularly encouraging.

The guard dog programme by Cheetah Outreach is limited by the available number of suitable dogs (i.e. those from well managed breeding lines, and which are less at risk of inheritable diseases or conformation disorders). An increase in number of farmers making use of this tool can only occur if there are sufficient numbers of healthy puppies sourced from reputable breeders to meet demands. Therefore the ability of both sexes of dogs to effectively reduce livestock losses is meaningful as the pool from which to select candidates both for breeding and use in the field is not restricted.

Conclusion

In summary, while the findings presented here support the use of LGD to reduce livestock losses regardless of herd type and sex of dog, it is imperative to consider that these effects may not always be replicated if other measures or combination of methods to reduce wildlife-livestock conflict are not also employed.

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