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Effectiveness of 0.1% Deltamethrin and Horse Owner Awareness in Managing *Ixodid* and *Argasid* Ticks in Lesotho

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Abstract

This study evaluated horse owner awareness and management practices for tick control, and assessed the effectiveness of 0.1% deltamethrin in reducing tick infestations in horses in Lesotho. A cross-sectional survey was conducted involving 321 horse owners, alongside an experimental assessment using 432 horses. Data were collected using structured questionnaires and analysed using descriptive statistics, Chi-square tests and Wilcoxon signed – rank tests. The results showed that awareness of tick infestation varied across regions, with 43% of horse owners in semi-urban areas, 32% in urban areas, and 25% in rural areas recognizing ticks as a problem. Tick infestation was reported to be more prevalent during the summer season particularly in rural areas where traditional control methods such as hand dressing were commonly used. The application of 0.1% deltamethrin significantly reduced tick counts, achieving a 70.4% reduction after the first treatment and 68.6% after the second treatment. However, a small proportion (12%) showed limited or no response suggesting possible development of resistance or improper application practices. In conclusion, while horse owners demonstrate moderate awareness of tick infestation and control methods there are gaps in knowledge and effective management practices. Although 0.1% deltamethrin is effective in reducing tick burden, its efficiency may be compromised over time. Therefore, improved farmer training and the adoption of integrated tick management strategies are recommended to enhance sustainable control of ticks in horses.

Keywords: Deltamethrin 0.1%, Horse Owners, Education

Introduction

Horses are a significant part of rural communities' livelihoods in Lesotho, where they are present in a variety of areas and agricultural systems. Horses are widely used throughout the nation for food, recreation, draft power, and athletic competition [1]. Additionally, they are kept as companions or for tasks like packing and plough work. According to FAO [2]. Lesotho's favourable ecological circumstances, which include a sizable region covered in the foothills and mountains that are best suited for extensive farming, allow for the sustainability of horses in the country. The horse business, which makes up 4.9% of the GDP, is typically engaged in substance farming, while commercial livestock husbandry is starting to emerge [3].

However, there are a number of challenges that the development of horses must overcome, including external parasites. The external parasite infestation makes it difficult for horses to perform their regular tasks and services as needed [4]. Horse production is dominated by external parasites such ticks like *Rhipicephalus appendiculatus, Rhipicephalus evertsi evertsi, Hyalomma rufipes, Rhipicephalus (Boophilus) decoloratus, and Otobius megnini*. Ticks have been blamed for severe blood losses, weight loss, decreased milk production, low fertility, and frequently fatalities in horses because they are voracious bloodsuckers. Additionally, they act as disease-carrying agents, causing harm to hide and skins and, as a result, industrial rejection of hide and skin products. As far as environmental variables like temperature, humidity, altitude, and vegetation types are concerned; the distribution of ticks is connected globally [5].

Though, direct and indirect risks that tick infestations bring to working horses; chemical treatment is still the most efficient tick control strategy in Lesotho. Being known to significantly harm the environment, frequent use of acaricides is said to make some tick species resistant [6]. As a result, acaricides must be used frequently and at high doses, which is more harmful to the environment. Tick resistance has been a significant problem in Lesotho since the introduction of acaricides such organochlorines, organophosphates, macrocyclic lactones, carbamates, amidines, or synthetic pyrethroids [7]. Unrestricted and frequent use of acaricides by horse owners as well as the usage of local knowledge favours the development of tick resistance. In order to evaluate the use and effectiveness of the most commonly used acaricides for the management of ticks in three regions of Lesotho, this study was planned to identify the main species of horses' ticks in the area [5].

Material and Methods

Study Area

The study was conducted in two districts of Lesotho being Maseru and Mafeteng. The capital and largest city of Lesotho is Maseru and is situated on the along Caledon River, a border between South Africa and Lesotho. With warm, rainy summers and mild to chilly, dry winters, Maseru has a typical subtropical highland climate that borders on a dry-winter subtropical highland. In the Southern Hemisphere, the typical daily temperature during the summer months of December to March is 22°C. The typical temperature in winter, which lasts from June to September, is 9°C. January is the warmest month, with highs of 15 to 33°C. The temperatures in July, which is the coldest month, range from 3 to 17°C. From 3 mm in July to 111mm in January, on average, it rains. On the other side, Mafeteng is the district's only town and capital. Mafeteng shares a western border with the South African province of the Free State. The nation experiences 100mm of rain on average each year, with the majority falling from October to April, when it rains the most. Despite rain falling every month of the year, run-offs cause a shortage of groundwater. Because of its altitude, the area experiences a temperate temperature that is generally humid. In the winter, the temperature in lowlands ranges from 32°C to 7°C.

Sample Size Determination

The formula N = [1.962 * P exp. (1 - P exp.) / d2] was used to determine the sample size of 324 horse owners. Z (95 % level of

confidence) = 1.96, p is the estimated baseline proportion of horse owners who were presumed to have adequate knowledge about ticks and the use of acaricides in horses = 0.20, and e is the margin of error = 0.05 as per Thrusfield, (2007). It was assumed that 20% of horse owners would have sufficient awareness of ticks and the use of acaricides because no research on farmers' knowledge and acaricide usage had been done in the selected areas.

Sampling Procedure

In the districts of Maseru and Mafeteng, three regions-urban, semi-urban, and rural-were chosen using the purposive sampling technique. The districts were organized into resource centres within each of the three general regions of urban, semi-urban, and rural areas. The sampling frame only included areas where horses were reared. Masianokeng, Morija, Semonkong, and Ramokoatsi served as the urban areas' representatives. Ramabanta, Ha-Ntsi, Ts'akholo, and Thabana-Morena made up the semi-urban areas, while Matelile, Ha-Mosala, Ribaneng, and Marakabei made up the rural areas.

A total of 27 horse owners from each village were randomly selected, resulting in a sample size of 322 participants overall and 108 participants in each region. Most of the respondents were heads of households. In addition, 432 horses participated in the data collection process, and only horses that had not been treated with any acaricides (tick grease) for at least one month prior to sample collection were considered for inclusion in the study. The chosen animals were closely checked for any tick infestations and inventoried. There were used 144 horses each region, or a total of 36 horses per resource center. Using spot-on applications, acaricides (tick grease) were administered (hand dressing).

Experimental Design

Survey

A structured questionnaire survey was used to collect data for a cross-sectional investigation. The socioeconomic characteristics of horse owners, the different types of tick grease used, the frequency of tick grease application, the method of application, the rotation of tick grease use, tick control procedures, and the horse owners' knowledge of ticks were all examined through structured questionnaire interviews. Additionally, issues with and solutions for managing horses on a daily basis were looked into.

Experimental

The horses which were not treated with any acaricides (tick grease) for a minimum period of a month prior sample collection were included in the present study. The animals selected were examined carefully for any tick infestation and recorded as positive and negative depending on the presence and absence of ticks on the body of the horses. The administration of acaricides (tick grease) was done using spot-on (hand dressing).

Results and Discussion

Demographic Characteristics of Horse Owners

Gender of Horse Owners

Table 1 presents the findings, which include a summary of the socio-demographic data for the horse owners who were interviewed. According to the current study's findings, male farmers are more likely than female farmers to raise horses across all regions. Males are reportedly disproportionately represented in semi-urban areas (97.1%), followed by rural areas (96.2%). The Chi-square test results showed that the region had a significant ($p > 0.05$) impact on the respondents' gender when significance was assessed at the 0.05 level, but the Post hoc test was unable to demonstrate a link between the two variables. The results of

the current study are in line with the findings of [8] who noticed that men are mostly engaged in horse ownership than women.

The findings were further confirmed by [9], who claimed that while women handle tasks like caring for small stock animals like chickens and milking dairy animals, men make the majority of management decisions when it comes to livestock production. These decisions include information on range and pasture conditions, water availability, and the prevention and control of various diseases that may affect their livestock. Furthermore [10], went on to highlight the fact that most women in developing nations own some cattle since they serve as domestic servants in their communities, while men tend to handle livestock chores more frequently.

Age of Horse Owners

According to the current study, all of the respondents who were questioned ranged in age from 25 to over 60. The findings revealed that horse owners older than 60 years old dominated all of the regions, while those under 25 years old made up the smallest percentage. The findings showed a favourable correlation between age and the number of horse owners in the three regions. The non-significant correlation between age and region was found by the Chi-square test ($p > 0.05$). According to the study's findings, the average age of horse owners in urban, semi-urban, and rural areas was over 40 years old in 72.8 %, 77.5%, and 81.3% of cases, respectively. The majority of farmers that were interviewed were older than 60.

Similar findings by [11] demonstrated that youth movement from rural to urban areas in pursuit of greener pastures was a factor in the greater percentage of rural farmers who were 60 years of age or older. As [12] noted, young people typically move to urban areas in order to pursue their tertiary education goals and land better-paying employment. As a result, elderly individuals who are left to take care of horses are no longer active and unable to understand prescriptions regarding tick prevention. The findings of the present study are also consistent with those of [13] who claimed that elderly farmers engage in livestock husbandry as a social activity in communal areas, paying for customary bride prices, draught, rites, and high prestige. Additionally, previous research studies discovered that persons over 31 actively engage in horse rearing, in part because mature and elderly people typically own animals in developing nations.

Education Level of Horse Owners

According to the current study's analysis of horse owners' educational backgrounds, respectively, 52.5%, 42.8%, and 40.8% of respondents in the rural, semi-urban, and urban areas were illiterate. Regarding formal education, the findings showed that farmers with primary level education 40.6 % were more likely to keep horses, particularly in semi-urban areas. The percentage of farmers with secondary education was higher in urban regions 28.2%, whereas the proportion of horse owners with postsecondary education was lowest in urban areas. When significance was tested at the p-value level of 0.05 the Chi-square showed a significant $p < 0.01$ association between education and region at which the horses were reared, however, the Post Hoc test failed to reveal the exact variation between the two variables.

Overall, the study's findings showed that rural areas often have worse educational outcomes than urban areas. This is supported by the finding that post-primary education was more prevalent among farmers in urban regions compared to rural areas, where it was least prevalent. This implies that adopting new technologies targeted at raising the welfare standard of horses and resulting in higher output would be simpler for farmers in urban settings.

The current study's findings are consistent with those of [14] who discovered that the majority of horse owners 96 % had only an elementary education, with those who were illiterate coming in second 66 %. Since free primary education was implemented in 2000, Lesotho's elementary education has increased, although the majority of people drop out of primary school due to financial difficulties [15]. Additionally, [16] pointed out that the high illiterate class has a detrimental effect on livestock productivity as well as their willingness to adopt new management and animal usage technology. Therefore, raising farmers' educational lev-

els is of utmost significance for overall agricultural output.

Owners Experience in Horse Industry

The vast majority of respondents in the three regions have kept horses for periods ranging from less than a year to more than 20 years. According to the current study's findings, the majority of horse owners had 6–10 years of experience with horse ownership (40.8%, 45.7%, 48.8% in urban, semi – urban and rural areas respectively). In all locations, the lowest percentage of horse owners was seen among individuals with less than a year's worth of experience and those with more than 20 years. Because most farmers have experience raising horses, these findings imply that the management of horses is unlikely to be compromised, protecting the wellbeing of working horses in Lesotho. The owners' experience and the region were found to be significantly ($p > 0.03$) correlated by the Chi-square analysis, but no significant relationship ($p > 0.05$) was found by the Post Hoc test.

Table 1: Demographic Characteristics of Horse Owners in the Urban, Semi-Urban and Rural Areas of Maseru and Mafeteng Districts in Lesotho

Category	Urban (%)	Semi-urban (%)	Rural (%)	S. E	X^2	Sig.
Gender						
Male	89.3	97.1	96.2	0.04	7.44	0.02
Female	10.7	2.9	3.8	0.19		
Age						
below 25	5.8	2.9	2.5	0.23	7.48	0.68
26 – 30	4.9	5.1	6.2	0.19		
31 – 40	16.5	14.5	10	0.11		
41 – 50	21.4	21	28.8	0.09		
51 – 60	25.2	20.3	22.5	0.09		
above 60	26.2	36.2	30	0.71		
Education level						
Primary	26.2	40.6	35	0.07	19.04	0.02
Secondary	28.2	15.9	11.2	0.09		
High school	2.9	0.7	0	0.25		
Tertiary	1.9	0	1.2	0.67		
Informal education	40.8	42.8	52.5	0.06		
Experience in horse ownership (years)						
< 1	2.9	1.4	0	0.25	16.544	0.035
1 – 5	43.7	40.6	43.8	0.07		
6 – 10	40.8	45.7	48.8	0.06		
11 – 20	12.6	8	1.2	0.12		
> 20	0	4.3	6.2	0.16		

X2 = Pearson Chi – Square, S. E = Standard Error, Sig = Significance level

The findings of the present study are consistent with those of [17], who found that horse rearing expertise is a significant factor in enhancing horse owners' confidence in farming and decision-making. Those who have previously worked in the equestrian

sector have a better chance of survival than those who have never been involved. Additionally, [18] noted that a farmer's managerial skill can be determined by their level of farming experience, education, and frequency of interaction with extension services. These factors also help farmers better grasp the advantages and disadvantages of technology. But according to [19], farming experience in areas with a high tick challenge causes farmers to rely mostly on alternative tick control methods because acaricide compounds are expensive, which raises the occurrences of tick resistance to acaricides.

Awareness of Horse Owner's on Ticks Infesting Their Horses

Type of Ticks Known by Horse Owners

The findings of the current study, which are presented in Table 2, reveal the different species of ticks that horse owners are familiar with as well as how they affect three districts in Maseru and Mafeteng. The higher proportion of horse owners seemed to be aware of hard ticks in the urban (58.8 %) and semi-urban areas 55.2% while horse owners in the rural areas were more familiar with the soft ticks 43.4 %. According to the results, metropolitan areas had the lowest rate of soft ticks 13.6 %, followed by semi-urban areas 23.9 %. The Chi-Square test revealed a significant ($p > 0.05$) correlation between the region and farmers' knowledge of ticks. In this study, every participant claimed to have observed ticks. This is not surprising given that the respondents are farmers whose lives are intimately linked with animals, pastures and forests, where ticks are commonly found.

The current study's findings concur with those of [20], who noted that hard tick species like *Rh. sanguineus* and *A. tigrinum* are prevalent in urban environments. Furthermore, Walker et al. (2014) noted that the three hard tick species (*B. decoloratus, H. rufipes*, and *A. hebraeum*) are known to be the most common in various regions of the world in horses of all ages; as a result, owners can recognize them during inspections of their horses in an effort to control high infestations.

Effect of Ticks in Horses in Different Regions

According to the study's findings, ticks constitute a serious threat to horses for every respondent in every region. The findings revealed no evidence of a region's influence on how ticks impact an animal ($p > 0.05$). These findings are consistent with those of Radostitis et al. (2008) who found that severe tick burdens stress animals to the point where they become anorexic, which may lower productivity. The fact that ticks induce mechanical harm, inflammation, and hypersensitivity due to salivary production that causes toxicosis and paralysis served as additional support for this (Rajput et al., 2006). In addition, heavy infestation of ticks in ears and other body parts cause injuries which serve as the portal entry of other pathogens that may lead to death. Moreover, tick infestation in horses is associated with huge economic losses especially through rejection of lowered hides and skins attributed to tick damage (Betancur et al., 2018).

Table 2: Awareness of Horse Owners on Ticks Infesting Their Horses in Urban, Semi-Urban and Rural Areas of Maseru and Mafeteng Districts in Lesotho.

Category	Urban (%)	Semi-urban (%)	Rural (%)	S. E	X^2	Sig.
Type of ticks known by horse owner						
Hard ticks	58.8	55.2	31.7	0.06	6.28	0.03
Soft ticks	12.6	22.4	43.4	0.14		
Both	28.6	22.4	24.9	0.19		
Outcome of ticks on horses in different regions						
Yes	92.6	96.4	98.1	0.03	7.61	0.52
No	7.4	3.6	1.9	0.17		

X2 = Pearson Chi – Square, S. E = Standard Error, Sig = Significance level.

Control Methods of Ticks' Infestation in Horses in Different Regions

Control Practices by Horse Owners

According to the findings in Table 3, acaricides are more commonly used by horse owners in the three regions than conventional herbs. According to the findings, horse owners in urban and semi-urban areas used acaricides more frequently 73.5% and 59.4%, respectively, while those in rural areas rely more on a combination of acaricides 39.8%, traditional herbs 29.9%, and physical removal 30.3%. When put through the Chi-Square test, the findings of the present investigation revealed a significant ($p > 0.05$) correlation between the region where a horse is raised and the tick management strategy. The findings of [22], who claimed that acaricides are mostly utilized to control ticks in horses due to their efficacy, are supported by these findings. The study from [23] also noted that most horse owners remove ticks on their animals during grooming or before riding especially when tick infestation is very small. Moreover, George et al. (2004) reported the higher price of acaricides as one of the reasons for some farmers to rely on traditional methods of treatments for many diseases.

Frequency of Treatment Application on Ticks

According to the study's findings, 44.2%, 56.0%, and 57.8% of horse owners in rural, semi-urban, and urban settings, respectively, give their animals' acaricides when necessary. A higher percentage, 40.0%, of horse owners in urban areas, compared to a lower percentage, 13.9%, in rural areas, treat their animals on a monthly basis. The location was shown to have a significant ($p > 0.05$) impact on the frequency of medication application with regard to tick control on horses by the Chi-Square test. The current study's findings do not agree with those of Pukuma et al. (2011), who stressed that horse owners have created annual immunization programs against parasites that threaten their horses. According to [24] most farmers complain about the efficacy of medicine being low and prices being high. For these reasons, farmers are reluctant to buy medicine hence why they treat animals when necessary. In addition, some farmers do not trust the veterinary treatment; therefore, rely on traditional methods of treatment.

Mode of Treatment Application

The majority of horse owners in rural areas 52.3% use hand dressing to apply acaricides to reduce ticks on their animals, according to the study's findings, while only 2.3% employ the pour-on method. The two treatments that are most effective against ticks in cities are hand dressing 35.6% and injection 34.8%. The semi-urban horse owners appeared to prefer hand dressing 45.7% over other administration techniques; spraying, injection, and pour on mode reported lower proportions 12.2%, 20.0%, and 22.0%, respectively. Despite the Post Hoc test's failure to detect a link, the findings of the Chi Square test showed a significant ($p > 0.05$) correlation between the location and the method of medication delivery. The primary components of measures to combat tick-borne diseases, which constitute a significant barrier to the development of the livestock business, are tick management utilizing acaricides in containers, spray courses, or hand dressing techniques [25]. On the other hand, [21] claimed that the application of spot treatment or hand dressing can cover the predilection spots on the parts of the body that are not properly treated by spray or dips. Additionally, applying pesticides by hand to specific body parts in small amounts using aerosols, oils, and dusts takes time and effort, but in some cases, it may be more efficient and cost-effective than treating the entire animal [26].

Effectiveness of Acaricide (Tick Grease- Deltamethrin 0.1% M/M) Against Ticks

According to the findings of the current study, which are shown in Table 8, there was a significant ($p > 0.05$) difference between the pre-treatment and post-treatment, with the percentage of tick count reduction during the first and second treatments being 70.4 and 68.6 respectively. The percentage of tick counts that were reduced was slightly lower during the second treatment than it was during the first, despite the fact that all treated horses showed a noticeable decline in ticks on both occasions.

The lower decline during the second administration of the medication may have been caused by the tick grease's diminished effectiveness against ticks due to the emergence of microbial resistance.

Table 3: Control Methods of Tick Infestation on Horses by Horse Owners in Urban, Semi-Urban and Rural Areas of Maseru and Mafeteng Districts in Lesotho.

Category	Urban (%)	Semi-urban (%)	Rural (%)	S. E	X^2	Sig.
Control practices of ticks by horse owners						
Manual removal	26.4	28.3	30.3	0.09	12.1	0.04
Use of acaricides	73.5	59.4	39.8	0.06		
Traditional remedies	6.4	12.3	29.9	0.28		
Frequency of treatment application						
Monthly	40	22.6	13.9	0.64	5.86	0.09
Seasonal	15.8	21.4	28.3	0.08		
When necessary	44.2	56	57.8	0.12		
Mode of treatment application						
Hand dressing	35.6	45.8	52.3	0.06	8.63	0.1
Spraying	11.9	12.2	22.6	0.04		
Injection	34.8	20	22.8	0.14		
Pour on	17.7	22	2.3	0.26		

X^2 = Pearson Chi – Square, S. E = Standard Error, Sig = Significance level.

Table 4: Tick Count Reduction for Tick Grease (Deltamethrin 0.1% M/M) In Different Time Periods.

Treatments	N	Day 0 TC Mean	Day 28 TC Mean	TCR (%)	Sig.
1st Treatment	432	24.30^a	17.10^b	70.4	0
2nd Treatment	432	39.85^a	27.34^b	68.6	0

ab: Means within a row with no common superscripts differ significantly ($p < 0.05$), Sig = Significance level, N = Number examined, TC = Tick count, TCR = Tick count reduction

The report from Estrada-Peña et al (2013) stated that the use of tick grease may greatly lower the abundance of the tick species and aid to reduce the risk of tick-borne diseases lends credence to the findings of the present investigation. Using Deltamethrin 0.1 m/m, the primary component of the tick grease used, demonstrated efficacy above 95 % in vivo, according to [27], but when used on animals in the field, it demonstrated much lower results, with only 70.4% of effectiveness, which is consistent with the results of the current study.

However, [28] claimed that at day 6 of tick grease, deltamethrin's efficacy was 100%. However, compared to the findings of the current investigation, Jain et al. (2021) reported low efficacy of 13.2%, 12.3%, and 16.2% at 3, 7, and 14 days, respectively.The results presented in Table 5 show the reaction of horses on tick loads with regard to application of tick grease. The use of tick grease had great contribution on reducing the burden of tick loads on horses, however, roughly 9.7% of horses did not respond positively when treated with tick grease while 1.3% remained constant between the pre-treatment and post-treatment.

Table 5: Wilcoxon Signed Ranked Table.

Category	Treatment1 (N)	Treatment 2(N)
Negative Ranks	381[a]	353[a]
Positive Ranks	42[b]	49[a]
Ties	9[c]	4[c]
Total	432	432

Footnote: N = Number examined: a. Tick spp. post – test Tick spp. pre – test, c. Tick spp. post – test = Tick spp. pre – test

Since the majority 88.0% of the horses treated with tick grease had lower tick counts, the study's findings point to tick grease's effectiveness against all four genera of ticks that were found in the study regions. The indiscriminate use of tick grease, which frequently occurs without knowledge of the factors responsible for the dynamics of the tick population and ultimately results in the development of resistant tick species as well as environmental pollution, may be to blame for the approximately 12.0% of horses that did not respond to tick grease.

Conclusion

Based on the study's findings, it can be concluded that men over 40 who are illiterate and less educated predominate in the horse sector in Lesotho. Due to inadequate technical expertise in the use of management measures aimed at controlling ticks as well as effective use of acaricides, working horses are severely tick infested. Furthermore, the acaricides used in the current investigation demonstrated an average one-week residual effect, which was comparable with the seven-day tick re-infestation period. Therefore, it is advised that policies regarding the use of acaricides in horses be developed as well as raising awareness among horse owners on appropriate control strategies and effects of ticks infesting their horses.

Ethical Considerations

Based on worldwide standards for the treatment of animals used in research, the investigation and ethics committee at the Department of Animal science at the National University of Lesotho approved this work.

Conflict Of Interest

The authors declare no conflict of interest.

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