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Research Application Summary

Factors influencing tick load on dairy cattle herds in hot-humid and coastal environment of Ghana

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Abstract

The use of chemicals for ecto-parasite control and accompanying development of resistance to known acaricides are of major concern. Though acaricide use may still be needed in areas of heavy tick infestation, strategic management regime that screens susceptible herds from getting into contact with the vector is crucial. The objective of this study was to determine effect of management, level of biosecurity, type of kraal/barn and season on total tick count in hot-humid environment and Accra plains of Ghana. Data were subjected to Least squares (LS) analysis using Generalized Linear Model (GLM) Type III Procedure of SPSS version 25. The analysis showed that effect of breed, farm and location on Log10 (X +1) + 0.5 total tick load was masked by management regimes and level of biosecurity practices observed. Similarly, effect of breed, farm and location on tick load was masked by management regimes and level of biosecurity practices observed. Jersey cattle had the least (P<0.01) tick load. Dairy herds kept under exclusive zero grazing had the least (P<0.01) tick load, followed by partial zero gazing and range grazing in descending order. Ashanti region recorded the highest (P<0.01) tick load, followed by Greater Accra whereas Eastern region had the least (P<0.01) tick challenge in the dairy herds. Tick load in the dairy herds decreased greatly (P<0.01) with decreasing intensity of rains with respect to season. Sex of cattle was a poor determinant of tick load in the dairy herds studied. Dairy herds that had regular feed supplementation recorded lower tick count whiles those given occasional and no feed supplementation had similar (P>0.05) and higher tick count. Dairy herds maintained in insect-proof barn/housing had the least tick load. Open Kraal and roofed barn recorded a similar (P>0.05) tick infestation. Practicing of moderate level of biosecurity led to the least (P<0.01) tick count, with low and very low practices of biosecurity followed in descending order. Interaction effects were observed among the factors determining tick load in the dairy herds. Choice of productive dairy breed combined with good housing—preferably insect-proof, zero grazing, adequate feeding through supplementation and good level of biosecurity practices could reduce tick infestation in the dairy herds in Ghana.

Key words: Biosecurity, breed, diary cattle, Ghana, grazing-management, non-genetic factors, tick infestation, type of housing

Résumé

L'utilisation de produits chimiques pour le contrôle des ectoparasites et le développement de la résistance aux acaricides qui en découle constituent une préoccupation majeure. Bien que l'utilisation d'acaricides puisse encore être nécessaire dans les zones de forte infestation de tiques, un régime de gestion stratégique qui empêche les troupeaux sensibles d'entrer en contact avec le vecteur est crucial. L'objectif de cette étude était de déterminer l'effet de la gestion, du niveau de biosécurité, du type d'étable/kraal et de la saison sur le nombre total de tiques dans un environnement chaud et humide et dans les plaines d'Accra au Ghana. Les données ont été soumises à une analyse des moindres carrés (LS) à l'aide de la procédure de type III du modèle linéaire généralisé (GLM) dans SPSS version 25. L'analyse a montré que l'effet de la race, de la ferme et de l'emplacement Log10 (X +1) + 0,5 sur le nombre total de tiques était masqué par le type de gestion et le niveau des pratiques de biosécurité observées. De même, l'effet de la race, de la ferme et de l'emplacement sur la charge de tiques a été masqué par les régimes de gestion et le niveau de pratiques de biosécurité observés. Les bovins Jersey avaient enregistré la charge de tiques la plus faible (P<0,01). Les troupeaux laitiers maintenus sous la stabulation permanente avaient la charge de tiques la plus faible (P <0, 01), suivis du pâturage occasionnel et du pâturage intensif par ordre décroissant. La région d'Ashanti a enregistré la charge de tiques la plus élevée (P <0,01), suivie du Grand Accra, tandis que la région de l'Est a eu le moins de problèmes de tiques (P <0,01) dans les troupeaux laitiers. Le nombre de tiques chez les troupeaux laitiers a fortement diminué (P<0,01) avec la diminution de l'intensité des pluies par rapport à la saison. Le sexe des bovins était un mauvais déterminant de la charge en tiques dans les troupeaux laitiers étudiés. Les troupeaux laitiers qui recevaient une supplémentation alimentaire régulière enregistraient le nombre de tiques inférieur tandis que ceux recevant une supplémentation alimentaire occasionnelle et sans supplémentation alimentaire avaient un nombre de tiques similaire (P> 0,05) et supérieur. Les troupeaux laitiers maintenus dans des étables/logements à l'écart des insectes avaient le moins de tiques. L'étable ouvert et le kraal couvert ont enregistré une infestation de tiques similaire (P>0,05). La pratique d'un niveau modéré de biosécurité a conduit au nombre de tiques le plus faible (P <0,01), avec des pratiques de biosécurité faibles et très faibles suivies par ordre décroissant. Des effets d'interaction ont été observés entre les facteurs déterminant la charge en tiques parmi les troupeaux laitiers. Le choix d'une race laitière productive combinée à un bon logement - de préférence en isolement d'insectes, sans pâturage, une alimentation adéquate grâce à la supplémentation et un bon niveau de pratiques de biosécurité pourraient réduire l'infestation par les tiques chez les troupeaux laitiers au Ghana.

Mots clés : Biosécurité, race, bovins laitiers, Ghana, gestion des pâturages, facteurs non génétiques, infestation par les tiques, type de logement

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Introduction

Tick infestations have been known for triggering many tick-borne diseases with resultant reduction in productive yields leading to great economic losses in beef and dairy enterprises. Of the 866 species of ticks in the world described (Latif and Walker, 2004), *Amblyomma variegatum, Hyolomma marginatun rufiges, Boophilus decoloratus, Boophilus gyegyi, Boophilus annullatus, Rhipicephilus senegalensis, Hyolomma truncatim, Rhipicephilus evertsi evertsi* and *Rhipicephilus* spp., in descending order, are the most important tick population of cattle in Ghana (Walker and Koney, 1999). Feeding of these ticks on the hosts causes a variety of losses directly due to injection of toxins, anaemia, skin damage, irritation, and general stress leading to reduced milk yield, and meat production. Indirectly, ticks cause depressed immune function and transmit several pathogens (Manjunathachar *et al*., 2014).

Many approaches to tick control have been employed (Manjunathachar *et al*., 2014; Ashour, 2017). Yet, the control of ticks and tick-borne diseases is still unsatisfactory and requires concerted efforts (Ashour, 2017). Assessment of different level of biosecurity measures on tick count or load in dairy herd is unfortunately limited. The influences of management regimes, environmental variables and their interactions on total tick count and control are not well known. There is also paucity of data on effect of location (geographical zones), type of housing, and feed supplementation on the tick load of dairy herds in Ghana. Information on seasonal variation of the tick vectors in various environments is vital for strategic control of tick burden (Walker, 2011). The objective of this study was to assess factors (breed and non-genetic) influencing total tick load/infestation on dairy cattle herds in hot-humid and coastal environment of Ghana.

Materials and methods

This study was conducted in the hot-humid and coastal Savannah zones of Ghana from January, 2016 to April, 2018. The study areas have been described in Coffie *et al*. (2018).

Sampling techniques. Nine dairy farms were purposively selected for this study on the basis of management system/regime, level of biosecurity measures observed, type of barn or kraal used and the willingness of the owner to accept interventions used for the study. Simple random sampling was used to select at least three animals for tick count, depending on the herd size of a farm in a given season. A total of 127 cattle were used in the study.

Methods of data collection. Prior to data collection, all selected facilities and the cattle were sprayed every 5 to 6 days starting from 20th February to 10th of March, 2018 for three consecutive times in order to obtain a fair ground for build-up of ticks for total tick count (TTC). Data obtained from each farm included location (regions—Ashanti, Eastern and Greater Accra), Season of Sampling (major rainy, minor and dry seasons), breed of cattle (Sanga, GSH, Friesian-Sanga crossbred, Jersey and Zebu), Sex, level of feed supplementation (regular, partial and no feed supplementation), level of biosecurity (not observed, low and close to medium), and type of Kraal/Barn (insect proof barn, open Kraal and roofed barn).

Data on seasonal effect on TTC were taken in April, May and June for rainy season; September, October and November for minor rainy season; and December, January and February for the dry season records. Tick count was done at 13th to 15th day of the stated months in every given season. At the last month of each season (March, July and November), cattle were sprayed after 20^{th} of the month with Cypermecthrin/Amitraz and after the tick count exercise. This was done to prevent carrying tick load from one season to the other.

Regular feed supplementation involved provision of spent grains, cassava and plantain peels provided every day whereas partial supplementation was given only when supplements were available as described by Coffie *et al*., (2015).

Level of biosecurity practices were scored based on the implementation of biosecurity measures involving the three major biosecurity components, i.e., isolation, traffic control and sanitation (Buhman *et al*., 2007; Mathis and Hagevoort, 2010) with slight modification in scoring the farms from low to high percentage risks depending on how the animals were prone to predisposing and inciting factors of tick-borne diseases, with much emphasis on the compliance of the biosecurity management practices. Average score (SA) for each biosecurity major component was estimated by summing the scores (S) of performance indicators obtained by farm for key performance areas (KPA) divided by number of RPA, thus, SA = ∑S/N. Weighted (risk) Score (SW) was given by percentage weight (W) assigned to each major component multiply by S_A, i.e. $W_S = S_A * W$; W=33.33 % for each biosecurity component. Overall percentage weighted score (PSW) was obtained by summing the three S_W divided by 4 and multiply by 100, thus, PSW = $(S_W1 + S_W2 + S_W3)/4 * 100$. The overall PS_W ranging from 25 to 34 % was considered low risk farm (High biosecurity practices observed); 35 to 49% equals moderate risk farm (moderate observation of biosecurity practices on farm); and ≥ 50 % or more was tagged as a high risk farm with little observation of biosecurity practices.

Type of housings were categorised into insect proofed barns, roofed barn and open Kraal. Insect proofed barns had simple standard barns that had been designed to prevent entry of insects and other vectors. Roofed barns/cattle houses were considered as a standard cattle structure for provision of shelter for cattle, usually, constructed in wooden, metallic and/or concrete with roofs. Open Kraals were corral or fenced enclosures for holding cattle usually after grazing or at night.

Statistical analysis. Data on the total tick count were transformed to a scale, using the formula, $Y = Log_{10} (X +1) + 0.5$ to confer normality (Marufu, 2008) prior to analysis. The Data were then subjected to Least squares (LS) analysis using Generalized Linear Model (GLM) Type III Procedure of IBM Statistical Package for Social Sciences (SPSS, 2017) version 25. Differences between means were separated by pairwise comparisons of estimated marginal means (SPSS, 2017).

Results and discussion

Effect of Farm management on total tick count. Farm management system had significant ($P<0.01$) influence on total tick count. The farm effect was determined by the management practices adopted. Farms that practiced range grazing (sedentary husbandry system) had the highest ($P<0.01$) tick load followed by partial zero-grazing with the exclusive zero-grazing having the least. This result indicates that individual farm and management regimes determine the success of tick control programme. This has also been observed by Swai *et al*. (2006) in that traditionally managed pastoral and grazed smallholder dairy cattle farms experienced heavy tick infestation, while the zero-grazed smallholder cattle had almost no ticks on the hosts. Therefore, reshaping management regimes to prevent exposure of hosts to the vectors is the option for tick prevention and control.

Effect of breed on total tick load in different management regimes. Type of breed also influenced ($P<0.01$) tick infestation load. Zebu (*Bos indicus*) and Friesian-Sanga crossbreds had the highest ($P<0.01$) tick count. Sanga and Ghana Shorthorn (GSH) breeds had similar ($P>0.05$) total tick count but had higher than the count obtained in Jersey cattle. The differences in total tick count observed in this study were masked by management practice. Overall, Sanga and GSH breeds had lower tick loads than the crossbreds and zebu (Table, 1) indicating that the local cattle were more resistant to tick infestation than crossbred and the exotic breeds (Gashaw, 2005). However, Jersey cattle recorded few or no tick count because the breed was managed in insect proofed barn that might have prevented the exposure of the cattle to tick vectors. Swai *et al*. (2006) also observed that most tick infestations are seen in traditionally managed pastoral and grazed smallholder dairy cattle, whereas the zero-grazed smallholder cattle have almost no ticks on the hosts.

Table 1. Effect of breed, location, sex of cattle, level of biosecurity practices, season, and other facors on total tick load/count

Fixed factors	N	Least square means (± SE) for Y = Log10 (X +1) + 0.5)
Management	**127**	**0.000***
Range grazing	48	2.6 ± 0.03[a]
Partial zero grazing	32	2.4 ± 0.04[b]
Exclusive zero grazing	47	1.6 ± 0.03[c]
Breed	**127**	**0.000***
Sanga	27	2.2 ± 0.03[b]
Wash (gsh)	19	2.2 ± 0.04[b]
Fr-sanga cb	27	2.3 ± 0.04[a]
Jersey	9	2.0 ± 0.06[c]
Zebu	45	2.3 ± 0.03[a]
Location (regions)	**127**	**0.009***
Ashanti	48	2.3 ± 0.06[a]
Eastern	31	2.1 ± 0.06[c]
Greater Accra	48	2.2 ± 0.10[b]
Season	**127**	**0.000***
Rainy season	48	2.6 ± 0.06[a]
Minor season	32	2.4 ± 0.06[b]
Dry season	47	1.7 ± 0.10[c]
Sex of cattle	**127**	**0.847***
Male	52	1.2 ± 0.03
Female	75	2.2 ± 0.02
Feed supplementation	**98**	**0.000***
Supplementation	12	2.2 ± 0.05[b]
Partial supplementation	39	2.5 ± 0.03[a]
No supplementation	47	2.5 ± 0.03 [a]
Type of housing	**127**	**0.000***
Insect-proof	33	2.0 ± 0.04[b]
Open kraal	28	2.3 ± 0.03[a]
Roofed barn	66	2.3 ± 0.02[a]
Level of bsm	**98**	**0.000***
Very low lbsp	48	2.6 ± 0.03[a]
Low lbsp	32	2.5 ± 0.03[b]
Moderate lbsp	18	2.0 ± 0.04[c]

*=P-value; LBSP=biosecurity practicess observed; abcMeans assigned with different superscript letters(a to d) are significantly different.

Effect of location on total tick load/count. Location significantly influenced (P<0.01) the total tick count in dairy cattle of (Table 1). Cattle in Ashanti region had the highest total tick count, followed those obtained in Greater Accra. Eastern region had the least (P<0.01) count. The hot-humid and moist semi-deciduous forest of Ashanti therefore favour tick development and phenology (Walker and Koney, 1999). The differences observed in total tick count between cattle in Ashanti and Eastern regions with a similar climatic condition might be attributed to differences in the production system adopted by cattle farmers. Eastern region dairy herds mostly kept their cattle under intensive (exclusive) zero-grazing with insect–proof housing where cattle had little or no exposure to tick vectors. Tick abundance is known to be higher in moist humid environment (where Ashanti and Eastern region are located) than in the costal savanna zones (as found Greater Accra) (Table 1).

Effect of season and sex of cattle on total tick count. Season was one of the determinants of total tick count. Major rainy season had the highest (P<0.01) total tick count and was followed by minor rainy season. Dry season recorded the least (P<0.01) count. This finding is similar to that of DeClercq *et al*. (2012) who observed a significant increase in the abundance of tick population with increasing rainy periods of the year in Benin. The distinct seasonal differences in the total tick count observed in this study might be due to variations in temperature, high humidity, moisture and thick vegetation cover which influence tick phenology (Swai *et al*., 2006; Walker, 2011). This environmental condition enhances laying, development and eclosion of instar ticks. Greatest tick abundance occurs in season of maximum moisture and growth of vegetation to shelter the questing ticks (Walker, 2011). Sex of cattle had no (P>0.05) effect on the total tick count in the study areas.

Effect of feed supplementation. Cattle that were regularly provided with supplementary feed had a lower (P<0.01) total tick count. Animal given partial and no feed supplementation had a similar (P>0.05) tick count. The findings suggest that farmers who practiced regular feed supplementation observe biosecurity measures, practice zero-grazing and good managerial practices that regularly prevent hosts-vectors associations record low tick festation.

Type of housing. Type of housing used for keeping dairy herds significantly (P<0.01) influenced tick count. Insect-proofed barn recorded little or no tick count whereas roofed and open kraal had similar (P>0.05) but more (P<0.01) total tick count than those observed in insect proof ones. Insect-proofed barn apart from serving as a screen between cattle and the obligate haemo-parasites, also prevents intensively kept cattle from getting into contact with infected ones. Annan-Prah (2011) indicated that strategic and tactical management of ticks should include good barn management for zero-grazed animals, and separate infested cattle from the healthy ones. This study observed that cattle kept under intensive housing recorded lesser count as compared to those cattle exposed, which is consistent with the finding obtained by Swai *et al*. (2006).

Level of biosecurity measures employed. Level of biosecurity greatly influenced total tick count. Implementation of moderate level of biosecurity principles resulted in a drastic reduction in total tick count, followed by low level observation of the measures which registered high tick count. This confirm the assertion made by Buhman *et al*. (2007) that developing and maintaining biosecurity though difficult, is the cheapest, most effective means of disease control available, and no disease prevention programme works without it. Biosecurity through its principles of traffic control, isolation and sanitation, together with good management played a crucial role in preventing tick infestation in this study.

Interactions effect on fixed factors. Significant interactions existed between breed and season, and supplementation, type of housing and level of biosecurity practices, Interaction between breed and location and sex of cattle were not significant. There was also insignificant interaction effect between location and season in this study. Significant interaction between breed and season, feed supplementation, Type of housing, and LBSP is an indication that the performance of the genotypes (Crossbred, Jersey, Sanga,) are not equally influenced by the different environments. Change in the relative performance of two or more genotypes measured in two or more environments would therefore aid in improvement and evaluation of farm animal genetic programmes and development of cattle production objectives (Gebreyohannes *et al*., 2014) with swift tick prevention/control approaches. It has been noted that changes in responses to multiple factors that operate together (interactions) to bring about the observed differences in tick abundance (Sonenshine, 2018).

Conclusion

Tick load/infestation on dairy cattle herds was influenced by individual farm management practoces adopted, grazing methods adopted, breed, geographical location of farm, season feed supplementation, type of housing, and level of biosecurity measures. Interaction effects were observed among the factors determining tick load in the dairy herds. Sex of cattle was a poor determinant of tick load in the dairy herds studied.

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