



Quantitative indigenous ethnoveterinary knowledge of medicinal plants used for ruminant tick management in the Guiriko region, Burkina Faso

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Research

Abstract

Background: Ticks remain a major constraint to ruminant production in Burkina Faso, particularly in pastoral systems with limited veterinary services. This study documented ethnoveterinary knowledge and inventoried plant-based remedies used for tick control in the Guiriko pastoral region.

Methods: A cross-sectional ethnoveterinary and botanical survey was conducted from February 2022 to April 2023 in two pastoral areas (Saho and Sidéradougou). Data were collected through semi-structured interviews with 140 livestock farmers selected by stratified random sampling. Use reports (UR), relative frequency of citation (RFC) and informant consensus factor (ICF) were calculated, with Bonferroni correction for multiple comparisons.

Results: All farmers reported tick infestations and the use of synthetic acaricides, while 46.4% also used medicinal plants. A total of 493 use reports covering 31 traditional remedies from 14 plant species were recorded. The most cited species were *Chamaecrista nigricans* (Vahl) Greene (UR = 95; RFC = 67.9%), *Carica papaya* L. (66; 47.1%), *Calotropis procera* (Aiton) W.T. Aiton (52; 37.1%), *Ocimum americanum* L. (48; 34.3%) and *Azadirachta indica* A. Juss. (43; 30.7%). Leaves were the most

used part (71%). Decoction (48.4%) and maceration (25.8%) were the main preparation methods; bathing and topical application were the main administration routes. Informant consensus was high (ICF = 0.97). No inter-zone differences remained significant after Bonferroni correction ($p > 0.0036$).

Conclusions: Traditional ethnoveterinary knowledge is an important resource for sustainable tick control in Burkina Faso. Pharmacological validation and toxicity assessment are needed before integration into animal health programs.

Keywords: Ticks, Ruminants, Ethnoveterinary medicine, Medicinal plants, *Chamaecrista nigricans*, Burkina Faso

Background

Livestock production is one of the cornerstones of the rural subsistence and commercial economy in Burkina Faso and plays a major role in the country's socio-economic development. It contributes significantly to agricultural growth, food security, employment generation, household income, and the supply of animal-source foods. The sector accounts for approximately 40% of agricultural value added and generates nearly 30% of the country's export earnings (FAO 2021). It also provides livelihoods for a large proportion of the rural population (FAO 2019). Livestock contributes about 20% of the gross domestic product and remains the country's third-largest source of foreign exchange after gold and cotton (INSD 2023). Beyond its economic contribution, livestock represents a strategic asset for rural households by supporting savings, animal traction, soil fertility, and resilience to climatic and economic shocks (FAO 2018).

Despite its importance, livestock productivity continues to be constrained by numerous health challenges, among which tick infestations and tick-borne diseases remain particularly important because they reduce animal productivity, damage hides and may transmit pathogens of veterinary importance (Biguezoton *et al.* 2016, Jongejan and Uilenberg 2004, Kasaija *et al.* 2021). Ticks are among the most damaging ectoparasites affecting ruminants in tropical and subtropical regions (Heylen *et al.* 2023). They cause direct losses through blood feeding, skin lesions and reduced weight gain (Jongejan and Uilenberg 2004, Ocaido *et al.* 2019), as well as decreased milk production and hide depreciation, and in severe cases animal mortality (Biguezoton *et al.* 2016, Rodriguez-Vivas *et al.* 2018).

In addition, they act as vectors of several pathogens responsible for economically important diseases such as babesiosis, anaplasmosis (Kasaija *et al.* 2021), theileriosis (Ullah *et al.* 2023), and heartwater (CIRDES 2014; Kasaija *et al.* 2021). Nevertheless, quantitative data remain fragmented in many West African countries, including Burkina Faso, where information on the epidemiology and economic impact of tick infestations is still limited (Ouédraogo *et al.* 2021; Makwarela *et al.* 2025).

In Burkina Faso, several tick species belonging mainly to the genera *Amblyomma*, *Hyalomma* and *Rhipicephalus* infest domestic ruminants (Biguezoton *et al.* 2016; Ouédraogo *et al.* 2021). Among them, *Amblyomma variegatum* remains one of the most widespread and economically important species because of its broad geographical distribution and its role in the transmission of heartwater (CIRDES 2014; Kasaija *et al.* 2021). More recently, the expansion of *Rhipicephalus microplus* across several West African countries has raised considerable concern due to its invasive character, remarkable adaptability and resistance to multiple classes of acaricides (Boka *et al.* 2023; Salvador *et al.* 2025). Tick distribution and abundance are influenced by several factors, including climatic conditions, host availability, transhumance movements, livestock trade, and changes in production systems. Ongoing environmental and climatic changes may further alter the ecology of these parasites and facilitate the spread of certain species into new geographical areas (Bouchard *et al.* 2019; Yessinou *et al.* 2022).

Tick control still relies largely on the use of synthetic acaricides. Although these products have significantly reduced infestations and the burden of tick-borne diseases, their effectiveness is increasingly threatened by the emergence and spread of acaricide resistance among tick populations, as recently documented in West Africa (Boka *et al.* 2023; Salvador *et al.* 2025). Furthermore, the intensive and sometimes inappropriate use of these substances raises concerns about environmental contamination and residues in animal-derived products (Ferrigno *et al.* 2017), adverse effects on non-target organisms (Szabó *et al.* 2018), and rising production costs for livestock farmers (Mollong *et al.* 2025). These challenges highlight the need for more sustainable and locally adapted tick-control strategies. A paradigm shift in tick management is therefore required to promote livestock production systems that rely less on synthetic pesticides while enhancing ecological resilience and sustainable parasite regulation. In response to these concerns, increasing research efforts have focused on the development of alternative control methods that are affordable, environmentally friendly, and accessible to livestock keepers. Among these approaches, traditional veterinary medicine based on the use of medicinal plants remains widely practised in many rural African communities. In Burkina Faso, livestock farmers continue to rely on medicinal plants to

prevent and treat a variety of animal diseases, including parasitic infestations (Tamboura *et al.* 1998; Dahourou *et al.* 2021; Tianhoun *et al.* 2023). Rooted in generations of accumulated experience, these ethnoveterinary practices constitute a valuable reservoir of indigenous knowledge and a potential source of locally adapted solutions for animal health management. Their contribution to the development of sustainable and environmentally sound parasite-control strategies has increasingly been recognized (Ndou *et al.* 2023; Hankiso *et al.* 2024; Kamba and Chimonyo 2024; Aremu *et al.* 2026).

Despite the growing interest in ethnoveterinary medicine, important gaps remain regarding the plant species used against ticks, their preparation methods, modes of application, and actual acaricidal efficacy. The Guiriko region provides a particularly relevant setting for investigating these issues because livestock production is a major economic activity and farmers continue to rely heavily on traditional knowledge for animal health management (Tamboura 2006). Tick infestations are common in the area, where species belonging to the genera *Amblyomma*, *Hyalomma*, and *Rhipicephalus* occur regularly. Among them, *Amblyomma variegatum* is the dominant species and exhibits marked seasonal fluctuations (Sidiki *et al.* 2025). A better understanding of the diversity of these species and their seasonal dynamics is essential for guiding the rational use of traditional remedies and assessing their effectiveness against different biological stages of the parasites.

In this context, the present study aimed to document the use of acaricidal plants in traditional veterinary medicine in pastoral areas of Burkina Faso. Specifically, it sought to (i) assess livestock farmers' perceptions of tick infestations in ruminants, and (ii) identify medicinal plants used for tick control, together with their preparation methods and modes of administration. Ultimately, this work seeks to contribute to the preservation and scientific valorization of indigenous ethnoveterinary knowledge and to support the development of improved plant-based alternatives for sustainable tick management in Burkina Faso.

Materials and Methods

Study area

The study was carried out in the Guiriko region, situated in western Burkina Faso between latitudes 10° and 13° N and longitudes 2° and 5° W. The region belongs to the North-Sudanian agroecological zone and experiences climatic conditions generally favorable to livestock production (INSD 2020). Rainfall typically ranges between 800 and 1,100 mm per year, while mean annual temperatures fluctuate around 25–30 °C (Sanon *et al.* 2014 ; ANAM, 2022). For analytical purposes, the year was considered according to three main climatic periods: the rainy season, the cool dry season, and the hot dry season. Vegetation is dominated by wooded and shrub savannas interspersed with gallery forests, fallows, and natural grazing lands that constitute important feed resources for livestock (Traoré *et al.* 2012 ; Sanon *et al.* 2014). Field investigations were conducted in the pastoral areas of Saho (12°24'00" N; 3°24'00" W) and Sidéradougou (10°42'53" N; 4°16'25" W), located in the provinces of Houet and Tuy, respectively (Figure 1). These sites were selected because they reflect the major ecological and livestock-production characteristics of the region. Both areas are characterized by extensive cattle husbandry, seasonal livestock mobility, and environmental conditions known to favor tick development and persistence (Sidiki *et al.* 2025). Their accessibility, together with the active participation of livestock farmers and local authorities, also influenced their selection. The resident population's livelihood largely depend on crop farming and livestock production. Administrative boundaries were obtained from the National Topographic Database of the Institut Géographique du Burkina (IGB) (IGB, 2012), and spatial analyses were conducted using ArcGIS 10.1 (Esri Inc., Redlands, CA, USA) (Esri 2012).

Study design and sampling of surveyed livestock farmers

The survey targeted professional livestock farmers managing herds of at least 20 Tropical Livestock Units (TLU). A sampling frame comprising 327 eligible livestock farmers was established in collaboration with local administrative authorities, community leaders, and livestock farmers' organizations operating in the pastoral areas of Saho (145 farmers) and Sidéradougou (182 farmers).

Prior to the main survey, a pilot investigation involving 10 livestock farmers (5 per pastoral area) was conducted to evaluate the relevance and clarity of the questionnaire. Results from this preliminary assessment indicated that approximately 90% of respondents reported both the presence of ticks in their herds and the use of plant-based remedies for their control. This proportion was subsequently used to determine the minimum sample size according to the formula proposed by Dagnelie (1998):

$$N = \frac{Z^2 \times P(1 - P)}{d^2}$$

where N = represents the total sample size; Z = 1.96 corresponds to the standard normal value at a 5% significance level ($\alpha = 0.05$); P = 0.9 is the estimated proportion of livestock farmers reporting both tick presence and the use of ethnoveterinary

plant-based remedies; and $d = 0.05$ is the selected margin of error ($1\% < d < 15\%$). The precision of this estimate ($P = 90\%$) was assessed using 95% confidence intervals and further supported by a sensitivity analysis varying the expected prevalence between 0.70 and 0.95, confirming the adequacy of the chosen sample size.

Based on these calculations, a total of 140 livestock farmers were retained for the study. To ensure adequate representation of production systems, the sample was stratified according to pastoral area and herd-size category (20-50 TLU, 51-100 TLU, and >100 TLU). Respondents were then selected randomly within each stratum. Eligibility required ownership of livestock for at least one year and permanent residence within the study area. Seasonal livestock keepers resident for less than six months annually were not included in the survey.

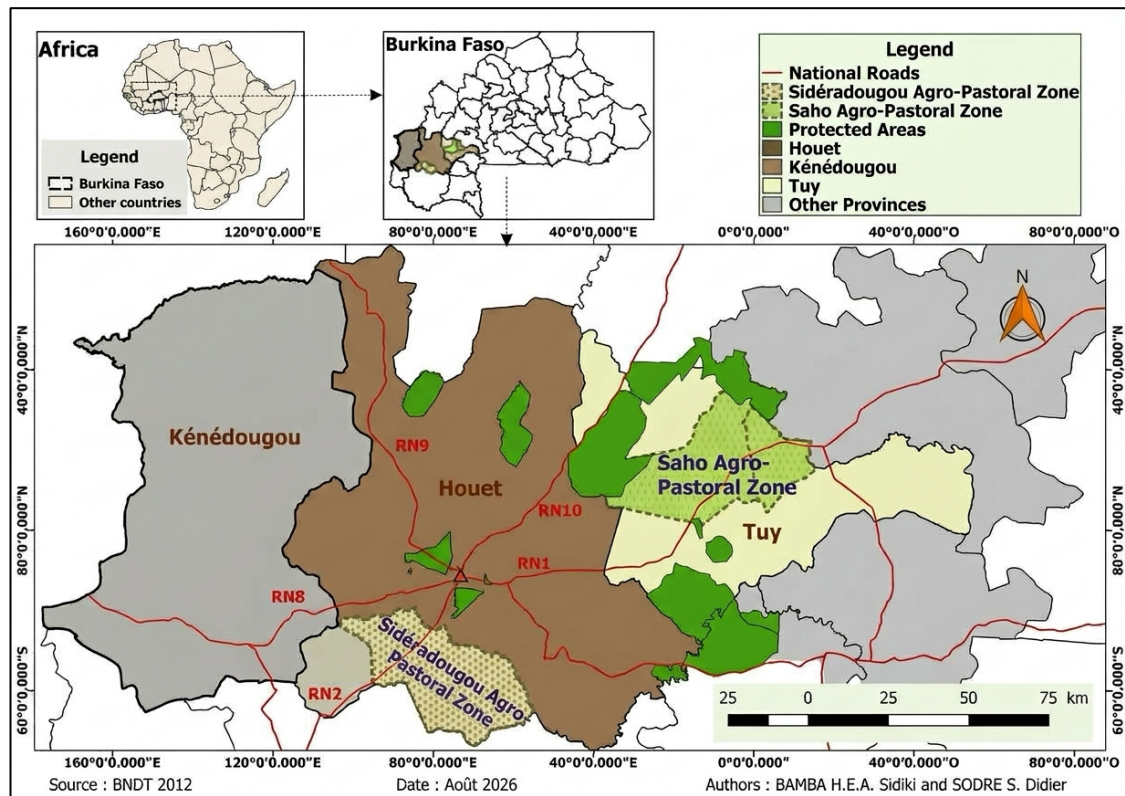


Figure 1. Location of the pastoral areas of Saho ($12^{\circ}24'0''$ N; $3^{\circ}24'0''$ W) and Sidéradougou ($10^{\circ}42'53''$ N; $4^{\circ}16'25''$ W) in the Guiriko region, Burkina Faso.

Ethnoveterinary and ethnobotanical data collection

Data collection was undertaken between February 2022 and April 2023 among 140 livestock farmers equally distributed between Saho and Sidéradougou. The survey approach was inspired by ethnobotanical investigation methods previously developed for Burkina Faso (Tamboura 2006). An initial exploratory phase was conducted to evaluate and refine the survey instrument through discussions with selected livestock farmers. Following this preparatory stage, the final questionnaire was administered during face-to-face interviews. Before each interview, the objectives of the study were explained and the consent of participants was obtained. Interviews were conducted using a semi-structured questionnaire implemented through the KoBoToolbox platform. Whenever necessary, local translators facilitated communication between investigators and respondents. Plant species mentioned by livestock farmers were subsequently collected in the field for botanical identification and voucher preparation. The questionnaire addressed four main themes:

- Socio-economic characteristics of livestock farmers and herd-management practices, including age, farming experience, herd composition, herd size, and animal-health management strategies;
- Identification of medicinal plant species used for tick control and documentation of local names and traditional knowledge associated with these plants;
- Description of remedies, including plant parts utilized, preparation techniques, administration methods, treatment frequency, perceived effectiveness, and possible adverse effects;
- Ecological information concerning plant availability, collection sites, seasonal occurrence, and local abundance.

To evaluate the relative importance of medicinal plants used against ticks, two commonly employed quantitative ethnobotanical indices were calculated.

The Relative Frequency of Citation (RFC) was used to estimate the local prominence of each species:

$$RFC = \frac{UR}{N}$$

where UR represents the number of respondents mentioning a given plant species and N the total number of respondents interviewed.

The Informant Consensus Factor (ICF) was calculated to assess the level of agreement among livestock farmers regarding the use of medicinal plants for tick control:

$$IFC = \frac{N_{ur} - N_t}{N_{ur} - 1}$$

where N_{ur} correspond to the total number of use reports recorded for tick treatment and N_t represents the number of plant species cited. Values approaching 1 indicate strong convergence of knowledge among respondents, whereas lower values suggest greater heterogeneity in plant selection and use. Together, these indices provide insight on the cultural importance of plant species and the consistency of ethnoveterinary knowledge within the study communities.

Plant collection and identification

The main plant specimens cited by the surveyed livestock farmers were collected and subsequently identified using the herbarium collections of public institutions responsible for forestry services in the Guiriko region, as well as the National Centre for Scientific and Technological Research (CNRST). Identification was based on the morphological characteristics of the collected plant material and comparison with reference herbarium specimens. The collected plant material was labeled with the local and scientific names, the date and place of collection, and the reported uses. The specimens were used for botanical identification but were not deposited in an institutional herbarium.

Data Analysis

The collected data were analyzed using SPSS software version 21 (IBM Corp., Armonk, NY, USA). Descriptive statistics (frequencies and percentages) and quantitative statistics (means $\pm$ standard deviations) were used to summarize the data. The chi-square test (χ^2) was applied to the qualitative variables, whilst the quantitative variables (livestock farmers' age, years of experience, herd size) were subjected to one-way analysis of variance (ANOVA), followed by Student's t-tests to compare the measured variables. Comparisons were performed at a 5% significance level. Given the multi-response nature of the ethnobotanical data, only descriptive analyses were used for these variables, with frequencies expressed as percentages of respondents citing each option. Finally, for multiple species comparisons, adjustments for multiple testing (Bonferroni correction approach) were considered when interpreting the results.

Results

Socio-economic characteristics of the livestock farmers surveyed

The socio-economic characteristics of the surveyed livestock farmers are presented in Table 1. All livestock farmers were male ($n = 140$). The average age of farm managers was 46.17 ± 5.67 years, with a statistically significant difference observed between the pastoral areas of Saho and Sidéradougu ($df = 1, 138; p = 0.015; \eta^2 = 0.042$). The mean years of experience in ruminant livestock farming was 36.31 ± 7.98 years and did not show a significant difference between the two areas ($df = 1, 138; p = 0.067; \eta^2 = 0.024$). The comparison between Saho and Sidéradougu was based on the fact that these two pastoral areas constitute the main sites of the study and may differ in terms of socio-demographic characteristics, cultural practices and livestock management. Examining these characteristics in the two sites helped to describe the study population and provided a basis for interpreting possible differences in perceptions of ticks, tick-control practices and the use of medicinal plants. The majority of these farmers were uneducated (66.4%) and among those who were educated (33.6%), 7.1% had secondary education. Their main activities are livestock farming (94.3%) and agro-pastoralism (5.7%), which show a significant difference ($\chi^2 = 8.82; df = 1; p = 0.003$) between the two pastoral areas. Livestock farming was the main livelihood activity among the surveyed respondents, particularly in Sidéradougu, where all respondents identified livestock farming as their primary occupation. Islam was the predominant religion among the surveyed farmers (82.1%), followed by Catholicism (11.43%) and traditional religious beliefs (6.43%). Religious affiliation varied significantly between the two

pastoral areas ($\chi^2 = 4.81$; $df = 1$; $p = 0.029$). The surveyed population was ethnically diverse, although Peul farmers were predominant (72.86%). The distribution of ethnic groups differed significantly between the two pastoral areas ($\chi^2 = 13.87$; $df = 1$; $p = 0.001$).

Religion and ethnicity were documented to describe the socio-cultural characteristics of the livestock farmers and the context in which local livestock-management and ethnoveterinary knowledge is maintained and transmitted. However, these characteristics were not considered as direct determinants of medicinal plant use or tick-control practices, since their specific relationships with these practices were not assessed in the present study.

The differences observed in age, occupation, religious affiliation and ethnic composition between the two pastoral areas provide a useful socio-cultural context for understanding the subsequent findings on farmers' perceptions of ticks, livestock-management practices and the use of traditional remedies. Differences in age and farming experience may influence the acquisition and transmission of practical knowledge related to tick recognition and control. Likewise, the occupational profile reflects the degree of dependence on livestock and the importance attached to maintaining animal health. Despite differences between the two sites, the predominantly pastoral nature of both areas provides a common context for livestock management and exposure to tick-infested environments.

Although the present study did not specifically assess whether religion or ethnicity influenced the choice of medicinal plants or other tick-control practices, documenting these characteristics remains relevant for describing the social context in which local knowledge and practices are acquired, maintained and transmitted.

Table 1. Socio-economic characteristics of livestock farmers surveyed in the two pastoral areas covered by the study

Variables	Pastoral areas				Global		P-value
	Saho		Sidéradougou				
	(N)	(%)	(N)	(%)	(N)	(%)	
Gender:							
- Men	70	100	70	100	140	100	1
- Women	0	0	0	0	0	0	
Religion:							
- Catholic	3	4.3	13	18.6	16	11.43	0.029
- Muslim	62	88.6	53	75.7	115	82.14	
- Animist	5	7.1	4	5.7	9	6.43	
Average age:	-	45.01 ± 6.69	-	47.34 ± 4.16	-	46.17 ± 5.67	0.015
Years of experience:	-	35.05 ± 9.28	-	37.55 ± 6.25	-	36.30 ± 7.98	0.067
Main activities:							
- agropastoral	8	11.4	0	0	8	5.7	0.003
- livestock farming	62	88.6	70	100	132	94.3	
Level of education:							
- uneducated	56	80	37	52.86	93	66.44	0.000
- literate	5	7.14	3	4.28	8	5.71	
- primary	9	12.86	20	28.6	29	20.71	
- secondary	0	0	10	14.26	10	7.14	
Ethnic groups:							
- Bôbô	4	5.7	18	25.7	22	16.43	0.001
- Bwaba	5	7.14	0	0	5	2.86	
- Dioula	0	0	1	1.43	1	0.71	
- Mossi	3	4.3	1	1.43	4	2.86	
- Peul	58	82.86	44	62.86	102	72.86	
- Sambla	0	0	1	1.43	1	0,7	
- Tiéfo	0	0	3	4.29	3	2,1	
- Toussian	0	0	2	2.86	2	1,4	

Values are expressed as frequency (percentage) or mean $\pm$ SD. Differences were tested using χ^2 test or ANOVA where appropriate

Practices and constraints in ruminant farming

The average number of ruminants expressed in tropical livestock units (TLU) (Rothman-Ostrow *et al.* 2020) and raised by the surveyed farmers differed significantly among cattle, sheep and goats ($p < 0.001$), with cattle representing the largest proportion of the herds. Cattle (43.71 ± 9.20 TLU) compared to sheep (3.97 ± 1.58 TLU) and goats (3.58 ± 1.22 TLU) in both pastoral areas. Mean herd sizes per site were largely dominated by cattle (Saho: 41.64 ± 9.20 TLU; Sidéradougou: 45.78 ± 9.20 TLU) compared to sheep (Saho: 3.89 ± 1.58 TLU; Sidéradougou: 4.05 ± 1.58 TLU) and goats (Saho: 3.46 ± 1.22 TLU; Sidéradougou: 3.70 ± 1.22 TLU). Analysis of variance revealed significant differences between sites for total herd size ($p = 0.009$) and cattle numbers ($p = 0.007$), whereas sheep and goat numbers did not differ significantly ($p = 0.557$ and $p = 0.251$, respectively). Within each site, ANOVA showed a highly significant effect of species on herd composition (Saho: $p < 0.0001$; $\eta^2 = 0.906$; Sidéradougou: $p < 0.0001$; $\eta^2 = 0.945$). The predominance of cattle is relevant to tick control because cattle constitute the main livestock component and provide an important host population for ticks. The larger cattle herds may therefore increase opportunities for tick feeding and reproduction and contribute to repeated exposure of livestock to tick infestations. Most of the livestock were raised under an extensive production system (96%), while the remaining 4% were classified under the other production system category recorded during the survey. Most farmers reported that their animals grazed mainly on natural pastures, and 95.7% indicated that the animals were kept outdoors. The proportion of farmers reporting outdoor grazing differed significantly between the two pastoral areas ($p = 0.013$), with a higher proportion in Sidéradougou (55.7%).

The predominance of extensive grazing and the use of natural pastures mean that livestock are frequently exposed to vegetation and grazing areas where ticks may occur. This type of management may favour repeated contact with ticks and can make their control more difficult than in systems where animals are kept in confined or semi-confined conditions.

With regard to the types of housing used by the livestock farmers surveyed, the use of fenced pens with tree branches predominates (97.14%) compared with other types of housing (2.86%), with no significant difference between the two pastoral areas ($p = 0.13$). These enclosures are mainly used to keep or gather animals and may constitute places where livestock come into repeated contact with ticks, especially when the same enclosures are used regularly and environmental conditions are favorable for tick survival. However, the present data do not allow us to establish whether these enclosures actually contribute to higher tick abundance; this interpretation should therefore be treated with caution. Finally, the main constraints reported by the farmers surveyed in ruminant farming are health problems related to diseases (85.71%), the presence of ticks (77.86%), feeding difficulties (67.14%) and climate change (62.8%). These constraints were reported in both pastoral areas, with no statistically significant difference in their overall distribution between the two sites ($p = 0.070$) (Figure 2). The relatively high frequency of tick infestation among the constraints reported by farmers suggests that ticks are perceived as an important animal-health concern. This finding is consistent with the extensive production system observed in the study areas, where livestock have frequent contact with natural grazing environments and may therefore be repeatedly exposed to ticks. The simultaneous reporting of disease, feeding difficulties and tick infestation highlights the need to consider tick control as part of overall herd health and productivity management rather than as a separate issue.

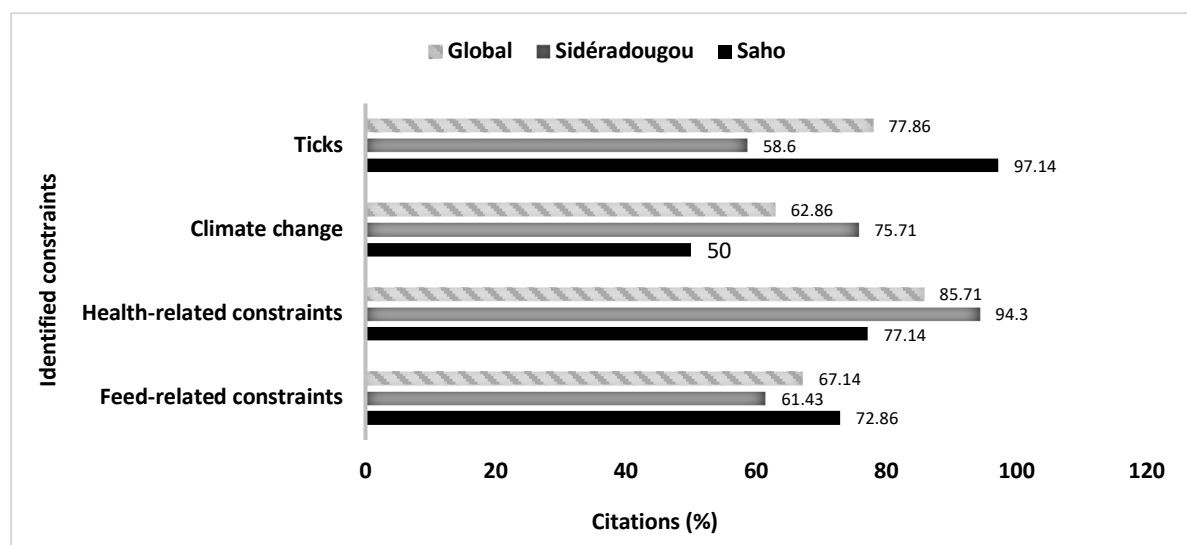


Figure 2. Constraints related to ruminant farming reported by farmers surveyed in the two pastoral areas covered by the study

Perceptions of ticks among the livestock farmers surveyed

The farmers surveyed reported the presence of ticks on livestock in their ruminant herds under various names in local languages, namely « *koti* » in Fulfulde, « *dêmê* » in Bôbô, « *soungum* » in Sambla, « *tchontchonfouan* » in Bwamu, « *kambsé* » in Mooré, « *tètè* » in Dioula and « *kôgba* » in Toussian. Table 2 summarises information on tick perceived occurrence, periods of heavy infestation, perceived impacts on livestock, and control methods used by the farmers surveyed. In general, almost all farmers (95.71%) reported that tick occurrence had increased during the five years preceding the survey, that is, since 2020. This perception was similar in the two pastoral areas ($p = 0.343$). In each area, 95.71% of farmers reported a marked increase in tick occurrence. Only a small proportion considered the level to be unchanged or moderate (1.43%), reported a lower level (2.14%), or perceived a decrease in tick occurrence (0.71%). Overall, farmers in Saho and Sidéradouguou had a similar perception of an increase in tick occurrence. For these livestock farmers, the impacts of ticks on livestock are animal mortality or decreased animal production (62.86%) and dietary restriction (37.14%), with no significant difference ($p = 0.48$) between the two areas. These responses indicate that farmers mainly associated tick infestation with losses in animal performance and, to a lesser extent, with restrictions affecting livestock feeding. However, the period of heavy infestation varies significantly depending on the pastoral zone ($p < 0.001$), indicating a strong association between the zone and the season of infestation. In Saho, farmers mainly reported heavy tick infestations during the rainy season (77.14%), while 21.43% considered the hot dry season to be the period with the highest infestation levels and only 1.43% reported the cold dry season. In Sidéradouguou, the pattern was reversed, with 82.86% of farmers identifying the hot dry season as the period of heavy infestation, compared with 17.14% for the rainy season and none for the cold dry season. Overall, the rainy season accounted for 47.2% of responses, compared with 52.1% for the hot dry season. However, these overall proportions conceal a clear difference in farmers' perceptions between the two pastoral areas.

This contrast in perceived seasonality is relevant to tick control, as it suggests that the timing of control measures may need to take local seasonal patterns into account rather than being applied in the same way in both areas.

With regard to tick control methods, the practices used by the farmers surveyed are generally grazing restrictions (52.14%), manual tick removal (10%), synthetic acaricides (100%), waste oil (20.71%) and medicinal plants (46.43%). Since farmers could mention more than one method of tick control, the percentages are not mutually exclusive and therefore cannot be considered as a single distribution of control strategies. All farmers reported using synthetic acaricides, confirming that chemical treatment was the most commonly reported approach to tick control. The use of medicinal plants was also frequently mentioned, showing that traditional remedies remain part of the tick-control practices used by farmers. The use of traditional veterinary medicine is mainly motivated by the high cost of synthetic acaricides (68%), the perceived effectiveness of traditional remedies (59%), the accessibility and availability of medicinal plants (72%), the remoteness of veterinary centres (51%) and the lack of knowledge about how to use these synthetic chemicals (36%). These findings suggest that farmers' choice of plant-based remedies may be related to their perceived effectiveness, but also to the ease with which these plants can be obtained and the difficulties associated with the use of conventional acaricides. Medicinal plants may therefore represent an accessible complementary option for some farmers, especially in areas where access to veterinary services is limited. An apparent difference between pastoral areas was observed in terms of control methods ($p \approx 0.05$); however, due to the multi-response nature of these data, no robust statistical conclusions can be drawn. These findings should therefore be interpreted mainly as a description of the practices reported by farmers, with greater attention given to their diversity and frequency than to direct comparisons between the two pastoral areas.

Table 2. Perceptions of ticks and control strategies applied in the two pastoral areas of the study

Variables	Pastoral areas				Global		P-value (χ²)
	Saho		Sidéradougou				
	N	%	N	%	N	%	
Level of tick occurrence:							
- average	2	2.86	0	0	2	1.43	0.343
- significantly higher	67	95.71	67	95.71	134	95.71	
- less	1	1.43	2	2.86	3	2.14	
- decrease	0	0	1	1.43	1	0.71	
Impact on livestock:							
- dietary restriction	24	34.28	28	40	52	37.14	0.480
- mortality/decrease in production	46	65.71	42	60	88	62.86	

Period of heavy infestation:							0,000
- rainy season	54	77.14	12	17.14	66	47.2	
- hot dry season	15	21.43	58	82.86	73	52.1	
- cold dry season	1	1.43	0	0	1	0.7	
Control methods used:							
- synthetic acaricides	70	100	70	100	140	100	0.050
- grazing restrictions	29	41.43	44	62.9	73	52.14	
- manual tick removal	10	14.3	4	5.71	14	10	
- waste oil	19	27.14	10	14.3	29	20.71	
- medicinal plants	28	40	37	52.86	65	46.43	

Medicinal plants with acaricidal effects

To combat ticks in ruminants in the two pastoral areas, 31 distinct traditional recipes were identified among the livestock farmers surveyed, combining the medicinal plant used, including the parts used, preparation methods and methods of administration (Figure 3). These recipes involved 14 medicinal plant species belonging to 10 botanical families.

These acaricidal remedies were distributed among 10 distinct botanical families with Fabaceae (87.15%), Lamiaceae (56.42%), Meliaceae (49.30%) and Caricaceae (47.14%) being the most frequently reported families. The most commonly used acaricidal plant species are *Chamaecrista nigricans* (67.85%), *Carica papaya* (47.14%), *Calotropis procera* (37.14%), *Ocimum americanum* (34.28%) and *Azadirachta indica* (30.70%). The main parts of the plants used in the preparation of remedies were the leaves (71%), bark (16%), seeds (10%), bulbs or pods (3%) and pulp (3%). These parts were prepared alone (74.2%) or in combination with other organs (25.8%). The methods used to prepare the remedies listed were decoction (48.39%), maceration (25.81%), powder (19.35%), infusion and fresh latex (3.23% each). These preparations were mainly administered by bathing (48.39%), skin application (45.16%), fumigation and spraying (3.23% each) over a period of at least two to 15 days. The quantities to be administered vary and depend on the form of the preparations.

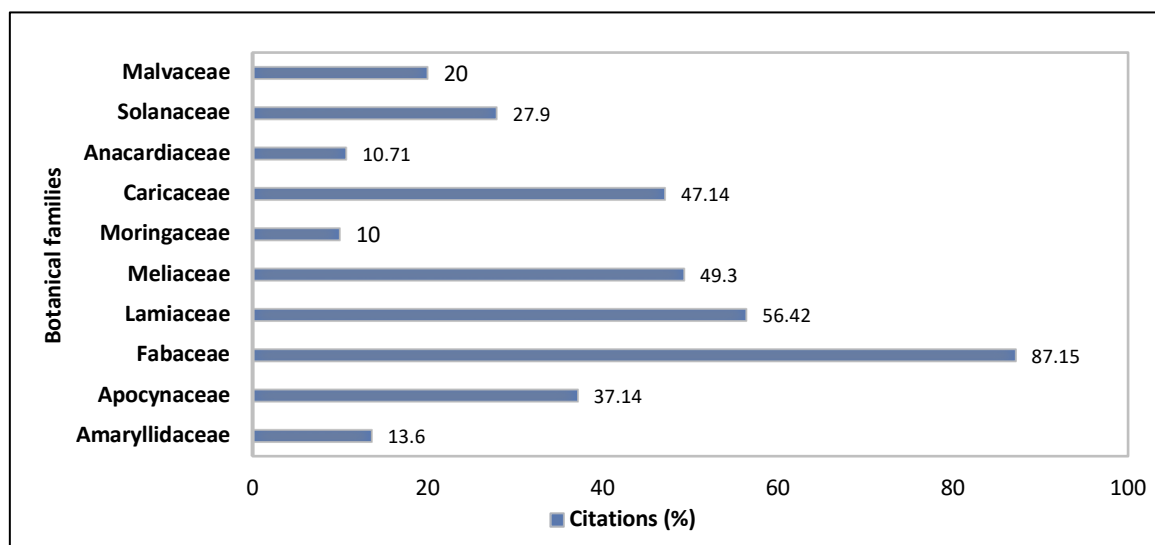


Figure 3. Botanical families of acaricidal medicinal plants used by livestock farmers surveyed in the pastoral areas of Saho and Sidéradougou in the Guiriko region.

Ethnobotanical indices and interzonal comparison

Tables 3 and 4 present the ethnobotanical indices for 14 plants used to treat ticks in ruminants in the pastoral zones of Saho and Sidéradougou ($n = 140$). A total of 493 use reports (UR) were recorded, with an overall informant consensus factor (ICF) of 0.97 (Table 5). The most frequently cited species were *Chamaecrista nigricans* (UR = 95; RFC = 67.86%) and *Carica papaya* (UR = 66; RFC = 47.14%). A total of 244 use reports were recorded in Saho and 249 in Sidéradougou. *C. nigricans* was the most frequently reported species in both areas, with 50 use reports in Saho and 45 in Sidéradougou. *Carica papaya* was reported 29 times in Saho and 37 times in Sidéradougou. *Ocimum americanum* accounted for 16 use reports in Saho and 32 in Sidéradougou, whereas *Azadirachta indica* was reported 29 times in Saho and 14 times in Sidéradougou (Table 4).

The statistical results for the comparison of plant use between the two pastoral areas are presented in Table 4.

Table 3. Traditional recipes for acaricides made from local plants, as reported by livestock farmers surveyed in the pastoral areas of Saho and Sidéradougou

Names		Family	Plant Parts Used	Preparation Methods	Administration Methods	Treatment Duration
Plant scientific names	Local Names					
<i>Adansonia digitata</i> L. 1753	- golombi (Peul) - sira (Dioula) - tohéga (Mooré)	Malvaceae	Leaves	Decoction	Bath	3-5 consecutive days, 1-2 weeks
			Bark		Topical application	
			Fruit pulp	Maceration	Bath	
<i>Waltheria indica</i> L. 1753	- sùm (Mooré) - kounkanba (Bwamu) - kôkou (Dioula) - dolo (Peul)	Malvaceae	Leaves	Decoction	Bath	1-2 times/week or every 2 days, 5-10 days
				Powder mixed with water	Topical application	
<i>Ocimum americanum</i> L. 1753	- gnunu gnouga (Mooré)	Lamiaceae	Leaves	Decoction	Bath	1 application/day, 3-7 days
				Powder mixed with water	Topical application	
<i>Hyptis spicigera</i> Lam. 1789	- kim ruudg gnonga (Mooré)	Lamiaceae	Leaves	Light infusion	Bath	1 application/day, 3-7 days
				Powder mixed with water	Topical application	
<i>Khaya senegalensis</i> (Desr.) A. Juss. 1830	- kahi (Peul) - diala (Dioula) - kouka (Mooré); - peemou (Bwamu)	Meliaceae	Leaves	Maceration	Bath	1 application/day, 3-10 days
			Bark	Decoction	Topical application	
<i>Azadirachta indica</i> A. Juss. 1830	- nim (Mooré) - nimiri (Bwamu) - nimi (Dioula)	Meliaceae	Leaves	Decoction	Bath	1-2 times/week or every 2 days, 10-15 days
				Maceration		
			Seeds	Powder mixed with water	Topical application	1 application/day, 3-5 days
<i>Chamaecrista nigricans</i> (Vahl) Greene 1899	- zambracouca (Mooré) - humba-gnihoun (Bwamu) - gangrabôbê (Peul)	Fabaceae	Leaves	Decoction	Bath	1 application every 2 days, 10-15 days
				Maceration		
			Bark	Decoction	Topical application	
<i>Parkia biglobosa</i> (Jacq.) Benth. 1865	- nère (Dioula) - nète (Peul)	Fabaceae	Leaves	Decoction	Bath	1 application/day, 3-5 days
			Seeds	Powder mixed with water	Topical application	
				Maceration	Bath	
<i>Calotropis procera</i> (Aiton) W.T. Aiton 1811	- poutrepouga (Mooré) - kôpé (Dioula) - mbérew (Peul)	Apocynaceae	Leaves	Maceration	Bath	1 application/day, 7-10 days (avoid wounds/mucosa)
				Decoction	Topical application	

<i>Allium sativum</i> L. 1753	- gwanya (dioula) - lèi (Mooré)	Amaryllidaceae	Bulbs	Powder mixed with water	Topical application	1 application/day, 3-5 days
				Maceration	Bath	
			Leaves	Decoction	Bath	
<i>Carica papaya</i> L. 1753	- papay tiiga (Mooré)	Caricaceae	Leaves	Decoction	Bath	1-2 applications/day, 7-14 days (avoid mucosa/eyes)
				Maceration		
			Seeds	Powder mixed with water	Topical application	1-2 applications/day for 2-3 days
			Leaves	Fresh latex		
<i>Sclerocarya birrea</i> (A. Rich.) Hochst. 1848	- noabga (Mooré) - hédi (Peul) - bodiro (Bwamu)	Anacardiaceae	Leaves	Decoction	Bath	1 application/day for 3-5 days
			Bark	Decoction	Topical application	
<i>Nicotiana tabacum</i> L. 1753	- kauli (Peul) - taba (Dioula et Mooré)	Solanaceae	Leaves	Maceration	Bath	1-2 applications/day for 2-4 consecutive days
				Decoction	Topical application	
				Dry powder	Fumigation	1 exposure of 30-60 min/day for 2-3 days
<i>Moringa oleifera</i> Lam. 1785	- arzan-tiiga (Mooré)	Moringaceae	Leaves	Decoction	Bath or Sprinkling	1 application every 2 days, for 7-14 days
			Seeds	Powder mixed with water	Topical application	
				Maceration	Bath	
			Bark	Decoction	Topical application	

Table 4. Comparative ethnobotanical indices of medicinal plants used for tick control in ruminants across the pastoral zones of Saho and Sidéradougou, Guiriko region, Burkina Faso (n = 140; χ^2 test).

Plant Species	Family	Use Reports (UR)			RFC (%)			p-value (χ^2)	Significance after Bonferroni correction ($\alpha = 0.0036$)
		Saho	Sidéradougou	Global	Saho	Sidéradougou	Global		
<i>Nicotiana tabacum</i>	Solanaceae	22	17	39	31.43	24.29	27.86	0.547 ns	-
<i>Adansonia digitata</i>	Malvaceae	11	5	16	15.71	7.14	11.43	0.219 ns	-
<i>Chamaecrista nigricans</i>	Fabaceae	50	45	95	71.43	64.29	67.86	0.728 ns	-
<i>Allium sativum</i>	Amaryllidaceae	7	12	19	10.00	17.14	13.57	0.327 ns	-
<i>Calotropis procera</i>	Apocynaceae	25	27	52	35.71	38.57	37.14	0.824 ns	-
<i>Parkia biglobosa</i>	Fabaceae	11	16	27	15.71	22.86	19.29	0.398 ns	-
<i>Azadirachta indica</i>	Meliaceae	29	14	43	41.43	20.00	30.71	0.030	ns after correction
<i>Moringa oleifera</i>	Moringaceae	9	5	14	12.86	7.14	10.00	0.438 ns	-
<i>Khaya senegalensis</i>	Meliaceae	16	10	26	22.86	14.29	18.57	0.340 ns	-
<i>Carica papaya</i>	Caricaceae	29	37	66	41.43	52.86	47.14	0.312 ns	-
<i>Waltheria indica</i>	Malvaceae	7	5	12	10.00	7.14	8.57	0.797 ns	-
<i>Ocimum americanum</i>	Lamiaceae	16	32	48	22.86	45.71	34.29	0.019	ns after correction
<i>Sclerocarya birrea</i>	Anacardiaceae	8	7	15	11.43	10.00	10.71	1.000 ns	-
<i>Hyptis spicigera</i>	Lamiaceae	14	17	31	20.00	24.29	22.14	0.669 ns	-
Total		244	249	493				0.82 ns	

UR: Use Reports; RFC: Relative Frequency of Citation; ns: not significant. p-values were obtained using the χ^2 test. No significant differences were observed between zones after Bonferroni correction ($p < 0.0036$).

Table 5. Global Informant Consensus Factor for tick control

Category	N _{ur} (UR)	N _t	ICF
Medicinal plants for tick control	493	14	0.97

N_{ur}: total number of citations (Use Reports); N_t: number of plant species used; ICF: informant consensus factor; $ICF = (N_{ur} - N_t) / (N_{ur} - 1)$;

N_{ur} (total UR) = 493; N_t (number of species) = 14. Percentages may exceed 100% due to multiple responses per informant.

Discussion

Characteristics of the farmers surveyed

In this study, all surveyed livestock farmers were male, with a mean age of 46.17 ± 5.67 years and an average of 36.30 ± 7.98 years of experience in ruminant farming. This male predominance has been previously reported (Tamboura 2006; Zerbo *et al.* 2011) and remains consistent with more recent findings in Burkina Faso (Yarga *et al.* 2022). Similarly, it corroborates the findings of various authors who report that men are overwhelmingly overrepresented among those who possess and manage knowledge related to traditional veterinary medicine across Africa (Chitura *et al.* 2018; Dharani *et al.* 2015; Tianhoun *et al.* 2023). According to Chitura *et al.* (2018) and Dharani *et al.* (2015), this disparity is linked to the historically greater involvement of men in herd management and the selection of therapeutic practices in pastoral systems. In the present study, the exclusively male composition of the surveyed population should be considered when interpreting the reported tick control practices. Men generally have primary responsibility for herd management, including animal movement, grazing, and livestock care, which gives them frequent opportunities to observe the health of animals and detect tick infestations. Their practical experience may contribute to their knowledge of periods of high tick activity, common attachment sites, and methods of control, such as manual removal and the use of plant-based preparations. This involvement may also help explain the preservation and continued use of local knowledge on tick control. However, the absence of women from the survey is a limitation, as their potentially complementary knowledge, particularly regarding the preparation and use of traditional remedies, was not documented. The findings on ethnoveterinary practices should therefore be interpreted mainly as reflecting the knowledge and practices of the men responsible for herd management, rather than the full range of knowledge present within pastoral households.

Furthermore, the significant age difference between the Saho and Sidéradougu areas, although associated with a small effect size ($\eta^2 = 0.042$), may influence the way knowledge related to tick management is acquired and passed on, as older farmers generally have greater practical experience, as reported in studies conducted in Burkina Faso and Niger (Abdou *et al.* 2020). Over the years, this experience may have enabled older farmers to become familiar with seasonal changes in tick abundance, common attachment sites, signs of infestation, and the control methods available in their communities. Such knowledge can help farmers recognize infestations and maintain locally used control practices, including the use of plant-based remedies. However, if younger people become less involved in livestock keeping, the gradual ageing of the farming population could make the transfer of this knowledge more difficult. The age difference observed between the two areas should therefore be considered when interpreting differences in farmers' perceptions of ticks, treatment practices, and the use and transmission of traditional knowledge related to tick control, as older farmers generally accumulate greater practical experience, as reported in other studies conducted in Burkina Faso and Niger (Abdou *et al.* 2020).

The absence of a significant difference in farming experience suggests a relatively homogeneous level of expertise between the two pastoral areas. This similarity is consistent with the comparable length of experience in ruminant farming reported in the two areas. Farmers in both sites have therefore had similar opportunities to develop practical knowledge of herd health management. The pastoral nature of the two areas, together with livestock movements and the exchange of practices among farmers, may also help explain the similarities observed in their knowledge and management practices. This relative similarity in farming experience is relevant to tick control, as differences in tick-control practices between the two areas are unlikely to be explained simply by differences in farmers' level of experience. Similar observations have been reported in ethnoveterinary studies, where the duration of livestock farming practice and accumulated indigenous knowledge significantly influence the use and transmission of medicinal plant-based remedies for animal health management (Oda *et al.* 2024). Moreover, the relatively high mean age of farmers in both pastoral areas reflects a well-established professional profile, with more than 35 years of experience in ruminant farming. The long experience of these livestock keepers is an important source of practical knowledge for herd health management, including the recognition and control of tick infestations according to seasonal patterns. This experience may help farmers detect infestations early and choose control measures that are suited to local conditions. However, the relatively advanced age of many livestock keepers also highlights the need to pass this knowledge on to younger generations. Therefore, greater involvement of young herders in herd inspection, tick identification, the appropriate use of acaricides, and the preparation and application of plant-based remedies would help sustain this practical knowledge while encouraging the adoption of improved tick control methods.

Moreover, the majority of farmers surveyed (66.4%) in the study did not have access to formal education. This finding is consistent with studies conducted by Sanou *et al.* (2023), which found a similarly low rate of school enrolment among rural farmers in the Burkinabe Sahel. The high proportion of farmers without formal education may be related to their early involvement in livestock keeping and to the pastoral nature of their livelihoods, where knowledge is often acquired through observation, experience, and learning from other livestock keepers. In terms of tick control, this way of acquiring knowledge

may help maintain practical skills such as recognizing ticks, removing them manually, and using medicinal plants. However, limited formal education may also make it more difficult for some farmers to access written information on the proper use and dilution of acaricides, acaricide resistance, and safety precautions. For this reason, tick-control advice in these areas should rely more on practical demonstrations, visual materials, field-based training, and communication in locally understood languages, rather than depending mainly on written information.

Furthermore, livestock farming was the predominant economic activity for the majority of the livestock farmers surveyed (94.3%). The high level of specialization in livestock farming observed in the present study shows that ruminant production is the main source of livelihood for most households surveyed. This differs from the mixed crop-livestock systems reported by Chitura *et al.* (2018) in South Africa and reflects the more pastoral nature of the study areas. This dependence on livestock also has implications for tick control. When livestock provides most of the household income, tick infestations can have a direct effect on farmers through losses in animal condition and productivity, as well as the costs of treatment and diseases transmitted by ticks. Farmers therefore have a strong interest in keeping their animals healthy, although their dependence on livestock may also make them more vulnerable to the economic consequences of heavy infestations.

In this context, preventing tick infestations is particularly important. Regular inspection of animals, manual removal of ticks when necessary, and appropriate use of acaricides can help reduce infestation levels and associated losses. Locally used plant-based remedies may also provide additional options, provided that their effectiveness and safety are established. Tick-control programs should therefore consider the economic importance of livestock to these households and promote practical and affordable measures that farmers can realistically apply under local conditions.

With regard to farming systems, the predominance of permanent extensive farming (96%), characterized by the almost exclusive use of natural outdoor pastures, reflects a pragmatic strategy of adaptation to environmental constraints, particularly the seasonal dependence on natural fodder resources (Kiema *et al.* 2014). The widespread use of paddocks enclosed by branches (by more than 94% of the farmers surveyed) is a direct and logical consequence of maintaining the extensive system, highlighting the importance of pastoral mobility in optimizing pasture use and livestock protection (Kiema *et al.* 2014). These characteristics of the farming system are important for understanding tick exposure. Permanent extensive grazing keeps animals in frequent contact with natural vegetation and communal grazing areas where ticks can survive, increasing the risk of repeated infestation. Reliance on natural pastures also limits farmers' ability to act directly on the environmental stages of ticks, while branch-enclosed paddocks may concentrate animals in frequently used resting or holding areas, potentially increasing exposure where conditions are favorable for tick survival. Under these conditions, tick control should not rely solely on treating individual animals. Regular inspection of livestock, manual removal of attached ticks, and appropriate use of acaricides should be combined with measures aimed at reducing repeated exposure, such as timing treatments according to seasonal tick activity, managing frequently used resting areas and, where feasible, rotating or modifying grazing areas. These measures should consider the mobility and practical constraints of extensive pastoral farming.

The stability of average herd sizes per household, with approximately 44 TLU for cattle and 4 TLU for small ruminants, reflects the predominance of cattle within livestock systems. This interspecific variation was highly significant ($p < 0.001$; $\eta^2 = 0.923$), indicating that more than 90% of the variance in herd size is attributable to species. The analysis also revealed significant differences between sites for total herd size ($p = 0.009$) and cattle numbers ($p = 0.007$), whereas sheep and goat populations did not differ significantly ($p = 0.557$ and $p = 0.251$, respectively). The predominance of cattle in household herds is relevant to tick control because cattle can support the feeding and reproduction of adult ticks. The relatively large number of cattle may therefore contribute to maintaining tick populations in the study areas and to repeated exposure of livestock during grazing. The significant differences in total herd size and cattle numbers between the two sites may also partly account for differences in the level of exposure to ticks, particularly where larger cattle herds provide more opportunities for tick-host contact. In contrast, the similar numbers of sheep and goats between the sites suggest that differences in small-ruminant herd size are unlikely to be a major factor explaining variation in tick exposure between the two areas.

Within each site, the effect of species remained highly significant (Saho: $p < 0.0001$; $\eta^2 = 0.91$; Sidéradougu: $p < 0.0001$; $\eta^2 = 0.92$). These findings confirm the central role of cattle, not only as a major economic asset but also as a cornerstone of livestock farmers' livelihood strategies in the study area (Somda *et al.* 2019). From a tick-control perspective, the high proportion of cattle in the herds suggests that they should receive particular attention in surveillance and control efforts. Their predominance means that maintaining effective control measures in cattle could help reduce both the burden of infestation and the number of ticks that survive to the reproductive stages. However, the presence of ticks on sheep and

goats shows that control measures should not focus exclusively on cattle. A herd-level approach that includes all ruminant species is therefore needed to ensure that tick populations associated with small ruminants are not overlooked, especially where different host species share the same grazing areas.

Finally, the ethnic composition of the livestock farmers surveyed in the two study areas was dominated by the Peul (72.86%). The Peul are historically transhumant pastoralists who have traditional expertise in livestock management and knowledge of herbal remedies. Furthermore, ethnic diversity, which is more pronounced in Sidéradougou, where the Tiéfo, Toussian, Sambla and Dioula peoples coexist, contrasts with the Saho area (mainly populated by the Peul). This variation reflects the migratory dynamics and transhumant practices well illustrated in regional literature (Yarga *et al.* 2022). These results also corroborate the observations made by Coulibaly *et al.* (2021) et Traoré *et al.* (2024) who highlighted the impact of migratory movements on ethnic diversity in Sahelian pastoral areas. The ethnic composition of the surveyed livestock keepers is an important factor to consider when interpreting tick-control practices. Ethnoveterinary knowledge, ways of recognizing infestations, and treatment choices are developed and passed on within communities and social networks (Nwafor *et al.* 2022). The strong representation of Fulani livestock keepers, particularly in Saho, may therefore help explain the prominent role of pastoral knowledge related to herd management and the use of traditional treatments in the information collected (Yarga *et al.* 2022). In Sidéradougou, the greater ethnic diversity reflects a more varied social setting, where different forms of livestock-keeping knowledge and practices may coexist and be shared among communities (Coulibaly *et al.* 2021; Traoré *et al.* 2024).

This diversity is also relevant to tick control. Different groups of livestock keepers may perceive infestations differently, use different plant species or preparation methods, and have varying preferences for conventional acaricides or traditional treatments (Megersa 2021; Boakye *et al.* 2024). Such variation can help identify a wider range of locally used plant remedies. However, differences in practices may also result in variations in treatment effectiveness and safety (Oda *et al.* 2024). Tick-control and extension programs should therefore take local practices into account rather than assuming that the same traditional method or communication strategy will be suitable for all pastoral areas (Zannou *et al.* 2021). A practical approach would be to build on locally recognized practices while providing consistent technical guidance on acaricide use, the preparation and application of plant-based products with demonstrated acaricidal activity, appropriate dosages, treatment frequency, and safety precautions (FAO 2025).

Overall, tick control in the study area is closely linked to an extensive livestock system that relies strongly on farmers' experience and local knowledge (Kiema *et al.* 2014). These forms of knowledge are valuable for recognizing and managing infestations, but limited access to technical information, extensive grazing, and the predominance of cattle may contribute to continued exposure to ticks (Adakal *et al.* 2013). An integrated approach combining local knowledge with veterinary recommendations, regular herd surveillance, rational acaricide use, and the evaluation of medicinal plants as complementary control options therefore appears appropriate (Zannou *et al.* 2021).

Livestock farming constraints and the impact of ticks

Livestock farmers' perceptions regarding the increased presence and recent rise in tick populations on ruminants are consistent with the observations reported by Sidiki *et al.* (2025) in the pastoral areas studied and by Mampasi (2025) in other African contexts. However, farmers' reports of increased tick abundance may not be explained only by greater awareness of the problem. They may also be related to changes in environmental conditions, seasonal patterns, herd management, grazing practices, or the effectiveness of the control methods used. Since this study did not assess changes in tick abundance over a longer period, these factors cannot be considered as confirmed causes but may provide possible explanations for the farmers' observations.

Seasonal variation in tick infestation

This seasonal pattern should be interpreted with caution because the present study did not examine the effects of individual environmental factors, such as temperature, humidity, rainfall, and vegetation cover. Previous studies have shown that these factors influence the activity and survival of free-living tick stages, but their effects can vary with tick species and local ecological conditions (Rodriguez-Vivas *et al.*, 2018; Heylen *et al.*, 2023; Makwarela *et al.*, 2025). The differences recorded between Saho and Sidéradougou are likely related to both environmental conditions and livestock management practices, rather than to a single climatic factor (Sidiki *et al.*, 2025). From a practical point of view, these seasonal differences should be considered when planning tick control, with greater attention given to the periods of highest infestation in each pastoral area.

Impacts of tick infestation on livestock and farmers' livelihoods

The impacts of ticks reported by livestock farmers include mortality and reduced animal productivity, followed by food restrictions. These observations corroborate those of Jongejan and Uilenberg (2004) and Ocaido *et al.* (2019). These effects can have direct consequences for household livelihoods by reducing the number of animals and the quantity of animal products available for consumption or sale. At the same time, farmers may have to spend more on veterinary treatment and tick control. For households that depend largely on livestock, repeated animal losses and lower productivity can therefore reduce the income and other benefits obtained from livestock production. In addition, these parasites are recognized as vectors of pathogens responsible for major blood-borne diseases such as babesiosis, theileriosis, anaplasmosis and cowdriosis (Ouédraogo *et al.* 2021; Kasaija *et al.* 2021). The impacts perceived by farmers may therefore result from both the direct effects of tick infestation and the diseases associated with tick-borne pathogens.

Tick-control practices used by livestock farmers

Control strategies implemented by farmers involve a combination of methods, including synthetic acaricides, grazing restriction, plant-based remedies, manual tick removal, and the use of spent engine oil. The use of different control methods shows that farmers combine several options depending on what is available, what they consider effective, and what they have learned from experience. Similar combinations of conventional treatments and traditional practices have also been reported in other African livestock systems (De Meneghi *et al.*, 2016; Mthi *et al.*, 2020; Lorusso *et al.*, 2021; Phaahla *et al.*, 2025). Although the use of synthetic acaricides is widespread (100%), the present results do not show a clear relationship between acaricide use and farmers' financial capacity, as all surveyed farmers reported using synthetic acaricides. However, the fact that 68% of farmers considered the cost of these products to be a constraint indicates that their use may not be equally affordable for everyone. Differences may therefore exist in how often treatments are applied or in the quantities of acaricides used, even though synthetic products are widely used. In contrast, alternative practices such as manual tick removal and the use of spent engine oil were also reported and may provide additional options for farmers seeking accessible methods of tick control. Grazing restriction is also employed to reduce animal exposure to heavily infested areas.

In this context, our results highlight a marked duality in control strategies, characterized by the widespread use (100%) of chemical acaricides alongside the use of ethnoveterinary medicine by a substantial proportion of livestock keepers (46.4%). This reliance is primarily driven by the high cost of chemical products (68%) and the limited accessibility of veterinary services (51%), reflecting continued dependence on local resources. These findings are consistent with several African studies reporting the complementary use of medicinal plants and manual tick removal in livestock systems (Mthi *et al.* 2020; Lorusso *et al.* 2021; Phaahla *et al.* 2025).

Use of spent engine oil and associated risks

The use of spent engine oil was also reported by some livestock keepers as a way of controlling ticks, probably because it is readily available. However, spent engine oil is not an approved veterinary acaricide and may contain harmful substances, including polycyclic aromatic hydrocarbons and heavy metals. Repeated contact with the oil can expose both animals and handlers to these substances. In addition, disposing of used oil in the environment may contaminate soil and water. This practice has been empirically reported in several African studies (Dreyer *et al.* 1998; Azokou *et al.* 2016; Githaka *et al.* 2022; Mollong *et al.* 2025).

Synthetic acaricides, resistance and medicinal plants

However, reliance on synthetic acaricides raises concerns regarding long-term sustainability because of the increasing emergence of acaricide-resistant tick populations in several African livestock systems (De Meneghi *et al.* 2016; Boka *et al.* 2023; FAO 2023). This issue may become more important when the same active ingredients are used repeatedly or when treatment doses and intervals are not properly controlled. However, acaricide resistance was not assessed in the present study, so it cannot be concluded from the control practices reported by the farmers. The widespread use of synthetic acaricides nevertheless shows the need to monitor their effectiveness and encourage their proper and responsible use. In parallel, the use of medicinal plants reflects both economic and cultural considerations, widely documented in African pastoral systems (Mvumi 2021; Dharani *et al.* 2015). Unlike synthetic acaricides, there is still limited evidence that tick populations develop resistance to complex plant-based preparations. Repeated use of the same plant compounds could theoretically reduce their effectiveness over time, but this has not been demonstrated under the conditions of the present study. Medicinal plants should therefore not be considered completely free from this risk. Rather, they may provide useful complementary options for tick control, provided that their effectiveness and safety are confirmed through experimental studies.

Safety considerations related to traditional treatments

When protective equipment is not used during the preparation and application of plant-based treatments, farmers may come into direct contact with the preparations through the skin or eyes. This could increase exposure to irritant or potentially toxic compounds, particularly when concentrated preparations are used. However, the present survey did not specifically assess the use of personal protective equipment. This point should therefore be considered as a potential safety concern rather than as a common practice among the farmers surveyed.

The use of pharmacologically active plants, such as *Nicotiana tabacum* and *Calotropis procera*, also warrants further assessment of their safety when used in food-producing animals, particularly with regard to potential residues and consumer safety (WOAH 2023 ; FAO 2025). The possibility of residues in milk or meat may depend on the plant species, the active compounds involved, the method of preparation, the dose, the route of administration, and the time between treatment and the use of animal products. These aspects therefore require specific investigation before such plant-based treatments can be recommended for routine use in livestock.

Diversity and use of acaricidal medicinal plants

The farmers surveyed in the two pastoral areas reported 31 traditional remedies prepared from 14 plant species belonging to 10 botanical families. Fabaceae was the most frequently represented family, followed by Lamiaceae, Meliaceae and Caricaceae. The prominence of Fabaceae is consistent with findings from other African ethnoveterinary studies, in which species from this family are commonly used by livestock keepers to manage animal-health problems (Chitura et al. 2018; Zerbo et al. 2025).

Chamaecrista nigricans showed the highest relative frequency of citation (RFC = 67.9%), followed by *Carica papaya* (47.14%), *Calotropis procera* (37.1%), *Ocimum americanum* (34.3%), and *Azadirachta indica* (30.7%). The frequent use of *C. nigricans* may be explained by its availability in the study area, its familiarity to livestock keepers, and the confidence placed in the remedies prepared from this plant. The reported use of this species may also be related to the bioactive properties described for plants within this genus. However, the present study did not investigate its phytochemical composition or directly assess its acaricidal activity. The use of several of the other reported species for tick control is consistent with findings from previous studies (Fouche et al., 2019; Salman et al., 2020; Gareh et al., 2022; Shakya et al., 2024; Phaahla et al., 2025; Corpuz et al., 2025).

The high Informant Consensus Factor (ICF = 0.97) reflects a strong degree of agreement among the respondents concerning the use of medicinal plants against ticks. This high consensus suggests that the reported practices are widely shared among livestock keepers rather than being based on isolated individual knowledge. The persistence of such shared practices may reflect their local acceptance and perceived usefulness in tick management. Nevertheless, a high level of consensus should not be interpreted as evidence of acaricidal efficacy or safety. These aspects need to be confirmed through experimental studies under controlled conditions.

Differences between pastoral areas

The use of some plant species showed descriptive differences between the two pastoral areas. For instance, *Azadirachta indica* was reported by 41.43% of farmers in Saho, compared with 20% in Sidéradouougou, while *Ocimum americanum* was cited by 22.86% and 45.71% of farmers, respectively. However, these differences were not statistically significant after correction for multiple comparisons ($p > 0.05$). Thus, although the frequencies suggest some variation in the plants used between the two areas, the results do not provide sufficient evidence of a significant difference in plant-use practices.

Chamaecrista nigricans showed similar levels of use in Saho and Sidéradouougou (35.7% and 32.1%, respectively), indicating that this species was commonly used in both pastoral areas. The differences observed for some of the other species may reflect variations in local availability, accessibility, or farmers' familiarity with particular remedies, although these factors were not specifically assessed in the present study. The relatively consistent use of *C. nigricans* in both areas makes it a relevant candidate for further investigation, particularly regarding its potential as a locally available plant-based option for tick control.

Plant parts and preparation methods

Leaves were the most frequently used plant parts, followed by seeds, bark, bulbs or pods, and pulp. The frequent use of leaves may be partly explained by their accessibility and ease of collection. In addition, harvesting leaves is generally less damaging to plants than removing bark or roots, which may favor their use in traditional practices. Similar patterns have

been reported in ethnoveterinary studies conducted in Burkina Faso and South Africa (Tianhoun *et al.*, 2023; Phaahla *et al.*, 2025).

Seeds were also used in several remedies, particularly those prepared from *Carica papaya*. Previous studies have reported acaricidal or antiparasitic activity associated with *C. papaya* seeds (Shyma *et al.*, 2014; Bravo-Ramos *et al.*, 2021; Dhoot *et al.*, 2024). These observations highlight the importance of evaluating the specific plant parts traditionally used by livestock keepers, since the biological activity of a species may vary considerably among its different organs.

Decoction was the most commonly reported preparation method, followed by maceration, powders, and pastes. Washing or bathing and direct topical application were the main methods of administration, with treatment periods ranging from 2 to 15 days. These traditional practices provide useful information for selecting plant preparations and treatment approaches for subsequent experimental evaluation. However, the reported duration of treatment should not be taken as evidence that repeated applications are necessary to control the different tick stages, as the effectiveness of these practices was not assessed in the present study.

Safety of traditional remedies

Although these plant remedies are commonly used by livestock keepers, their safety remains poorly documented. The present survey did not investigate possible toxic effects, adverse reactions, or the presence of residues in animal products. Particular attention should therefore be given to plants with known pharmacologically active constituents, such as *Nicotiana tabacum* and *Calotropis procera*, whose safety requires further assessment before regular use in food-producing animals (Wadhwani *et al.* 2021; Abdisa *et al.* 2024; Habeeb *et al.* 2024; Zhang *et al.* 2024). Further studies should consider the plant species and plant part used, the active constituents, preparation method, dose, and route of administration. Where relevant, appropriate withdrawal periods should also be established, particularly for animals intended for human consumption (FAO 2025; WOA 2023).

Scope and contribution of the study

The present study provides additional information on the plants traditionally used against ticks in ruminants in the Guiriko region. In this area, previous ethnoveterinary studies have focused mainly on gastrointestinal parasites, trypanosomiasis, or medicinal plants used for a broader range of animal health problems (Tianhoun *et al.*, 2023; Hounyèmè *et al.*, 2022; Tamboura *et al.*, 1998; Zerbo *et al.*, 2011). The identification of 14 plant species and 31 traditional remedies, along with information on the plant parts used, preparation methods, routes of administration, and treatment duration, provides a useful starting point for selecting locally used remedies for experimental evaluation.

The frequent citation of *Chamaecrista nigricans*, together with the high level of consensus among informants, makes this species particularly relevant for further investigation. However, the findings presented here describe traditional practices and farmers' perceptions and should not be taken as evidence of acaricidal efficacy or safety. Experimental studies are therefore required to determine the effectiveness and safety of the reported preparations and to assess their potential contribution to tick-control programs.

Limitations of the study

The survey, conducted exclusively among male household heads, may underestimate the role of women and other household members, and the relationship between education level and plant use was not assessed. This limitation reduces the extent to which the findings can be generalized to the ethnoveterinary knowledge of the entire household, particularly with regard to the preparation and use of plant-based remedies. Data collected through interviews over a limited period (February-April) may be subject to recall bias and seasonal variability. Although the survey was conducted over a relatively short period, farmers were asked to report their usual practices and previous experiences with tick control. Consequently, some information, particularly concerning the timing and frequency of plant use, may have been affected by recall bias.

The multi-response nature of ethnobotanical data may have affected the statistical independence of observations, although appropriate descriptive analyses and Bonferroni correction were applied. This should be considered when interpreting differences in plant-use frequencies, as farmers could report more than one plant species or tick-control method. Most remedies involved a single plant part, and the predominantly wild origin of the 14 recorded species raises sustainability concerns. Repeated harvesting from wild plant populations, especially when roots, bark, or other plant parts whose removal can damage the plant are collected, may increase pressure on local plant resources. However, the present study did not

assess species abundance, regeneration capacity, harvesting intensity, or conservation status. It is therefore not possible to determine the sustainability of the reported uses from the present data alone.

The limited information on plant combinations also restricted the assessment of potential synergistic effects. In addition, the study did not experimentally assess the acaricidal activity, toxicity, or dose-response relationships of the reported remedies. Further laboratory studies, followed where appropriate by field evaluations, are therefore needed to identify the most promising plant preparations and to determine whether they could be considered for broader use.

Despite these limitations, the use of free listing, visual aids, and plant specimens for botanical identification helped to document the remedies reported by farmers with greater precision. Future studies could build on these findings by including women and other household members, assessing the availability and regeneration of the plant species used, and experimentally evaluating the efficacy and safety of the most frequently reported remedies.

Conclusion

This study documented the ethnoveterinary knowledge of livestock farmers in the Guiriko region of Burkina Faso regarding the use of medicinal plants for tick control. A total of 493 use reports were recorded, covering 31 traditional remedies prepared from 14 medicinal plant species belonging to 10 botanical families. *Chamaecrista nigricans*, *Carica papaya*, *Calotropis procera*, *Ocimum americanum* and *Azadirachta indica* were the most frequently reported species, with *C. nigricans* having the highest citation frequency. The high Informant Consensus Factor (ICF = 0.97) indicates a strong degree of agreement among farmers regarding the plants used for tick control.

The findings further show that plant-based remedies are integrated into a broader tick-control system rather than being used as an alternative to conventional treatments. Although all farmers reported using synthetic acaricides, 46.4% also used medicinal plants. The reported use of these remedies was associated mainly with their local availability, perceived effectiveness, the cost of synthetic acaricides and limited access to veterinary services. Perceived periods of high tick infestation also differed between the two pastoral areas, with the rainy season predominating in Saho and the hot dry season in Sidéradougou. These differences underline the importance of considering local management practices and area-specific seasonal patterns when designing tick-control strategies.

The documentation of 14 plant species and 31 remedies, together with information on plant parts, preparation methods, routes of administration and treatment duration, provides a useful basis for selecting locally recognized practices for further investigation. The frequent citation of *C. nigricans*, combined with the high level of consensus among farmers, supports its prioritization for experimental assessment. However, the present study describes traditional practices and farmers' perceptions and does not demonstrate the acaricidal efficacy, toxicity, optimal dose or safety of the reported preparations.

Further research should therefore focus on experimentally evaluating the most frequently reported plants and preparations, including their activity against relevant tick stages, dose-response relationships and safety. Their availability, regeneration and harvesting pressure should also be assessed, particularly for species collected from wild populations. Linking these experimental and ecological assessments with the ethnoveterinary knowledge documented in this study may help identify locally appropriate and scientifically validated complementary options for tick management in pastoral livestock systems.

Declarations

List of abbreviations: INSD: Institut National de Statistiques et de Demographie, CNRST: National Center for Scientific and Technological Research, INERA: Institute of the Environment and Agricultural Research, CRE: Regional Center of Excellence in Fruits and Vegetables, CERPP: Regional Center of Excellence on Pastoral Productions, CIRDES: International Centre for Research-Development on Livestock in the Subhumid Zone, IGB: Geographic Institute of Burkina Faso, BNDT: National Topographic Database, ESRI: Environmental Systems Research Institute, TLU: Tropical Livestock Units, RFC: relative frequency of citation, UR: use reports, ICF: Informant Consensus Factor.

Ethics approval and consent to participate: The present study relied exclusively on interviews with livestock farmers from the pastoral areas of Saho and Sidéradougou and did not involve any experimental procedures on animals. The study protocol complied with applicable national and international ethical guidelines. Interviews were conducted only after obtaining informed consent from the participants for the publication of the data they provided, while ensuring their anonymity and confidentiality. By adhering to ethical research standards, this approach supports data-driven analyses that can contribute to improving animal health management practices.

Consent for publication: Not applicable

Availability of data and materials: The authors state that they will provide the data for this study if requested.

Competing interests: The authors declare no conflicts of interest.

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Author contributions: BHEAS: Conceptualized and designed the study protocol, led and conducted data collection, performed data analysis, wrote the first manuscript draft, revised and approved the final version. SE, ZA, TFD, and AS: Conducted field investigations and data collection, contributed to data analysis, reviewed and approved the final manuscript. KA and MH: Contributed to conceptualization and protocol development, provided technical guidance, critically reviewed manuscript drafts, approved the final version. All authors read, revised and approved the final manuscript.

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Literature cited

- Abdou H, Maina AA, Marichatou M, Issaka CM, Bakasso BD, Abass YD. 2020. Pastoralists' perception of climate change and adaptation strategies to environmental constraints in Niger. *Revue d'Élevage et de Médecine Vétérinaire des Pays Tropicaux*. 73(4):187-195. doi: 10.19182/remvt.31873
- Abdisa T, Dinbiso TD. 2024. Toxic plants and their impact on livestock health and economic losses: a comprehensive review. *Journal of Toxicology* 2024:9857933. doi: 10.1155/2024/9857933
- Adakal H, Stachurski F, Chevillon C. 2013. Tick control practices in Burkina Faso and acaricide resistance survey in *Rhipicephalus (Boophilus) geigyi* (Acari: Ixodidae). *Experimental and Applied Acarology* 2013;59(4):483-491. doi: 10.1007/s10493-012-9610-5
- Adenubi OT, Ahmed AS, Fasina FO, McGaw LJ, Eloff JN. 2018. Application of ethnobotanical repellents and acaricides in prevention, control and management of livestock ticks: a review. *Research in Veterinary Science* 119:1-9. doi: 10.1016/j.rvsc.2016.09.001
- ANAM (National Meteorological Agency of Burkina Faso). 2022. Climatic and rainfall data for the Hauts-Bassins / Guiriko region (1991-2020). Ouagadougou, Burkina Faso. Document ANAM - État du climat 2022
- Aremu AO, Omogbene TO, McGaw LJ, Masondo NA. 2026. A critical insight of African ethnoveterinary research: A multi-database bibliometric review on trends and patterns from 2001 to 2024. *Journal of Ethnopharmacology* 367:121626. doi: 10.1016/j.jep.2026.121626
- Azokou A, Achi YL, Koné P, Stachurski F. 2016. Control of livestock ticks in Côte d'Ivoire using traditional methods. *Livestock Research for Rural Development* 28(4):Article 052. <https://lrrd.org/lrrd28/4/azok28052.htm>
- Balinandi S, Chitimia-Dobler L, Grandi G, Nakayiki T, Kabasa W, Johnson B, Julius JL, Deon KB, Maja M, Lawrence M. 2020. Morphological and molecular identification of ixodid tick species (Acari: Ixodidae) infesting cattle in Uganda. *Parasitology Research* 119:2411-2420. doi: 10.1007/s00436-020-06742-z
- Biguezoton A, Adehan S, Adakal H, Zoungrana S, Farougou S, Chevillon C. 2016. Community structure, seasonal variations and interactions between native and invasive cattle tick species in Benin and Burkina Faso. *Parasites & Vectors* 9:43. doi: 10.1186/s13071-016-1305-z
- Boakyé MK, Adanu SK, Buami EK, Agyemang AO. 2024. Ethnoveterinary treatment of livestock in Ghana: Cultural importance and consensus on plants used. *Heliyon* 10(13):e33809. doi: 10.1016/j.heliyon.2024.e33809
- Boka OM, Biguezoton A, Achi YL, Kande S, Koffi SL, Akoto RP, and Yapi YG. 2023. Resistance of the invasive tick *Rhipicephalus (Boophilus) microplus* to the new range of acaricides distributed in Côte d'Ivoire. *European Scientific Journal* 19(18):284. doi: 10.19044/esj.2023.v19n18p284
- Bouchard C, Dibbernardo A, Koffi J, Wood H, Leighton P, Lindsay L. 2019. Increased risk of tick-borne diseases in the context of climate and environmental changes. *Canada Communicable Disease Report* 45(4):89-98. doi: 10.14745/ccdr.v45i04a02

- Bravo-Ramos JL, Flores-Primo A, Paniagua-Vega D, Sánchez-Otero MG, Cruz-Romero A, Romero-Salas D. 2021. Acaricidal activity of the hexanic and hydroethanolic extracts of three medicinal plants against southern cattle tick *Rhipicephalus (Boophilus) microplus* (Acari: Ixodidae). *Experimental and Applied Acarology* 85(1):113-129. doi: 10.1007/s10493-021-00654-Y
- Chitura T, Muvhali PT, Shai K, Mushonga B, Kandiwa E. 2018. Use of medicinal plants by livestock farmers in a local municipality in Vhembe district, South Africa. *Applied Ecology and Environmental Research* 16:6589-6605. doi: 10.15666/aeer/1605_65896605
- Corpuz AV, Florentino CM, Quilana PET, Reotutar AJP, Reyes RAT. 2025. Acaricidal activity of *Azadirachta indica* (Neem Tree) and *Carica papaya* (Papaya) leaf extracts against *Rhipicephalus sanguineus* (Dog Ticks) using spray method. *Online Journal of Biological Sciences* 25(2):426-436. doi: 10.3844/ojbsci.2025.426.436
- Coulibaly M, Samaké S, N'Diaye B, Mallé M, Sanoussi A, Cissé D, Sogodogo D, Daou M, Dabo H, Korbo A, Timbely D. 2021. Vulnerability of agro-pastoralists to climate variability and change in the rural commune of Diéma (Mali). *Afrique Science* 18(5): 66-85. <https://afriquescience.net/admin/postpdfs/bd38aed12470179b72b9e086688f78ab1727959640.pdf>
- Dagnelie P. 1998. Theoretical and applied statistics. Volume 1: Descriptive statistics and basics of statistical inference. Bruxelles: De Boeck & Larcier. 508 p. ISBN: 9782804127701. <https://decitre.fr/livres/statistique-theorique-et-appliquee-9782804127701>
- Dahourou LD, Konate A, Tapsoba ASR, Kaboré BA, Kaboré A, Tamboura HH, and Traoré A. 2021. Farmers' awareness and ethno-veterinary practices regarding porcine cysticercosis in the province of Boulkiemde, Burkina Faso. *Journal of Medicinal Plants Research* 15(4):150-159. doi: 10.5897/JMPR2020.7042
- Damalas CA, Koutroubas SD. 2016. Farmers' exposure to pesticides: toxicity types and ways of prevention. *Toxics* 4(1):1. doi: 10.3390/toxics4010001
- De Meneghi D, Stachurski F, Adakal H. 2016. Experiences in tick control by acaricide in the traditional cattle sector in Zambia and Burkina Faso: possible environmental and public health implications. *Frontiers in Public Health* 4:239. doi: 10.3389/fpubh.2016.00239
- Dharani N, Yenesew A, Aynekulu E, Tuei B, Jamnadass R. 2015. Traditional Ethnoveterinary Medicine in East Africa: A Manual on the Use of Medicinal Plants. Edited by Dawson I.K. Nairobi, Kenya: World Agroforestry Centre (ICRAF), 199 p. ISBN: 978-92-9059-335-5. <https://cifar-icraf.org/publications/downloads/Publications/PDFS/B15647.pdf>
- Dhoot VV, Bhojne GR, Dhoot VM, Panchbhai CG, Somkuwar AP, Raghuvanshi DS, Jadhav SG, Game YG. 2024. Anthelmintic evaluation of *Carica papaya* against gastrointestinal nematodes in goats. *International Journal of Veterinary Sciences and Animal Husbandry* doi: 10.22271/veterinary.2024.v9.i3f.1442
- Dreyer K, Fourie LJ, Kok DJ. 1998. The efficacy of used engine oil against ticks on cattle. *Onderstepoort Journal of Veterinary Research* 65(4):275-279. <https://repository.up.ac.za/bitstream/handle/2263/20719/36dreyer1998.pdf?sequence=1>
- Environmental Systems Research Institute (Esri). 2012. ArcGIS Desktop Release 10.1. Redlands (CA): Esri. Esri ArcGIS 10.1 Release Information... Ferrigno S, Guadagnini R, Tyrell K. 2017. Is Cotton Conquering Its Chemical Addiction? A Review of Pesticide Use in Global Cotton Production. London, United Kingdom: Pesticide Action Network UK (PAN UK). p. 1-36. <https://pan-uk.org/site/wp-content/uploads/Cottons-chemical-addiction-FINAL-LOW-RES-2017.pdf>
- Food and Agriculture Organization of the United Nations (FAO). 2018. Impacts of bovine and poultry production systems on livelihoods in Burkina Faso. Rome, Italy: FAO. p. 1-11. <https://openknowledge.fao.org/server/api/core/bitstreams/0199e3d3-1c86-4c05-bb29-a8fb8f516a80/content>
- Food and Agriculture Organization of the United Nations (FAO). 2019. The future of livestock farming in Burkina Faso: challenges and opportunities in the face of uncertainties. Rome, Italy: FAO. Licence: CC BY-NC-SA 3.0 IGO. p. 1-56. <https://openknowledge.fao.org/server/api/core/bitstreams/1c86-4c05-bb29-a8fb8f516a80/content>
- Food and Agriculture Organization of the United Nations (FAO). 2021. Burkina Faso country profile: contribution of the livestock sector to socio-economic development. Rome: FAO; p. 1-108. <https://www.fao.org/countryprofiles/index/en/?iso3=BFA>
- Food and Agriculture Organization of the United Nations (FAO). 2023. Framework and roadmap proposal established for the new guidelines on acaricide resistance management of livestock ticks [Internet]. Rome: FAO; 2023 Mar 20 [cited 2026 Sep 3]. Available from: FAO - Acaricide resistance management of livestock ticks
- Food and Agriculture Organization of the United Nations (FAO). 2025. Guidelines for sustainable tick control and acaricide resistance management in livestock. Rome: FAO. 38 p. doi: 10.4060/cd4964en

- Fouche G, Adenubi OT, Leboho T, McGaw LJ, Naidoo V, Wellington KW, Eloff JN. 2019. Acaricidal activity of the aqueous and hydroethanolic extracts of 15 South African plants against *Rhipicephalus turanicus* and their toxicity on human liver and kidney cells. *Onderstepoort Journal of Veterinary Research* 86(1): a1665. doi: 10.4102/ojvr.v86i1.1665
- Gareh A, Hassan D, Essa A, Kotb S, Karmi M, Mohamed AE-HH, Alkhaibari AM, Elbaz E, Elhawary NM, Hassanen EAA, Lokman MS, El-Gohary FA and Elmahallawy EK. 2022. Acaricidal properties of four neem seed extracts (*Azadirachta indica*) on the camel tick *Hyalomma dromedarii* (Acari: Ixodidae). *Frontiers in Veterinary Science* 9:946702. doi: 10.3389/fvets.2022.946702
- Institut Géographique du Burkina (IGB). 2012. Base Nationale de Données Topographiques (BNDT). [Internet]. Ouagadougou: IGB ; [consulté le 22 mars 2026]. https://igb.bf/?page_id=85&utm_source=chatgpt.com
- Githaka N, Kanduma E, Wieland B, Darghouth MA, Bishop R. 2022. Acaricide resistance in livestock ticks infesting cattle in Africa: current status and potential mitigation strategies. *Current Research in Parasitology & Vector-Borne Diseases* 2:100090. doi: 10.1016/j.crpvbd.2022.100090
- Habeeb A, Ramesh S, Shanmugam R. 2024. *Calotropis procera* and the pharmacological properties of its aqueous leaf extract: a review. *Cureus* 16(5): e60354. doi: 10.7759/cureus.60354.
- Hankiso M, Asfaw Z, Warkineh B, Abebe A, Sisay B, Debella A. 2024. Ethnoveterinary medicinal plants and their utilization by the people of Soro District, Hadiya Zone, southern Ethiopia. *Journal of Ethnobiology and Ethnomedicine* 20:21. doi: 10.1186/s13002-024-00651-6
- Heylen DJA, Kumsa B, Kimbita E, Frank MN, Muhanguzi D, Jongejan F, Adehan SB, Toure A, Aboagye-Antwi F, Ogo NI, Juleff N, Crafford D, Fourie J, Labuchange M, Maddler M. 2023. Tick-borne pathogens and body condition of cattle in smallholder rural livestock production systems in East and West Africa. *Parasites & Vectors* 16:117. doi: 10.1186/s13071-023-05709-0
- Hounyèmè RE, Kaboré J, Gimonneau G, Somda MB, Salou E, Missihoun AA, Bengaly Z, Jamonneau V, Boulangé A. 2022. Molecular epidemiology of Animal African Trypanosomosis in southwest Burkina Faso. *PLoS Neglected Tropical Disease*. 16(8):e0010106. doi: 10.1371/journal.pntd.0010106
- International Center for Research-Development on Livestock in the Subhumid Zone (CIRDES). 2014. Impact of ticks and tick-borne diseases on livestock in the North, Centre and South of Côte d'Ivoire. Bobo-Dioulasso: CIRDES; 2014. Technical Sheet No. 35. 1-8 p. <https://cirdes.org/wp-content/uploads/2019/04/Fiche-technique-35.pdf>
- Isman MB. 2020. Botanical insecticides in the twenty-first century—fulfilling their promise? *Annual Review of Entomology* 65:233-249. doi: 10.1146/annurev-ento-011019-025010
- Jongejan F, Uilenberg G. 2004. The global importance of ticks. *Parasitology* 129(S1):S3-S14. doi: 10.1017/S0031182004005967
- Kasaija PD, Estrada-Peña A, Contreras M, Kirunda H, de la Fuente J. 2021. Cattle ticks and tick-borne diseases: a review of Uganda's situation. *Ticks and Tick-borne Diseases* 12(5):101756. doi: 10.1016/j.ttbdis.2021.101756
- Kamba ET, Chimonyo M. 2024. Utilisation of indigenous knowledge to control gastrointestinal nematodes in Southern Africa. *Tropical Animal Health and Production* 56:100. doi: 10.1007/s11250-024-03941-z
- Keter LK, Mutiso PC. 2012. Ethnoveterinary practices and uses of medicinal plants among pastoralists in Kenya. *Journal of Ethnobiology and Ethnomedicine* 8:10. doi: 10.1186/1746-4269-8-10.
- Kiema A, Tontibomma GB, Zampaligré N. 2014. Transhumance and natural resource management in the Sahel: constraints and prospects facing changes in pastoral systems. *Vertigo - la revue électronique en sciences de l'environnement* 14(3):16. doi: 10.4000/vertigo.15404
- Lorusso V, Ene J, Onyiche TE, Ogo NI. 2021. Tick control practices in Nigeria and Cameroon: a survey of livestock farmers. *Tropical Animal Health and Production* 53(1):1-12. doi: 10.1007/s11250-020-02518-3
- Makwarela TG, Seoraj-Pillai N, Nangammbi TC. 2025. Distribution and prevalence of ticks and tick-borne pathogens at the wildlife-livestock interface in Africa: a systematic review. *Veterinary Sciences* 12(4):364. doi: 10.3390/vetsci12040364
- Mampasi AS. 2025. Identification of ticks in cattle and farmers' perceptions of their control strategies in the Masi-Manimba Territory, Kwilu Province, Democratic Republic of the Congo (DRC). *Revue Africaine d'Environnement et d'Agriculture* 8(2):148-157. doi: 10.4314/rafea.v8i2.13
- Megersa F, Kassahun A, Giday M. 2021. Medicinal plants used in ethnoveterinary practices in Adea Berga District, Oromia Region of Ethiopia. *Evidence-Based Complementary and Alternative Medicine*. 5641479 doi: 10.1155/2021/5641479
- Mollong E, Lébré M, Marie-Magdeleine C, Lagou SM, Naves M, Bambou JC. 2025. Sustainable management of tick infestations in cattle: a tropical perspective. *Parasites & Vectors* 18:62. doi: 10.1186/s13071-025-06684-4

- Mthi S, Rust J, Yawa M, Tyasi L. 2020. Ethnoveterinary medicinal plants application for the treatment of tick-borne diseases in cattle around the Eastern Cape Province of South Africa. *Journal of Medicinal Plants for Economic Development* 4(1):a100. doi: 10.4102/jmped.v4i1.100
- Mvumi BM, Nyahangare ET, Eloff JN, Belmain SR, Stevenson PC. 2021. Cattle tick control in Africa: potential of ethnoveterinary plants. *CABI Reviews* 2021:2. doi: 10.1079/PAVSNNR202116042
- National Institute of Statistics and Demography (INSD). 2020. National Statistical Yearbook 2019 [Internet]. Ouagadougou: INSD; 2020 [cited 2026 Sep 3]. https://www.insd.bf/sites/default/files/2021-12/Annuaire_Statistique_National_2019.pdf
- National Institute of Statistics and Demography (INSD). 2023. Quarterly economic situation bulletin, Q1 2023. Ouagadougou: INSD; 2023. 65 p. https://insd.bf/sites/default/files/2023-10/BTC_T1_2023.pdf
- Ndou RV, Materechera SA, Mwanza M, Otang-Mbeng W, Ijane MF. 2023. Indigenous knowledge and use of medicinal plants for ethnoveterinary within the North West Province, South Africa. *Frontiers in Veterinary Science* 10:1273562. doi: 10.3389/fvets.2023.1273562
- Nimpaye H, Nduwimana F, Nisubire D, Nijimbere G, Ndikuriyo R, and Bisusa Muhimuzi A. (2023). Distribution and abundance of livestock ectoparasite ticks in the three agro-ecological zones of Burundi. *African Journal of Tropical Environment Research* 2(2). <https://ajter.com/wp-content/uploads/2023/08/NIMPAYE-et-al-2023-ajter-2-2-Pub.pdf>
- Nwafor IC, Nwafor CU. 2022. African smallholder farmers and the treatment of livestock diseases using ethnoveterinary medicine: a commentary. *Pastoralism* 2022;12:29. doi: 10.1186/s13570-022-00244-6
- Ocaido M, Otim CP, and Kakaire D. 2019. Impact of major diseases and vectors in smallholder cattle production systems in different agro-ecological zones and farming systems in Uganda. *Livestock Research for Rural Development* 21(9): 155. <https://lrrd.cipav.org.co/lrrd21/9/ocai21155.htm>
- Oda BK, Lulekal E, Warkineh B, Asfaw Z, Debella A. 2024. Ethnoveterinary medicinal plants and their utilization by indigenous and local communities of Dugda District, Central Rift Valley, Ethiopia. *Journal of Ethnobiology and Ethnomedicine* 20:32. doi: 10.1186/s13002-024-00665-0
- Ouédraogo AS, Zannou OM, Biguezoton AS, Kouassi PY, Belem A, Farougou S, Oosthuizen M, Saegerman C, Lempereur L. 2021. Cattle ticks and associated tick-borne pathogens in Burkina Faso and Benin: apparent northern spread of *Rhipicephalus microplus* in Benin and first evidence of *Theileria velifera* and *Theileria annulata*. *Ticks and Tick-borne Diseases* 12(4):101733. doi: 10.1016/j.ttbdis.2021.101733
- Phaahla CS, Shai JL, Maduna V, Moropeng RC, Magano SR. 2025. Documentation of ethnoveterinary knowledge and alternative practices for cattle tick control in Sekhukhune District, Limpopo Province, South Africa. *Frontiers in Veterinary Science* 11:1488960. doi: 10.3389/fvets.2024.1488960
- Rodriguez-Vivas RI, Jonsson NN, Bhushan C. 2018. Strategies for the control of *Rhipicephalus microplus* ticks in a world of conventional acaricide and acaricide resistance management. *Parasites & Vectors* 11(1):431. doi: 10.1186/s13071-017-2424-3
- Rothman-Ostrow P, Gilbert W, Rushton J. 2020. Tropical Livestock Units: re-evaluating a methodology. *Frontiers in Veterinary Science* 7:556788. doi: 10.3389/fvets.2020.556788
- Salvador VF, Morais IML, Leal LLLL, Tamiozo GL, Chagas HDF, Silva IS, Ferreira LL, Borges FA, Prata MCA, Costa-Junior LM, da Costa AJ, Monteiro CMO, Lopes WDZ. 2025. Resistance of *Rhipicephalus microplus* to different acaricides in tropical climates: are the laboratory and field results related? *Veterinary Parasitology* 336:110441. doi: 10.1016/j.vetpar.2025.110441
- Salman M, Abbas RZ, Israr M, Abbas A, Mehmood K, Khan MK, Sindhu ZUD, Hussain R, Saleemi MK, Shah S. 2020. Repellent and acaricidal activity of essential oils and their components against *Rhipicephalus* ticks in cattle. *Veterinary Parasitology* 283:109178. doi: 10.1016/j.vetpar.2020.109178
- Sanon HO, Savadogo M, Tamboura HH, Kanwé BA. 2014. Caractérisation des systèmes de production et des ressources fourragères dans un terroir test de la zone soudanienne du Burkina Faso. *VertigO - la revue électronique en sciences de l'environnement* 14(2). doi: 10.4000/vertigo.15171
- Sanou L, Savadogo WA, Diawara S, Savadogo P. 2023. Perceptions locales des perturbations écologiques sur la dynamique de la végétation du Parc National du W, Burkina Faso. *Revue Écosystèmes et Paysages* 3(2):1-14. doi: 10.59384/recopays.tg3204
- Shahzad S, Akinsulie OC, Idris I, Devnath P, Ajagbe D, Aliyu VA, Oladoye MJ, Ukauwa C, Ugwu CE, Ajulo S, Oyeleye BS, Ikele CG, Shelly SY. 2025. Ticks and tick-borne diseases in Global South countries: impact and implications of environmental changes. *Frontiers in Tropical Diseases*.6:1597236. doi: 10.3389/fitd.2025.1597236

- Shakya M, Singh M, Gautam K, Jamra S, Agrawal V, Jayraw AK, Jatav GP, Gupta SK, Kumar S. 2024. Assessment of Antitick and Repellent Activity of *Azadirachta indica* oil against Adults and Larvae Stages of *Rhipicephalus microplus*. *Psyche: A Journal of Entomology* 2224036 8 pages. doi: 10.1155/2024/2224036
- Shyma KP, Gupta JP, Ghosh S, Patel KK, Singh V. 2014. Acaricidal effect of herbal extracts against cattle tick *Rhipicephalus (Boophilus) microplus* using in vitro studies. *Parasitology Research* 113(5):1919-1926. doi: 10.1007/s00436-014-3839-3
- Sidiki BHEA, Fidèle TD, Sawadogo A, Kaboré A, Hamani M. 2025. Tick fauna (Acari: Ixodidae) of domestic ruminants in the Hauts-Bassins region, Burkina Faso: a prevalence and seasonal survey. *World's Veterinary Journal* 15(3):720-733. doi: 10.54203/scil.2025.wvj73
- Somda NR, Ilboudo D. 2019. Pastoral livestock farming in Burkina Faso: a sector driving economic growth and hope for improved well-being. *Bulletin de l'Office International des Épizooties*. 2019;2:105-117. <https://bulletin.woah.org/?panorama=praps-burkinafaso>.
- Szabó MPJ, Martins MM, de Castro MB, Pacheco RC, Tolesano-Pascoli GV, Dos Santos KT, Martins TF, de Souza LGA, May-Junior JA, Yokosawa J, Labruna MB. 2018. Ticks (Acari: Ixodidae) in the Serra da Canastra National Park in Minas Gerais, Brazil: species, abundance, ecological and seasonal aspects with notes on rickettsial infection. *Experimental and Applied Acarology* 76(3):381-397. doi: 10.1007/s10493-018-0300-9
- Tamboura HH, Sawadogo L, Kaboré H, Yaméogo SM. 1998. Ethnomédecine vétérinaire et pharmacopée traditionnelle dans le plateau central du Burkina Faso: cas de la province du Passoré. *Biotechnologie, Agronomie, Société et Environnement* 2(3):181-191. <https://popups.uliege.be/1780-4507/index.php?id=15886>
- Tamboura HH. 2006. Biological activity of aqueous extracts of *Holarrhena floribunda* (G. Don) Durand & Schinz (Apocynaceae): study of male hormonal-type effects in rats. [PhD thesis]. Ouagadougou (Burkina Faso): Université de Ouagadougou. 183 p. <https://ethnopharmacologia.org/bibliotheque-ethnopharmacologie/activite-biologique-des-extraits-aqueux-de-holarrhena-floribunda-g-don-durand-schinz-apocynaceae-etude-des-effets-de-type-hormone-male-chez-le-rat/>
- Tianhoun DF, Meda NR, Konate A, Kaboré A, Tamboura HH, Belem AMG. 2023. Ethnoveterinary study on livestock practices and the use of medicinal plants against gastrointestinal parasites of small ruminants in the BWA community in Burkina Faso. *International Journal of Veterinary Sciences and Animal Husbandry* 8(4):100-107. doi: 10.22271/veterinary.2023.v8.i4b.575
- Traoré CADG, Delay E, Diop D, Bah A. 2024. Agent-based model for analyzing the impact of movement factors of sahelian transhumant herds. *Human-Centric and Intelligent Systems* 4(3):363-381. doi: 10.1007/s44230-024-00075-1
- Traoré L, Ouédraogo A, Thiombiano A. 2012. To what extent do protected areas determine the conservation of native flora? A case study in the Sudanian zone of Burkina Faso. *ISRN Botany* 2012:168196 doi: 10.5402/2012/168196
- Ullah H, Rehman AU, Ullah N, Tariq M, Farooq U, Bibi S, Khan A, Jamil M, Ramzan F, Ayub M. 2023. Biomorphic study of *Rhipicephalus sanguineus* (Acari: Ixodidae) under laboratory conditions. *Journal of Bioresource Management* 10(1):1-7. <https://corescholar.libraries.wright.edu/jbm/vol10/iss1/1/>
- Wadhvani BD, Mali D, Vyas P, Nair R, Khandelwal PA. 2021. A review on phytochemical constituents and pharmacological potential of *Calotropis procera*. *RSC Advances* 11(57):35854-35878. doi: 10.1039/d1ra06703f
- Walker AR, Bouattour A, Camicas JL, Estrada-Peña A, Horak IG, Latif AA, Pegram RG, Preston PM. 2003. Ticks of domestic animals in Africa: a guide to identification of species. Edinburgh: Bioscience Reports; 221 p. <http://www.alanwalker.com/index.php/guidebooks/ticks/>
- Wanzala W, Hassanali A, Mukabana WR, Takken W. 2018. Essential oils of indigenous plants protect livestock from infestations of *Rhipicephalus appendiculatus* and other tick species in natural pastures. *Journal of Pest Science* 91(1):395-404. doi: 10.1007/s10340-017-0853-0
- World Organisation for Animal Health (WOAH). 2023. Terrestrial Animal Health Code. Chapter 6.10. Responsible and prudent use of antimicrobial agents in veterinary medicine. <https://www.woah.org>
- Yarga HP, Ouédraogo L, Kiema A, Ouédraogo S. 2022. Dynamique d'occupation des terres de la zone pastorale de Sidéradougou : un front agricole très actif qui affecte la disponibilité des ressources fourragères. *Revue de Géographie de l'Université de Ouagadougou* 11(2):85-102. https://revuegeographieouaga.com/wp-content/uploads/2023/07/05_RGOL_324_V3_accepte_ok_MP_C.pdf
- Yessinou RE, Cazan CD, Bonnet SI, Farougou S, and Mihalca AD 2022. Geographical distribution of hard ticks (Acari: Ixodidae) and tick-host associations in Benin, Burkina-Faso, Ivory Coast and Togo. *Acta Tropica* 232: 106510. doi: 10.1016/j.actatropica.2022.106510

- Zannou OM, Ouedraogo AS, Biguezoton AS, Kouassi PY, Belem A, Lempereur L, Yao KP, Abatih E, Zoungrana S, Lenaert M, Toe P, Farougou S, Saegerman C. 2021. First tick and tick damage perception survey among sedentary and transhumant pastoralists in Burkina Faso and Benin. *Veterinary Medicine and Science* 7(4):1216-1229. doi: 10.1002/vms3.414
- Zerbo I, Balima LH, Sanou CL, Thiombiano A. 2025. Diversity of plants used in traditional veterinary medicine in Central-Eastern Burkina Faso. *Ethnobotany Research and Applications* 30:1-30. doi: 10.32859/era.30.2.1-30
- Zerbo P, Millogo-Rasolodimby J, Nacoulma-Ouédraogo OG, Van Damme P. 2011. Medicinal plants and medical practices in Burkina Faso: the case of the Sanan. *Bois et Forêts des Tropiques* 307:41-53. doi: 10.19182/bft2011.307.a20481
- Zhang W, Pan X, Fu J, Cheng W, Lin H, Zhang W and Huang Z. 2024. Phytochemicals derived from *Nicotiana tabacum* L. plant and their pharmaceutical potential. *Frontiers in Pharmacology* 15:1372456. doi: 10.3389/fphar.2024.1372456