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Breeder's knowledge on ticks and tick-borne diseases and management strategies in Menoua division (Western region of Cameroon)

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Abstract
Cattle are challenged by numerous tick species in the Western highlands of Cameroon. Consequently, several tick-borne diseases (TBDs) are known to be endemic in this region. To face this situation, farmers mainly resort to the use of chemical acaricides. But to date, no study has focused its attention on the evaluation of tick control methods in this area. Therefore, the present study was designed to assess the knowledge and practices of breeders against ticks and TBDs in Menoua Division. A descriptive cross-sectional survey was conducted in 4 Sub-divisions of Menoua Division. Breeders who consented to the study were interviewed using semi structured questionnaires. Interviews were conducted in French, English or local language (Fulfulde). The questionnaire was made of 25 questions sectioned into; (i) farmer's knowledge on ticks and TBDs, (ii) treatment practices of infested animals and, (iii) the estimated amount spent for vector control of ticks. All the breeders interviewed had a good knowledge on ticks and the main direct effects they inflict on animals. However, only 7% of respondents associated ticks to the main TBDs. Manual removal and chemical control using synthetic acaricides (usually pyrethrinoids) were the main methods of tick control. Despite the multiplication of treatments (on average 1/week), their effectiveness was not perceived by almost all breeders (82.0%; n = 82) who complained of treatment failures, regardless of the sites and molecules used. In addition, each farm spent on average 8, 521 ± 2, 968 CFAF (US$16.08 ± 5.6)/month for vector control. That is a cumulative amount of CFAF 588, 000 (US$1, 109.45)/month and CFAF 7, 056, 000 FCFA (US $ 13, 313.49)/year for all the farms visited. The lack of pasture (OR = 43.5; $p<0.001$), ignorance of breeders (OR = 16; p = 0.0009), the non-support of breeders by competent services of MINEPIA (OR = 12; p = 0.0006) and the phenomenon of transhumance (OR = 230; p = 0.0002) constituted the main risk factors predisposing cattle to infestations. This study indicated that, despite the good knowledge of breeders on ticks, their main challenge lies in treatment failures within the framework of vector control. It is therefore urgent that the competent services deploy in the farms to support them in the management of ticks and TBDs.

Keywords: tick, TBDs, knowledge, practices, breeders, acaricides, Menoua division

Introduction
Cattle are regarded as the main source of animal proteins and as an important source of revenue for the rural population of Cameroon (FAO, 2008). According to the National Institute of Statistics (2017), the cattle population has recently been estimated to about 6.5 million heads. They contribute significantly to milk, hoof, bones, blood, hides, skin production and to the socio-cultural values which account for about 54% of the capital values of the cameroonian livestock industry (MINEPIA, 2011; Sam-Wobo *et al*., 2016).
The Western highlands of Cameroon represents the third cattle breeding area in the country with a herd estimated at 1, 989, 200 heads (MINEPIA, 2011). Here, the majority of cattle, being mostly of indigenous species (*Bos indicus*), are kept according to the traditional pastoral management of the Fulani herdsmen (Kouam-Simo, 2020). This extensive grazing system predisposes cattle to numerous tick species, especially during the wet season when the tick burdens reach the highest abundance (Silatsa *et al*., 2019b; Lontsi-Demano *et al*., 2020).

Indeed, it has been shown that ticks affect production of over 80% of the world's cattle population (De-Castro *et al*., 1997; Gondard *et al*., 2017). Their direct effects on cattle are anaemia, irritation, inflammation, paralysis, allergies, abscesses, hypersensitivity, immuno-suppression and skin deterioration at the biting site which often leads to reduction in weight gain and milk yield (Mans *et al*., 2004; Laamri *et al*., 2012). More importantly, ticks can also transmit several pathogens as they are vectors of various tick-borne diseases (TBDs) (De la Fuente *et al*., 2017).

Tick-borne haemoparasites have been shown to cause anaemia, jaundice, anorexia, emaciation, infertility, reduction of productive potential (such as reduced birthrate, decreased milk yield, decreased growth rate, weight loss in young growing animal, late maturity of slaughter stock and decreased work efficiency of draft animals) and even death (Salih *et al*., 2015; Ukwueze and Kalu, 2015). According to Lontsi-Demano *et al*. (2021), several TBDs are known to be endemic in cattle of Menoua Division, including anaplasmosis (by *Anaplasma marginale*), babesiosis (by *Babesia bigemina* and *Babesia bovis*) and theileriosis (by *Theileria spp*). The prevalence and incidence of these diseases would have increased with the recent introduction of the invasive and multiresistant tick species of livestock (*Rhipicephalus microplus*) in the meridional part of Cameroon due to cross-border transhumance (Kamani *et al*., 2017; Motta *et al*., 2017; Silatsa *et al*., 2019a). Moreover, TBDs display with high morbidity and mortality in exotic cattle (i.e. *Bos taurus*) when introduced in an area for crossbreeding purposes, thus representing a major limitation to the improvement of cattle production (Lorusso *et al*., 2016).

A current global estimate of economic losses from ticks and TBDs is approximately US$ 20-30 billion per annum (Lew-Tabor and Rodriguez Valle, 2016). In a study conducted in 1982 at the Wakwa research station situated in the principal cattle rearing region of Cameroon (Adamawa region), more than 63% of animal mortality was attributed to TBDs (Achukwi *et al*., 2001).

The fact that there is no available vaccine against ticks and TBDs, vector control remains the main prevention approach. Breeders in Menoua Division resort to the use of chemical acaricides and manual removal. However, ticks become resistant to acaricides and manual removal is more fastidious regarding high level of cattle infestation. Some studies have been carried out in Menoua Division on the inventory of tick species and the methods used for their control (Tedonkeng *et al*., 2005; Kouam *et al*., 2015; Payne *et al*., 2017). However, none has focused its attention on evaluating breeder's knowledge on ticks, TBDs and operational control methods applied in the field. There has been paucity of information in this sense, although the ixodidian parasitic fauna of cattle in Menoua Division is abundant and diverse, made up of 14 species. Among these, we note the recent introduction of the invasive cattle tick *R. microplus* which has become the most abundant to the detriment of native species (Lontsi-Demano *et al*., 2020), and poses a serious threat to livestock. Indeed, in addition to being a vector of several TBDs, this tick species seems to be more resistant to the different classes of acaricides available on the market which can no longer protect the animals (Adehan *et al*., 2016; Abah *et al*., 2017). Therefore, the present study was designed to assess the knowledge and practices of farmers towards ticks and TBDs in view to highlight the risk factors predisposing cattle to infestations in Menoua Division.

Materials and Methods

Study site

This study was carried out in Menoua Division (5°27'0" Latitude North and 10°4'0" Longitude East), located in the Western highlands of Cameroon. With a population size of about 372, 244 inhabitants, this zone covers a surface area of 1, 380 km^2, leading to a population density of 270 inhabitants/km^2 (BURCREP, 2010). Menoua Division comprises six Sub-divisions out of which four were selected for this study based on the cattle population size, frequency and cattle supply points namely: Dschang, Fokoue, Fongo-Tongo and Nkong-Ni (Figure 1). The average altitude of Menoua Division is 1, 382 m. It is limited to the North by the Mifi Division, to the South by the Moungo Divsion and the Nkam River, to the East by the Haut-Nkam Division and to the West by the Bamboutos mountain range.

This Division is a peculiar zone as far as topography and climate are concerned. It is located in a savannah landscape within the Guineo-Congolese bioclimatic domain, on the Cameroon Volcanic Line. Two seasons can be distinguished as follows: the rainy season (March to October) and the dry season (November to February) (Olivry, 1986). Annual precipitation ranges from 1, 200 mm to 1, 800 mm. The maximum precipitation is in August and September. The average annual temperature is 20.2 °C and fluctuates during the day between 13.4 °C and 27.5 °C. The daily humidity varies from 33 to 98% (Tazen *et al*., 2013). These characteristics create favorable conditions for maintaining a high density of parasitic disease vectors. The flora is made of forest galleries localized especially in sacred groves of the traditional chiefdoms. The forests also consist of eucalyptus, pine, cypress, oil palm, etc. (Tazen *et al*., 2013). The Menoua cattle herd is made up of approximately 9, 256 heads DDEPIA-ME (2019). Agriculture and animal husbandry are the main economic activities; no industrial activity is observed in the area (Tazen, 2009).

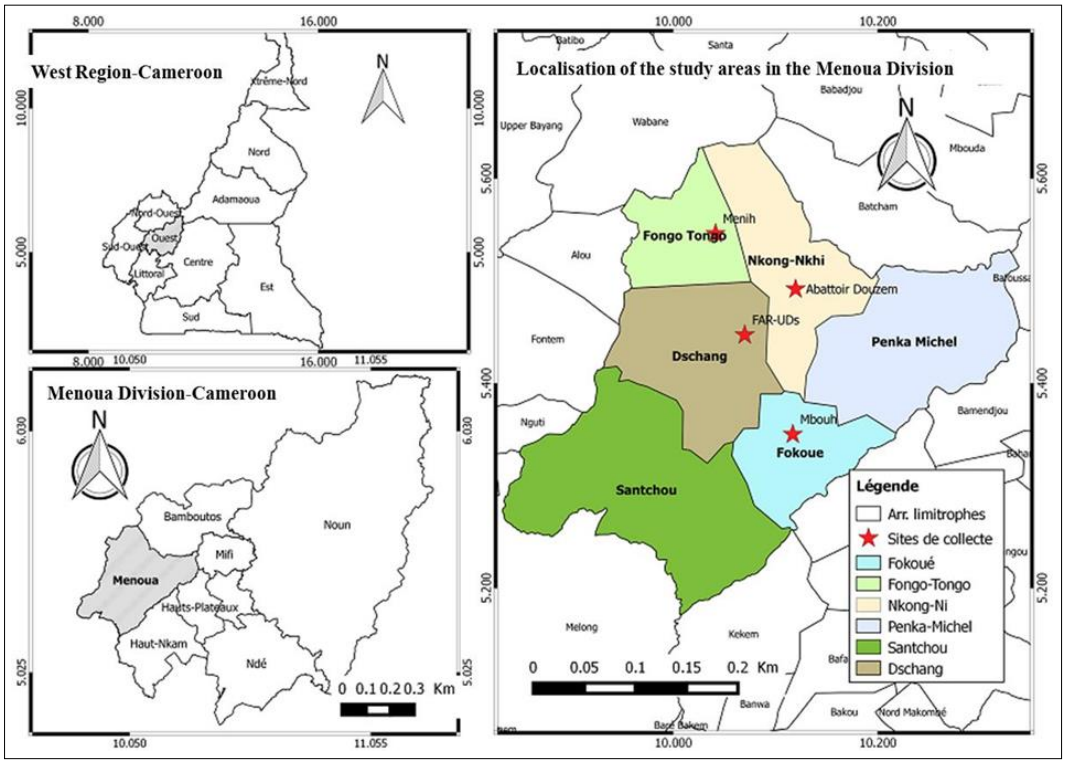


Fig 1: Map of Menoua Division showing the sampling sites

Study design

This study was a descriptive cross-sectional survey to assess farmer's knowledge and practices on ticks and the prevention of tick-borne diseases in Menoua Division. A questionnaire to assess herd manager's (shepherds/owners) basic knowledge on ticks, their effects on animals, the main control methods used against these ectoparasites, the associated pathologies they cause and finally the financial costs incurred to implement these control programs. Before the beginning of the survey, interviewers were trained on how to use the questionnaire and on methods to approach respondents in order to obtain their consents. Interviewers were three students with at least the Master level. The survey was conducted between November 2017 to January 2018. Farmers who gave their consents to participate in the study were interviewed and the interviews were undertaken either in French, in English, in local language (Fulfulde) to accommodate each individual and even in private to avoid influence from other people. A questionnaire consisting of 25 questions was used to assess: (i) socio-demographic characteristics of participants (age, gender, level of education); (ii) knowledge about ticks and the diseases they transmit; (iii) the origin and use of acaricide products for the treatment of animals and (iv) the financial cost for the management of ticks and associated pathologies in cattle. Only farmers whose consent forms were approved were included in the study.

Data analysis

Data recorded were registered in the Microsoft Excel database. Data cleaning was performed to check for inconsistencies in data entry and responses. Data were analyzed using SPSS version 22 statistical software package. Means, frequencies and proportions were used for descriptive analysis. Comparison between means was assessed using ANOVA. To identify the risk factors that predispose cattle raised in Menoua Division to tick infestations and therefore to the pathologies they transmit, the odds ratios (OR) as well as their 95% confidence intervals (95% CI) were computed using MedCalc v14.8.1 software. Statistical significance was set at $p<0.05$.

Ethical approval

This study has been approved by the Institutional Animal Care and Use Committee (IACUC) N°: 2017/187/UB/FS/HOD/ZAP of the University of Buea. Authorizations to conduct trips in animal farms and slaughterhouses in order to interview respondents were obtained from the Regional Delegate of the West region and the Divisional Delegate of Livestock, Fisheries and Animal Industries of Menoua Division. The study purpose was also explained to shepherds and herds owners then their free consents to participate were obtained. As compensation for their collaboration, advices were prodigated.

Results

During the field trips to the animal farms of Fokoue, Fongo-Tongo, Dschang sub-divisions and at the slaughterhouse of Nkong-Ni, a total of 100 shepherds out of the 129 (77.52%) in Menoua Division were questioned in order to assess their level of knowledge on ticks, the pathologies they transmit to livestock and the control strategies used to combat them. It emerges from this survey that the shepherds were all males, aged 18 to 52 years with an average age of 35.65 ± 15.01. Majority were illiterates (53%), and 65.0 had at least 15 years of experience in the activity (Table 1).

Table 1: Sociodemographic characteristics of the shepherds in Menoua division

Items	Characteristics	N	Frequency (%)
Gender	Male	75	100
	Female	0	0
Educational level	Illiterate	53	53.0
	Primary level	24	24.0
	Secondary level	23	23.0
	University level	0	0.0
Age (years)	[11-20]	34	34.0
	[21-30]	34	34.0
	[31-40]	16	16.0
	[41 and more[	16	16.0
Years of experience	1-5	12	12.0
	6-10	17	17.0
	11-15	6	06.0
	16 and more	65	65.0

Herd information

The shepherds all revealed that the animals feed much better in the rainy season (100%) unlike the dry season. Therefore, during this unfavorable period, herders of the Nkong-Ni (100%) and Dschang (100%) sub-divisions opted for the expansion of the grazing area while those of Fokoue (100%) and the majority of Shepherds of Fongo-Tongo (67%) preferred to lead their animals for transhumance in the Santchou sub-division. In addition, the small proportion (33%) of pastoralists who have chosen to keep their herds on farms in the Fongo-Tongo sub-division also expanded the grazing area by including cooking salt in the diet of animals (Figure 2).

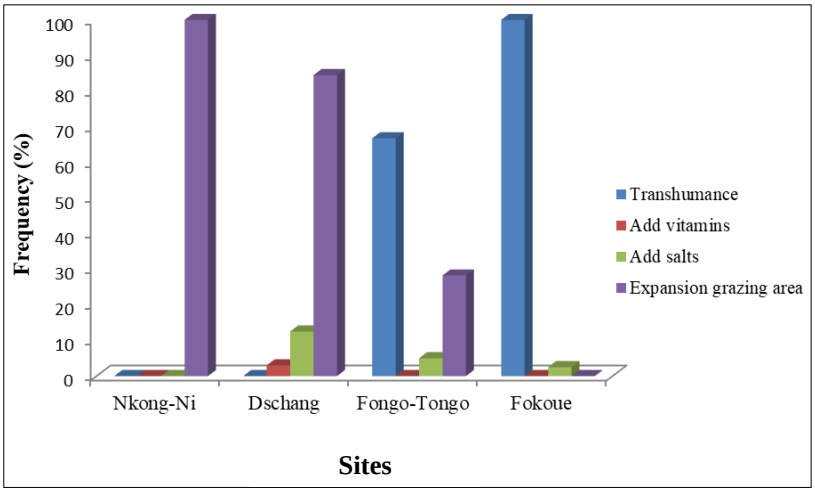


Fig 2: Alternative solutions for cattle nutrition during the adverse period

General knowledge on ticks and tick-borne diseases of cattle

All the breeders interviewed in Menoua Division had knowledge about ticks. However, the best-known genera were *Amblyomma* (50.0%) and *Boophilus* (48.0%). Very few knew about the genus *Rhipicephalus* (2.0%). Moreover, the genera *Hyalomma*, *Ixodes* and *Haemaphysalis* were completely unknown to the shepherds. Regarding the effects of these ectoparasites on animals, most of the shepherds said blood spoliation (49.0%) and skin lesions (45.0%) are the main direct damages resulting from the attachment of the parasite on its host. However, 24% of respondents had no knowledge on the pathogenic role of ticks on their livestock even though most (69.0%) only knew about dermaphilosis (Table 2). In addition, almost all of them had no knowledge about how these pathogens are transmitted to their animals. These breeders claimed that the veterinary services visit their farm on average once a year for vaccination sessions. However, these vaccinations do not include in their agenda the fight against ticks and the pathologies they transmit. Rather, the vaccination sessions aim is to prevent animals against certain livestock diseases of great priority.

Table 2: Knowledge on ticks and their effects on cattle

Items	Characteristics	N	Frequency (%)
Description of genus	*Amblyomma*	50	50.0
	Rhipicephalus	2	02.0
	Boophilus	48	48.0
	Hyalomma	0	0.0
	Ixodes	0	0.0
	Haemaphysalis	0	0.0
	None	0	0.0
Direct effects	Blood spoliation	49	49.0

	Skin lesions	45	45.0
	Irritations	3	03.0
	Toxic actions	0	0.0
	None	3	03.0
Indirect effects	Anaplasmosis	3	03.0
	Dermatophilosis	69	69.0
	Babesiosis	0	0.0
	Theileriosis	4	04.0
	Cowdriosis	0	0.0
	None	24	24.0

Tick control methods used by breeders

In the absence of MINEPIA implementation campaigns to control ticks and the diseases they transmit to livestock in Menoua Division, herders have opted for vector control. Thus, three main methods of controlling ticks were used by breeders in our study area. These included the spraying of miticides, manual tagging and pour-on formulation. The first two methods were mainly used by the Fongo-Tongo herders. In Fokoue, the breeders used all three methods alternately. In Dschang, it was rather the spray and pour-on formulation that were used unlike Nkong-Ni where no treatment was applied (Figure 3). However, it is important to note that the footbath, the drug bath and herbal medicine have not been used by the breeders of Menoua Division. Despite the fact that most of the shepherds treated all the animals in their flocks in case of an infestation, they did not place any concern or importance on the treatment of the pasture.

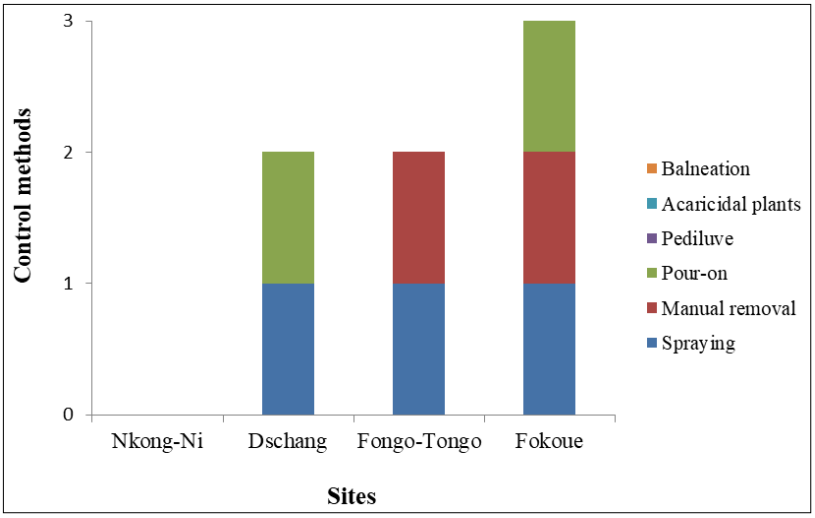
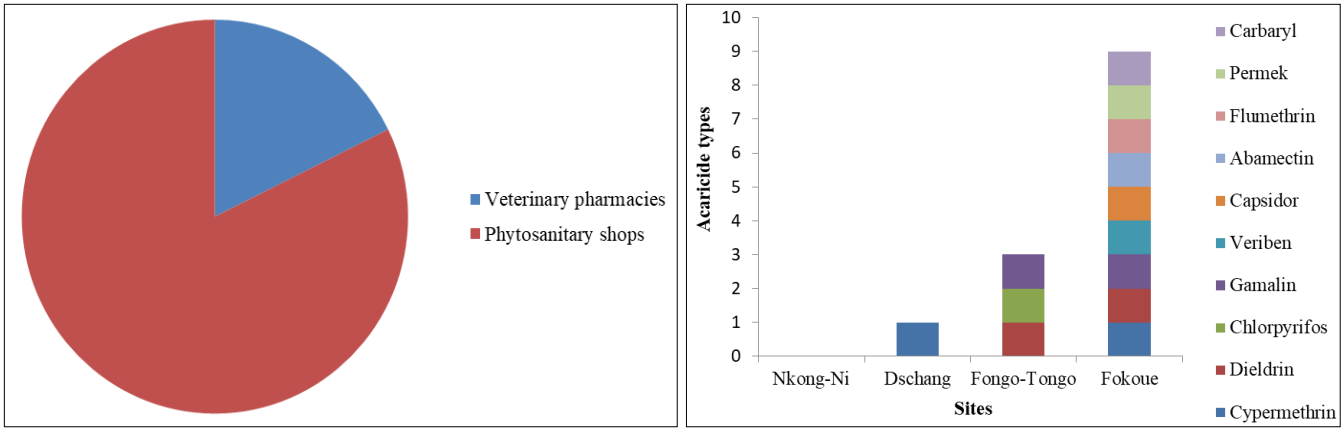


Fig 3: Main tick control methods used by breeders

Origin of acaricide products used for the treatment of animals

Breeders of Menoua Division obtained their acaricides mainly from phytosanitary shops (82.0%) while very few obtained their supplies from veterinary pharmacies (18.0%) (Figure 4A). However, the types of acaricide selected by breeders for treatment of animals varied from site to another. Indeed, according to Figure 4B, it can be seen that the farmers of Fokoue used a wide range of acaricides (9 types) compared to those of Fongo-Tongo (3 types) and Dschang (only 1 type). In Nkong-Ni, on the other hand, no acaricide treatment was carried out. It was also noticed that the most used acaricides in Menoua Division belonged to the class of Pyrethroids.



A **B**

Fig 4: Supply points and types of acaricides used by farmers

Evaluation of acaricide treatments carried out by breeders in Menoua division

The frequencies of treatments carried out by breeders in Menoua Division are presented in Figure 5A. It emerges that the majority of breeders (75%) carried out acaricide treatments on animals two to three times a month despite manual pricking which was carried out weekly in the Fongo-Tongo and Fokoue sites. Although many efforts are being made by actors in the beef industry in this area to fight against ticks, the duration of animal protection is not consistent with their expectations. Indeed, 68.0% of breeders affirmed that the persistence of the acaricides used lasts for two weeks while only 3% of respondents found that the acaricide used for the treatment is able to protect their animals beyond one month (Figure 5B). Regarding the cost of treatment, everyone declared that the price of acaricides on the market is not affordable to set up real strategies for controlling tick populations. From Figure 5C, it can be noticed that the average monthly expenses for the treatment of animals are significantly higher in Dschang (12, 100 ± 2, 606 CFAF), followed by Fokoue (9, 545 ± 2, 699 CFAF) and finally Fongo-Tongo (7, 500 ± 1129 CFAF) (p<0.001). In addition, it is important to note that each farm pays on average 8521 ± 2968 CFAF/month for vector control against ticks. That is to say a cumulative total of 588, 000 FCFA for all the farms visited. By trying to conjecture these economic losses over the year, they amount to CFAF 7, 056, 000. Despite the efforts made, and this regardless of the sites and the nature of the acaricides used, all the breeders were confronted to failures in the treatment of animals. It is precisely for this reason that 82.0% of respondents said they were not satisfied with the plethora of molecules they use to fight against ticks (Figure 5D).

It is however useful to recall that the acaricide treatments were carried out only on animals. No farm processed pasture and paddocks.

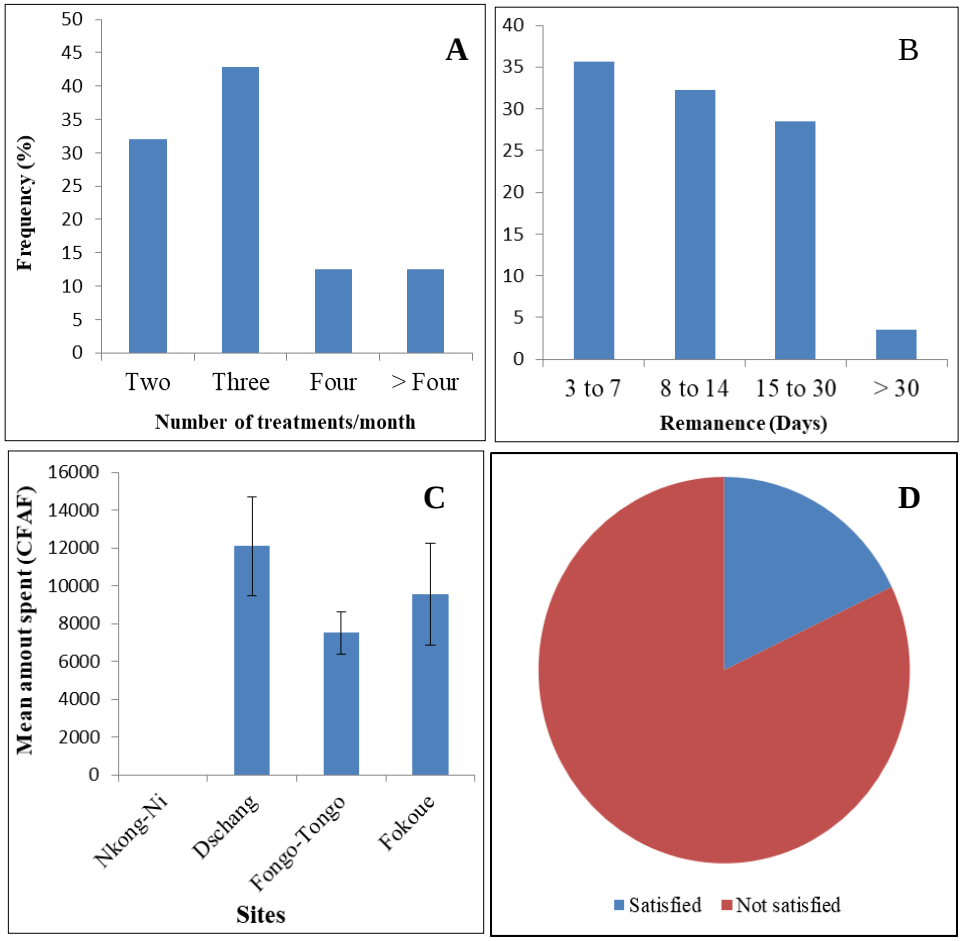


Fig 5: Evaluation of the control by chemical acaricides used by breeders: A = Frequency of treatment; B = Persistence of acaricides; C = Cost of acaricide treatments; D = Level of satisfaction of breeders

Risk factors predisposing cattle to tick infestation

Table 3 presents the main factors favoring the infestations of cattle by ticks in Menoua Division. It emerges that the lack of pasture, ignorance of breeders, the non-support of breeders by the competent services of MINEPIA and the transhumance of breeders with their herds during the dry season constituted the main risk factors predisposing the animals to infestations (p<0.05). Indeed, animals that deploy more energy to search for pasture over long distances during the day are significantly more likely (OR = 43.5; p<0.001) to be infested, unlike those that have it on nearby pastures. The behavior of breeders also favors animal infestations. Indeed, those who did not know the role of ticks in disease transmission had more infested animals (OR = 16; p = 0.0009) than the breeders who knew about the vectorial role of ticks. Likewise, herds that were monitored by a veterinarian or animal health professional were less infested, unlike herds led by shepherds who had not received any training in this regard (OR = 12; p = 0.0006). In addition, the main risk factor predisposing cattle to tick infestations in this study area is transhumance. In fact, animals transhuming during the great dry season were the most affected by ticks (OR = 230; p = 0.0002) unlike those who remained in the pastures.

Table 3: Risk factors predisposing cattle to tick infestations

Items	Modalities	N	Infested	OR (95% CI)	p-value
Pasture	Present	10	04	1	
	Absent	90	87	43.5 (7.86-240.59)	<0.0001
Ignorance of breeders	No	26	18	1[a]	
	Yes	74	72	16 (1, 58-161, 17)	0.0009
Accompaniment	Yes	10	4	1[a]	
	No	90	80	12 (2.88-49.93)	0.0006
Pasture treatment	Yes	0	0	1[a]	
	No	100	84	5.1 (0.09-267.39)	0.42
Transhumance	No	42	14	1[a]	
	Yes	58	58	229.9 (13.24-3993.82)	0.0002
Treating staff	Veterinary	2	1	1[a]	
	Breeder	48	40	5 (0, 28-88, 53)	0.27
Acaricide remanence	Strong	4	2	1[a]	
	Medium	28	24	6 (0.65-55.66)	0.11
	Weak	68	60	7.5 (0.92-60.89)	0.05

Legend: OR (95% CI): Odd Ratio (95% Confidence Interval); [a]Reference category

Discussion

The study main objective was to assess the knowledge and management strategies of breeders with regards to ticks and TBDs in Menoua Division. The practice of breeding in Menoua Division is done mainly by men of the Bororo ethnic group, aged between 18 to 52 years (with an average age of 35.65 ± 15.01), with a poor level of education. Most of them have been doing this job since their early childhood. This could be due to the fact that breeding for the latter is considered a prestigious activity through which social consideration is acquired. Indeed, Saeed *et al*. (2015) believe that herding among the Fulani is a traditional practice that constitutes the main means of subsistence for rural populations. According to Lesse (2009), the youngest are introduced to this activity from early childhood, which allows them to take over from the parents to increase the size of the family herd which will be distributed to future generations and so on.

All respondents had knowledge about ticks (mainly the genera *Amblyomma* and *Boophilus*) and the direct effects they inflict on their hosts. However, the involvement of ticks in the transmission of pathogens is still poorly understood. This is due to the fact that ticks are considered today as the main obstacle to the development of animal husbandry in most pastoralist countries with regard to the register of vector-borne diseases. Several studies have shown that ticks affect 80% of the world's cattle population (De-Castro *et al*., 1997; Gondard *et al*., 2017) causing economic losses estimated at approximately US$ 20-30 billion per year (Lew-Tabor and Rodriguez-Valle, 2016). Lack of knowledge of the main TBDs to the detriment of the direct effects is justified by the low level of education of breeders (mostly illiterate) and the lack of support for breeders by the competent services of MINEPIA on the vectorial role of ticks through educational talks and training seminars.

To control ticks in Menoua Division, herders resort to manual removal and the use of chemical acaricides. However, the tedious nature of manual removal has led the majority of breeders to opt more for acaricide control even if on some farms the shepherds are recruited to manually remove ticks from animals on a weekly basis (generally for ticks of the genus *Amblyomma*). Indeed, these breeders perceive this tick as the one that inflicts the most damage on cattle through abscesses, wounds which can secondarily be infected by bacteria, deterioration of leather and skin and more seriously its involvement in dermatophilosis (Mans *et al*., 2004; Laamri *et al*., 2012). Despite the multiplication of treatments (on average once/week), the average duration of animal protection does not exceed one week, regardless of the nature of acaricide used. Three main reasons can be put forward to justify this situation: almost all farmers obtain acaricides from phytosanitary shops and itinerant traders, sometimes from counterfeit products, instead of veterinary pharmacies (Têko-Agbo *et al*., 2003; Abiola, 2005); the misuse of acaricidal products by breeders who do not comply with the manufacturer's instructions for use (Bouyer, 2009; Vougat-Ngom *et al*., 2017) and the invasion of farms by the invasive and multiresistant cattle tick *R. microplus* that was accidentally introduced in the western highlands (Silatsa *et al*., 2019; Lontsi-Demano *et al*., 2020). Since its introduction surely from Nigeria following cattle trade (Kamani *et al*., 2017; Motta *et al*., 2017), this tick has invaded farms to the detriment of native species. With regards to *R. microplus* in all countries recently invaded by this tick, it quickly emerged as the species associated with the greatest economic losses in cattle breeding (Frisch, 1999) for 3 main reasons: the very weak immune response of certain taurine breeds to this tick; its vectorial competence for virulent pathogens in livestock (*Babesia bigemina*, *B. bovis* and *Anaplasma marginale*) (Guerrero *et al*., 2006) and its ability to rapidly develop resistance against acaricides (Li *et al*., 2007; Lynen *et al*., 2008; Madder *et al*., 2011; Rodriguez-Vivas *et al*., 2011).

Respondents claim that animals feed much better in the rainy season rather than in the dry season. To overcome this effect of drought (between the months of November to February) which causes the scarcity of pastures and dryness of water bodies to supply the animals, the breeders migrate with their herds in the flood plain of Santchou which is crossed by several rivers, the most important of which are; Black Ouata, Nkam and Menoua. Menoua Division is also a large agricultural basin which supplies several large towns in Cameroon and some CEMAC countries (Gabon, Equatorial Guinea and Central African Republic) with tubers, fruits and vegetables: thus, this creates permanent agro-pastoral conflicts (Ahoudji, 2009) and makes it impossible to these breeders to set up fodder fields to feed the animals. The practice of transhumance is not always without consequences. Indeed, during transhumance, particularly while traveling towards grazing areas, cattle herds tend to be frequently in contact with other herds and wildlife, compared to when they are sedentary at grazing locations. Despite this variability in contact rates, the interactions between cattle herds, both during traveling and at grazing areas, were reported to have relatively short durations (<1h). Nevertheless, a short contact

time, particularly if at close proximity, could be sufficient for the transmission of highly infectious diseases, especially during the peak of the infectious periods (Sellers and Parker, 1969; Mardones *et al*., 2010). Although infectious diseases are the major animal health problem for the livestock sector in Cameroon (Pamo, 2008; Awa and Achukwi, 2010), the most commonly reported causes of death for cattle during transhumance included accidents and plant intoxications.

The lack of pasture, the ignorance of breeders, the non-support of breeders by the competent services of MINEPIA and the transhumance of breeders and their herds during the dry season are the main risk factors predisposing animals to infestations. In fact, the lack of pasture leads herders to adopt alternative solutions such as transhumance and nomadism. This can be explained by the absence of grazing areas developed by the competent services of MINEPIA and the impossibility for breeders to set up fodder fields. Since the Menoua Division has a high population density with a strong agricultural vocation, land disputes between farmers and herders are very intense in this geographical area. The majority of herders and their herds are therefore forced to move to potentially at-risk areas in search of pasture. It is during these movements that they come into contact with ticks lying in ambush in search of a host. This result corroborates that of Motta *et al*. (2017) who found that it is during the movements of pastoralists with their herds in search of pastures and cattle markets that animals are more exposed to infestations. The non-support of breeders by the veterinary services through training sessions constitute risk factors insofar as, due to the high cost of acaricide products and drugs, breeders are unable to maintain a steady rate of treatment for effective control. According to Jorgensen *et al*. (1992), husbandry methods are among the factors most influencing the prevalence of bovine tick-borne diseases. Extensive production systems with low inputs can in no way support the purchase of acaricides necessary to implement real tick control programs (Achukwi *et al*., 2001). In addition, the lack of advice from veterinarians who are specialists in the care and monitoring of animals is a serious handicap. The non-treatment of pasture by sedentary breeders adopting food supplements as an alternative nutrition solution during the unfavorable period should not be neglected since the immature stages are not combated in the vegetation which is nevertheless a reservoir for ticks (Frebling, 2006).

Conclusion

This study reveals that breeders of Menoua Division have a good knowledge on ticks. However, they are still very ignorant of the vectorial role of ticks in the transmission of TBDs. Consequently, the competent services of MINEPIA must build these breeders through training seminars and educational talks on the dangers that these ectoparasites represent for their herds. Vector control strategies applied by breeders and directed against ticks are becoming increasingly ineffective in Menoua Division. These treatment failures are believed to be associated with the accidental introduction of the invasive and multiresistant cattle tick *R. microplus* on farms and which has established itself as the most abundant species to the detriment of native species. It becomes imperative for decision-makers to take urgent measures to find effective and lasting solutions to this problem in order to save the cattle industry in Menoua Division as a whole.

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