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(RESEARCH ARTICLE)

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Impact of ecoclimatic zone variation on the prevalence of *Babesia bovis* and Babesia bigemina in Mali

Modibo DIAKITE [1,*], Brahima SACKO [1,2] and Amadou SERY [1]

[1] *Diagnostic and Research Service, Central Veterinary Laboratory, Bamako, Mali.*
[2] *Department of Biology, Faculty of Science and Technology, University of Science, Technology and Technology, Bamako, Mali.*

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Abstract

The study took place from June 2019 to September 2020 in the Sudanoguinean, Sudanian and Sahelian ecoclimatic zones of Mali. Its aim was to determine the prevalence of *Babesia bovis* and Babesia bigemina in each of these zones. A sample of 648 cattle, including 327 females and 321 males, examined for Babesia bigemina and *Babesia bovis* parasites and their vectors, using blood and tick sampling. Microscopic examination of the blood smears revealed the presence of the *Babesia bovis* parasite in 200 cattle out of 648 examined, i.e. an overall prevalence rate of 30.86%, and the presence of Babesia bigemina in 156 cattle, i.e. an overall prevalence rate of 24.07%. The present study showed a significant difference in *Babesia bovis* prevalence between ecoclimatic zones ($p<0.05$). On the other hand, statistical analysis of Babesia bigemina prevalence results revealed no significant difference ($p>0.05$) between zones. There was no significant difference between male and female prevalence of *Babesia bovis* and Babesia bigemina ($P> 0.05$). The same was true for the prevalence of *Babesia bovis* and Babesia bigemina observed in the different age groups, ($p>0.05$). The study revealed that the Boophilus microplus species is absent in the Sahelian zone.

Keywords: Prevalence; Babesia *Bigemina; Babesia bovis*; Mali.

1. Introduction

Mali is the leading livestock producer in the UEMOA (West African Economic and Monetary Union) region, with a herd of 11,758,377 cattle and 43,494,990 small ruminants. It contributes 15.2% to the gross domestic product and is the third largest export after gold and cotton. Animal diseases have always been a major constraint to the development of livestock farming in general. Among these pathologies, ticks and tick-borne diseases, notably *bovine babesiosis*, occupy an important place. Annual economic losses caused by the R. (B.) *microplus* tick alone in southern Africa estimated at US$160 million [5]. In sub-Saharan Africa, *babesiosis*, *anaplasmosis*, theileriosis and cowdriosis (heart water) are the main tick-borne livestock diseases, causing major economic losses [6]. Very few studies have been carried out on bovine babesiosis in Mali is the leading livestock-producing country in the UEMOA (West African Economic and Monetary Union) region, with a herd of 11,758,377 cattle and 43,494,990 small ruminants. It contributes 15.2% to the gross domestic product and is the third largest export after gold and cotton. Animal diseases have always been a major constraint to the development of livestock farming in general. Among these pathologies, ticks and tick-borne diseases, notably Studies have focused on the parasites responsible for babesiosis and on the vectors. Serological surveys carried out during the 1980s revealed that Babesia *bigemina* was the dominant parasite species in Mali, with a maximum serological prevalence of 57.5% for Babesia *bigemina* in the Sikasso region, compared with 38.1% in the District of Bamako [15]. During the same period, three tick species identified as the sole vectors of bovine babesiosis in Mali. These were *Rhipicephalus* (*Boophilus*) *geigyi*, R (B) *annulatus* and R. (B) *decoloratus*. During the same period, a new tick, R.(B)

* Corresponding author: Modibo DIAKITE.

microplus, added to the three tick species already known to be vectors of bovine babesiosis in Mali. This new tick originates from South Asia, where *Babesia bovis* is the dominant species. It first identified in Mali in the Sikasso region in 2013. The R. (B) microplus tick known to be the most invasive vector and the most resistant to all conventional acaricides available on the market [17]. This tick species is therefore a serious threat to cattle farming in the West African sub-region. The concern of Mali's veterinary services about the threat of a new, more dangerous vector of bovine babesiosis than those already known at national level prompted the need to undertake research on *Babesia bovis* and its vectors in Mali. As a result, we decided to carry out surveys to improve our knowledge of the situation of *Babesia bovis* babesiosis and Babesia bigemina babesiosis in Mali. More specifically, our surveys aimed to determine the prevalence of babesiosis and its vectors in the Sudano-Guinean, Sudanian and Sahelian zones of Mali.

2. Materials and methods

2.1. Materials

2.1.1. Biological material

Blood and ticks collected from cattle are the main biological material.

2.2. Method

2.2.1. Characteristics of the study area

The study took place in three ecoclimatic zones: the Sahelian zone, the Sudanian zone and the Sudano-Guinean zone.

The Diema circle, which represents the Sahelian zone, is located in the Kayes region. This circle has the characteristics of the Sahel, with shrub-savanna vegetation cover and average rainfall of 550 to 750 mm (distributed over 45 to 55 days), with varying degrees of fluctuation from one year to the next.

The cercle of Dioïla represents the Sudanian zone. It is located in the center of southern Mali. Formerly part of the Koulikoro region (Mali's second-largest administrative region), it is now part of the Dioïla region [11].

Vegetation cover is more or less dense and varied (Sudanian savannah) [2, 12]. Annual rainfall is 700 mm in the north and almost 1000 mm in the south.

2.2.2. Site selection

A preliminary field visit carried out to conduct interviews with the heads of veterinary services in the various project zones. This visit also used to select the communes, villages and herds studied.

The sampling plan was as follows:

- 3 Cercles: Diema, Dioïla, Kadiolo ;
- 2 Communes chosen per Cercle, and 3 villages chosen per Commune (i.e., a total of 18 villages);
- 3 cattle sampled per herd of at least 50 head, for a total sample of 648 cattle for the entire study.

2.2.3. Survey type and period

This is a cross-sectional survey conducted over the period from June 2019 to September 2020.

2.2.4. Sample size, blood sampling and tick collection

The sample size for the present study was 648 cattle. This figure breaks down as follows: 216 cattle per ecoclimatic zone, 108 cattle per Commune, 36 cattle per village and 3 cattle per herd. Blood sampling and tick collection from cattle were carried out at the end of the dry season and during the rainy season between June 2019 and September 2020. Blood drawn from the jugular vein of cattle. The blood drawn into vacuum Vaccutainer tubes containing EDTA anticoagulant using a sampling needle. Each tube was marked with the site code, animal identification number and date of collection. The tubes containing the collected blood were placed in a rack and then stored in a cooler containing ice cubes. Tick collections carried out on cattle from which blood drawn. Ticks were collected from both sides of the animal in 7 predefined anatomical regions: "ear", "head-neck", "dorsal region", "abdomen-legs", "ano-genital region", "tail" and "feet". Ticks then preserved in Falcon tubes containing a 70°C ethanol solution. The tubes containing ticks collected from the same animal were marked with the site code, animal identification number and collection date corresponding

to the tube containing the blood sample. The tubes containing ticks then placed in a tube crate for transport to the laboratory.

2.2.5. Questionnaire

A questionnaire administered to herd owners at each site visited. The questions concerned the type of farming, herd size, prophylaxis and cross-border transhumance.

2.3. Experimental protocol

At the Central Veterinary Laboratory in Bamako, smears were prepared on glass slides with a margin at one end. Smears fixed in methanol solution for 5 minutes, then stained in Rapid GIEMSA solution for 5 minutes. They washed under a stream of tap water and dried. After receiving 2 or 3 drops of immersion oil, the dried smears were placed under the '' objective X100 binocular electric microscope for *Babesia bovis* and Babesia bigemina in red blood cells.

Ticks collected during both seasons identified and counted by species at the Central Veterinary Laboratory in Bamako. Identification made using an electric binocular magnifier. Ticks placed in Petri dishes under the magnifying lens. The key of WALKER and al [19] used to identify the ticks. Tick identification focused on the search for the vectors *Babesia bovis* and Babesia bigemina. Identification based primarily on morphological characteristics. After identification, ticks not carrying *Babesia bovis* and Babesia bigemina placed in vials containing 70°C alcohol. These vials placed in tick boxes and stored at the ''Tick and tick borne diseases'' (TMT) laboratory for posterity. Tick vectors *Babesia bovis* and *Babesia bigemina* counted by species. After counting, the numbers entered into the database. The ticks returned to the vials containing the 70°C alcohol solution and stored in the tick boxes.

2.4. Data analysis

The raw database entered using Microsoft EXCEL 2010 and analyzed using Stata version 12.1. The ''chi 2'' test used to compare the different variables, notably the prevalence of *Babesia bovis* and Babesia bigemina. The variables compared were *Babesia bovis* and Babesia bigemina prevalence rates in the three zones, and as a function of cattle age and sex.

3. Results

3.1. Prevalence of *Babesia bovis* in ecoclimatic zones

200 cattle tested positive for *Babesia bovis* out of 648 examined in the ecoclimatic zones. A sample of 216 cattle tested in each ecoclimatic zone. 100 cattle tested positive for *Babesia bovis* in the Sudano-Guinean zone, compared with 89 in the Sudanian zone and 11 in the Sahelian zone. In descending order, the prevalence rates recorded were 46.29% in the Sudanoguinean zone, 41.20% in the Sudanian zone and 5.09% in the Sahelian zone (Table 1). Statistical analysis revealed a significant difference between the three zones, ($P< 0.05$).

3.2. Prevalence of Babesia bigemina in ecoclimatic zones

156 cattle were positive for Babesia bigemina out of 648 examined in the ecoclimatic zones. In the Sudanoguinean zone, 51 cattle tested positive for Babesia bigemina, compared with 55 positive cases in the Sudanian zone and 50 in the Sahelian zone. The prevalence rates recorded were, in descending order, 25.46% in the Sudanian zone, 23.51% in the Sudanoguinean zone and 23.14% in the Sahelian zone (Table 2). Statistical analysis revealed no significant difference between the three zones ($P> 0.05$).

Table 1 Variation in the prevalence of *Babesia bovis* in different ecoclimatic zones

Ecoclimatic zones	Negative	Positive	Total	Prevalence (%)	p-value
Sahelian	205	11	216	5.09	0.00
Sudanese	127	89	216	41.20	
Sudano-Guinean	116	100	216	46.29	
Total	448	200	648	30.86	

Pearson chi2 = 45.5462 Pr = 0.000

Table 2 Variation in the prevalence of *Babesia bigemina* in different ecoclimatic zones

Ecoclimatic zones	Negative	Positive	Total	Prevalence (%)	p-value
Sahelian	166	50	216	23.14	0.83
Sudanese	161	55	216	25.46	
Sudano-Guinean	165	51	216	23.51	
Total	492	156	648	24.07	

Pearson chi2 = 0.3546 Pr = 0.838

3.3. Prevalence of *Babesia bovis* by sex of cattle

The prevalence rate of *Babesia bovis* was higher in male cattle (32.08%, 103/321) than in female cattle (23.54%, 77/327). Statistical analysis of the results showed no significant difference between *Babesia bovis* prevalence rates in male and female cattle (P> 0.05), (Table 3).

3.4. Prevalence of Babesia bigemina by sex of cattle

The highest Babesia bigemina prevalence rate recorded in male cattle (24.61%, 79/321) and the lowest in females (23.54%, 77/327). Analysis of the results revealed no significant difference between the prevalence rates of Babesia bigemina in male and female cattle (P> 0.05), (Table 4).

Table 3 Variation in the prevalence of *Babesia bovis* according to the sex of the cattle

Sexe des bovins	Negative	Positive	Total	Prevalence (%)	p-value
Female	230	97	327	29.66	0.50
Male	218	103	321	32.08	
Total	448	200	648	30.86	

Pearson chi2 (1) = 0.4459 Pr = 0.504

Table 4 Variation in the prevalence of *Babesia bigemina* according to the sex of the cattle

Sexe des bovins	Negative	Positive	Total	Prevalence (%)	p-value
Female	250	77	327	23.54	0.75
Male	242	79	321	24.61	
Total	492	156	648	34.07	

Pearson chi2 (1) = 0.1002 Pr = 0.752

3.5. Prevalence of *Babesia bovis* according to age of *cattle.*

The highest prevalence of *Babesia bovis* in cattle of different age groups was recorded in adults (33.33%, 43/129), followed by calves (30.91%, 98/317) and bulls/heifers (29.20%, 59/202). Analysis of the results revealed no statistically significant difference (p>0.05) between the prevalence of *Babesia bovis* in cattle of different age groups, (Table 5).

3.6. Prevalence de *Babesia bigemina* according of *cattle*.

The highest prevalence of Babesia bigemina in cattle of different age groups was recorded in adults (25.58%, 33/129), followed by calves (24.29%, /77317). And bull calves/heifers (22.77 %, 46/202). Analysis of the results revealed no statistically significant difference (p>0.05) between the prevalence of Babesia bigemina in cattle of different age groups, (Table 6).

Table 5 Variation in *Babesia bovis* prevalence as a function of cattle age

Age of cattle	Negative	Positive	Total	Prevalence (%)	p-value
Adult	86	43	129	33.33	0.73
Taurillon/Genisse	143	59	202	29.20	
calves/Velles	219	98	317	30.91	
Total	448	200	648	30.86	

Pearson chi2(2) = 0.6286 Pr = 0.730

Table 5.1 Variation in *Babesia bigemina* prevalence as a function of cattle age

Age of cattle	Negative	Positive	Total	Prevalence (%)	p-value
Adult	96	33	129	25.58	0.83
Taurillon/Genisse	156	46	202	22.77	
calves/Velles	240	77	317	24.29	
Total	492	156	648	24.07	

Pearson chi2 (2) = 0.3557 Pr = 0.837

3.7. Abundance of *Babesia bovis* and Babesia bigemina tick vectors in ecoclimatic zones

1,310 ticks of all species collected. Of these, 9727 ticks carrying *Babesia bovis* and *Babesia bigemina*, belonging to four species, identified. These were *Rhipicephalus* (Boophilus) *microplus* (3,766 individuals), R.(B) annulatus (2,747 individuals), R.(B) geigyi (2,567 individuals) and R.(B) decoloratus (647 individuals). The different species of tick's vectors of *Babesia bovis* and *Babesia bigemina* identified in the three-ecoclimatic zones. The study revealed that the *Boophilus microplus* species is absent from the Sahelian zone. (Tables).

3.7.1. Abundance of Boophilus microplus in ecoclimatic zones

The overall abundance of Boophilus microplus in all ecoclimatic zones is 33.29% (3766/11310). The Sudano-Guinean zone came out on top with an abundance rate of 44.44% (2364/5319). This zone followed by the Sudanian zone, with an abundance of 32.48% (1402/4316) of the R. microplus species. This tick is absent from the Sahelian zone (Table 6).

Table 6 *Boophilus microplus* abundance in ecoclimatic zones

Ecoclimatic zone	*Boophilus microplus*	Total tick's	Abondances (%)
Sahelian	0	1675	0.00
Soudanese	1402	4316	32.48
Sudano-Guinean	2364	5319	44.44
Total	**3766**	**11310**	**33.29**

3.7.2. Abundance of Boophilus annulatus in ecoclimatic zones

The overall abundance of Boophilus annulatus in the ecoclimatic zones was 24.28% (2747/11310). The Sudano-Guinean zone was more dominant than other zones, with an abundance of 27.99% (1489/5319). This zone followed in order by the Sudanian zone: 21.17% (914/4316) and the Sahelian zone: 20.53%. (344/1675).

Table 6a *Boophilus annulatus* abundance in ecoclimatic zones

Ecoclimatic zone	*R. annulatus*	Total ticks	Abundance (%)
Sahelian	344	1675	20.53
Soudanese	914	4316	21.17
Sudano-Guinean	1489	5319	27.99
Total	**2747**	**11310**	**24.28**

3.7.3. Abundances of Boophilus geigyi in ecoclimatic zones

The overall abundance of *Boophilus geigyi* in all ecoclimatic zones is 22.69% (2567/11310). The Sahelian zone has the highest abundance of this tick, at 34.98% (586 /1675). It followed by the Sudanian zone: 29.12% (1257/4316) and the Sudano-Guinean zone: 13.61% (724/5319). (Table 7).

Table 7 *Boophilus geigyi* abundance in ecoclimatic zones

Ecoclimatic zone	*Boophilus geigyi*	Total ticks	Abundance (%)
Sahelian	586	1675	34.98
Soudanese	1257	4316	29.12
Soudano-guinean	724	5319	13.61
Total	**2567**	**11310**	**22.69**

3.7.4. Abundances of Boophilus decoloratus in ecoclimatic zones

The Boophilus decoloratus tick had an overall abundance of 5.72% (647/11310) in all ecoclimatic zones. This species was most abundant in the Sahelian zone, with a rate of 20.65% (346/1675). In the Sudano-Guinean zone, the abundance of this tick was 3.25% (173/5319). The Sudanian zone recorded the lowest abundance of Boophilus decoloratus at 2.96% (128/4316),(Table 8).

Table 8 *Boophilus decoloratus* abundance in ecoclimatic zones

Ecoclimatic zones	*Boophilus. decoloratus*	Total ticks	Abundance (%)
Sahelian	346	1675	20.65
Soudanese	128	4316	2.96
Soudano-guinean	173	5319	3.25
Total	**647**	**11310**	**5.72**

4. Discussion

Overall, the results show that the hemoparasites *Babesia bovis* and Babesia bigemina are present in all the ecoclimatic zones studied. The four species of tick vectors of *Babesia bovis* and Babesia bigemina - Boophilus microplus, Boophilus annulatus, Boophilus geigyi and Boophilus decoloratus - were found in all three ecoclimatic zones (Sudano-Guinean zone, Sudanian zone and Sahelian zone). The only exception was the absence of the Boophilus microplus tick in the Sahelian zone. The presence of the Boophilus microplus tick in the Sudanian zone can explained by the fact that it was first reported in southern Mali in 2013 by ADAKAL and al [1]. This introduction into the country is thought to have taken place via cross-border transhumance of cattle herds from southern Mali (including cattle from the cercle de Dioïla) to the Republic of Côte-d'Ivoire. The absence of Boophilus microplus in the Sahelian zone may be due to the fact that *cattle* herds in this area generally transhume to the Islamic Republic of Mauritania, or to the "Baoule" river valley within Mali, where the presence of Boophilus microplus has not yet been reported either in Mauritania or in the "Baoule" river valley. Our results differ from those obtained by TEEL and colleagues in Mali [18], who described the presence of three vectors of bovine babesiosis (Boophilus annulatus, Boophilus geigyi and Boophilus decoloratus).

The *Babesia bovis* prevalence rate (46.29%) recorded in the Sudanoguinean zone. This result is comparable than obtained by DJAKARIDJA and al [4] and YEO and al [20], who respectively found a 45.2% and 45.83% of *Babesia bovis* in the northern Côte d'Ivoire zone, more or less comparable to the Cercle de Kadiolo from a climatic point of view. The high prevalence of *Babesia bovis* in the Sudanoguinean and Sudanian zones can explained by the presence of *Boophilus microplus*, the main vector of *Babesia bovis* [13]. Other studies have obtained *Babesia bovis* prevalence rates ranging from 13.16% to 59.33% in West Africa. [4,7]. The overall *Babesia bovis* prevalence rate recorded in our study (30.86%) also fell within this range.

Statistical analysis of the results showed no significant difference between *Babesia bovis* prevalence rates in male and female cattle (P> 0.05). The same trends observed by DJAKARIDJA and al [4], who showed that the influence of sex on the prevalence of haemoparasitosis is not statistically proven. Similar trends obtained by FETHU and al [9], BIHONEGN and al [3]. However, Hamsho and al [10] found a significant difference between the prevalence rates of *Babesia bovis* and Babesia bigemina in male and female cattle (P< 0.05). The overall prevalence of Babesia bigemina was 24.07% in our study. In a study conducted in Côte d'Ivoire, MISHRA and al [16] obtained a similar prevalence for Babesia bigemina (26.7%). In another study conducted in northern Benin, FAROUGOU and al [7] found a higher prevalence of Babesia bigemina (57%). Our figures are higher than those obtained by YEO and al [20], Hamsho and al [10] and Bihonegn and al [3], who obtained prevalences of 13.61%, 7% and 0.248% respectively for Babesia bigemina.

Analysis of the results revealed no significant difference between the prevalence rates of Babesia bigemina in male and female cattle (P> 0.05). Similar results obtained by BIHONEGN, al [3], DJAKARIDJA, al [4], FAROUGOU, and al [7].

Analysis of the results revealed no statistically significant difference (p>0.05) between the prevalence of *Babesia bovis* and Babesia bigemina in cattle of different age groups. Similar results were obtained by YEO and al [20] and Fethu and al [9], who showed that the age factor had no influence on the prevalence of *Babesia bovis* and Babesia bigemina parasites (P>0.05). In a study conducted in northern Benin, FAROUGOU and al [8] found that adult cattle were more infested with hemoparasites than young cattle (p<0.05).

5. Conclusion

The present study determined the prevalence of the hemoparasites *Babesia bovis* and Babesia bigemina in three ecoclimatic zones of Mali, namely the Sahelian zone, the Sudanian zone and the Sudano-Guinean zone. The study also enabled us to establish a link between the prevalence of the hemoparasites studied and their vectors. This enabled us to establish that the higher the prevalence of vectors, the higher the prevalence of *Babesia bovis* and Babesia bigemina. This factor enables decision-makers to develop a control strategy for these vectors, with a view to reducing the risks associated with the appearance of babesiosis in bovine herds.

Compliance with ethical standards

Acknowledgments

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Disclosure of conflict of interest

Modibo DIAKITE coordinated the design and planning of the study, the implementation of the laboratory analyses and the writing of the article; Brahima SACKO, and Sekouba BENGALY, participated in the design, planning and implementation of the study; Amadou SERY participated in the statistical analysis of the data.

References

[1] ADAKAL, H., BIGUEZOTON, A., ZOUNGRANA, S., COURTIN, F., DE CLERCQ, E.M. and MADDER, M., (2013). Alarming spread of the Asian cattle tick Rhipicephalus microplus in West African another three countries affected Burkina Faso, Mali and Togo. *Exp Appl Acarol 61, 383-386.*

[2] AQUASTAT, 2005

[3] BIHONEGN WODAJNEW, HAIMANOT DISASSA, TADELE KABETA, TILAHUN ZENEBE AND GIRMA KEBEDE, (2015). Study on the Prevalence of Bovine Babesiosis and Its Associated Risk Factors in and Around Assosa Woreda, Benishangul Gumuz Regional State, Western Ethiopia. Wollega University, School of Veterinary Medicine, Nekemte, Ethiopia girmakebede27@yahoo.com

[4] DJAKARIDJA B, YAO KOUASSI P, GRAGNON BIEGO G, G. ACAPOVI-YAO, MAVOUNGOU J. F, N'GORAN KOUAKOU E. (2014). Epidemiological situation of bovine hemoparasites in two livestock areas of Côte-d'Ivoire: the case of the former Savanes and Bandama Valley regions.Revue Med. Vet., 165, 9-10 297-303.

[5] DOLD A., COCKS M. (2001) Traditional veterinary medicine in the Alice district of the Eastern Cape Province, South Africa. *South African Journal of Science*, 97, 375–379.

[6] EYGELAAR, D., F. JORI, M. MOKOPASETSO, K.P. SIBEKO, N.E. COLLINS, I. VORSTER and M.C. OOSTHUIZEN, 2015. Tick-borne haemoparasites in African babesiosis from spreading buffalo (*Syncerus caffer*) from two wildlife 8 (1): 1-11.

[7] FAROUGOU S., KPODEKON M. and TASSOU A.W. (2007). *Seasonal abundance of ticks (Acari: Ixodidae) cattle parasites in the area sudanian of Benin: the case of the department of Borgou and Alibori*. Polytechnic school of Abomey-Calavi,

[8] FAROUGOU S., TASSOU A.W, TCHABODE D.M, KPODEKON M. BOKO C, YOUSSAO A.K.I, (2007). Ticks and hemoparasites of cattle in northern Benin. Magazine Med. Vet*.,* 2007, 158, 8-9, 463-467

[9] FETHU LEMMA, ADUGNA GIRMA and DIRSHA DEMAM**,** (2016). Prevalence of Bovine Babesiosis in and Around Jimma Town South Western Ethiopia**.** *Advan. Biol. Res., 10 (1): 37-42, 2016*.

[10] HAMSHO A, TESFAMARYM G, MEGERSA G, MEGERSA M (2015) A CROSS-SECTIONAL STUDY OF BOVINE BABESIOSIS IN TELTELE DISTRICT, BORENA Zone, Southern Ethiopia. J Veterinary Sci Technol 6: 230. doi:10.4172/2157-7579.1000230

[11] INGENIEUR CONSEIL for DEVELOPMENT (ICD). (2006). *Improving Economic and Social Impact of Rural Electrification* (IMPROVES-RE). Monographic report, Dioila Circle

[12] MADDER M. (2010). *Prospects for the management of the invasive tick Rhipicephalus (Boophilus) microplus in West Africa*. International Consortium for Ticks and Tick-borne Diseases (lCTTD), 20p.

[13] MARCHAL Celine (2011). Bovine babesiosis eradication campaign in New Caledonia (2008-2010). PhD thesis in veterinary medicine. of alfort. France. weather-Mali ; 2000

[14] MILLER D. K, O. DIALL, T. M. CRAIG and G. G. WAGNER (1984). Serological prevalence of bovine babesiosis in Mali. *Trop. Anim. Prod*. 16,71-77.

[15] MISHRA G.S., CAMUS E., BELOT J., N'DEPO, (1979). Survey of parasitism and calf mortality in northern Côte d'Ivoire: preliminary observation. *magazine Elev Med. Vet.*

[16] SANOU, P.J., (2012). Perceptions and farmers' strategies to control the tick Rhipicephalus (Boophilus) microplus in the western region of Burkina Faso. Rural development engineer thesis. Univ. Polytechnic of Bobo-Dioulasso, 60p.

[17] TEEL P.D and BAY D.E, AJIDAGBA P. A. (1988). Ecology, distribution and relationships of ticks (Acari: Ixodidae) infesting livestock in Mali. *Bull. ENT. Res.* 78, 407-424.

[18] WALKER A.R., BOUATTOUR A,CAMICAS J-L, ESTRADA-PENAA., HORAK I.G, LATIF A.A, PEGRAM R.G & PRESTON P.M, (2003). Ticks of Domestic Animals in Africa: A Guide to Identification of species

[19] YEO NAWOLO, YAHAYA KARAMOKO, SORO DOFARA, ZAHOULI FAUSTIN BI, ZOUH JOEL ABOU OKON LANDRY, BIEGO GUILLAUME GRAGNON. 2017. Prevalence of Trypanosoma, Babesia and Anaplasma in cattle reared in the North of Côte d'Ivoire. International Journal of Biosciences | IJB |.ISSN: 2220-6655 (Print), 2222-5234 (Online) http://www.innspub.net Vol. 10, No. 2, p. 21-28, 2017.