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Tsetse challenge, trypanosome and helminth infection in relation to productivity of village Ndama cattle in Senegal

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An International Scientific Journal

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Tsetse challenge, trypanosome and helminth infection in relation to productivity of village Ndama cattle in Senegal

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Abstract

Data on tsetse fly, and on village Ndama cattle collected over a 4-year period in southern Senegal, were analysed. A total of 431 Ndama cattle in four herds of three villages in the Upper Casamance area of southern Senegal were monitored monthly. ***Glossina*** *morsitans submorsitans* and *Glossina palpalis gambiensis* are present in the study area. Mean tsetse apparent density was 5.4 flies/trap/day. Trypanosome ***(Trypanosoma*** *congonlense* and *Trypanosoma vivax*) infection rate in flies was 2.4 (s.e. 0.37)%. Tsetse challenge index was 17.3 (s.e. 4.18). Mean monthly trypanosome prevalence in cattle was 2.5 (s.e. 0.51)%. Highest trypanosome prevalence occurred during the dry season, and animals less than 1-year old were more frequently infected than older animals. The linear relationship between the loglO+l tsetse challenge and the arcsine of the trypanosome prevalence was significant only when mean monthly values of these variables over the 4-year period were used with tsetse challenge preceding infection rate by 3 months. Mean monthly prevalence of strongyle, *Strongyloides* spp., ***Toxocara*** spp. and coccidia were 34.4 (s.e. 0.60), 2.1 (s.e. 0.18), 1.2 (s.e. 0.45) and 15.6 (s.e. 0.47)%, respectively. Calf mortality rate at 1, 6 and 12 months of age was 2.1 (s.e. 2.1), 5.2 (s.e. 2.8) and 12.2 (s.e. 3.3)%, respectively. Calving interval (584 s.e. 58 days) was not influenced by trypanosome status of the cow during lactation. Calving interval was shorter by 167 days when the calf died before 1 year of age in comparison to calving intervals for which the calf survived beyond one year. Live weight at birth, 6 and 12 months of age were 15.8 (s.e. 0.54). 48.1 (s.e. 2.56) and 71.1 (s.e. 5.44) kg, respectively. Mean lactation length, total and daily milk offtake were 389 (s.e. 16) days, 231 (s.e. 15) litres and 0.69 (s.e. 0.037) litres, respectively. Trypanosome infection during lactation did not have a significant effect on the amount

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of milk extracted for human consumption nor did trypanosome status affect calf growth. © 1999 Elsevier Science B.V. All rights reserved.

Keywords: Tsetse challenge; Trypanosomosis: Helminthiosis; Ndama cattle; Productivity

1. Introduction

Because of their trypanotolerance, Ndama cattle constitute a unique animal genetic resource which forms the basis of large ruminant agriculture in many parts of West Africa where the risk of trypanosomosis is high. The Ndama cattle breed are a multipurpose breed that produce milk. meat, power and manure and therefore contribute a great deal to the income and welfare of millions of farmers in mixed trop-livestock production systems in West Africa. However, a complex set of technical factors related to health, nutrition and management constrain the productivity of Ndama cattle kept under traditional husbandry systems. The relative importance of these factors needs to be determined if strategies to make better use of this genetic resource are to be developed to meet the growing demand for animal products in West Africa. To this end, an epidemiological study was carried out from 1988 to 1992 in the Upper Casamance region of southern Senegal to investigate causes of variation of Ndama cattle productivity and the stability of the trypanotolerance trait under village management systems. This study was part of a large epidemiological programme that was conducted by International Livestock Centre for Africa (ILCA now ILRI) and National Agricultural Research Institutes in many sites in Africa with different degrees of trypanosomosis risk. This paper reports findings on the tsetse challenge, prevalence of parasitic diseases (helminthiosis, trypanosomosis) in village Ndama cattle in southern Senegal and how these factors affect the reproduction performance, calf growth and milk production.

2. Materials and methods

2.1. The study area

The study was carried out in the region of Upper Casamance in Southern Senegal. The climate in this region is of a sudano-guinean type. Annual rainfall was 1018. 1045, 787. and 684 mm in 1988, 1989, 1990 and 1991, respectively. The unimodal rainfall in this area occurs between June and October. Four herds in these villages (Salamata, Yassiriba, Sare Pathe) were selected for the investigation Ndama cattle health characteristics and production parameters over a 4-year period (1988-1992). Salamata and Yassiriba are along the Mahon forest boundaries and close to a stream. Sare Pathe is located in the forest of Bakor. The criteria used to select villages were the presence of tsetse flies (but the infection rates were not taken into account), accessibility (particularly during the rainy season when roads becomc impractical), and farmcrs willingness to participate to the monitoring program.

2.2. Herd management

Animals graze natural pastures which form the main source of the food supply. Animals have access to millet, rice and sorghum residues that are consumed directly in the fields from November. Shortage of food supply during the hot dry season (March, April, May and June) is the single most important constraint that faces the herd owners in this area. Animals are tethered individually overnight in crop fields during the dry season and are moved to the forest during the cropping season to avoid damage to crops. Mating is not controlled and calving occurs all year round. However, peak calving is recorded in July and August. Milking is performed once a day, and begins one week after calving. The calf is allowed to suckle its dam for a few seconds to trigger milk let-down and thereafter, is tethered at the foot of the dam during the course of milking. A main feature of the milking system in the study area is that milking for human consumption is suspended during part of the dry season and is resumed during the next wet season.

2.3. Experimental design

2.3.1. Animals

A total of 431 Ndama cattle kept in four herds of three villages were monitored monthly for 52 months in Salamata and Yassiriba with 163 animals, and for 24 months in Sare Pathe with 268 animals. Animals were individually tagged on both ears. Animals were managed under traditional village conditions and therefore were subjected to natural tsetse challenge. Routine vaccination against rinderpest, anthrax, hemorrhagic septicaemia, and contagious bovine pleuropneumonia was given. Animals were also treated with diminazene aceturate (Berenil®, 3.5 mg kg^{-1} body weight) when trypanosomes were detected and the packed red cell volume (PCV) was below 20%.

2.4. Field recording and laboratory determinations

2.4.1. Monitoring of tsetse flies

Twelve biconical traps, as described by Challier and Laveissière (1973), were placed at each site each month for three consecutive days and harvested every 24 h. Traps were set 100 m apart from each other, in savannah and riverine areas. All flies caught were identified and recorded with reference to biotope, species, sex, teneral/non-teneral status, and age group by wing-fray method as described by Jackson (1946). All live non-teneral flies were then dissected in a 0.9% saline solution and the midgut, labrum, hypopharynx and the salivary glands were examined for the presence of trypanosomes by phase-contrast microscopy at 320 x magnification using a combination of periplan 10 x eyepieces and a long-distance L32 objective.

2.4.2. Cattle herd monitoring

Each month, immediately following the tsetse trapping on the site, blood samples were collected from the jugular vein of the cattle into evacuated tubes containing EDTA. The PCV was measured and the level of parasitaemia estimated using phase-contrast examination of the blood buffy-coat (Murray et cil., 1983). Whenever the PVC declined

below 20%, blood smears were made in order to determine if other haemoparasites (e.g., *Babesia* spp, *Anuplasma* spp.) were present. Faeces samples were collected from the animal's rectum for the entire herd every 3 months and monthly for animals aged O-3 years. Faecal samples were immediately examined for the presence of gastro-intestinal parasites using the McMaster egg-counting technique (Murray et al., 1983). Animals were weighed each month using an electronic scale (Barlo, Australia) and milk offtake for human consumption was measured using a graduated tube. Information on herd dynamics including the date of birth, mortality and animal transactions (e.g., purchases, sales, exchanges and transfers) were routinely collected during weekly herd visits.

2.5. Data analysis

A regression analysis of the arcsine of trypanosome prevalence on log 10+1 of the challenge index (CI), the product of the apparent density and the infection rate of flies, was performed to investigate the relationship between these two variables. SAS General Linear Mode1 procedures (SAS Institute, 1989) were used to analyse health parameters and production traits. Statistical models used for the analysis of variance of these variables included the fixed effects of village and herd within village, the month and year the observation was made, age category (category 1: <1 year, category 2: 1-3 years, category 3: >3 years) and sex of the animal (female, entire male, castrated male).

For each trait analysed, specific additional factors were also included in the statistical model as necessary. For instance, analysis of PCV also included the trypanosome status of the animal and the interaction between trypanosome and helminth infections. The data set used to investigate the effects of these factors on PCV was formed by using data from animals for which both faecal and blood samples were analysed for the determination of blood and gastro-intestinal parasites. Also, the data set used to analyse PCV excluded data from 49 animals which were infected with *Babesia* spp. or *Anaplasma* spp. and that had a mean PCV of 19 (S.D. 10)%. Additional factors for the analysis of calving interval included parity of the previous parturition and the trypanosome status of the cow. Calving number was classified into two groups, with group one formed by parturition number 1 and 2, and group two composed of cows with three or more calvings. Cows were also grouped into non-infected and infected with trypanosomes after the first parturition of the interval. Trypanosome status was also included in the analysis of calves LW growth up to the age of 12 months. Two classes of infection status (non-infected and infected at least once with trypanosomes), between the age of O-6 months and between 6-12 months, were formed. For the analysis of lactation length, total and daily milk for human consumption, the following classes of factors were included: three seasons of calving (season 1, the wet season: June, July, August, season 2: the cool dry season, October, November, and season 3, the hot dry season, February, March, April), two levels of infection status (non-infected and infected at least once during lactation irrespective of the time during lactation when the infection occurred), the interaction between season and infection status, and two types of milk extraction practices (continuous milk extraction throughout lactation, and suspension, and later resumption of milk offtake).

Mean calving intervals and cow survival rate, calf mortality rate, calf live weight at 1 year, and milk offtake for human consumption, were combined to determine productivity indices as described by Agyemang et al. (199 1).

3. Results

3.1. *Tsetse challenge*

Tsetse flies present in the study area were identified as *G.m. submorsitans* and *G.p. gambiensis*. Out of the 10210 flies caught from March 1988 to March 1992, 64% were *G.m. submorsitans* and *36%* were *G.p. gambiensis*. The number of flies caught per trap per day is an estimate of the apparent density of tsetse flies and the average apparent density found in this study was 5.4 flies/trap/day. The number of *G.p. gambiensis* trapped was highest during the rainy season (June-September) and during the first months of the dry season (November-January) whereas most of catches of *G.m. submorsitans* occurred during the second half of the dry season (February and May). The dissection of 50% of the caught flies gave a mean monthly infection rate by *T. congolense* or *T. vivax* of 2.4 (s.e. 0.37)%. Mean monthly CI, an estimate of the trypanosomosis risk, was 17.3 (s.e. 4.18). Fig. 1 shows the seasonal pattern of changes in CI. Tsetse challenge was more pronounced from Januar-April, peaked in March and decreased gradually as the dry season progressed. Lowest CIs were recorded during the rainy season. There was a sharp decrease in tsetse apparent density and CI in 1991 and 1992 compared to 1988 and 1990 (Table 1).

3.2. Trypanosome infection rates in Ndama cattle

The overall mean trypanosome prevalence was 2.5 (s.e. 0.51)%. Infection rates due to *T. congolense* and *T. vivax* were 1.89 (se. 0.43) and 0.64 (s.e. 0.27)%, respectively.

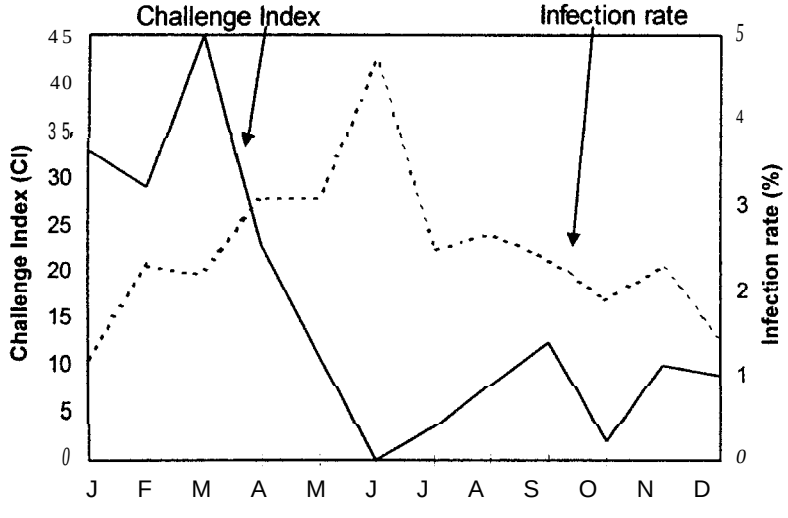

Fig. 1. Monthly tsetse challenge index and cattle infection rates with *T. congonlense* and *T. vivax*.

Table 1
Number of flies caught, number of flies dissected, mean yearly number of *Glossina morsitans submorsitans* and *Glossina palpalis gambiensis* caught per trap per day, flies infection rates by *Trypanosoma congonlense* and *Trypanosoma vivax*, and tsetse challenge index (tsetse infectionxnumher of flies caupht per trap per day) at Kolda from March 1988 to March 1992

	Number of months	Number of flies		FTD[a]	FIR[b]	TCI[c]
		Caught	Dissected			
Year						
1988	10	2528	1546	6.1	2.1	21.1
1989	12	3968	2120	8.4	1.7	18.2
1990	11	2879	1121	6.4	4.8	33.7
1991	12	835	292	1.9	1.0	0.9
1992	3	84	29	0.8	2.8	0.1

[a] FTD = Fly per trap per day
[b] FIR Fly infection rates
[c] TCI: tsetse challenge index

Trypanosome infection rates were significantly affected by village ($p<0.001$), month of the year ($p<0.01$) and age of the animal ($p<0.001$). The monthly relative number of animals infected with trypanosomes was larger in Yassiriba (4.3 s.e. 0.68%) than in Salamata (1.5 s.e. 0.54%) or Sare Pathe (1.7 s.e. 0.59%). Trypanosome infection rates increased steadily each year from January, during the dry season, and peaked in June, the end of the dry season (Fig. 1). Lowest infection rates were recorded in December and January. There was a time lag of 3 months between peak of the trypanosome prevalence and that of the tsetse challenge. When the log+1 of the monthly tsetse challenge was regressed on the arcsine of the mean monthly infection rates aggregated over the 4-year period, significant relationship ($R^2 = 0.52$, $p > 0.01$) was detected between these two factors. However this relationship was no longer significant when the 48 monthly infection rates and monthly tsetse challenges were used in the regression analysis. Adult animals aged more than 3 years were more affected by trypanosomes (3.6 s.e. 0.5%) than younger animals (1.9 s.e. 0.5%). Castrated males tended also to be less infected with trypanosomes than both entire males and females (Table 2) but the difference was not significant ($p = 0.16$).

3.3. Gastro-intestinal parasites

Out of 6016 animal-month faecal samples analysed, 34.4 (s.e. 0.60), 2.1 (s.e. 0.18). 1.2 (s.e. 0.45) and 15.6 (s.e. 0.47)% were infested with strongyle, *Strongyloides* spp. *Toxocara* spp. and coccidia, respectively. The proportion of animals infested with strongyle and mean egg output were lowest during the dry months of January–May. The frequency of faecal samples infested with *Strongyloides* spp. increased gradually each year from April to reach a peak in June and remained high (>40%) in July, August and September, the wettest months of the year. Mean strongyle EPG followed the same pattern, but its peak occurred in September, 3 months later than when the proportion of faecal sample infested with strongyle is highest. Mean strongyle egg counts were higher in animals less than 1-year-old (BPG = 346 s.e. 47) than in animals 1–3 years old (EPG = 286 s.e. 43), or in animals more than 3 years old (EPG = 220 s.e. 44). It has also

Table 2
Mean (± s.e.m.) infection rate with *Trypanosoma congonlense* and *Trypanosoma vivax* and mean ((± s.e.m) packed cell volume (PCV %) in Ndama cattle kept under village management conditions at Kolda, Senegal, between 1988 and 1992

Source of variation	Trypanosome infection rate (%)			Packed cell volume (%)		
	n	Mean ± s.e.m	Significance	*n*	Mean±s.e.m	Significance
Overall mean	9905	2.5 ± 0.51		5957	27.8 ± 0.28	
Village			***			***
Yassiriba	1005	4.3 ± 0.7		749	28.3 0.32	
Salamata	4101	1.5 ± 0.5		2787	27.4029	
Saré Pathé	4799	1.7 ± 0.6		2421	27.50.30	
Year			***			***
1988	259	1.4 ± 1.2		210	30.6 ± 0.43	
1989	1458	2.4 ± 0.6		1013	29.2 ± 0.30	
1990	1137	3.2 ± 0.7		792	26.3 ± 0.32	
1991	3396	3.1 ± 0.5		2148	26.4 ± 0.29	
1992	3655	2.4 ± 0.6		1794	26.2 ± 0.30	
Sex			***			***
Female	6772	2.8 ± 0.3		3582	27.6 ± 0.24	
Entire male	2968	3.4 ± 0.4		2279	26.4 ± 0.25	
Castrated male	165	1.3 ± 0.3		96	29.3 ± 0.52	
Age						
<l year	1586	1.9 ± 0.7	***	1310	27.9 ± 0.30	***
l-3 year	3398	1.9 ± 0.5		2745	27.5 ± 0.29	
Strongyle infestation						*NS*
Negative				4074	28.1 ± 0.30	
Positive				1883	27.5 ± 0.41	
Tryp. × Strongyle infection						***
Negative negative				5831	29.4 ± 0.17	
Negative positive				126	26.1 ± 0.48	
Positive negative				1845	29.1 ± 0.19	
Positive positive				88	26.4 ± 0.51	
Positive positive				38	25.8 ± 0.76	

***$p<0.001$.
NS = not significant.

been noted that *Strongyloides* spp. egg output was greater in animals infected (4.4 s.e 0.35%) than in animals not infected (1.9 s.e. 0.35%) with trypanosomes. Age of the animal had a significant effect on the frequency of samples infested with *Toxocara* spp. and *Strongyloides* spp. Animals less than 1-year-old were more frequently infested with *Toxacaru* spp. than older animals. While adult animals were free of *Toxacara* spp. and *Strongyloides* spp., the frequency of strongyle-type infestation was almost as high (34 s.e. 2.5%) as in young animals (36% s.e. 2.7).

3.4. Packed cell volume

In general there was a trend of a decline of PCV from 1988 to 1992 (Table 2). Each year, PCV reached its peak in February and the lowest values were recorded from May to

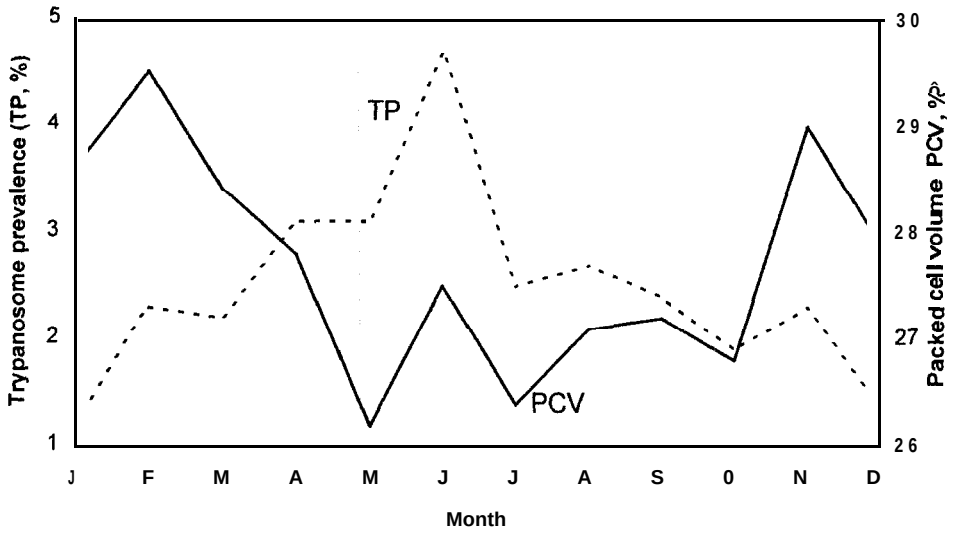

Fig. 2. Monthly packed cell volume (PCV, %) and trypanosome prevalence in village Ndama cattle between 1988 and 1992.

October, coinciding with the end of the dry season and the rainy season (Fig. 2). Highest PCVs were recorded each year from November to February, with peak values reached in February. Thereafter. there was a sharp decrease of PCV values from February to May. This period coincided with the time when food supply was critical and when significant increases in trypanosome infection rates were seen. In general there was a decline in PCV values of 3.3% in animals infected with trypanosomes. Castrated males had higher PCV than entire males or females. The effect of strongyle infection was close to significance levels (p = 0.08). In general strongyle-free animals had higher PCV than infected animals. Although, the effect of the interaction between strongyle and trypanosome infections was not significant, PCV values shown in Table 2 suggest an additive effect of these infections on the development of anaemia.

3.5. Mortality rates

Out of the 225 calves bom during the course of the monitoring programme, 2.1 (s.e. 2.1), 5.2 (s.e. 2.8) and 12.2 (s.e. 3.3)% died before the age of 1, 6 and 12 months, respectively.

3.6. Calving inter-vals

The unadjusted mean calving interval was 634 (s.d. 186) days. The least square mean calving interval was 584 (s.e. 58) days. Cows whose calf died before the age of 12 months had calving intervals shorter (by 167 days, $p<0.05$) than that of cows whose offspring survived beyond 12 months of age. The trypanosomosis status of cows did not affect significantly calving intervals. When the previous calving number was 1 or 2, the calving

interval was greater by 98 days than when the previous calving number was greater or equal to 3. Mean calving intervals were 663 (s.e. 78), 493 (s.e. 73) and 445 (s.e. 65) days for cows that had calved previously in 1988, 1989 and 1990, respectively.

3.7. Live weight changes

Live weight at birth, 6 and 12 months of age were 15.8 (s.e. 0.54), 48.1 (s.e. 2.56) and 71 .l (s.e. 5.44) kg, respectively. Only the season of calving had a significant effect on calf weight at 6 months of age. Calves born during the late dry season (February-May) were lighter at 6 months of age ($p < 0.05$, 42.9 s.e. 3.48 kg) than those bom during the wet season (50.5 s.e. 2.95 kg) or in the early dry season (50.7 s.e. 3.09 kg). Trypanosome infection status did influence significantly calf LW at 6 or 12 months of age. The average LW of empty cows was 222 (s.e. 1.3) kg. Cows lost LW during the second half of the dry season, from March to June and they gained LW progressively during the wet season, but it was until November, the early dry season, that they fully recovered their LW. The difference between the highest cow LW in November and the lowest LW in June was an average of 25 kg.

3.8. Lactation characteristics

Mean lactation length, total milk extracted for human consumption and daily milk offtake were 389 (s.e. 16) days, 231 (s.e. 15) litres and 0.69 (s.e. 0.037) litres, respectively. Lactation length was longer when calving occurred during the wet season (season 1: June-September: 446 s.e. 18 days) than when calving took place during the early dry season (season 2: October-January: 358 s.e. 23 days) or during the late dry season (season 3: February-May: 365 s.e. 33 days). Cows for which milk offtake was suspended had a longer lactation length (452 s.e. 18) days) than cows that were continuously milked (327 s.e. 20 days. Cows that calved in season 1, the wet season, out-produced (264 s.e. 17 1) cows that gave birth during the dry seasons 2 and 3 (188 (s.e. 22) and 240 (s.e. 31)) litres, for seasons 2 and 3, respectively).

The interaction between season of calving and trypanosome infection on lactation length was significant ($p<0.05$). Cows that gave birth in late dry season and that were infected with trypanosomes during lactation had the shortest lactation length of 318 (s.e. 60) days. Trypanosome infection did not appear to affect lactation length when calving occurred in the wet season or in the early dry season. Total and daily milk offtake appeared also to be minimal in cows that calved in late dry season and that were infected with trypanosomes during lactation, but these differences were not significant. When calving occurred in early dry season and the cows were detected parasitaemic, total and daily milk offtake were 166 (s.e. 36) and 0.560 (s.e. 0.09) litres, respectively. In contrast cows that calved in the same period but that were not detected parasitaemic produced 210 (s.e. 18) litres during the entire lactation and 0.740 (s.e. 0.044) litres per day. Trypanosome infections that occurred during the wet season or during the last part of the dry season did not seem to affect milk offtake. Total milk offtake of non-infected and infected cows that started lactation between February and June were 242 (s.e. 23) and 238 (s.e. 56) litres, respectively.

3.9. Productivity indices

Mean calving interval (584 days), cow survival rate (98.5% per year), calf survival rate (88% per year), calf LW at one year of age (71.1 kg), and milk offtake during the first 12 months of lactation (216 kg) found in this study were combined to produce productivity indices. Index 1 which is the amount of 1-year-old calf LW plus the LW equivalent of milk extracted for human consumption produced per cow per year was 62.8 kg. Index 2, the LW of 1 -year-old calf produced plus LW equivalent of milk offtake per 100 kg of cow maintained per year was 28.8 kg. Index 3, the LW of a 1-year-old calf produced plus LW equivalent of milk offtake per 100 kg of cow metabolic LW was 120.8 kg.

4. Discussion

In the present study, the population of tsetse flies decreased lover the experimental period. The apparent density of tsetse flies was particularly low in 1991 and 1992 as compared to the previous years. These changes in the population of flies may be attributed to the effect of continuous trapping for 4 years in the same site. Another contributing factor to the decline of the tsetse population could have been the reduced rainfall recorded during 199 1 and 1992 and also the occurrence of bush-fires which may have destroyed their habitat or caused migration of a great deal of them. However. the decline in the challenge index in 1991 and 1992 did not translate into reduced trypanosome infection rates in cattle during these years. The regression of the monthly trypanosome infection rates on the monthly challenge index after a log transformation of tsetse challenge and arcsine transformation of trypanosome infection rates showed a significant correlation between these two parameters. However, correlation was only apparent when data was aggregated over the 4-year period and that challenge preceded the prevalence data by three months. The correlation of these two parameters on a monthly basis year by year failed to detect any significant relationship between these two factors. The absence of significant relationship was apparent even when the moving average of the tsetse challenge was used in the regression analysis. There were many months when the number of flies caught was zero in 199 | and 1992, but trypanosomes were detected in the blood of the animals. This suggests that although the challenge index is a simple field estimate of the seriousness of trypanosomosis in an area, it may fail to give valid assessment of the problem if data is collected for a short period of time or if there are many months when the challenge index is zero. Even when the index is zero it does not mean that flies are totally absent. Vectors other than *G.m. submorsitans* and *G.p. gambiensis* (e.g. mechanical transmitters) and reservoirs may also have played a role in the transmission of trypanosomes to cattle.

The overall trypanosome prevalence (2.5%) found in the present study is relatively low. Animals in Yassiriba were more frequently infected with trypanosomes than those in Salamata and Sare Pathe. The herd size in Yassiriba was smaller than in other villages. This, coupled with the fact that Yassiriba was located deeper in the forest and at the vicinity of a stream may have created conditions for animals in Yassiriba to be more exposed to tsetse flies than in other villages where these conditions did not occur. In the

present study there was an increase in the trypanosome prevalence as the animals aged. The higher capacity of young animals to resist trypanosomosis relative to adult animals has already been reported (Stephen, 1986; Rowlands et al., 1993) and is suggested to be related to the superior erythropoeitic response of younger animals (Murray, 1988). However, as suggested by Rowlands et al. (1993), differences in exposure may contribute to these variation in trypanosome prevalence in animals of different age classes. In this study castrated males tended to be less subjected to trypanosome infection than entire males and females. It would have been thought that being used for work, the physical stress castrated males undergo during work would increase their susceptibility to infection. It is likely that both young animals and castrated males are less infected than other categories of animals because of differences in their respective management. Not only are draught animals better fed during the dry season but also both the young and draught animals graze in the vicinity of the homesteads and are not watered in gallery forest where contact with flies is more likely. The time lag between peaks of tsetse challenge and trypanosome prevalence in cattle found in this study is similar to that reported in studies in Ethiopia (Rowlands et al., 1993) and Gambia (Claxton et al., 1992). This is supposedly due to the time interval between the infective bite and the detection of trypanosomes in the animals (Leak et al., 1993).

Although, this study showed a significant relationship between trypanosome prevalence and tsetse challenge, the seasonal variations of trypanosome infection rates suggests also that nutrition could be a confounding factor. Indeed, increases in trypanosome prevalence during the dry season, from January to June. coincided with poor nutrition during that period and the consequent reduction in animal LW and PCV%. Work done in Gambia showed that nutritional stress depresses the capacity of the animals to cope with trypanosome infection (Little et al., 1994).

The present study has also provided information on the epidemiology of gastro-intestinal parasites in Ndama cattle in southern Senegal. Infestations with strongyle-type parasites were more frequent and EPG values greater in the wet season than in the dry season. In general, adult animals appeared as frequently infested with strongyle-type parasites as younger animals and could therefore constitute a source of contamination of pastures. Studies in Gambia revealed the same epidemiological characteristics of gastrointestinal nematodes in Ndama cattle (Kaufmann and Pfister, 1990).

This study has also shown that when calving occurred during the late dry season calves had a slow growth rate up to 6 months of age. Growth of calves bom during this period was impaired by low milk output of the dam due to poor nutrition.

Although, previous studies (Agyemang et al., 1993) have indicated the depressing effect of trypanosome infection on reproductive performance, in the present study calving interval was not affected by the trypanosome status of Ndama cows during lactation. This finding is in agreement with that of Thorpe et al. (1988). The most important factor that influenced the reproductive performance in the work described here was whether the calf survived or not up to 12 months of age. The calving interval of cows whose calves died before the age of 12 months was lower by 167 days than that of cows that suckled their offspring over 12 months. Indeed, the depressing effect of suckling on post-partum cyclicity of Ndama cows is reported by Sanyang et al. (1995). As pointed out by Thorpe et al. (1988), use of calving interval as an estimate of reproductive performance fail to

take into account non-fertile cows in the herd and this may mask the effect of trypanosome infection on reproductive performance.

The mean lactation length (389 s.e. 16 days) and total milk for human consumption (23 1 s.e. 15 litres) found in this study carried out in southern Senegal where milking is done once a day agrees with the level of lactation performance by Ndama cows milked once daily in Gambia. Lactation length and milk offtake were 437 (s.e. 16.6) days and 239 (s.e. 19.3) litres in the once-daily milking system in Gambia (Agyemang et al., 1991). Trypanosome infection did not affect lactation length or total milk offtake. This again agrees with the results obtained in Gambia where non-infected cows out-produced infected cows during lactation by only 24 kg during a 14-month location period and this difference was not significant (Agyemang et al., 1991). However, trypanosome infection caused a reduction in milk production during the 6 months following infection in Ndama cows in Gambia (Agyemang et al., 1990). Larger lactation length and greater milk offtake seen in cows starting lactation during the wet season when food was plentiful and of good quality as compared to the dry season, suggest that nutrition is the driving factor that determines milk production of the village Ndama cows. Cows calving during the last part of the dry season performed better than those calving during the early part of the dry season. For the latter, most of the lactation length occurred during dry months whereas the former will benefit from the pastures improvement in the next wet season. In terms of milk production, cows that gave birth between November and January were more severely affected by food shortage than cows calving in other seasons. Feed restriction was compounded in these cows by trypanosome infections and led to the shortest lactation length. The trends observed regarding the interaction of season of calving and trypanosome infection on milk offtake suggest that well fed Ndama cows could produce milk with a no major negative influence of trypanosome infection. Similarly, Agyemang et al. (1990) suggested that the depressive effect of trypanosome infections on milk production could be reduced through the provision of additional food to cattle showing signs of the disease.

Finally, the productivity indices found in this study (Index 1 = 62.8 kg per cow, Index 2 = 28.3 kg per 100 kg cow LW and index 3 = 120.8 kg per 100 kg metabolic LW) are in agreement with productivity indices found in Ndama cattle under once-daily milking system in Gambia where index 1, 2 and 3 averaged 60.4, 28.3 and 120.2 kg (Agyemang et al., 1991). Village Ndama cow productivity seems relatively lower than that found in Ndama cows reared on station with no milk extraction. Productivity indices 1, 2 and 3 were 70.1, 29.1 and 127.0, respectively for Ndama cows reared on station in Senegal (Fall et al., 1983).

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