

Production and Health Parameters of N'Dama Village Cattle in Relation to Parasitism in the Guinea Savannah of Côte d'Ivoire

L. Knopf^{1*} C. Komoin-Oka² B. Betschart³
B. Gottstein⁴ J. Zinsstag¹

Key words

N'Dama cattle – Animal production – Parasitism – Côte d'Ivoire.

Summary

The central Guinea savannah of Côte d'Ivoire is a very suitable area for cattle breeding due to the abundance of forage throughout the year; the presence of tsetse flies favors farming of trypanotolerant livestock. Little is known on the productivity and overall health status of N'Dama cattle under traditional farming conditions in the humid savannah of Côte d'Ivoire. This study aimed at investigating productivity parameters (demography, live weight, overall health status) of local N'Dama cattle to generate baseline knowledge on production and health parameters including aspects of ecto- and endoparasitism under traditional farming conditions in this area. In a longitudinal study, three randomly selected village cattle herds were monitored during a period of 20 months. The annual calving rate was $52 \pm 1\%$ (mean and standard error) and the annual cumulative mortality rate of calves under one year of age was $19 \pm 6\%$. Birth weights were 16.5 ± 0.9 kg for males and 15.7 ± 1.1 kg for females. Adult females achieved a mean weight of 198 ± 5 kg. The live weight of young N'Dama cattle showed no significant relationship with tick and gastrointestinal strongyle burdens. N'Dama cattle could be productive in this harsh environment, but the local production of milk and beef was still insufficient to meet consumers' demand. Based on the assessed parameters the authors simulated the potential development of N'Dama cattle breeding in this area over a ten-year period, with the option of increased milk or meat production.

■ INTRODUCTION

In contrast with the more arid savannah areas of West Africa, the central Guinea savannah (or V-Baoulé) of Côte d'Ivoire does not suffer from important forage shortage during the dry season. Since the 1970s the Ivorian government has made considerable efforts to increase local cattle-breeding activities in the area, which is suitable for trypanotolerant livestock production. Trypanosomosis control programs have been run since the 1970s (SODEPRA and later on various local and international NGOs). In this area the tsetse fly pressure is variable and rather low, 0-2.2 flies per trap per day (LANADA, 1998).

Through these efforts, among others, Côte d'Ivoire could improve its beef supply. But, still today, 50% of the red meat consumed have to be imported from Sahelian countries and Europe. Over 85% of dairy products are imported from various countries (FAO statistical databases). Cattle breeding is a welcome secondary activity to diversify cash crop production of coffee and cocoa, subject to continuously dropping prices. But it is also interesting for civil

1. Swiss Tropical Institute, Dept of Public Health and Epidemiology, PO Box, 4002 Basle, Switzerland

2. LANADA, laboratoire central de pathologie animale, PO Box 206, Bingerville, Côte d'Ivoire

3. Institute of Zoology, University of Neuchâtel, rue Emil Argand 11, 2007 Neuchâtel, Switzerland

4. Institute of Parasitology, University of Berne, Länggass-Strasse 122, PO Box, 3001 Berne, Switzerland

* Corresponding Author

Office vétérinaire fédéral, PO Box, CH-3003 Berne, Suisse
Tél. : +41 31 324 39 94 ; fax : +41 31 323 95 43
E-mail : lea.knopf@bvvet.admin.ch

servants and private enterprises in nearby cities. Compared to Northern Côte d'Ivoire, the farmers of the humid savannah have not used cattle draft power so far, particularly because the technical knowledge is still lacking (in the whole area).

Most of the data available on N'Dama productivity in West Africa are from on-station-managed N'Dama cattle in Ghana (21), The Gambia (18), Senegal (7), Burkina Faso (4) and Northern Côte d'Ivoire (20, 10). Except for other climatic conditions, such as those in The Gambia (1, 5, 12, 17, 23) and in Senegal (1, 7), productivity data on N'Dama under traditional management conditions are only available for Northern Côte d'Ivoire (19, 15, 2), where slightly drier climatic conditions prevail. Other studies on productivity of indigenous cattle, such as Mashona cattle or West African Shorthorn breeds, were carried out in Zimbabwe (8) and Benin (9). These authors emphasize that the productivity of indigenous cattle under traditional low input farming systems is underestimated.

Since cattle breeding activities are expected to increase in the central humid savannah area of Côte d'Ivoire and this area is expected to become a center of national dairy production, the veterinary authorities are interested in the production and health parameters of local trypanotolerant N'Dama cattle. The project planning and the fieldwork were carried out in close partnership with LANADA and local farmers.

As the N'Dama breed is considered to be trypanotolerant and should not need additional systematic trypanocidal treatments, the authors focused their work on additional ecto- and endoparasites which might affect production and health. The presented data may also serve as baseline data of traditional village cattle prior to implementation of antiparasitic treatment schemes. Simulation of livestock production was attempted to devise options for production priorities.

MATERIALS AND METHODS

This study was carried out in the district of Toumodi, Central Côte d'Ivoire. The main study site, the village of Bringakro, is situated at 6.4° latitude N and 5.1° longitude W. Its humid savannah climate (Guinea savannah) was characterized by annual rainfalls of 1021 mm (1997), 1105 mm (1998), 1231 mm (1999), a mean temperature of 29.6°C (range of monthly mean temperatures: 26.8–34.3°C) and a mean relative air humidity of 72.6% (LAMTO, station géophysique, Taboo, Côte d'Ivoire). There are two rainy seasons (main peak in May/June, minor peak in September/October) and two dry seasons. This area is very suitable for cattle farming in terms of fodder abundance throughout the year. There is hardly any forage shortage and many water ponds are scattered in the area. The V-Baoulé area could be suitable for the development of dairy industry; it is near economically important market places and has also well-developed roads and transport facilities.

All N'Dama cattle herds are managed under traditional conditions: during the day, cattle are led to communal, natural pastures by herdsmen or let free, and at night, they are kept in private or communal paddocks throughout the year. With the exception of minerals no other supplementary feeding is given. Various artificial and natural water ponds are accessible within 5 km. Most of the farmers of the village of Bringakro do not practice prophylactic treatment schemes against parasites or other diseases. Veterinary services provide regular vaccinations, but are hardly ever called for other purposes, such as herd health problems and individually sick animals.

A longitudinal cohort study of three cattle herds in the village was carried out from November 1997 to June 1999. The herds were

selected randomly (by lottery, in front of all cattle owners) from a list of the 14 functional night holding paddocks located in the community of Bringakro; the cattle owners were residents of Bringakro. The inclusion criteria were: no acaricide treatment during the study period and consent to participate in the study. No prophylactic herd treatment against any parasite took place. However, during the study period, the authors recorded and treated sick animals individually (severe clinical cases) for ethical reasons.

All animals of the three selected herds ($n = 144$, initially) were ear-tagged. Herd sizes were 36, 50 and 86 cattle at the end of the study. Blood and fecal samples were collected six times between January 1998 and June 1999 (Table I). Blood samples were used for blood smears and dark ground/phase contrast buffy coat microscopy to check for blood parasites. Fecal samples were analyzed by the McMaster technique (eggs per gram feces or egg). As a rapid assessment, ticks were counted monthly on a standard square surface of the dewlap (13) and the herds were visited weekly to collect demographic data (birth, death, offtake). The live weight was measured four times during the study using electronic livestock scales. The calves were weighed at the latest 21 days after birth. The socioeconomic status of cattle breeding in this area was assessed by farmer interviews ($n = 23$) using a questionnaire adapted from Itty (11). These farmers were selected randomly from a list of small-scale cattle breeders in the whole Toumodi area and were asked for their consent to participate in the interviews.

The age of the animals was estimated by dentition, number of calvings and herd history. Young calves, which were born before the start of the study, were not included in the calculation of calf mortality or calving rates. One herd was never milked.

Herd structure and descriptive analysis were calculated with EPI-Info (vers. 6.04, 1997, Centers for Disease Control and Prevention, USA). Herd structures were relative age distributions by sex. The average annual herd structure was expressed as relative frequencies by age and sex.

Table I
Study design

Period		Number of animals sampled			
Year	Month	Ticks	Blood	Feces	Weight
1997	Dec.	22	0	0	142
1998	Jan.	93	134	130	0
	Feb.	59	0	0	0
	Mar.	63	0	0	0
	Apr.	96	0	0	0
	May	36	132	135	132
	Jun.	108	0	0	0
	Jul.	106	139	133	0
	Aug.	128	0	0	0
	Sep.	103	0	137	0
	Oct.	106	0	0	0
	Nov.*	–	–	–	–
	Dec.	82	0	0	0
1999	Jan.	98	146	137	118
	Feb.	124	0	0	0
	Mar.	74	139	136	0
	Apr.	117	0	0	0
	May	66	141	118	118

* Cattle enclosures damages, no sampling

Calf mortality was analyzed with Proc lifetest and Proc phreg of the package Statistical Analysis Systems (SAS, Cary, NC, USA, vers. 6.12) using proportional hazard regression with the covariates herd and sex. Until the end of the study, censoring was not necessary since no calves were sold or left the herd due to other reasons than natural death. The calving rate was calculated as annual cumulative incidence, assuming mean age at first conception of 41 months (23), as follows:

$$\text{Calving rate } j = \frac{C_j}{N_j + 0.5(I_j - E_j)}$$

where C_j is the number of calves born in year j ; N_j is the number of reproductive females at the beginning of year j ; E_j are the reproductive females leaving the herd during the year j ; I_j are the immigrating reproductive females during the year j .

Calving frequency was calculated as monthly average of two observation cycles (November-June). In case of a single observation cycle (July-October) the figure represents the total number of births observed. Birth weights of calves were analyzed by a general linear model (SAS, proc glm) with sex and herd as fixed effects. The live weights of animals more than one year of age were analyzed by a mixed model (SAS, proc mixed) with a random effect for the individual animal, nested within herd:

$$Y_{ijk} = \mu + \text{sex}_i + \text{herd}_j + \text{season}_k + \text{animal(herd)}_{ijk} + e_{ijk}$$

where Y_{ijk} is the live weight of a given age category of animal ijk at the measurement; μ is the overall mean of the live weight; sex_i stands for male or female; herd_j stands for the three different herds; season_k are the four season levels (very dry, little dry, very rainy, little rainy); animal_{ijk} is the random effect of the animals nested within the herd; e_{ijk} is the residual error of the model.

The influence of the tick burden on the live weights of animals younger than four years was analyzed using a general linear model (SAS, proc glm) with the following fixed effects: sex, herd and season. A similar model was used to test the effect of gastrointestinal parasitism (epg positive) on live weight (all animals), containing fixed effects for sex, season, herd, animal, age group, and presence of strongyles; for animals under one year of age the effect of the presence of *Strongyloides papillosus* and *Toxocara vitulorum* was included additionally.

Cattle production estimates for the whole humid savannah area of V-Baoulé (3032 km²) with 14,256 animals in total, including 5308 breeders (ANADER, 1997), were obtained using the public domain, spreadsheet-based Livestock Development Planning System (LDPS2, vers. 2, 1998, Sector Analysis and Policy Branch, FAO, Rome, Italy). Equilibrium herd structures, used for production simulations over 10 years and for ex-ante impact assessments, were obtained by a prurun of the model over a period of 20 years with the observed productivity parameters (Otte, FAO pers. commun.). Ex-ante impact assessments were carried out for the following: a) reduced young stock mortality from 19 to 10%; b) increased fertility from 52 to 75%; and c) increased milk production from 280 l per lactation to 500 l per lactation (simulating the instantaneous replacement of a part of the existing cows by crossbred animals). Stochastic expression of productivity parameters was not possible with LDPS2 macros.

RESULTS

Farmer interviews (n = 23) on the role of cattle breeding indicated that the main role of cattle was its savings function (priority for 81% of the farmers). But herd structures (Figure 1) indicated also market-

oriented sale of young bulls for slaughter (mean age at offtake: 3.5 years). Old females were slaughtered only in case of disease. All other purposes mentioned, such as availability of meat for occasional home consumption and sale of young heifers, were of minor importance. In this area the use of draft oxen was not practiced and animal products, such as hide for the leather industry or manure as fertilizer, were neither used nor commercialized, although most of the cattle owners had crops. All decisions concerning herd management were taken by the owner, who usually hired a Fulbe herdsman to take daily care of the cattle. Some of the cattle were milked and the milk was commercialized exclusively by the Fulbe herdsman for their own benefits.

During the whole study period no cattle was bought. One owner entrusted two young heifers to another herd and two animals had to be put down due to severe disease and accident; no natural death occurred in animals older than 14 months.

The annual calving rate was $52 \pm 1\%$ (mean and standard error) per reproductive female (n = 82). There were two calving peaks during the year (Figure 2), one in March/April and a second one in November. Only two cows calved a second time during the observation period; the calving intervals were 419 (calf alive) and 429 days (first calf died at less than three months of age).

Cumulative calf mortality from birth to one year was $19 \pm 6\%$. All deaths occurred in the first 210 days after birth (Figure 3). Neither sex nor herd differences significantly affected calf survival. The least square means of average birth weights were 16.5 ± 0.9 kg for males and 15.7 ± 1.1 kg for females. Live weight growth curves showed that females reached an adult weight plateau between four and five years (Figure 4). The difference in weights between sexes was significant (p = 0.04) from the age of four years onwards and it was assumed that female maturity was reached then.

Since no prophylactic treatment was applied, the parasite burden in these trypanotolerant cattle could be considered natural: the findings

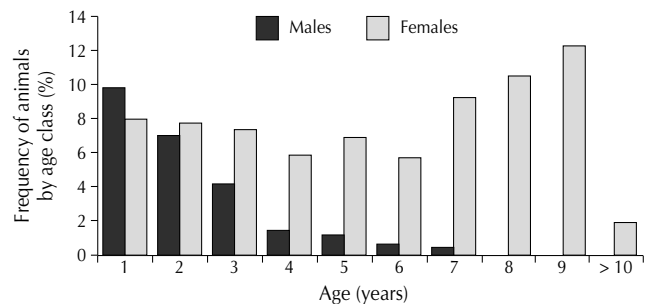


Figure 1: Average annual herd structure of three N'Dama village cattle herds (n = 165 animals) in the Guinea savannah, Côte d'Ivoire.

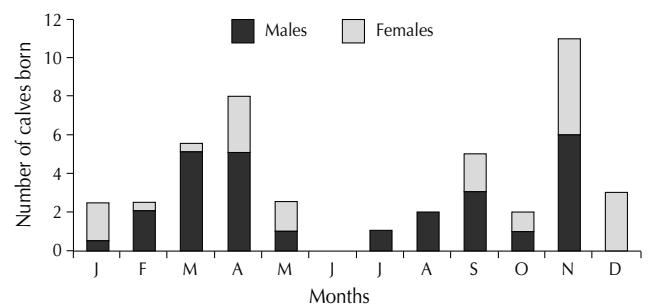


Figure 2: Monthly calving frequency of N'Dama village cattle in the Guinea savannah of Côte d'Ivoire; total number of calves born, n = 60.

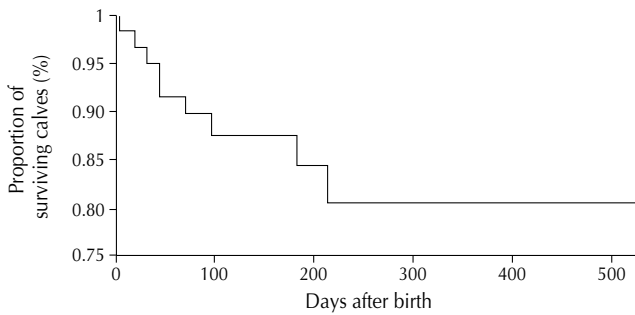


Figure 3: Survival of N'Dama village cattle calves in the first 530-day observation period after birth.

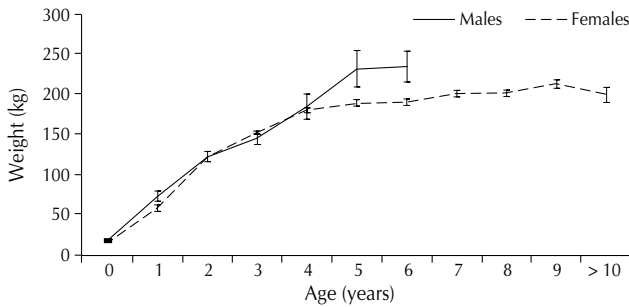


Figure 4: Means of live weight (± s.e.) of N'Dama village cattle by sex and age.

of six seasonal samplings gave overall average prevalences of 2.7% for *Trypanosoma brucei* and 1% for *Trypanosoma congolense*. Strongyles were the most common gastrointestinal parasites with an average overall prevalence (epg positive) of $46 \pm 2\%$ in all animals (926 fecal samples), followed by coccidia ($9 \pm 1\%$), *Strongyloides papillosus* ($3 \pm 1\%$), *Moniezia* spp. ($2 \pm 1\%$) and *Toxocara vitulorum* ($2 \pm 0.4\%$).

Strongyloides papillosus was observed in $22.1 \pm 8.6\%$ of calves under one year old, whereas *Toxocara vitulorum* reached a prevalence of $12.3 \pm 5.1\%$. Generally the animals carried low burdens of gastrointestinal parasites, with the exception of some clinical cases in young calves that carried high burdens of *T. vitulorum* (77,600 epg maximum) or *S. papillosus* (26,000 epg maximum). The geometric means of strongyle fecal egg counts decreased from 20 epg in one-year-old cattle to 8 epg at three years and stayed below 9 epg (after the age of five years). There was no significant difference in live weights between animals excreting and not excreting gastrointestinal nematode eggs. Furthermore, all animals carried ticks throughout the year. No significant effect of the tick burden on the weight gain could be shown in animals between 0-24 months (n = 15) and animals between 25-48 months (n = 50).

Using the estimated productivity parameters, production was then simulated over a ten year period (Table II). Without changing the farming conditions, and using an equilibrium herd structure, animal numbers remain stable at 14,500. The average milk production for human consumption is stable at around 726 tons per year. Meat production stabilizes after ten years at approximately 214 tons per year. If calf mortality could be reduced from the actual 19% to 10%, the animal number would increase moderately by 2100 to a total of 16,600 animals, while estimated annual milk and meat production would increase by 5% (765 tons) and 8% (232 tons), respectively. Increasing the calving rate from the actual 52% to 75% increases average annual milk and meat production by 64% (1194 tons) and 28% (274 tons), respectively, and herd size by 10,000 to 24,500 animals. Improved fertility and reduced mortality combined yield

Table II

Simulation of mean annual milk and meat production over ten years with regard to changes of productivity parameters in N'Dama village cattle herds

	Milk (tons)	Meat (tons)
Baseline production in 10 years	726	214
Mean annual production in 10 years due to:		
Increased fertility, 52 to 75%	1 194	274
Increase of milk production lactation, 250 to 500 l	1 308	214
Reduced mortality, 19 to 10%	766	232
Reduced mortality and increased fertility	1 262	302

a 74% (1262 tons) increase of average annual milk production. Average annual meat production rises by 41% (302 tons) and herd size increases by 14,000 animals to a total of 28,500 animals. Finally, average annual milk production through crossbreeding increases by 80% (1307 tons), while meat production and animal numbers are maintained on baseline level.

DISCUSSION

The estimates of production and health parameters in this study were in line with others under comparable conditions (see below), despite the relatively short duration of the observation period. Reports in the literature quote calving rates in N'Dama cattle in West Africa ranging from 28 to 68% in The Gambia (5, 12, 16, 24), of 53% in Senegal (1), 65% in Zaire and 45-48% in Northern Côte d'Ivoire (11, 15). Station-managed N'Dama herds can reach calving rates higher than 70%, which can be mainly explained by a lower age at first calving, (15, 23) and lower calving intervals, which could both be achieved under very good management conditions. The observed biannual calving peak might indicate that nutritional influence on fertility was less important here than in drier savannahs like those in The Gambia (23). Landais et al. (15) also observed a biannual calving peak, although with a slight shift in the peaks as they occurred in October and March in Northern Côte d'Ivoire (drier climate). The estimate of calf mortality (0-1 year) in this study was higher than those observed on station in Senegal (7), Ghana (21), The Gambia (17), but within the range of reported data of village cattle mortality in Northern Côte d'Ivoire (2, 15), Senegal (1) and The Gambia (5). Death in young calves occurred mostly within the first 100 days. Although the authors carried out 12 necropsies, including microscopy of smashed brain smears, the causes of death could not be identified with the techniques available in the field. No pathognomonic signs of ehrlichiosis (due to *Ehrlichia ruminantium*), trypanosomosis or heavy gastrointestinal parasitism were observed – although the serological prevalence of ehrlichiosis is $31 \pm 3\%$ (13) – which may have reflected a certain level of enzootic stability. No correlation of *Ehrlichia* positive serology with mortality could be found, but more data are needed to support such a hypothesis.

In live calves, high fecal egg counts of *S. papillosus* and *T. vitulorum* were found. In contrast with Chartier et al. (3), no significant relationship between the two parasites and calf mortality could be shown. This may also be due to the limited number of calves in

the study. *S. papillosus* and *T. vitulorum* do not seem to be of high importance in dry savannahs as those in The Gambia (22), whereas they may considerably contribute to calf mortality in the humid tropics as reported by Chartier et al. in Zaire (3).

The milking practice of herdsmen, who commercialize milk to gain additional income, can be in competition with the minimal needs of the calf, which may lead to malnutrition, hence to calf's susceptibility to diseases and thus to increased mortality. Since mortality differences between herds were not significant, it was assumed that the milking practice had no major influence on the calf mortality. More detailed investigations on the high calf mortality in village cattle are needed to identify possible causes.

Gastrointestinal nematode fecal egg counts in the study area were moderate despite continuous exposure and transmission throughout the year, which was in line with other data from an abattoir study in the area (14). The continuous transmission might be actually a reason for moderate gastrointestinal parasite burdens, because of the continuous stimulation of the immune system and comparatively good nutritional status throughout the year. The former was supported by the absence of a significant age dependency of fecal egg counts, in contrast with Zinsstag et al. (25, 26), who observed a significant age dependence of fecal egg counts in Gambian N'Dama cattle, where transmission is highly seasonal.

The seasonal epidemiology and the spectrum of ticks on N'Dama village cattle of this area are described in detail by Knopf et al. (13). The present results confirm previous findings, i.e. the live weight and tick burden correlate poorly within groups of animals with varying degrees of tick infestation (Stachurski, pers. commun.). Trials with untreated versus tick control schemes groups are needed to further assess the direct impact of ticks on cattle production in this area.

The productivity simulations of the present study did not include stochastic elements and thus no confidence limits could be computed. Without intervention the Toumodi area could durably produce on average 726 tons of milk and 214 tons of meat per year during a ten-year period.

An improvement of production is needed to meet the increasing demand for milk and meat of large urban centers (Abidjan, Bouaké, Yamoussoukro) near the study area. Among the various options to increase production, increased fertility combined with reduced calf mortality appear to be most promising. But reasons for low fertility and high calf mortality have to be identified and acceptable interventions need to be tested for their profitability prior to implementation. The resulting doubling of the animal number should not affect pasture resources.

Alternatively, milk production could be increased rapidly by crossbreeding, maintaining the animal number on a constant level. Introducing exotic crossbreeds in this area requires improved management strategies, including parasite control and good surveillance of young calves, whose profitability needs to be considered. A new balance must be found between the superior disease resistance of N'Dama cattle and the higher productivity of crossbreeds (26), which are presumably highly susceptible to parasites and other diseases.

■ CONCLUSION

N'Dama cattle are well adapted to their environment; they are able to resist harsh conditions and multiparasite pressure, and can remain productive even with minimal input. Interventions to increase fertility would be an option to improve N'Dama cattle production, if they are profitable and if natural resources allow an increase of the animal number. When considering crossbreeding to increase milk

production, it is necessary to take into account crossbreeds' higher susceptibility to parasitic diseases and, consequently, higher input costs for disease control and improved management. Moreover, the growing resistance to antiparasitic treatments has to be kept in mind.

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Résumé

Knopf L., Komoin-Oka C., Betschart B., Gottstein B., Zinsstag J. Paramètres de production et de santé en relation avec le parasitisme chez les bovins N'Dama villageois en savane guinéenne de la Côte d'Ivoire

La savane guinéenne au centre de la Côte d'Ivoire est une zone propice à l'élevage bovin. Elle est abondante en fourrage durant toute l'année et la présence de la mouche tsé-tsé y favorise l'élevage de cheptel trypanotolérant. Les connaissances de la productivité et de la santé globale des bovins N'Dama dans les conditions d'élevage traditionnel en savane humide de la Côte d'Ivoire sont limitées. Le présent travail a eu pour objectif d'étudier les paramètres de productivité (démographie, poids vif, état de santé général) des bovins N'Dama locaux pour l'établissement d'une base de données sur les paramètres de production et de santé, en incluant les aspects d'ectoparasitisme et d'endoparasitisme, dans les conditions d'élevage traditionnel dans cette zone. Dans une étude longitudinale, trois troupeaux villageois sélectionnés au hasard ont été suivis pendant une période de 20 mois. Le taux moyen de vêlage annuel a été de 52 ± 1 p. 100 (moyenne et écart-type) et le taux de mortalité cumulatif annuel des veaux âgés de moins d'un an a été de 19 ± 6 p. 100. Le poids moyen à la naissance a été de $16,5 \pm 0,9$ kg pour les mâles et $15,7 \pm 1,1$ kg pour les femelles. Les femelles adultes ont atteint en moyenne un poids de 198 ± 5 kg. Aucune corrélation significative n'a été établie entre le poids vif de jeunes bovins N'Dama et la charge de tiques et de strongles gastro-intestinaux. Les bovins N'Dama peuvent être productifs dans cet environnement difficile, mais la production locale de lait et viande reste insuffisante par rapport à la demande des consommateurs. Sur la base des données recueillies, les auteurs ont simulé le développement potentiel de l'élevage de bovins N'Dama dans cette zone sur une période de 10 ans, avec en option l'accroissement de la production laitière ou de viande.

Mots-clés : Bovin N'Dama – Production animale – Parasitisme – Côte d'Ivoire.

Resumen

Knopf L., Komoin-Oka C., Betschart B., Gottstein B., Zinsstag J. Parámetros de producción y de salud del ganado N'Dama de pueblo en relación con el parasitismo en la sabana Guinea de Costa de Marfil

La sabana de Guinea central de Costa de Marfil es un área ideal para la cría de ganado, debido a la abundancia de forraje durante todo el año. La presencia de moscas tsé-tsé favorece la cría de ganado tripano-tolerante. Es poco lo que se sabe sobre la productividad y el estado de salud general del ganado N'Dama bajo la condiciones de cría tradicional en la sabana húmeda de Costa de Marfil. El presente estudio tiene como objetivo la investigación de los parámetros de productividad (demografía, peso vivo, estado de salud general) del ganado N'Dama local, con el fin de generar un conocimiento de base sobre la producción y los parámetros de salud, incluyendo aspectos ecto y endoparasitarios, bajo condiciones de cría tradicionales en esta área. Mediante un estudio longitudinal, se seleccionaron al azar y se siguieron durante un periodo de 20 meses tres hatos de ganado de pueblo. La tasa de parto anual fue de $52 \pm 1\%$ (promedio y desviación estándar) y la tasa de mortalidad anual acumulada de los terneros menores de un año de edad fue de $19 \pm 6\%$. Los pesos al nacimiento fueron de $16,5 \pm 0,9$ kg para los machos y de $15,7 \pm 1,1$ kg para las hembras. Las hembras adultas lograron un peso medio de 198 ± 5 kg. El peso vivo del ganado N'Dama joven no mostró una relación significativa con la carga de estróngilos gastrointestinales y de garrapatas. El ganado N'Dama puede ser productivo en este medio difícil, pero la producción local de leche y de carne fue aún así insuficiente para llenar la demanda de los consumidores. Con base en los parámetros anteriores, los autores simularon el desarrollo potencial de la cría de ganado N'Dama en esta área para un periodo de 10 años, con la opción de un aumento de la producción de leche y de carne.

Palabras clave: Ganado bovino N'Dama – Producción animal – Parasitismo – Côte d'Ivoire.