Productivity of cattle farms located in the district of Ouake northwest of Benin Republic

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Abstract-A study involving 30 cattle herds with a total of 1173 heads was conducted in the district of Ouake (northwest of Benin) to compare the productivity of three types of cattle breeding system: peri-urban livestock associated with agriculture (type 1), small Fulani livestock (type 2) and the great nomadic herding (type 3). The type of breeding system had a significant effect (p <0.05) on the demographic parameters of the surveyed herds. Thus, the proportion of cows was higher (p <0.05) in herds of type 1 (44.6 vs. 39.0 and 39.1% for types 2 and 3 respectively). By cons, that of heifer 1 was smaller (5.1 vs. 12.9 and 10.3% for types 2 and 3 respectively). The fertility rate was higher (p <0.05) in flocks of type 1 (83.4 vs. 72.0 and 74.7% for types 2 and 3 respectively). The mortality rate before weaning was lower (p <0.05) in herds of type 1 (6.2 vs. 15.7 and 23.0% for types 2 and 3 respectively). The numerical productivity at weaning was higher (p <0.05) in type 1 herds (77.9 vs. 60.5 and 57.6% for types 2 and 3 respectively). The type of breeding system significantly affected the daily milk offtake at the 4th week of lactation (0.94 vs. 1.71 vs. 1.31 kg) and the amount of milk consumed by calves in 3 months (134.3 vs. 184.0 vs. 223.6 kg) respectively for types 1, 2 and 3. The type of breeding system had also a significant effect (p<0.05) on calves weight at birth (13.7 vs. 16.7 vs. 18.3 kg), at 3 months of age (34.8 vs. 41.5 vs. 46.9 kg) and 6 months of age (51.9 vs. 66.6 vs. 77.8 kg) for types 1, 2 and 3 respectively.

Keywords-Growth; Milk offtake; Fertility; Mortality; Borgou; Somba; Benin Republic.

I. INTRODUCTION

The economy of Benin Republic is based primarily on the rural sector which is spending more than 70% of the population [17]. The livestock contributing 25% to agricultural GDP, provides security for families and is a tool in the fight against poverty. The cattle population of Benin estimated at 1.9 million heads [9] is composed of Bos taurus breeds (Borgou, Somba and Lagune), Bos indicus breeds (M'Bororo, Gudali and White Fulani) and their crossbreeds. The geographical distribution of these different breeds under the influence of climatic factors conditioning the food resources and the importance of the presence of tsetse flies, vectors of trypanosomiasis [7; 8]. Thus, almost 90% of the national herd is concentrated in the northern departments of the country [17]. Ouake district part of the northern area of the country is nevertheless characterized by a weak development of the cattle. To determine the main limiting factors, modes of operation and productivity of cattle farms in

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the district of Ouake, zootechnical diagnosis was made. The typology of cattle farms located in the district of Ouake was the starting point of this zootechnical diagnosis [4]. Three types of cattle farms have been identified [4]: peri-urban livestock associated with agriculture (type 1), small Fulani livestock (type 2) and the great nomadic herding (type 3). These three types of cattle farms were distinguished by geographic location, age and ethnicity of the farmer, herd size, breed of animals and husbandry practices adopted [4].

This study aims to compare the productivity of different types of cattle farms identified in the district of Ouake and present the main results obtained on demographics and herd structure and the main parameters of production and reproduction.

II. MATERIALS AND METHODS

A. Study environment

District of Ouake is located west of the department of Donga northwest of Benin between 9°24' and 10°15' north latitude and 1°05' and 2°12' east longitude. It covers an area of 1,500 km² [13]. Ouake is a very undulating peneplain with low gradients to more or less inclined slopes giving rise to broad valleys and shallow flared shape. The climate is Sudanian humid with a rainy season from May to October and a dry season from November to April. The mean annual rainfall calculated over a period of ten years (1998 to 2008) was 1251 \pm 227 mm. The annual mean temperature and relative humidity during the same period were respectively 27.2 ± 0.6 °C and $61.7 \pm 1.3\%$. The vegetation is savannah and herbaceous with strong pressure from human activities and includes woody species such as Vitelaria paradoxa, Parkia biglobosa, Adansonia digitata and Borassus aethiopum etc ... The region is subject to two types of winds: the maritime trade wind which blows from April to October and the harmattan, which blows from November to March.

B. Survey Methodology

The retrospective method for estimating demographic parameters in tropical ruminant livestock population developed by Lhoste et al. [12] and used by Alkoiret et al. [2] was used in this study. Ten herds were selected randomly from each of the three types of cattle farms identified in Ouake district [4], to make the sample comprising 30 herds with a total of 1173 heads. The surveys were conducted using a semi-structured interview guide. Individual interviews with the herdsmen were used to collect information on events in the herds (birth, purchase, death, sale, gift, exchange, late pregnancy, parturition, abortion and stillbirth) and the herd structure (female calves, heifers, cows, male calves, subadult bulls and reproductive bulls). The data were collected for the last 12 months preceding the survey and were subsequently verified and completed during the counting and categorizing of each herd.

C. Demographic parameters of the herds surveyed

Demographic parameters of the herds were calculated using the formulas proposed by Lhoste et al. [12]:

Natural rates:

Abortion rate = Number of abortions * 100 / Number of cows

Parturition rate = Number of parturition * 100 / Number of cows

Fertility rate = Number of calves born alive * 100 / Number of cows

Mortinatality rate = Number of stillbirths * 100 / Number of calves born

Pre-weaning mortality rate = Calves dead before weaning * 100 / Calves born alive

Overall mortality rate = Number of deaths * 100 / Average herd size

Numerical productivity at weaning = Weaned Living calves * 100 / Number of cows

Management rates:

Offtake rate = Number of exploited animals * 100 / Average herd size

Intake rate = Number of immigrated animals * 100 / Average herd size

Net offtake rate = Offtake rate – Intake rate

D. Individual performances of animals

1. Determination of milk production

In each herd of the sample, the cows that calved during the investigation were subject to milk production control at the 4th week of lactation, which is considered the peak of lactation in local breed cows [7]. Hand milking was done by the herdsmen twice a day (7 a.m. and 18 p.m.). Calves were allowed to suck for about one minute in order to stimulate milk let down. They were then tied in front of their dams while cows were hand-milked. Partial milking was done in order to reserve milk for sucking calves which were prevented from sucking the dams. After milking, calves were allowed to resuckle their respective dams for 30 minute. The daily milk offtake (i.e. extractable milk for human consumption) at the 4th week of lactation (MO) was the sum of the morning and evening milk offtake and was weighed using a balance (50 g sensitivity). The amount of milk

consumed by calves (CM) was determined by weighing calves at birth and at three months. The difference in weight multiplied by the coefficient 7.4 is the estimate of the amount of milk consumed by the calves, according to an equation based on N'Dama and Baoule breeds [10], two breeds closed to local breeds.

2. Animal weighting

The weight of calves at birth, 3 and 6 months of age were identified using a balance (100 g sensivity). Weightings were made early in the morning before the access of calves to feed and check for pasture.

E. Statistical Analysis

Demographic parameters of the herds were subjected to analysis of variance ANOVA (type of cattle farms) in SAS[®] [15]. Means were compared with the Fisher LSD test. The results were presented as mean \pm standard deviations.

The characters analyzed were: the daily milk offtake at the 4th week of lactation (MO), the quantity of milk consumed by the calf of 0-3 months of age (CM), the weights of calves at birth (P0), 3 months (P3) and six months old (P6). The fixed factors tested were: the type of cattle farms, sex of calf, breed of animals and the lactation number of cows. The data were analyzed according to the fixed linear model using the GLM procedure of the software SAS[®] [15]. Duncan's test was used to compare least squared means significantly different.

Yijk = m + Ti + Pj + Rk + Eijk

Where:

Yijk = observed character (MO, CM, P0, P3, P6);

m = overall mean;

Ti = fixed effect of the type of cattle farms (T = 1, 2, 3; 3 classes);

Pj = fixed effect of sex of calf (P = female, male; 2 classes) or fixed effect of lactation number of cows (P = L1-2, L3-5, L \geq 6; 3 classes);

Rk = fixed effect of animal breed (R = Somba, Borgou, crossbreed; 3 classes);

Eijk = random residual effect.

III. RESULTS

A. Demographic parameters

The reports of the various animal categories in the herd structure (Table 1) showed significant variations (p<0.05). Thus, the proportion of cows was higher (p<0.05) in herds in type 1 compared with types 2 and 3. For cons, the proportion of heifer was lower (p<0.05) than that of types 2 and 3 (Table 1). The proportions of female calves and total female were identical (p>0.05) in the 3 types of cattle farms studied. The type of cattle farms had no significant effect (p>0.05) on the proportions of males (Table 1). But the part of reproductive bulls in the herds of type 1 was higher (p<0.05) than those of types 2 and 3. The average size of type 3 herds was respectively 6 and 3.5 times higher (p<0.05) than those of type 1 and 2. Herds in type 1 cattle farms had the best (p<0.05)

reproductive parameters (Table 2), characterized by the highest (p<0.05) parturition and fertility rates (p<0.05), the lowest (p<0.05) abortion rate and the best (p<0.05) numerical productivity at weaning (Table 2).

TABLE I. HERD STRUCTURE (%)	BY THE	TYPE OF	CATTLE	FARMS
IDENTIFIED IN OUAKE DISTRICT.				

Animal categories	Type 1	Type 2	Type 3					
Female, % :								
Female calves	$4.7\pm4.0^{\mathrm{a}}$	$5.8\pm3.0^{\mathrm{a}}$	4.4 ± 3.0^{a}					
Heifers	15.8 ± 11.1^{a}	22.8 ± 4.7^{b}	27.1 ± 4.2^{b}					
Cows	44.6 ± 9.6^{b}	39.0 ± 5.6^{a}	39.1 ± 6.0^{a}					
Total Female	65.1 ± 11.1^{a}	67.6 ± 5.4^{a}	70.7 ± 4.4^{a}					
Male, % :								
Male calves	11.0 ± 6.8^{a}	11.6 ± 5.65^{a}	6.88 ± 2.72^{a}					
Subadult bull	15.7 ± 9.7^{a}	16.4 ± 4.4^{a}	18.2 ± 4.2^{a}					
Reproductive Bulls	$8.3 \pm 3.4^{\mathrm{b}}$	4.4 ± 1.3^{a}	4.3 ± 1.7^{a}					
Total Male	34.9 ± 11.1^{a}	$32.4\pm5.4^{\rm a}$	29.3 ± 4.4^{a}					
Herd size (heads)	14 ± 6^{a}	25 ± 9^{a}	81 ± 26^{b}					
^{a,b,c} Means with different superscript letters on the same row differ significantly ($n < 0.05$)								

eans with different superscript letters on the same row differ significantly (p<0.05)

Peri-urban associated with agriculture cattle farms (Type 1) had the lowest (p<0.05) pre-weaning and overall mortality rates. By cons, the type of cattle farms did not affect (p>0.05) the rate of stillbirth (Table 2). The offtake rate was higher (p<0.05) in type 3 herds and the intake rate was the same (p>0.05) in the three types of cattle farms surveyed (Table 2). The net offtake rate was negative in the types 1 and 2 cattle farms and less (p<0.05) than that of the type 3 herds which was positive.

B. Individual performances of animals

1. Milk production

The type of cattle farms had a significant effect (p < 0.05) on the daily milk offtake (MO) at the 4th week of lactation (Table 3). The MO was higher (p<0.05) in type 2 cattle farms, following by type 3 nomadic herds and finally type 1 herds (Table 3). The effect of lactation number on MO was significant (p<0.05). Breeders took more milk from cows whose lactation numbers were between 3 and 5, followed by those with lactation number superior or equal to 6. By cons, cows in early career (L1-2) were less (p<0.05) collected (Table 3). The breed had a significant effect (p<0.05) on the MO (Table 3). The crossbred cows provided higher (p<0.05) MO, followed by Borgou's cows and finally cows of Somba breed. The amount of milk consumed by calves during the period of 0-3 months (CM) was significantly (p<0.05) affected by the type of cattle farms, the lactation number and the breed of calves. Thus, the largest CM was consumed by crossbreed calves in type 3 cattle farms in cows of lactation L3-5 (Table 3). For cons, the smallest CM was consumed by the calves Somba in Type 1 herds in cows of lactation L1-2.

TABLE II. DEMOGRAPHIC PARAMETERS BY THE TYPE OF CATTLE FARMS IDENTIFIED IN OUAKE DISTRICT.

Parameters, %	Type 1	Type 2	Type 3
Natural rates :			
Abortion rate	5.4 ± 5.1^{a}	16.9 ± 5.8^{b}	9.8 ± 3.7^{a}
Parturition rate	89.9 ± 11.4^{b}	77.7 ± 8.3^{a}	78.1 ± 5.6^{a}
Fertility rate	83.4 ± 10.1^{b}	71.9 ± 8.0^{a}	74.7 ± 6.6^{a}
Mortinatality rate	6.8 ± 5.8^{a}	$7.0 \pm 5.6^{\mathrm{a}}$	$4.4\pm2.8^{\rm a}$
Pre-weaning mortality rate	6.2 ± 5.1^{a}	15.7 ± 7.1^{b}	23.0 ± 10.0^{b}
Overall mortality rate	0.6 ± 0.5^{a}	1.3 ± 0.5^{ab}	1.73 ± 0.6^{b}
Numerical productivity			
at weaning	77.9 ± 10.9^{b}	60.5 ± 7.5^{a}	57.6 ± 8.7^{a}
Management rates :			

Offtake rate	0.3 ± 0.2^{a}	0.4 ± 0.3^{a}	2.84 ± 0.8^{b}			
Intake rate	1.4 ± 1.1^{a}	$0.5\pm0.4^{\mathrm{a}}$	$0.53\pm0.4^{\rm a}$			
Net offtake rate	-1.1 ± 1.0^{a}	-0.1 ± 0.8^{a}	2.32 ± 1.0^{b}			
^{a,b,c} Means with different superscript letters on the same row differ significantly (p<0.05)						

TABLE III.	LEAST	SQUARES	MEANS	(LSM)	AND	STANDARD
DEVIATION	S (SD) FC	CM^2				

Sources of variation		MO ¹ , k	g	CM ² , kg			
	Ν	LSM	SD	N	LSM	SD	
Type of cattle							
farms:							
1	24	0.94ª	0.38	58	134ª	38	
2	50	1.71°	0.51	41	184 ^b	29	
3	35	1.31 ^b	0.36	36	224°	28	
Lactation number:							
L 1-2	51	0.88 ^a	0.26	56	129 ^a	34	
L 3-5	27	2.20 ^c	0.23	43	229°	18	
$L \ge 6$	31	1.60 ^b	0.14	36	175 ^b	12	
Breeds:							
Somba	57	1.12 ^a	0.45	58	136 ^a	39	
Borgou	40	1.55 ^b	0.49	47	181 ^b	27	
Crossbreed	12	2.36 ^c	0.22	30	234 ^c	17	

^{a,b,c} Least-squares means with different superscript letters on the same row differ significantly (p<0.05) ¹ MO = daily milk offtake at the 4th week of lactation

 2 CM = quantity of milk consumed by the calf of 0-3 months of age

2. Calves growth performances

The type of cattle farms had a significant effect (p<0.05) on calves body weight at all ages considered (Table 4). Whether at birth, 3 or 6 months of age, live weight of calves of type 3 herds were the highest (p<0.05), followed by type 2 cattle farms. The lowest body weight (p<0.05) were recorded in type 1 herds. The effect of sex on calf body weight was not significant (p>0.05) either at birth or at 3 months of age (Table 4). But at 6 months of age, live weight of males was higher (p<0.05) than females. The breed of calves had a significant effect (p<0.05) on their weight at birth, 3 and 6 months of age (Table 4). Thus, crossbreed calves had the highest body weights of calves Somba were lower (p<0.05) at all ages considered.

IV. DISCUSSION

A. Demographic parameters

The high proportion of cows in the type 1 herds is related to the acquisition mode of the animals that were purchased at almost 2/3 [4] and not the result of natural increase of the herd size. Moreover, these herds content a high number of draft animals, hence the high proportion of reproductive bulls. The cattle herds' structure in the district of Ouake is consistent with observations made in the traditional herds in eastern of Borgou department of Benin [7], in the district of Gogounou in northeast Benin [2], in the ranch of Okpara, Benin [3] and in a rural highland district of Ethiopia (Boji, West Wellega) on Horro cattle [11]. The superiority of the reproductive and mortality parameters in herds of type1 is due to the sedentary farming method, associated with agriculture practiced by agropastoralists of this type. In addition, herds of type 1 with low size had benefited from improved farming conditions and had more reproductive bulls, hence the improvement of reproductive performances. The combination of low mortality parameters and offtake rate to high reproduction rate, resulting in improved productivity at weaning and numerical yield of Type 1 herds. Dehoux and Hounsou-Ve [7] obtained in their study area (northeast of Benin) a fertility rate of 65.4% and an abortion rate of 4%, lower than that of Ouake district. The mortality rates in this study are higher than those of cattle herds in the district of Gogounou [2] and those recorded at the ranch of Okpara [3; 18].

TABLE IV. LEAST SQUARES MEANS (LSM) AND STANDARD DEVIATIONS (SD) FOR CALVES' BODY WEIGHT (KG) AT BIRTH, 3 AND 6 MONTHS OF AGE.

Sources of variation	Weight at birth			Weight at 3 months			Weight at 6 months		
	N	LSM	SD	Ν	LSM	SD	N	LSM	SD
Type of cattle farms									
1	19	13.7 ^a	1.5	58	34.8 ^a	5.1	27	51.9 ^a	7.9
2	33	16.7 ^b	2.3	41	41.5 ^b	3.9	30	66.6 ^b	3.6
3	34	18.3°	2.3	36	46.9 ^c	3.8	23	77.8°	5.9
Sex									
Female	45	16.9 ^a	2.6	72	39.7 ^a	7.2	43	62.0 ^a	11.4
Male	41	16.4 ^a	2.9	63	40.5 ^a	6.0	37	68.1 ^b	11.9
Breeds									
Somba	13	12.7 ^a	0.9	54	34.4 ^a	4.9	25	51.3ª	8.0
Borgou	34	15.5 ^b	1.3	43	40.3 ^b	2.7	33	66.5 ^b	4.3
Crossbreed	39	19.1°	1.7	38	48.0 ^c	2.7	22	77.8°	6.1
^{a,b,c} Least-squares means with different superscript letters on the same row differ significantly (p<0.05)									

B. Individual performances of animals

The effect of the type of cattle farms on MO and CM is linked both to the milk production of the animals and also the number of milking cows in the herd. Thus, breeders of types 1 and 2 with few cows tend to take more milk than those of type 3 with a lot of cows, thus reducing the amount of available milk for calves. The evolution of milk production with lactation number is well known. Dehoux and Hounsou-Ve [7] noted an increase in milk production in Borgou 'cows from 1s to 3rd row of calving. A 34% increase in milk production was also observed in N'Dama cows between 1st and 7th rows of calving [10]. At the station Loumbila (Burkina Faso), the average increase in daily milk production over the first lactation was respectively 0.83, 0.34 and 0.80 1 / d for the 2^{nd} 3rd and 4th lactation, followed by a decrease respectively from 0.39 and 0.45 1 / d for the 5th and 6th rows of lactation [5]. Senou et al. [16] observed on Borgou cows daily milk production of 1.37, 1.63 and 2.43 1/d for the 2^{nd} , 3^{rd} and 4^{th} lactations respectively. This increase in milk production is linked to lower growth needs of cows completing their growth at the end of the 2nd lactation. From the 6th lactation, milk production drops because the cows become old [14].

The superiority of weight according to age groups of calves of type 3 could be explained by the mode of breeding used and the breed of animals raised. In fact, herds of type 1 are sedentary, those with type 3 are predominantly transhumant and type 2 consists of both sedentary and transhumant herds [4]. However, it was established that the transhumance mode of breeding, promotes better weight gain in animals with a longer grazing time and the continued displacement of animals in search of green pastures [2;7]. According Alkoiret et al. [2] crossbreed Borgou*Zebu calves (Type 3) had a higher body weight than calves Borgou (Type 2) and crossbreed Borgou*Somba calves (Type 1). Adanléhoussi et al. [1] established on cattle of Somba' breed, average birth weight of 12 kg less than that of type 1 calves. The weights of type 2 calves are comparable to those of Betecoucou Ranch [6] and Okpara ranch [19] in Benin Republic. The weights of type 3 calves are close to those recorded in the traditional herds of Gogounou district northeast of Benin Republic [2].

V. CONCLUSION

1. Peri-urban sedentary livestock associated with agriculture had a higher productivity compared to small Fulani livestock and great nomadic livestock.

2. Differences between the three types of cattle farms in Ouake district reside in a higher mortality rate and a lower fertility rate, with a concomitant lower numerical yield in the great nomadic livestock.

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