

Factors affecting the birth weight and neonatal mortality of Massa and Fulbe sheep breeds in a hot and dry environment, Cameroon

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Key words

Massa sheep - Fulbe sheep - Lamb - Environmental factor - Breed - Adaptation - Season - Birth weight - Mortality - Statistical analysis - Cameroon.

Summary

From 1986 to 1991, data from 377 and 422 Massa and Fulbe lambs were collected for birth weights and neonatal mortalities. The data were obtained from random bred foundation populations kept at the Animal Research Unit, Yagoua, Cameroon. Data analyzed by GLM procedure and chi-square were used to identify and quantify factors affecting birth weight and neonatal mortality. Results indicated highly significant breed, season and year of birth, birth type, parity, season by breed and season by year of birth effects on birth weight ($p < 0.001$). Breed by parity, breed by birth type, birth type by parity ($p < 0.01$) were equally significant sources of variation of birth weight. Though the Fulbe breed had a significantly higher birth weight than the Massa (2.88 vs. 1.99 kg), mortality in the latter was significantly lower (49.76 vs. 50.24 %). Mortality was significantly lower during the rainy season (16.82 %) than during the cold dry (42.90 %) and hot dry (40.28 %) seasons. The Massa breed though with a smaller birth weight was more adapted to the hot and dry environment than the Fulbe. Programming breeding for rainy season lambing could therefore increase productivity and production of both breeds.

■ INTRODUCTION

The potential of sheep production in Cameroon is high, especially as they are found in all the ecological zones of the country. The estimated population is about 2,358,100 with about 1,362,600 (57.8 %) belonging to the Sahel zone alone. About 47.5 % of this belongs to the Far-North Province and about 10.3 % to the North Province (Njwe, unpublished results). This estimate is indicative of the socio-economic importance of sheep in the area. Husbandry is, however, rural, extensive and subsistent. Diseases and parasites abound. Capital investment is minimal as inputs are usually generated within the homestead.

Deciry (4) reported information on the reproductive performance of the breeds. Cardinale *et al.* (2) reported high mortalities of

above 50 % in small ruminants in North Cameroon and attributed this mostly to diseases and, especially, digestive parasites and to *la peste des petits ruminants* (PPR). No serious attempt has been made to quantify environmental factors affecting their productivity and mortality. Information on such factors is important to optimize productivity and production.

The objective of this study was to identify and quantify factors affecting birth weight and neonatal mortality (lambs born alive but that died before 7 days) of Fulbe and Massa breeds.

■ MATERIALS AND METHODS

Experimental site

The Yagoua Station of the Institute of Animal and Veterinary Research (IRZV) is located in the stressful environment of the Far-North Province of Cameroon at an altitude of 300 m, latitude 10°23'N and longitude 15°16'E. The mean rainfall is 800 mm (falling within a period of about four months) and temperatures range from 12.5°C in January to 40°C in March. The year is

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divided into three seasons, which include a cold dry season (CDS) from October to January, a hot dry season (HDS) from February to May and a rainy season (RS) from June to September.

Experimental animals and management

The two major sheep breeds found in this area are the Fulbe (Peulh) and the Massa (Kirdi). The Fulbe sheep, widespread from Guinea Savanna through the Sudan to Sahel is characterized by a predominantly white coat colour. It has long legs and long and large drooping ears. Males have long spiral horns. Females are generally hornless, but when the horns are present they are usually quite small (7). The Massa is a local breed reared by the Massa, Toupouri and Mousgoum ethnic groups (4). The body size compared to that of the Fulbe is small. The breed is hairier and its coat colour is predominantly black or brown around the Yagoua region. It is predominantly white around the mountainous region of Mokolo. The forehead is flat, the ears short and small and the head large and rectilinear. Males have horns which are prismatic in shape, larger at the base and directed towards the back (3).

The two breeds were grazed separately on natural pastures of the savannah type all year round. They were lodged in separate barns to avoid crossbreeding. During the HDS they received feed supplements made of cotton seed-cake, bran and straws of rice and groundnut haulms.

Data collection

Data on breed, birth weight (weight within 24 h of birth in kg), sex, birth type, parity, season and year of lambing, and neonatal mortality were obtained from daily records kept from 1986 to 1991 at IRZV Yagoua, Cameroon. A total of 377 and 322 lambs of 145 Massa ewes and 422 and 346 lambs of 132 Fulbe ewes were used for the estimation of least squares means of birth weight and neonatal mortality (mortality between 0 and 7 days of birth), respectively.

Statistical analyses

Two statistical methods were involved in the analyses:

Method I

This method was used for testing the effects of the various environmental factors on birth weight and for estimating the least squares means (LSM) and standard errors (SE) of birth weight. The SAS computer program (16) with GLM procedure was used. A retained linear model comprising significant fixed effects, first order interactions and the random error, assumed to be identically, independently and normally distributed with a zero mean and variance σ^2 for the analysis was as follows:

$$Y_{ijklmno} = \mu + B_i + S_j + T_k + D_l + R_m + P_n + (BS)_{ij} + (BD)_{il} + (BP)_{in} + (DP)_{in} + (ST)_{jk} + e_{ijklmno}$$

where

$Y_{ijklmno}$ is the birth weight of the o^{th} lamb;

μ the overall mean ;

B_i is the fixed effect of the i^{th} breed ($i = 1, 2$);

S_j the effect of the j^{th} season ($j = 1, 2, 3$);

T_k effect of the k^{th} year of lambing ($k = 1, 2, \dots, 6$);

D_l effect of the l^{th} birth type ($l = 1, 2$);

R_m the effect of m^{th} sex ($m = 1, 2$);

P_n the effect of the n^{th} parity ($n = 1, 2, \dots, 4$);

$(BS)_{ij}$, $(BD)_{il}$, $(BP)_{in}$, $(DP)_{in}$ and $(ST)_{jk}$ first order interaction for breed by season of lambing, breed by birth type, breed by parity, birth type by parity, season by year of lambing and $e_{ijklmno}$ the random error associated with the weight of the o^{th} lamb of breed i , birth type l , sex m , parity n , lambing during season j of the k^{th} year.

Method II

This method involved the calculation of mortality rates as simple proportions of dead lambs to total number lambing. First order interactions involving mortalities were determined directly from observed mortalities using the basic definition of interaction. The effects of the various factors on the different neonatal mortality rates were then tested using the chi-square (χ^2) (12) test.

RESULTS AND DISCUSSION

Important sources of variation of birth weight are presented in table I. These include breed, season and year of lambing, birth type, parity, breed by season and season by year of lambing ($p < 0.001$). Birth type by parity, breed by parity and breed by birth type, all first order interactions, were equally significant sources of variation ($p < 0.01$). The effect of sex was moderately significant ($p < 0.05$). Similar results on birth type, parity, year of birth and sex have been reported by various authors (1, 6, 8, 9, 10, 11, 17). Comparative results have been reported by Ebangi *et al.* (7) and Rajab *et al.* (15), though with a non-significant sex effect ($p > 0.05$). Significant breed effect ($p < 0.001$) has been reported by Kiriro (10), Yapi (17) and Demeke (5).

Table I

Tests of significance for factors affecting birth weight (kg) of Massa and Fulbe sheep

Source of variation	DF	F value	P > F
Breed	1	593.28	0.0001
Season of lambing	2	12.11	0.0001
Year of lambing	5	6.61	0.0001
Birth type	1	31.93	0.0001
Sex	1	4.08	0.0438
Parity	3	5.15	0.0001
Breed x season	2	6.52	0.0001
Birth type x parity	3	4.00	0.0077
Breed x parity	3	3.69	0.0118
Breed x birth type	1	7.46	0.0065
Season x year	8	3.86	0.0001

The LSM and SE of main and subclass effects on birth weight are presented in tables II and III, respectively. The lamb birth weight differed significantly between the breed groups ($p < 0.001$). The Fulbe breed maintained this superiority in the subclass effects ($p < 0.001$). Male lambs were generally heavier than females in both single and twin births ($p < 0.05$). The season effect was highly significant on birth weight ($p < 0.001$) with heavier lambs obtained from rainy season lambings. Lambs born during the HDS and CDS did not differ significantly in birth weight ($p > 0.05$). The first order interaction of breed by season did not affect Massa

Table II

Least squares means (LSM) and standard errors (SE) of birth weight for significant main effects

Main effect	n	LSM (kg)	SE (kg)
Breed**			
Massa	377	1.99 ^b	0.04
Fulbe	322	2.88 ^a	0.04
Sex*			
Male	339	2.48 ^a	0.04
Female	360	2.40 ^b	0.04
Season**			
HDS	233	2.40 ^b	0.04
RS	182	2.54 ^a	0.05
CDS	284	2.37 ^b	0.04
Birth type**			
1	450	2.58 ^b	0.04
2	249	2.29 ^a	0.04
Parity**			
1	361	2.30 ^b	0.03
2	176	2.43 ^a	0.04
3	109	2.51 ^a	0.06
4	53	2.52 ^a	0.08
Year of lambing**			
1986	58	2.19 ^c	0.09
1987	161	2.20 ^c	0.05
1988	106	2.33 ^{bc}	0.06
1989	151	2.56 ^a	0.05
1990	129	2.47 ^{ab}	0.05
1991	94	2.38 ^b	0.06

* p < 0.05, ** p < 0.0001

CDS: cold dry season, HDS: hot dry season, RS: rainy season
LSM with different superscripts are significantly different

Table III

LSM and SE of birth weight for significant two-factor interaction

Subclass	n	LSM (kg)	SE (kg)
Breed x season**			
M x HDS	134	1.98 ^c	0.06
M x RS	90	1.96 ^c	0.06
M x CDS	153	1.88 ^c	0.05
F x HDS	99	2.73 ^b	0.06
F x RS	92	3.09 ^a	0.07
F x CDS	131	2.81 ^b	0.06
Birth type x parity*			
1 x 1	241	2.39 ^b	0.04
1 x 2	116	2.50 ^a	0.05
1 x 3	69	2.63 ^a	0.07
1 x 4	24	2.77 ^a	0.12
2 x 1	120	2.19 ^b	0.05
2 x 2	60	2.12 ^b	0.08
2 x 3	40	2.34 ^b	0.09
2 x 4	29	2.24 ^b	0.10
Breed x parity*			
M x 1	205	1.91 ^c	0.04
M x 2	90	1.97 ^c	0.06
M x 3	55	1.93 ^c	0.08
M x 4	27	1.95 ^c	0.11
F x 1	156	2.67 ^b	0.05
F x 2	86	2.75 ^b	0.07
F x 3	54	3.04 ^a	0.09
F x 4	26	3.06 ^a	0.11
Breed x birth type*			
M x 1	197	2.09 ^c	0.04
M x 2	182	1.84 ^d	0.05
F x 1	255	3.16 ^a	0.03
F x 2	65	2.64 ^b	0.09

* p < 0.01, ** p < 0.0001

F: Fulbe, M: Massa, RS: rainy season, CDS: cold dry season, HDS: hot dry season
LSM within the same effects with different superscripts are significantly different

lambs ($p > 0.05$). The seasonal influence on birth weight may be caused by variations in the physical environment due to changes in the weather (long dry season), which directly affect feed availability. The impact on the nutritional status of the pregnant ewe becomes very stressful during the hot dry and cold dry seasons. This is passed to the lamb through the prenatal developmental environment. The non-significant season by breed effect on the Massa may be an indication that the breed has become really adjusted to the environmental conditions. Whereas parity by breed interaction did not affect birth weight of Massa lambs, heavier lambs were dropped by the third and fourth parity Fulbe ewes (table III). Single lambs were significantly heavier than twin lambs ($p < 0.001$) and this superiority prevails in all two-factor interactions. This could be caused by the limitation of the capacity of the ewe to provide prenatal nourishment for the fetuses. Although year of lambing was a significant source of variation of birth weight, years are not repeatable and their specific effects are of limited interest.

Mortality rates evaluated with the chi-square test are presented in table IV. The results indicate that the mortality rate between the

breeds was significantly different ($p < 0.05$). A higher neonatal mortality rate of 50.24 % was registered for the Fulbe compared to 49.76 % for the Massa breed. This higher mortality rate for the Fulbe breed was apparent even in the two-factor interactions, but for Fulbe by sex interaction (table IV). The lower mortality rate (expression of more adaptability) for the Massa may result from a high maternal instinct and rare cases of abandonment of the lambs by the Massa dams as reported by Deciry (4). The neonatal mortality rate for the Fulbe breed was quite high compared to that obtained by Njoya and Ngo Tama (13). This may be due to genotype environmental interaction and management differences. Sex of the lamb did not significantly affect the mortality rate ($p > 0.05$). Similar results have been obtained by Patil *et al.* (14). However, higher mortalities were observed in males than in females (51.42 vs. 48.58 %). Sex by breed significantly affected mortality ($p < 0.05$).

Season of lambing was highly significant on the mortality rate, with the highest mortalities occurring in the cold dry season (42.90 %). The lowest neonatal mortality (16.82 %) was observed during the rainy season when the heaviest lambs were produced.

Table IV

Neonatal mortality rate by breed, sex and season of lambing

Effect	Number lambed	Dead (0-7 days)	Mortality rate (%)	Level of reduction ¹
Overall mean (μ)	768	422	54.95	
Breed*				
Massa	422	210	49.76 ^b	5.19
Fulbe	346	212	50.24 ^a	4.71
Sex (ns)				
Male	382	217	51.42	
Female	386	205	48.58	
Season of lambing**				
RS	205	71	16.82 ^c	38.13
DCS	307	181	42.90 ^a	12.05
HDS	256	170	40.28 ^b	14.67
Breed x sex*				
Massa male	213	109	25.83 ^a	
Fulbe male	169	107	25.36 ^a	
Massa female	209	101	23.93 ^b	
Fulbe female	177	101	23.93 ^b	
Season x breed**				
RS x Massa	102	32	7.58 ^e	47.37
RS x Fulbe	104	39	9.24 ^d	45.71
DCS x Massa	142	89	21.09 ^a	33.86
DCS x Fulbe	164	92	21.80 ^a	33.15
HDS x Massa	145	83	19.67 ^a	35.28
HDS x Fulbe	111	87	20.62 ^b	34.33

¹ Percentage reduction in neonatal mortality under planned breeding.

RS: rainy season, DCS: dry cold season, HDS: hot dry season, mortality rates within the same effects with different superscripts are significantly different

(ns): $p > 0.05$ * $p < 0.05$, ** $p < 0.01$

This is equally indicative in season of lambing by breed. Consequently, if all lambings were planned to occur during specific seasons in order to eliminate the season of lambing effect, mortality could be reduced by 38.13 % (54.95-16.82), 14.67 % (54.95-40.28) and 12.05 % (54.95-42.90) (table IV) during the rainy, hot dry and cold dry seasons, respectively. Njoya and Ngo-Tama (13) recorded mortality reductions of 17.4 and 25.0 % through feed supplementation and prophylactic treatment, respectively. During the rainy and hot dry seasons, the Massa die less than during the cold dry season. This may suggest that the Massa survive better in a hot environment than the Fulbe, also indicating better adaptability to a stressful environment than the Fulbe, which may have arrived more recently. The very high neonatal mortality rate during the hot dry season could be attributed to inherent nutritional and climatic stress effects on the foetus, within the maternal uterine environment.

CONCLUSION AND RECOMMENDATION

Results indicate that breed and non-genetic factors significantly affect birth weight and neonatal mortality. Though the Fulbe breed has a higher birth weight than the Massa, the latter appears to be more adjusted to the hot dry environmental conditions. This is indicated by the significantly lower mortality rate in the main and subclass effects. Heavier lambs are produced in the rainy season and they survive better. High neonatal mortalities occur in the hot dry and cold dry seasons for both breeds. It may therefore be necessary that a management programme aimed at increasing productivity and production be planned for rainy season lambing.

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Résumé

Ebangi A.L., Nwakalor L.N., Mbah D.A., Abba D. Facteurs affectant le poids à la naissance et la mortalité néonatale chez les moutons Massa et Foulbé dans un environnement chaud et sec au Cameroun

De 1986 à 1991, les données relatives au poids à la naissance et à la mortalité néonatale ont été recueillies sur 377 et 422 agneaux de race Massa et Foulbé. Ces données provenaient des populations d'origine, élevées à la Station de Recherches Zootechniques de Yagoua, Cameroun. Le modèle linéaire général (GLM) et χ^2 ont été utilisés pour analyser les données et pour identifier et quantifier les facteurs affectant le poids à la naissance et la mortalité natale. Les résultats ont montré qu'à la naissance les effets suivants étaient très significatifs ($p < 0,001$) : la race, la saison et l'année de naissance, le type de naissance, la parité, les interactions saison-race et saison-année de naissance. Les interactions race-parité, race-type de naissance, type de naissance-parité étaient également significatives quant aux variations de poids à la naissance. Bien que la race Foulbé ait présenté un poids à la naissance significativement plus élevé que celui de la race Massa (2,88 vs. 1,99 kg), la mortalité était significativement plus faible chez cette dernière (49,76 vs. 50,24 p. 100). La mortalité était significativement plus faible pendant la saison pluvieuse (16,82 p. 100) que pendant la saison sèche froide (42,90 p. 100) et la saison sèche chaude (40,28 p. 100). La race Massa, malgré son faible poids à la naissance, était mieux adaptée que la race Foulbé à l'environnement chaud et sec. Une programmation des naissances en saison pluvieuse permettrait ainsi d'accroître productivité et production de ces deux races.

Mots-clés : Ovin - Mouton Massa - Mouton Foulbé - Agneau - Facteur du milieu - Race - Adaptation - Saison - Poids à la naissance - Mortalité - Analyse statistique - Cameroun.

Resumen

Ebangi A.L., Nwakalor L.N., Mbah D.A., Abba D. Factores que afectan el peso al nacimiento y la mortalidad neonatal de las ovejas Massa y Fulbe en un medio caliente y seco en Camerún

Entre 1986 y 1991, se recolectaron datos a partir de 377 corderos Massa y 422 Fulbe, para los pesos al nacimiento y la mortalidad neonatal. Los datos fueron obtenidos al azar a partir de poblaciones mantenidas en la Unidad de Investigación Animal, Yagoua, Camerún. Los datos se analizaron mediante GLM y chi-cuadrado, con el fin de identificar y cuantificar los factores que afectan el peso al nacimiento y la mortalidad neonatal. Los resultados indican un efecto altamente significativo ($p < 0,001$) sobre el peso al nacimiento de la raza, estación y año de nacimiento, tipo de parto, paridad, estación por raza y estación por año de parto. Otros factores significativos de variación para el peso al nacimiento fueron la raza por paridad, raza por tipo de parto, tipo de parto por paridad ($p < 0,01$). A pesar de que la raza Fulbe presentó un peso al nacimiento significativamente más elevado que la Massa (2,88 vs. 1,99 kg), la mortalidad en esta última fue significativamente más baja (49,76 vs. 50,24 p. 100). La mortalidad fue significativamente más baja durante la estación lluviosa (16,82 p. 100) que durante la estación fría y seca (42,90 p. 100) y la seca y caliente (40,28 p. 100). La raza Massa, aunque con un peso al nacimiento menor, está más adaptada al medio caliente y seco que la Fulbe. Sin embargo, la programación de los partos para la estación lluviosa podría aumentar la productividad y la producción de ambas razas.

Palabras clave: Ovino Massa - Ovino Fulbe - Cordero - Factor ambiental - Raza - Adaptación - Estación - Peso al nacimiento - Mortalidad - Análisis estadístico - Camerún.