

**Research Article**

Reproductive Performance and Management of Three Breeds of Cattle under Major Constraints in Extensive Management

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ABSTRACT

Introduction: The reproductive performance and management of three cattle breeds under extensive management study was investigated due to a lack of baseline data for animal husbandry practices and planning breeding programs in the study area. This study evaluated the productive and reproductive performance, feed resources, feed management, and major constraints of three breeds of cattle (White Fulani, Sokoto Gudali, and Red Bororo) production under an extensive system in Northern Nigeria.

Materials and methods: A structured questionnaire survey and group discussion were used for collecting data. 60 farmers with 30 years of experience in cattle farming were selected to administer the questionnaire. Each breed (White Fulani, Sokoto Gudali, and Red Bororo) was grown by 20 farmers.

Results: The results indicated that 70% of the farmers agreed with the first service at the age of 2.3-3 years in the three breeds. The first calving at the age of 3.3-4 years was 40% for White Fulani farmers, while 80% for Sokoto Gudali and Red Bororo farmers respectively. The calving interval in the range of 1-2 years was adequately observed in all three breeds. The age of 13-15 years was reported as the female reproductive period in this study. The total number of calves produced per cow's lifetime in the present study was estimated at 8-11 for White Fulani and Sokoto Gudali, and 4-7 for Red Bororo. Feed resources and management of three breeds of cattle under extensive management indicated that natural pasture was the most common source of feed for cattle in the rainy season. Besides, natural pasture, tree leaves, and shrubs were used as cattle feed in the dry season. The main cattle production constraints reported by the farmers included feed and water in the study area. However, the breeds could survive and produce under these major constraints.

Conclusion: Alleviating these constraints could improve the productivity of White Fulani, Sokoto Gudali, and Red Bororo in their natural environment.

1. Introduction

In emerging nations, livestock production plays a significant role in agricultural activity¹. Animals are kept for various purposes due to their drought tolerance and cultural functions, as well as milk, meat, and egg production. Moreover, several farming activities, including manure to maintain soil fertility, and draught power for cultivation, transport, and food, are performed by animals^{2,3}. These agricultural activities, especially crop production, depend heavily on livestock since they potentially reduce risks in different management

conditions, farm diversity, and intensification⁴. Therefore, much more has to be done to increase the dairy business in Nigeria and achieve self-sufficiency in dairy products. It is crucial to comprehend the productive and reproductive capabilities of the dairy breeds and their crossbred to fully utilize the genetic potential of the available dairy animal resources⁵. A vital determinant in promoting the sustainability of a dairy farming system is the herd's or animal's reproductive success. However, the productive and reproductive success evaluation depends on composite

metrics indicating total performance⁶. Age at first service, age at first calving, birth weight, total milk yield, average milk yield per day, calving to first service interval, and calving interval are significant factors that affect a cattle's productive and reproductive efficiency⁷.

Further, these factors are crucial for dairy management's economics⁷. Similarly, the calving interval is likely the greatest indicator of a cattle herd's reproductive efficiency to assess⁸. In line with age at puberty, service per conception, gestation length, and birth weight of the fetus are the most significant parameters to quantify the farm economy. Biologically, milk production capacity is also influenced by puberty age, the timing of the first calf, the number of parities, and the length of the calving gap⁶.

Traditional animal management in tropic countries heavily depends on the revenue, household food supply, and production unit coming from livestock or livestock products⁹. The agricultural sector undergoes significant structural changes as the primary source of employment, sustenance, and income in the tropics. These changes occur due to the rising demand for animal protein and the fierce competition for limited land resources, leading to an increased demand for productivity per animal and unit area⁹.

Tight constraints on sub-Saharan Africa restrict the production of livestock in community areas. The greatest problem in terms of quantity and quality is the lack of feed during the dry seasons¹⁰. Insufficient supplies of high-quality livestock feed during the dry seasons with a competitive price, which does not endanger household food security, is the fundamental barrier to raising livestock productivity and production¹¹. Feed shortage contributes to low cattle output, illness incidence, and mortality rates¹⁰. Another typical obstacle is the lack of water. Although there is enough water in some places, it may not be of high quality to support normal development and performance¹². In some areas, animals have to travel up to 14 kilometers per day to get water during the dry seasons due to the drought¹⁰. When there are few water sources, they are shared by several animals, leading to disease transmission. This research was prompted by the lack of baseline information for establishing breeding programs and animal husbandry techniques in the study area. This study assessed the reproductive characteristics, management practices, and production limitations of three cattle breeds raised in an extended system.

2. Material and Methods

2.1. Ethical approval

The current study was conducted according to the guidelines of Animal Production and Health Faculty of Agriculture and Life Sciences Federal University, Wukari, Nigeria.

2.2. Location of the study

The study was conducted in Maiduguri and its environs,

Borno State, Nigeria. Maiduguri is located at latitude 11°80' and 11 '49' 59.9988" North and longitude 13° 9' 0.0000" East and an altitude of 354 m above sea level. It falls within the semi-arid zone of West Africa characterized by the short rainfall duration (3-4 months) which varies from 50 to 600 mm, with a long dry season (7-8 months). Ambient temperatures are high during April and May and is 40°C or above, while relative humidity at noon ranges from 5 to 45%. The natural grass types in this area include Northern gamba grass (*Andropogon gayanus*), Stylo grass (*Stylosanthes gracilis*), and Leucaena grass (*Leucaena gracilis*)¹³.

2.3. Selection of farmers

A total of 60 farmers were selected for this survey with at least 30 years of agro-pastoralist practices which is in line with the recommendation of the international livestock research institute¹⁴.

2.4. Data collection

Data were collected from three cattle breeds, namely White Fulani, Sokoto Gudali, and Red Bororo in an extensive managing system. Data collection lasted for 2 months, from November to December 2020, through observations and a combination of informal (verbal) and formal surveys (quantitative) with farmers in northern Nigeria. Primary data were collected by the administration of both open and close-ended structured questionnaires to the sample of farmers (White Fulani, Red Bororo, and Sokoto Gudali cattle) in the study area. The cows and their recording were regularly visited during the research. The questionnaire administered to the farmers centered on three main issues, specifically reproductive traits, feed resources and management, and major production constraints. Each subject contained multiple-choice and closed and open-end questions. The interviews were conducted in the animal herd. The criteria used for reproductive management included first service at age, first conception, first calving, and first birth weight of calve.

2.5. Statistical analysis

Descriptive statistics were computed using the Statistical Package for Social Scientists (SPSS version 25, USA) as described previously¹⁵. A p-value of < 0.05 was considered significant.

3. Results and Discussion

3.1. Reproductive and production performance of cattle

Table 1 shows the reproductive performance of three cattle breeds under extensive management. The results indicated that 70% of the farmers agreed with the age at first service of 2.3-3 years in the three breeds. This finding concurred with the report of Mindu et al. indicating that the mean age at first service recorded were 27.1, 24.2, 28.2,

Table 1. Reproductive performance of three breeds of cattle under extensive management in Nigeria

Reproductive traits	White Fulani		Sokoto Gudali		Red Bororo	
	N	(%)	N	(%)	N	(%)
Age at first service (years)						
1-1.6	1	10	0	0	1	11.1
1.7-2.2	5	50	1	10	2	22.2
2.3-3.0	4	40	7	70	6	66.7
3.1-4.0	0	0	2	20	0	0
Age at first calving (years)						
2.1-2.6	2	20	0	0	0	0
2.7-3.2	3	30	0	0	2	20
3.3-4.0	4	40	8	80	8	80
4.1-5.0	1	10	2	20	0	0
Calving interval (years)						
1-2	10	100	10	100	10	100
Female reproductive life (years)						
4-8	0	0	0	0	1	10
9-12	2	20	0	0	5	50
13-15	7	70	9	90	4	40
16-19	1	10	1	10	1	10
Total number of calves produced per lifetime of the cow						
4-7	3	30	1	10	5	62.5
8-11	6	60	6	60	3	37.5
12-15	1	10	3	30	0	0

24.1, and 25.9 months for the local cattle, Jersey crosses, Mithun crosses, Pure Jersey, and Brown Swiss crosses, respectively⁵. A study on Jersey breed in Ethiopia, indicated an average age of 722.24 days for first service, which falls within the ranged observed in the current study⁸.

Age at first service is when heifers reach the physical and sexual maturity necessary to receive service for the first time¹⁶. Age at first service marks the start of a heifer's productive and reproductive life, which impacts the female's productive and reproductive lifespan through its impact on her lifetime calf crop. Nutrition, genetics, and other environmental factors can significantly affect the age at first service¹⁷. According to the present study's findings on age at first calving, 40% of White Fulani farmers reported that their animal gave birth at the age range of 3.3-4 years. In contrast, this age range was observed in 80% of Sokoto Gudali and Red Bororo. The findings of the present study were consistent with the total projected average age at first calving, which was determined to be 40.9-46.6 months, with local cows' average first calving age being 47.16-48.7 months and crossbred cows' average first calving age being 37.95-39.4 months¹⁸. The age at first calving found in the present study was in line with a previous study confirming that the age at first calving varied from 29.7 to 46.0 months in East African towns¹⁹. The results of present study revealed that the average age at first calving (3.3-4 years) was higher than the averages for small and big dairy farms in Addis Ababa (34.2 months and 32.6 months), respectively⁸. The variations in first-calving ages may be caused by breed, nutritional status, and management practices for dairy cows. In terms of the calving interval, farmers said that 1 and 2 years of the interval was sufficient for all three breeds (White Fulani, Sokoto Gudali, and Red Bororo). The current finding was in line with the report of Mindu et al. who documented that 494, 491, 499, 457, and 494 days were recorded as the mean internal calving time for local cows, Jersey crosses, Mithun crosses, Pure Jersey, and Brown Swiss crosses, respectively⁵. Roberts mentioned that the calving interval

of a well-managed dairy herd should be between 12-13 months²⁰. Similarly, Esslemont reported that a calving interval of 365 days is ideal for effective production since it is a key indicator of cow reproductive performance²¹. A study in Ethiopia recorded the Jersey's mean calving interval of 450.09 days¹⁹. The extended calving interval described in the current study may result from dairy cattle's subpar reproductive efficiency. This may also result from management and environmental factors, such as techniques and effectiveness of heat detection, type and effectiveness of breeding services, and the cow's capacity to resume normal ovarian cyclicity after calving, overt heat signs, and conceive using the offered service¹⁹. Since the calving interval plays a significant role in determining breeding effectiveness and influences the economics of milk production, early breeding in most modern dairies aims to produce an ideal calving interval of 12 to 13 months. As a result, the calving interval is regarded as a key indicator of reproductive performance²². Long mean calving intervals lead to low calf crops and low output levels in dairy cows. However, reproduction in these animals is characterized by regular and shorter calving intervals (365-420 days)²³. The female reproductive life reported by the farmers in this study was 13-15 years.

Responses for White Fulani, Sokoto Gudali, and Red Bororo were 70%, 90%, and 40%, respectively. The report in this study agreed with the report of Terefe et al. who opined that Mursi cow's average reproductive lifespan is 14.2 years²⁴. According to the current study, the largest number of calves produced per cow during their lifetime was projected to be 4-7 for Red Bororo and 8-11 for White Fulani and Sokoto Gudali. The estimated calve production for White Fulani and Sokoto Gudali is in line with the report by Terefe et al. who documented the Mursi cow born 11 calves in average²⁴. Additionally, the Red Bororo bears fewer calves than the two breeds mentioned above. A dairy herd's reproductive efficiency can be assessed in several ways, including the pregnancy rate, the proportion of cows that calve per year, the average calving interval,

Table 2. Responses (%) on feed resources and feed management of three breeds of cattle under extensive management in Nigeria

Feed Resources and Utilization	White Fulani		Sokoto Gudali		Red Bororo	
	N	(%)	N	(%)	N	(%)
Feed source in the rainy season						
Natural pasture	10	100	10	100	10	100
Feed source in the dry season						
Natural pasture	2	20	2	20	3	30
Natural pasture and Tree/shrub leaf	5	50	4	40	2	20
Natural pasture and others	2	20	1	10	1	10
Tree/Shrub leaf	0	0	2	20	2	20
Tree/Shrub leaf and others	1	10	1	10	2	20
Grazing methods						
Free grazing	8	80	9	90	8	80
Free grazing and tethering	2	20	1	10	2	20
Seasonal feed shortage						
Yes	10	100	10	100	10	100
No	0	0	0	0	0	0

the average number of dry days, and the number of live calves that are born annually. The calving interval impacts the dairy herd's total milk production and the number of calves born, even though each factor influences the profitability of the dairy industry in slightly different way¹⁹.

3.2 Feed resources and feed management of cattle

Table 2 indicates the results of responses on feed resources and feed management of three cattle breeds under extensive management. The findings revealed that natural pasture was the utmost common source of feed for cattle grazing in the rainy season. Besides, natural pasture, tree leaves, and shrubs are used as cattle feed in the dry season. In the three cattle breeds, 100% of respondents pointed to feeding on the natural pasture during the rainy season. This report agreed with Terefe et al. who reported 92.1% of the respondents said the cattle are fed on natural pasture during the rainy season while natural pasture, shrubs, and other feed sources are common in the dry season²⁴. Free grazing was observed as a method in this study, a common feeding practice of cattle and other livestock in the pastoral production system in Africa²⁴. Several pastoral communities in Nigeria practice both free grazing and tethering to prevent cattle from traveling long distances. For example, calves are typically tied to grazing areas close to the homestead. According to all farmers (100%), there is a seasonal feed shortage. Due to the seasonal fluctuation in rainfall distribution, there is a substantial seasonal variation in feed resources²⁵. The seasonal shortage in the study area could result from seasonal patterns of rainfall with prolonged dry seasons in the area, lack of feed conservation, and the lack of technical knowledge of producing silage.

3.3. Major constraint of cattle production

According to farmers, the main cattle production constraint for White Fulani (20%), Sokoto Gudali (30%), and Red Bororo (40%) was water (Table 3). Feed was another major constraint as reported by 70% of farmers for White Fulani and Sokoto Gudali and 40% for Red Bororo. Generally, the farmers ranked feed and water as major production constraints. Farmers noted seasonal

variations could affect livestock feed availability, with the highest feed scarcity for Rwanda, Uganda, and Kenya in the dry season²⁶. Lack of food and water could be the result of a short-wet season or a prolonged dry season. Mutibvu et al. reported that the dry season worsen food shortage¹². The seasonal nature of rainfall patterns in many parts of Africa, which causes seasonal fodder quality and quantity swings, is a typical problem. In smallholder crop-livestock systems worldwide, the adoption rate of livestock-related technology is reported to be continuously low²⁷.

Table 3. Responses (%) on the major constraint of cattle production under extensive management in Nigeria

Constraints	White Fulani		Sokoto Gudali		Red Bororo	
	N	(%)	N	(%)	N	(%)
Feed	7	70	7	70	4	40
Water	2	20	3	30	4	40
Disease and parasites	1	10	0	0	0	0
Others	0	0	0	0	2	20

Other constraints are theft, insufficient trees for shade

4. Conclusion

In conclusion, the three cattle breeds have the potential for genetic resource improvement, and better productive and reproductive performance in the study area. The farmers continued growing the breeds despite severe obstacles like a lack of nutrition and water. A controlled crossbreeding and selection method should be used to preserve the local adaptive features of the breeds.

Declarations

Competing interests

The authors have declared that no competing interests exist.

Authors' contributions

This work was carried out in collaboration with the authors. Ayuba Dauda designed and coordinated data collection. Ayuba Dauda designed and coordinated data collection. Bassey Okon wrote the protocol performed the analysis and managed the analyses of the study. Affiong Joseph Henry wrote the first draft. Jibrin Dauda Nggada managed the literature search. All authors read and

approved the final manuscript draft.

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Availability of data and materials

Data and Materials used are available per request.

Ethical considerations

Ethical issues, such as data fabrication, double publication and/or submission, redundancy, plagiarism, consent to publish and misconduct have been checked by all the authors before publication in this journal.

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