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Assessment of herd size and structure of the savanah muturu on free range in relation to genetic improvement in the Benue trough of Nigeria.

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Abstract

The study was conducted in five local government areas of Benue state, Nigeria; to asses herd size and herd structure of the savanah muturu in relation to genetic improvement. A field study of the Savanah muturu herds were conducted. The mean herd sizes of the savanah muturu were 3.00 ± 0.43, 3.60 ± 0.73, 6.00 ± 2.00, 4.27 ± 0.67, 3.00 ± 2.00. In all the populations, the number of heifers and breeding bulls were low. The number of breeding females were equally low, calf crop were low and there were no heifers for replacement in all the herds. It is evident that allelic drift through random sampling will reduce heterozygosity in these populations. Fertility and other fitness related traits would also be reduced in these populations. Genetic improvement through selection would be practically impossible in these populations, as selection intensities would be too low to exert any improvement on deserve alleles and genotypes.

Keywords: Herd-size, Herd-structure, Genetic-improvement, Savanah- muturu.

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Introduction

The ratio between new born males and females in a herd determines herd size and structure is approximately one to one [1]. However, among the mature animals the ratio is generally much biased in favor of females. In Kalamoja, the proportion was found to be in the range of 49 to 85 percent [2]. Meadows [3] reported three reasons for high male calf mortality in the Kenyan district of Kajiado. It was noted that male calves are slaughtered at an early age: to save milk for human consumption, to reduce stress on the dam by a suckling calf, this is especially true during the dry season, to have meat available in manageable quantities for the family. A large number of studies have been concerned with the possible effect of the size of the herd on the pregnancy rate, it was concluded by most investigators that the pregnancy rate decreased with the size of the herd [1-6]. On the interval between parturition and conception, it was reported by De Kruit [6] that this interval is shorter in larger herds than in small herds, because insemination is started sooner after parturition in larger herd. This shorter interval between parturition and first insemination might account in part for the higher pregnancy rates recorded in the larger herds. Hewett [7] showed that repeat breeders are more common in the larger herds than in small herds. In the very small herds 8.5% of the animals failed to become pregnant after as many as three inseminations whereas this proportion was 13.1 in the larger herds. The number of agonistic interactions per hour in a herd was found by Miller and Wood–Gush [8] to be 1.1 at pasture and 9.5 at much greater density indoors. As herd size increases there are usually more occasions when re-grouping of animals occurs [9-11].

The muturu traits have been evaluated in a communal management system in some states. This system has been largely responsible for the conservation of the muturu [12] under the system; cattle belonging to various owners in a village are herded together. This system was developed to minimize damage to crops by these cattle and owners. Performance traits of muturu were also evaluated with no tsetse control. Muturu cattle improved its performance under field station compared to the traditional system with no tsetse control. The calving rate under the traditional system was reported as 57 percent as against 92 percent under field station. Muturu calved early 635 day compared to 761 days and 684 days for Zebu and its crosses respectively [13]. Muturu cattle are fertile producing viable calf per year [14,15]. The calving interval was 18-24 months under improved management. The animals under a tsetse free environment were found to perform better than those in a tsetse infected environment even under improved environment [13].

Productivity indices of the muturu in different production environments characterized by light and zero tsetse challenge had been reported. The animals under a tsetse free environment were found to perform better than those in a tsetse infected environment. The productivity index varied from 36.8-72.3 under the two systems [13]. Age at puberty is an important determinant of productive efficiency and herd size. According to Peters [16] Puberty, expressed as the time of first oestrus in the young female, is due to ovarian changes which are in turn controlled by complex endocrinological events. In muturu bull, Ezekwe [17] observed that under improved husbandry and nutritional conditions, puberty was reported at an early age of 11 months at a body weight of 87 kg. The study also revealed that muturu bulls could be used for breeding from the age of 15 months. Puberty was assumed to have occurred in any heifer when plasma progesterone values reached/exceeded /mg/mL [18,19]. The early maturity for breeding in the young bulls and the heifers would ensure increase herd in the muturu herds. Ezekwe and Kamalu [20] reported that muturu heifers under improved management reach puberty at an early age of 12.25-14.60 months and weighed 90.50 kg and 85.20 kg for supplemented and un-supplemented feeding respectively. It is worth knowing that the relatively early attainment of puberty by muturu heifers is higher than values obtained from other

breeds of tropical cattle. Rakha et al. [21] reported that local breeds of cattle in central Africa, namely; Angoni, Mashoma and Afrikander attained puberty at about the age of 20, 19 and 20 months, respectively. Corresponding body weights of these cattle breeds were 193 kg, 192 kg and 210 kg, respectively.

In Nigeria, Oyedipe et al. [22] reported that Sokoto gudali heifers on a high plane of nutrition reached puberty at the age of 19 months, while those on medium and low planes did so at 21.3 and 23.5 months respectively. In Kenya, Ronningen et al. [23] observed that Boran cattle reached puberty at the age of 16.6 months while McDowell [24] found that the age at puberty of red sindhi cattle in India was 36.7 months. From these reports, it is clear that there are considerable variations in age and body weight at which different breeds of cattle attain puberty. Muturu cattle breed is superior to most tropical breeds in reproductive efficiency. It is well known that small temperate cattle breeds attain puberty earlier than larger breeds [25]. Therefore the relatively early attainment of puberty by muturu cattle which is considerably a small breed indeed compared to larger tropical cattle is consistent with observations in temperate cattle. This is significant because in commercial production the age at puberty in relation to the life span of the animal influences the achievement of optimum reproductive performance of the breed [26]. Early attainment of puberty also shortens the generation interval, increase herd size as well as reduces the overhead cost per animal. Exploitation of this important reproductive traits of muturu cattle would therefore enhanced large herd size and have significant effect on beef production and its availability in Nigeria.

Herd size determines the level of selection and culling for genetic improvement. Higher reproductive efficiency of the savanah muturu under improve management will enhance large herd size. The larger the herd size, the higher the number of animals available for selection and replacement to maintain herd size. Herd size determines selection intensity, selection accuracy and genetic progress achieved through. The larger the herd size, the higher the opportunities available for more genotypes in the population to to express themselves for selection, culling and the faster the selection response. It is in view of the importance of herd size as it influences overall genetic progress due to selection, that this study was designed to assess the savanah muturu herd size and structure under rural farmers communities as it influences or determines the number of animals available for selection, culling and for replacement to maintain herd size.

Materials and Methods

Study area

The study was carried out in Taraba, Nasarawa, Kogi, Benue and Niger states of Nigeria. In Benue the study was carried out in five local government Areas of logo, Kwande, Buruku, Ushongo and Tarka. Benue state is located within the lower river Benue trough in the middle belt region of Nigeria. Its geographic coordinates are longitude 7°47′ and 10°C 0′ East, latitude 6° 25′ and 8°C 8′ North. The state has extensive plains of less than 150 m above sea level. The areas are flat to nearly level and undulating with the eastern part of the state having an altitude of the 1200 m above sea level. The climate of the area is the tropical climate with distinct wet and dry seasons. The rainy season commences in April to October with mean annual rainfall range of between 800–1500 mm. The temperature fluctuates between 17. 6°C-37.0°C while relative humidity is dependent on seasons but ranges from 50% to 80% being lowest during the dry season and highest during the rainy season.

Ayilamo is a rural community settlement in Logo located at a boundary between Wukari of Taraba State and Benue state. And the study also includes some selected parts of Tarkaa local government such as Mbaayogh, Mbakyagh–Mbahar council ward. The community is located at latitude 7^0 46^1 21" N and longitude 9^0 7^1 29'' E with an altitude of 217 m. It has temperature range of 24°–32°C, and a relative humidity of 65% to 82%, precipitation of 35%-40%. The terrain in the environment is generally very variable with Neutral soil pH. (5.5–8.5) there is natural vegetation of tree cover making up 45%. The areas have a management environment that is grass–land base (ranching) with a mixed system of agriculture (crop and livestock). Animal in these communities are confine mostly at night.

Experimental animals and their management

The animals that were used for the research were savannah muturu cattle comprising both sexes and different ages. The total number of the animals used for the research were 138, comprising of 35 number of males and 103 number of females. Out of the total number of the animals, thirty six (36) were calves, nineteen (19) were breeding bulls, 56 were breeding cows and twenty seven (27) were heifers. There was no castrated bull among all the samples. The populations were drawn from Logo and Tarka local government area of Benue State. The animals were managed under free range with no supplementary feeding, there is no evidence of veterinary care for the animals.

Experimental procedure and materials used

The study was carried out in two phases. In phase one, a survey by use of questioner was administered to rural farming communities that were associated with rearing of savanah muturu cattle. Phase two was a field study having identified muturu rearing communities in phase one. A One on one discussion and oral interview of farmers who were reported to had reared the muturu cattle but had no animals during the study was also carried out. The reasons for discontinuing the rearing of muturu cattles were sought. Rural farmer communities that had muturu animals on ground, physical assessment of body coat colour, individual herd size, herd composition, attempt to control inbreeding by use of castration, economics of production, health challenges, loses due to mortality (age group most affected), attempt to retain heifers for replacement, use of bulls of other breed (Bunaji) for serving the muturu dams were information obtained from the muturu farmers. An inventory of the entire population of savanah muturu cattle was also carried out. Photographs of savanah muturu cattle were taken from various herds using digital cameras. GPS Gadget were used to identify the location of the herds.

Parameters that were measured

Population size of animals (Muturu cattle), herd sizes, composition /herd proportion such as; number of breeding males, number of breeding females, number of calves, number

of castrated males or males not to be use for breeding and number of replacement heifers. Phenotypic characterization (presence or absence of horn, horn shape/orientation and coat color were also assessed.

Data collection and analysis

Data were collected on morphological traits, individual herd size, herd composition, attempt to control inbreeding by use of castration, economics of production, health challenges, loses due to mortality (age group most affected), attempt to retain heifers for replacement, use of bulls of other breed (Bunaji) for serving the muturu dams and population size. Data collected were subjected to descriptive statistics and analysis of variance to measure the effects of the parameters listed above.

Results

Herd size and composition in logo local government area of Benue state

The study indicated that the herd size in Logo North was 3.40 ± 0.43. Herd composition were 1.00 ± 0.16, 2.40 ± 0.39, 0.87 ± 0.16, 0.53 ± 0.12, 1.37 ± 0.24 and 0.57 ± 0.11 for the number of males, females, calves, breeding bulls, breeding cows, and number of heifers respectively (Table 1).

Table 2 presented the mean herd size in Tarka to be 3.60 ± 0.73. Herd composition were 0.50 ± 0.27, 3.10 ± 0.55, 1.00 ± 026, 0.30 ± 0.15, 1.50 ± 0.31, 0.80 ± 0.29 for number of males, females, calves, breeding bulls, breeding cows and number of heifers respectively.

Herd size and composition of savanah muturu in Ushongo local government area of Benue state

In Ushongo Local Government Area, mean herd size was 3.00 ± 2.00, while the average number of males and females were 3.00 ± 0.09 and 1.50 ± 0.50 respectively. Heifers were not available for replacement. Unwanted bulls were not castrated (Table 3).

Discussion

Herd size of the savanah muturu in Nigeria

In all the surviving populations of the savanah muturu, the herd sizes were very low. There were also no attempts to minimize inbreeding as unwanted bulls were not castrated nor exchange of bulls between farmers was not practiced. There were also no designed efforts to retain heifers for replacement. Therefore, there is no doubt that these populations had gone through high levels of inbreeding. This was indicated by the high levels of solid colors between and within the populations. Herd size has direct correlation with the level of inbreeding, where herd sizes were small, there would be a high level of inbreeding which in turn would lead to inbreeding depression. A simulation of herd dynamics proved that the rate of growth of the herd peaks when female calves dominate the kraal [27]. The young animal contributed about 50% of the herd size with more females (35%) than males (15%).

Herd composition and characteristics of the savanah muturu in Nigeria

The ratio of calves of one calf to a cow and the bull that provided animals for replacement was not obtainable in these

Table 1. *Herd size and composition of the savannah muturu under rural farmers in Logo (North) local government area.*

Variable	Mean	± SE
Herd size	3.40	0.43
Males	1.00	0.16
Females	2.40	0.39
Calves	0.87	0.16
Br. Bull	0.53	0.12
Br. Cows	1.37	0.24
Cas. Bulls	0.00	0.00
Heifers	0.57	0.11
SE: Standard Error; Br: Breeding; Cas: Castrated		

Table 2. *Herd Size and composition of the Savannah Muturu under rural farmers in Tarka (North) Local Government Area.*

Variables	Mean	± SE
Herd Size	3.60	0.73
Males	0.50	0.27
Females	3.10	0.55
Calves	1.00	0.26
Br. Bulls	0.30	0.15
Br. Cows	1.50	0.31
Cas. Bulls	0.00	0.00
Heifers	0.80	0.29
SE: Standard Error; Br: Breeding; Cas: Castrated.		

Table 3. *Herd size and composition of the savanah Muturu in Kwande local government area of Benue State.*

Location	Parameter	Mean	SE	SD	VAR	Coe. Var.
Kwande	Herds size	6.00	2.00	2.83	8.00	47.14
	Males	3.00	1.00	1.41	2.00	47.14
	Females	1.50	0.50	0.70	0.50	47.14
	Heifers	0.00	0.00	0.00	0.00	0.00
	Cow calves	1.00	-	-	-	-
	Bull calves	1.00	0.00	0.00	0.00	0.00
	Br. males	1.50	0.50	0.71	0.50	47.14
	Br. females	1.50	0.50	0.71	0.50	47.14
	Cast. males	0.00	0.00	0.00	0.00	0.00
SE: Standard Error; SD: Standard Deviation; Coe Var: Coefficient of Variation; Br: Breeding Cast: Castrated; Var: Variance.						

populations. There were more breeding females than heifers in the populations. This was so because, selection for sale were higher for the bulls and growers than the breeding females. The number of calf were also low as farmers were conscious of herd size, that a breeding female was allowed in the herd for longer time than bulls, heifers and growing bulls. A large number of studies have been concerned with a possible effect of the size of the herd on the pregnancy rate, it is concluded by almost all investigators that the pregnancy rate decreased with the size of the herd [1-6]. On the interval between parturition and conception, it is concluded by De Kruit [6] that this interval is shorter in larger herds than in small herds (Table 4).

Number of breeding males in the herd of the savanah muturu in Nigeria

In all the populations, the number of breeding bull were very low. This would likely have an effect on the rate of calf productivity. An infected male for several heat periods may not be able to have successful mattings that would result to pregnancy. Conception rate and calving interval could be affected significantly under this condition. The effect of inbreeding would also be more

Table 4. *Herd size and characteristics of savanah Muturu in Buruku local Goernment Area of Benue State.*

Location	Parameter	Mean	SE	SD	Variance	Coe. Var.
Buruku	Herd size	4.267	0.597	2.314	5.352	54.22
	Males	1.4	0.221	0.699	0.489	49.94
	Females	2.286	0.354	1.326	1.758	58.01
	Heifers	1.333	0.236	0.707	0.5	53.03
	Cow calves	1	-	-	-	-
	Bull calves	1.333	0.333	0.577	0.333	43.3
	Br. Males	1.167	0.167	0.408	0.167	34.99
	Br. Females	2.5	0.327	1.225	1.5	48.99
	Cast. males	-	-	-	-	-

SE: Standard Error; SD: Standard Deviation; Coe Var: Coefficient of Variation; Br = Breeding; Cast: Castrated.

pronounce when a breeding bull is use for long time as practiced by the rural savana muturu farmers. In matured animals the ratio is generally much biased with a preponderance of the female stock than males on the average, the female animals constituted 60 to 75% in each herd [28].

Number of breeding males in the herd of the savanah muturu in Nigeria

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Number of breeding females, heifers for replacement and castrated males in the herd of the savanah muturu in Nigeria

The number of breeding females determines the calf crop in the herd. The available heifers for replacement and maintenance of herd size is also determine by the breeding females in the herd. Calf crop were low and there were no heifers for replacement in all the herds. The proportion of breeding cows in the herd was 49.1% while the proportion of the breeding bulls was 6% [28]. The profitability of any cattle enterprise is highly determined by the number of breeding cows and young females in the herd [29]. Selection for genetic improvement was not possible in these herds as culling was not possible. Castration was not carried out on unwanted bulls in all the populations. Castration would have allows for culling unwanted bulls from the herd as well as control the rate of inbreeding. It may also have allow the fattening of bulls for sale. Hence, a side effect of inbreeding, there was no competitive pricing and prices as there was no design attempt for value chain intervention and value addition. Thus, pricing, prices and marketing outlet were low. The economic of production was very low despite the high cost of the muturu animal, and hence no economic driving force for continued rearing of savanah muturu animals. This had contributed immensely to the journey of this breed to extinction (Table 5).

Effect of herd size on genetic variation due to random sampling and genetic drift

In small populations, allelic drift through random sampling will reduce heterozygosity. This result agreed with the observation reported by Maule [30] who had shown that the typical coat color of the savannah muturu is black and white. The result is also analogous with the one reported by Adebambo [13]. The maintenance of genetic diversity in a herd is a function of the genetic effective population size [31,32], which is defined as the size of an idealized population that would experience the same magnitude of random genetic drift as the population of interest [33]. In small, populations allelic diversity is lost relatively quickly through random genetic drift but heterozygosity is less affected. Genetic drift is a strong force in small populations and can result in rapid loss of genetic diversity [34].

Effect of herd size on rate of inbreeding and inbreeding depression

Genetic concern that arises with small population is the potential for inbreeding, which is the breeding of related individuals. Inbreeding may reduce fertility, juvenile survival and lifespan. In small population that are isolated inbreeding is inevitable. Inbreeding occurs when mating of individuals that are more closely related than random individuals from a population [35]. Inbreeding causes a reduction in genetic variability which in return is the basis of inbreeding depression which affects fitness-related traits such as fertility, when recession alleles are deleterious [35-37]. Inbreeding depression has been documented in numerous animal species [38-41]. Two genetic mechanisms have been proposed as the cause of inbreeding depression both relate to the decrease in heterozygosity during the inbreeding process. The dominance effects (the presence of deleterious recessive alleles) are thought to account for a large proportion of the breeding depression observed [41-46].

Effect of herd size on selection intensity for genetic improvement

The rate of genetic change is proportional to selection accuracy. Selection accuracy is based on choosing animals with the best breeding value for the traits in question [47]. It is also reported that as the size of herd increases, the number of animals rejected in the selection process will also increases given room for the best animals to be selected, hence, selection intensity will also increase. As selection intensity increases, genetic change in the population will occur more rapidly [47-57].

Table 5. *Herd size and composition of the savanah Muturu in Ushongo local government area of Benue State.*

Location	Parameter	Mean	SE	SD	VAR.	Coe. var.
Ushongo	Herds size	3	2	2.43	5	37.14
	Males	3	0.09	1.31	2	45.14
	Females	1.5	0.5	0.8	0.5	49.14
	Heifers	0	0	0	0	0
	Cow calves	1	-	-	-	-
	Bull calves	1	0	0	0	0
	Br. males	1.3	0.4	0.61	0.5	47.14
	Br. females	1.4	0.4	0.81	0.5	47.14
	Cast. males	0	0	0	0	0

SE: Standard Error; SD: Standard Deviation; Coe Var: Coefficient of Variation; Br: Breeding; Cast: Castrated; Var: Variance.

Conclusion and Recommendations

Conclusion

The muturu cattle even though possesses the potential to enhance large herd size for effective selection and herd replacement, this was not so with the muturu herds under rural farmers. The herd sizes in the study populations were very low. There were more breeding females than heifers for replacement in the populations. The number of breeding bulls was very low; selection targeting heifers and young bulls for replacement and change of breeding males would not be possible with this populations. There is a high potential for inbreeding in this populations. Fitness-related traits like fertility, and heterozygosity will be greatly affected. It is also not possible to advance genetic improvement strategies with this population through selection. This is because there would be no animals to maintain herd size if selection is to be attempted. Selecting all the available animals will not only reduce selection accuracy and intensity, but would also affect selection progress achievable per generation [57-69].

Recommendations

The following recommendations were drawn from the study:

1. There is need for all the Muturu farmers to retain heifers and young bulls to which selection can be applied for genetic improvement.
2 Where the herd sizes are extremely low, there is need to adopt bull exchange practices during breeding for genetic improvement and to reduce rate of inbreeding depression.

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