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Reproductive Performance of Zebu Cattle Following Artificial Insemination (AI) in Adamawa State, North-Eastern Nigeria

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ABSTRACT

The precarious supply of animal products to Nigerian populace may worsen if livestock production is still based on the use of multipurpose indigenous cattle breeds with genetically low productive potentials. The main objective of this study was to determine the reproductive performance of Zebu cattle in an AI program in The Federal Polytechnic Mubi, Livestock Farm, Adamawa State, North-Eastern Nigeria. Twenty (20) female Zebu cattle comprising heifers and cows were selected at random from the cattle herds, February to March, 2016. The insemination was performed via recto-vaginal technique following estrus synchronization, using prostaglandin F2α (PGF2α). The results of the study showed animal age ranging from three (3) to ten (10) years old with parity from 0 to 5. The body condition scores of the animals vary from 2.0 to 2.5 indicating poor nutrition and management practices at the period. There was 100% estrus detection rate since all animals displayed signs of heat and were turned in for insemination. The findings showed a low success rate of 25% with higher failure rate of 75%. It was concluded that, Ayrshire and Brahman crossed Zebu female cattle through AI, though gave low fertility rates at the first attempt, is still the rapid means of improving milk production and reproductive efficiency of the combined adaptability and hardiness of the Zebu cattle (Bos indicus) with the genetically high reproductive and milk yield potentials of the exotic breeds (Bos taurus). There is still room for an in-depth future study of the effects of upgrading indigenous Zebu cattle crossed with exotic bulls to maximize production. This is important in realizing the goal of increasing the production and reproductive efficiency of the indigenous crossbred cattle in the country. This would also ensure sustainable food security in the North-East and Nigeria as a whole.

Keywords: Reproductive performance, Cattle, Artificial Insemination, Adamawa State, Nigeria

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INTRODUCTION

The Zebu (Bos indicus) cattle is the type which forms the foundation for both milk and beef production in Nigeria. However, the productivity and reproductive performance of Zebu cattle that are indigenous to the tropics is low (Pullan, 1979; Agyemang, Dwinger, Little & Rowland, 1997). The low productivity has been reported to be one of the several adaptive features that help to keep the animals in equilibrium with the stressful environment (Tizikara, Akinakun & Chibeka, 1985). To determine the reproductive performance of cattle, it is necessary to consider the fertility indices. Thus, reproduction is a vital factor in determining the efficiency of animal production (Peter & Ball, 1995). Assessment of fertility should not be based on a single criterion but on all criteria in conjunction with each other. The fertility indices include post-partum anoestrus period, days open, service interval, calving interval, pregnancy rate, conception rate, number of services per conception (NSC), calving rate, non-return rate and AI index (Wagner, 1986).

The main objective of this study is to determine the reproductive performance of Zebu cattle in an AI program in The Federal Polytechnic Mubi Livestock Farm, Adamawa State, North-Eastern Nigeria. The specific objectives are to: Determine the breeds of the cattle used for AI in the farm, ages and parity of the animals, body condition scores of the animals, estrus detection rate following synchronization, fertility rates and the number of inseminations per conception.

MATERIALS AND METHODS

The Study Area

The soils are a function of the underlying rocks, the seasonality of rainfall and the nature of the wood-land vegetation of the zone. The soils are derived from the basement complex, granite and gnesis that form the ranges of mountains. Adamawa State is located at the area where the River Benue enters Nigeria from Cameroon Republic and is one of the six states in the North-East geopolitical zone of Nigeria. It lies between latitudes 70 and 110 North of the Equator and between longitudes 110 and 140 East of the Greenwich Meridian (Mohammed, 1999). It shares an international boundary with the Republic of Cameroon to the East and interstate boundaries with Borno to the North, Gombe to the North-West and Taraba to the South-West (Adebayo, 1999; ASMLS, 2010a), as shown in Figure Ia.

According to Adebayo, and Tukur (1997), Adamawa State covers an area of land mass of about 38,741km^2. The state is divided into three Senatorial Zones (Northern, Central and Southern) which translates to three agricultural zones as defined by INEC (1996), which are further divided into 21 Local Government Areas (LGAs) for administrative convenience.

The State has a population of 2,102,053 persons (NPC, 1990). The main ethnic groups in the state are the Kilba, Higgi, Quadoquado, Lala, Yungur, Bwatiye, Chamba, Mbula, Margi, Ga'anda, Longuda, Kanakuru, Bille, Bura, Yandang, Fali, Gude, Verre, Fulani and Libo (Adebayo & Tukur, 1997; Adebayo, 1999; ASMLS, 2010b). The dominant religions are Christianity and Islam, although some of its inhabitants still practice traditional African religions.

The major occupation of Adamawa people is farming. The soil type is ferruginous tropical soils of Nigeria based on genetic classification of soils by the Food and Agricultural Organization of the United Nations (FAO, 1996).

The mineral resources found in the state include iron, lead, zinc and limestone (Adebayo & Tukur, 1997).

The common relief features in the state are the Rivers Benue, Gongola, Yadzaram and Kiri

Dam, Adamawa and Mandara mountains and Koma hills. The state has minimum and maximum rainfall of 750 and 1050 mm per annum and an average minimum and maximum temperature of 150C and 320C, respectively. The relative humidity ranges between 20 and 30% with four distinct seasons that include early dry season (EDS, October – December); late dry season (LDS, January – March); early rainy season, (ERS, April – June) and late rainy season (LRS, July – September), according to Adebayo (1999). The vegetation type is best referred to as guinea savannah (Areola, 1983; Adebayo & Tukur, 1997). The vegetation is made up of mainly grasses, aquatic weeds along river valleys and dry land weeds inter-spersed with shrubs and woody plants. Plant heights ranges from few centimeters (Short grasses) to about one meter tall (tall grasses), which form the bulk of animal feeds.

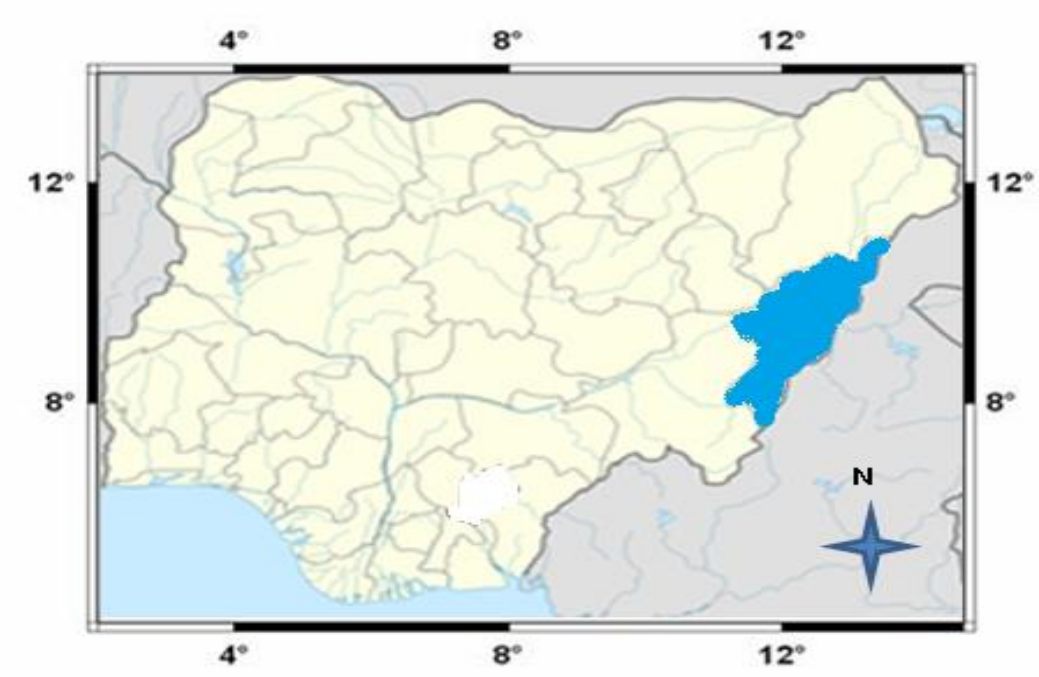

Figure Ia: Map of Nigeria Showing Adamawa State

Cash crops grown in the state include cotton and groundnuts, sugarcane, cowpea, benniseed, bambara nuts, tiger nuts, while food crops include maize, yam, cassava, sweet potatoes, guinea corn, millet and rice. The communities living on the banks of rivers engage in fishing, while the Fulani and other tribes who are not resident close to rivers are pastoralists who rear livestock such as cattle, sheep, goats, donkeys, few camels, horses and poultry for subsistence (Adebayo & Tukur, 1997; Adebayo, 1999).

The Study Site

The Federal Polytechnic Mubi Livestock Farm was established with the sole aim of providing facilities for research and learning purposes. The Federal Polytechnic Mubi Livestock Farm is located in Mubi-North LGA at the northern part of old Sardauna Province, which now forms Adamawa North Senatorial district as defined by INEC (1996) as shown in Figure Ib. The region lies between latitude 90 30´´ and 110 North of the equator and longitude 130 and 130 45´´ East of Greenwitch Meridian. It has an altitude of 696 meters above sea level with an annual mean rainfall of 1,220mm and a mean temperature of 15.20C during hamattan periods from November to February and

39.70C in April (ADADP, 1986). The town has essentially a mountainous landscape tranversed by river Yedzaram and many tributaries, Mandara and Adamawa Mountains form part of this undulating landscape (Mansir, 2006). The Gude, Fali, Fulani and other tribes dominate the area which has a lot of pasture land. Mubi region is bordered in the North by Borno State, in the West by Hong and Song LGAs and in the South and East by the Republic of Cameroon. It has a land area of about 4,728.77 km² and human population of about 759,045 going by NPC, (1991) census projected figure (Adebayo & Tukur, 1991). It has an international cattle market linking neighboring countries such as Cameroon, Chad, Central Africa, Niger, Mali and Senegal to Southern Nigeria where cattle are consumed.

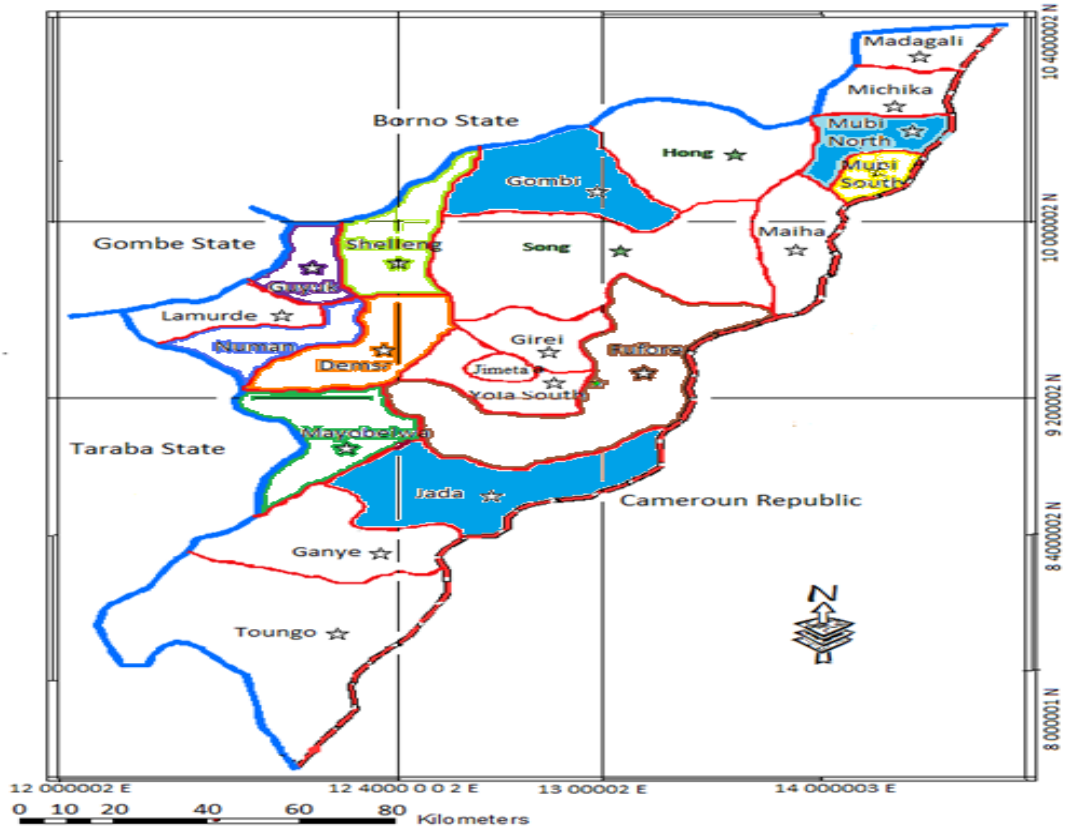

Figure Ib: Map of Adamawa State, Showing the Study Areas in Blue Color

Selection and Management of Animals

The 20 female animals comprising cows and heifers used for the study were selected at random from the cattle herd from February to March, 2016, as shown in Figure II. The Livestock Farm consists of five units including large ruminants (cattle), small ruminants (sheep and goats), piggery, rabbitary and poultry units. The common cattle breeds in the farm are the Zebu, such as White Fulani (Bunaji), Red Bororo (Rahaji), Sokoto Gudali (Bokoloji), Adamawa Gudali, Muturu and some crosses reflecting the common breeds in the state. Cattle population ranges between 120 and 150 animals including service bulls, castrated bulls, bullocks, heifers, dry cows, nursing cows and pregnant cows. The small ruminants unit has over 100 animals. There are, also, piggery and rabbitary units with more than 50 animals in each. The farm also has a poultry unit that accommodated 2,000 to 4,000 birds of both layers and broilers. The cattle are sourced from Mubi International Livestock Market which are

usually aggregated from other countries such as Cameroon, Chad, Senegal, Central Africa, Zambia and Burundi (Adebayo, 1999).

The livestock management in the farm involves taking out sheep, goats and cattle every morning and bringing them back in the evening by herdsmen to graze forages during the wet seasons and scavenge the crop residues and by-products during the dry seasons. Crop by-products are, also, gathered and preserved to supplement feeding during critical periods of the year. The animals drink water in the nearby Rivers Yadzaram and Vimtim but occasionally water is supplied to them using the polytechnic water tanker. Natural or pasture mating is the common breeding system in the farm. Make shift Kraals constructed with sticks and barbed wires are used to restrict cattle owned by individuals and members of staff, while permanent concrete kraal is used for cattle owned by the institution. The animals have access to veterinary services with limited use of ethno- veterinary medicine.

Materials Used for the Study

The materials used for the AI program include: Plastic inseminating pipettes or guns connected directly to the plastic syringes; Clean rubber or disposable plastic hand gloves; Lubricant or liquid paraffin; Cotton and paper towels; Straws of semen; Stainless steel vacuum containing liquid nitrogen and semen of Ayrshire and Brahman breeds (Figures IV and V); Kit box containing a thermometer, thermo flask and pair of forceps.

Breed Identification, Age, Body Condition Score and Conception Rate Determination

Data on the breed and age of animals were obtained by physical observation of peculiar characteristics, herdsmen's memory and farm records. Body condition scores of the animals were determined using visual indicators or a combination of the visual and palpation of key bone structures for fat cover. The key areas that were evaluated were the backbone, ribs, loin area and tail head by the use of a scale 0 – 5 grades as described by Jefferies (1961), Lawman et al. (1976), Pullan (1978), Gatenby (2002), Todd (2008) and Addass (2011). Conception were determined by calculating the number of animals inseminated divided by number of animals pregnant multiplied by 100.

Insemination Technique

The animals were inseminated about 12 hours after onset of heat and it was performed via recto-vaginal technique (Figure III) following estrus synchronization using prostaglandin F2α (PGF2α) as described by Nafarnda et al. (2005). This was preceded by removing the semen from the liquid nitrogen tank using forceps and was thawed in a water bath to a temperature of 37oC then loaded to the inseminating gun.

The gloved left hand was lubricated with liquid paraffin and the tails of the animals were raised up by the help of herdsmen and AI assistants to expose the rectum. This was followed by gentle insertion of the gloved left hand into the rectum for manipulation of the reproductive tract (cervix). The right hand was used to insert the inseminating pipette through the vulva opening which invariably was assisted by downward pressure of the fore-arm in the rectum. This caused the lips of the vulva to separate sufficiently to allow the instrument come in contact with the lining of the vagina. The inseminating pipette was introduced freely and gently with the tip pointed slightly upward in to the vestibulum. The hand in the rectum located and indicated the cervix. The procedure was done easily by following the vagina upward, the thumb was placed at the opening while grasping around the cervix with the other finger. The cervix was pushed forward so that, the folds of the wall of the vagina were straightened out. The pipette was then passed horizontally in to the cervix, the left hand in the rectum guided and directed the position of the cervix. The

inseminating pipette was inserted up to 2/3 of its length in to the cervical canal and the semen was deposited in the middle of the cervical canal. The inseminating pipette was then slowly and gently withdrawn. Hands were washed and gloves used were also properly disposed. Similar procedure was repeated in all the 20 animals inseminated during the program. The animals were then monitored for pregnancy. Pregnancy diagnosis was carried out by observing those that come on heat again and through rectal palpation after three months of insemination to establish the response rate of the inseminated animals. Conception rate was calculated as the percentage of animals pregnant divided by the number of animals inseminated.

Data Analysis

Data generated were subjected to descriptive statistics such as frequency distribution, percentages and means to explain ages, parity, BCS, estrus detection and conception rates.

RESULTS AND DISCUSSION

Breed of Animals

Table 1 highlights the Zebu cattle used for the study which include: White Fulani (Bunaji), Red Bororo (Rahaji), Sokoto Gudali (Bokoloji), Adamawa Gudali, Muturu and some crosses reflecting the common breeds in the state. The animals, again, were selected based on their physical soundness with well developed feet, mammary glands, teats, vulva and physiological qualities. There were no in-depth breed and genetic resource laboratory investigation to arrive at selection of the breeds. This implies that, the breeds used for the study may not be categorically said to be pure breeds but possibly crosses.

White Fulani cattle are, however, considered important for their genetic predisposition of hardiness, heat tolerance and adaptation to local conditions (Alphonsus et al., 2012). The White Fulani is a triple-purpose animal, with milk production of 2,300 kg per lactation. It may be fattened for beef, kept for milk production, or used as draught animal, especially the bull. Crosses of White Fulani and Holstein recorded increased milk production at NAPRI, Shika, Zaria (Alphonsus et al., 2012). They provide much of the beef consumed throughout Nigeria (Payne & Wilson, 1999; Alphonsus et al., 2012).

Table 1: Reproductive Indices of Zebu Cattle Following AI in Federal Polytechnic Mubi Livestock Farm

Breed	Heifer	Cow	Frequency	Percentage (%)
Zebu				
Age	3-6	7-10		
BCS	2.5	2.5		
Parity	0	1-5		
NAS	8	12	20	100
NAE	8	12	20	100
NAI	8	12	20	100
NAP	1	4	5	25
NAO	7	8	15	75

BCS = body condition score; NAS = number of animals synchronized; NAE = number of animals that came on estrus; NAI= number of animals inseminated; NAP = number of animals pregnant; NAO = number of animals open; NIC = number of insemination per conception

While Red Bororo (Rahaji) is considered an extremely prestigious breed that many herds use for crossbreeding, it tolerates neither humidity-related diseases nor poor nutrition (Blench, 1993). The Sokoto Gudali breeds are, also, considered useful milkers. Their milk yield at the National Animal Production Research Institute (NAPRI), Shika was higher than that of white Fulani (Payne & Wilson, 1999; Alphonsus et al., 2012). They have udders that are well developed with good teats, hence they are regarded as indigenous dairy breed. The female produces an average of 1,500 kg of milk per lactation (Payne & Wilson, 1999). Other breeds include Adamawa Gudali, Muturu and some Sangas or crosses which were available in the farm.

The results of the present study agree with Bello, Rwuaan and Voh, Jr. (2009); Mbap and Ngere (1995), who reported that, the use of indigenous cattle as a female resource for cross-breeding with exotic breeds by artificial insemination (AI) has been proven to be effective in producing a dual-purpose (beef/milk) animal suitable for many tropical regions. Similarly, research has also shown that, crossbred cattle have significantly better performance than indigenous Zebu cattle (Lobago, Bekana, Gustafsson & Kindahl, 2006; Negussie, Brannang, Banjaw & Rottmann, 1998).

Ages and Parity of Animals

Determination of ages of breeding stock is very important in any breeding program since animals are considered ready for breeding when they attain certain ages at puberty. Some signs of puberty manifest when animals are two to three years old in most tropical breeds of cattle. The results of the study therefore, showed that, the animals were selected and inseminated at the ages of three (3) to ten (10) years old. This was because the animals comprised of heifers and cows which had parity ranging from 0 to 5 as shown on Table 1. one (1) out of the five (5) animals conceived was a heifer of 4 years old, while the remaining four (4) were cows with 3 to 5 parities and aged between 7 to 10 years.

The results were in agreement with the earlier studies of Buck and Light (1982); Dawuda, Eduvie, Esievo and Molokwu (1988), who reported that, fertility indices of animals are affected by age and parity of the dams. This also implies that, when the animals are too young or too old, conception rate reduces and at times calving may be difficult. It is also an indicative that, breeders should ensure that, animals are bred at the appropriate ages for high conception rates and ease of calving.

It has been observed that, availability of feed resources, space and health care also affect positively the animal's puberty age, thereby creating room for early reproductive activity (MLA, 2006). Usually under good management practices, cattle start sexual play and breed at 1 to 3 years old. However, disease conditions, malnutrition, overcrowding and social vices could hamper early sexual maturity among cattle breeds of tropical origin (Bertram, 2000; McCosker, 2006).

Body Condition Scores

Evaluation of body condition scores of breeding stock is a necessity in a breeding program because it indicates the level of nutrition, physiological health status and soundness of the animals. The results indicated that, animals were bred at poor body condition scores of 2.0 to 2.5. Out of the five (5) animals conceived, one heifer and a cow were bred at BCS of 2.0 while the remaining three were inseminated at BCS of 2.5. This could be that, the breeding program took place during the dry season from February to March, 2016. And at this period of the year, there were no enough forages, the few forages and crop residues available had low nutrient content and were too dry for the

animals to utilize, which consequently affected their performance.

The results corroborate that of Buckley, O'Sullivan, Mee, Evans, and Dillon (2003); Roche, and Berry (2006), who reported close association between body condition scores with fertility and health status of the animals respectively. This shows that, animals with very low body condition scores will have low conception rates accompanied with difficulty in calving. Although evaluation of body condition could be looked at as an ongoing process, there are several key times when body condition scoring should be considered. These periods include late dry season in systems where female animals are managed almost entirely on communal pastures and range lands. For example, if cows are thin, early weaning should be considered. Non-lactating cows may pick-up condition by grazing forage alone or by feeding a small amount of supplement along with the grazed forage. Again, if young cows are thin and grass in the pasture is decreasing in nutrient quality there is need to strategically wean calves. Particular attention should be paid to young cows weaning their first calves, as they are most likely to be thin at this time. There may be need to consider early weaning of calves and giving cows access to higher quality forage.

According to Akpa et al. (2012), progressive cattle producers have recognized the important relationship between the physical appearance of their animals and reproductive performance outcomes. Body condition scores, also, allow producers to group cattle according to their nutritional requirements, thereby improving the efficiency of nutrition programs. Furthermore, body condition scores standardize the description of body condition in beef cows which greatly enhances communication among cattle producers, university educators, veterinarians and industry advisors. Body condition scoring of cows allows for analysis of management practices, application of research results and recommendations for individual cattle herds.

Estrus Detection Rate

Twenty (20) animals were synchronized in batches and those synchronized in the morning showed and manifested signs of heat late in the evening. While animals synchronized in the evening displayed signs of estrus in the morning. The visual signs of estrus displayed by the animals include restlessness, mucus from the vulva, mounting others and standing to be mounted. It was at standing heat that the animals were turned in for insemination. Eighteen (18) animals showed signs of heat at a single dose of prostaglandin F2α (PGF2α), while the remaining two were re-synchronized before they came on heat. Therefore, the estrus detection rate in this present study was 100% since all the 20 animals synchronized displayed signs of heat and were inseminated. The high detection rate could be attributed to the wealth of experience of the herdsmen on the farm who were able to recognized and detect the animals on heat promptly.

The results agree with that of Nafarnda et al. (2005); Alm-Packalén (2009); Alphonsus et al. (2014); Mai, Voh, Jr., and Deshi (2014), who reported that, the surest sign of estrus is the standing heat which is the best sign of a cow's fertile period. A detection rate of 80-85 percent is achievable in a well organized breeding program with experienced herdsmen and estrus detection aids.

Conception Rate and Number of Inseminations per Conception

Reproductive performance of any herd has been shown to be one of the most important starting points in any animal improvement package (Mukasa-Mugerwa et al., 1992). This implies that, whatever the goal of the production system is, reproductive traits appear to be economically important in cattle improvement programs. This is because, milk

and meat production depends on the reproductive efficiency of the cows, with the best cows being those that calf at an early age with little number of services per conception and with minimum calving interval thereafter. The findings on Table 1 shows that, out of the 20 animals inseminated, 5 of them conceived at a single service giving a success rate of 25%. While 15 of the animals did not conceive, giving a failure rate of 75%. The results of the present study shows a low conception rate in a single service as compared to that of Nafarnda et al. (2005), who reported a higher pregnancy rate (95%) when White Fulani breeds were crossed with Friesian breeds in Vom, Jos, Plateau State, Nigeria. Similarly, the conception rate, also, fell below that of Alphonsus, Akpa, Barje, Nwagu, and Orunmuyi (2014), who reported a higher pregnancy rate of 85 to 90% in Friesian crossed Bunaji dairy cows in Zaria, Nigeria.

Again, the conception rate of 25% is, also, lower than the 46.5% (Mai et al., 2014), 67.8% (Dawuda et al., 1987), 50% (Voh, Jr., Buvanandran & Oyedipe, 1987) and 48.8% (Eduvie & Dawuda, 1986) reported in indigenous Nigerian cattle. In their studies, season did not significantly affect the conception rates, which may be due to the apparent success of practicing feed supplementation particularly in the dry season. All the cattle used by the authors were in good body condition for reproduction. Hence, cows could not experience much reproductive failure due to nutritional stress in the dry season.

However, the low conception rate in this study may be due to the low BCS of the animals since they were selected and inseminated during the dry season. These critical periods are usually characterized by lean feed resources of poor quality as well as high wind and dust borne diseases. During these periods, the pasture and range lands become defunct, forages are dried up and bush fire clears large proportion of pastures leaving only forages along river banks, crop residues and by-products as the only sources of feed for cattle to scavenge. As a result of this, animals are unable to meet their protein and energy needs from available low-quality herbage with consequent marked weight loss and productivity (Adegbola, 1998).

For example, studies have shown that, the crude protein (CP) content of native grasses during the dry season is about 1.5 to 3% (Adamu et al., 1993) which is far below the minimum level of 7% CP required in forages to enhance voluntary intake, digestibility and utilization by ruminants. Thus, the conservation and utilization of cheap and readily available feedstuff is a major challenge facing livestock farmers in Northern Nigeria amidst feed crisis (Bogoro, 1997). These cheap feed resources include crop residues, agro-industrial by-products, animal processing wastes, brewery waste and by-products, farm animal wastes (poultry litters, animal faeces) and other forms of fibre, protein and energy by-products suitable for ruminant feeding as well as browse plants (Adegbola, 1985; Alhassan et al., 1987).

Other reasons for the low conception rate may be ascribed to errors in estrus detection, fouls estrus and since it was the first AI attempt in the farm, there may be likelihood of making mistake in the insemination. Nevertheless, the findings corroborated the assertion that, Zebu cattle have relatively poor fertility traits characterized by late maturity and long inter calving intervals attributed to an exceptionally large number of factors which often interact with each other (Oyedipe, Buvanendran & Eduvie, 1982; Lobago, Bekana, Gustafsson & Kindahl, 2006).

The optimal reproductive rate in livestock production is that which gives maximal economic profit per breeding female per year. In the case of cattle, it is maintaining a calf per

Figure II: One of the Herds from Which the Female Breeding Stock was Selected

Figure III: Demonstration of How AI was Performed

Figure IV: Ayrshire Exotic Bull used for the AI

Figure V: Brahman Exotic Bull used for the AI

cow per year (Eduvie & Dawuda, 1986). The fertility indices in cattle are mostly affected by genes (Mukasa-Mugerwa, 1989), climate (Mai, Ogwu, Eduvie & Voh, Jr., 1997), nutrition and body condition score of the dam (Zakari, 1981; Wilson, 1985) , suckling (Bello, Rwuaan &Voh, Jr., 2009), infectious diseases (Mshelia et al., 2010) and inaccurate estrus detection (Mai, Ogwu, Eduvie & Voh, Jr., 2002).

CONCLUSION

It was, therefore, concluded that, though both Ayrshire and Brahman crossed Zebu female cattle gave rise to low fertility rates. But since this was the first attempt and the program is a continuous exercise, with increased number of attempts, the use of AI in Zebu and exotic breeds will definitely improve reproductive efficiency and milk yield in the farm. The exotic breeds could, therefore, be successfully used to cross indigenous Zebu cattle through AI to save cost and other challenges associated with the importation of live exotic bulls. The findings in this study is hoped to go a long way in revitalizing and boosting cattle production in the study area and the Nigerian livestock industry as a whole.

RECOMMENDATIONS

Government, farmers and all stake holders should work hand-in-hand to phase out quack practitioners in the industry. In addition, adequate attention should be given to the management practices in the farms such as selecting cattle in their optimum age for breeding, adequate nutrition, early weaning of calves, ideal calve management, prompt culling of problem cows such as repeat breeders etc. Other factors like adequate knowledge of estrus detection, insemination and pregnancy confirmations should be the priority of cattle breeding industries in Nigeria.

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