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The Effect of Crossbreeding on Performance of Crossbred Dairy Cows and Indigenous Cattle Genetic Resources in the North Western Amhara, Ethiopia

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Authors' contributions

This work was carried out in collaboration between both authors. Authors KA and DK designed the study, wrote the protocol, and the first draft of the manuscript. Authors KA and DK managed the literature searches analyses of the study performed and the analysis. Authors KA and DK managed the experimental process and author KA identified the species of Animal. Both authors read and approved the final manuscript.

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ABSTRACT

In Ethiopia, crossbred cattle are mainly cross of zebu with Holstein-Friesian. The cattle have been used for milk production for decades. Therefore, the objective of the study was to evaluate the effect of crossbreeding on performance of crossbred dairy cows and indigenous cattle genetic resources. The study was conducted in three districts in 2013 namely, Farta, Gondar zuria and Bahir Dar zuria districts. Informal and formal field surveys were employed. Purposive sampling method was used giving due consideration of phenomic traits for cattle populations. Major ecological zones, the distribution of crossbred cattle populations and their socioeconomic importance were considered. The results revealed that the mean daily milk production for 50% Holstein Friesian and 50% indigenous cattle crosses in the Farta (9.14±4.32), Bahir Dar zuria

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(6.95±2.32) and Gondar zuria (6.27±2.75) districts differed significantly (P<0.001). The reproductive performances of the crossbreed cattle were also differed from district to district as well as from blood level to blood level. The age at first calving for 50% Holstein Friesian and 50% indigenous cattle crosses were found to be 1. 86±0.43, 2.16±0.40, 2.03±0.36 for Farta, Gondar Zuria and Bahir Dar Zuria Districts, respectively. Indiscriminate mating of indigenous cattle with exotic breeds, the existing production system, poorly designed crossbreeding and absence of herd registration and recoding systems are the major causes threatening diversity of indigenous cattle, with index value of 0.18, 0.12, 0.11 and 0.11, respectively. Crossbreeding results in inconsistent and rapid loss of genetic diversity by dilution of the autochthonous genetic makeup and poor heat detection/insemination, with 54.5, 43.6 and 66.34%, respectively. In this study, it was found that as the blood level increases the milk production decreased. The reproductive performance also had shown reduced performance. This can be due to gene segregation and management effects.

Keywords: Crossbreeding; genetic resources; indigenous cattle; performance.

1. INTRODUCTION

It appears important to estimate the expected level of heterosis and profitability of crossbreeding for traits of economic interest in dairy cattle [1]. Crossbreeding has resulted in good improvements in production of milk and meat, especially when supplemented with adequate management levels in terms of nutrition and disease control. Since the productive and reproductive potentials of Zebu cattle are relatively low, crossbreeding with *B. taurus* ensures high productive and reproductive performance. Improvement of the genetic potential of indigenous cattle was achieved by cross breeding with high producing cattle of temperate origin to exploit heterosis [2]. Artificial Insemination (AI) services in Ethiopia have been the most widely practiced animal biotechnology all over the country for enhancing crossbreeding. However, the constraints associated with AI in Ethiopia include loss structural linkage between AI center and service giving units, absence of collaboration and regular communication between national AI centers and stakeholders, lack of breeding policy and herd recording system, inadequate resource in terms of inputs and facilities, and absence of incentives and rewards to motivate AI technicians and this make difficult the crossbreeding processes [3]. AI service in Ethiopia is mainly being provided by the National Artificial Insemination Center (NAIC) established under Ministry of Agriculture (MOA). The objectives were for the production and distribution of semen and liquid nitrogen. NAIC supplies its products and services to farmers at a highly subsidized rate that is ETB 4 per dose of semen and ETB 15 per insemination. Ethiopia holds the largest cattle population in Africa estimated at about 43.1 million heads of cattle of which 10 million is dairy cows yielding 3.2 billion liters per year [4]. Crossbred cattle mainly cross of zebu with Holstein-Friesian cattle have been used for milk production for decades [5]. The cattle population in Ethiopia comprises 99.4% indigenous (Zebu), 0.5% crossbreeds and 0.1% exotic breeds which are mainly kept under smallholder subsistence farming [6]. Accurate evaluation of the reproductive efficiency of indigenous cattle and their crossbred in different production systems is essential for the development of appropriate breeding strategies [5]. The effect of crossbreeding has, however, also been disastrous, especially in the smallholder sector where less attention is given to matching the genotype to the environment. Reproductive efficiency of dairy cows is influenced by genetic, season, age, production system, nutrition, management, environment and disease [7]. However, in many cases, it has been measured mainly by considering parameters such as age at first service, age at first calving, days open, calving interval and number of services per conception [7,8].

Kahi [9] and Fedlu Hassen et al. [10] reported that the Ethiopian cattle genetic diversity is currently under threat mainly due to extensive planned as well as indiscriminate cross breeding, and to some extent interbreeding among the local populations. Loss of genetic diversity increases the risk of difficulties in subsistence for the millions of livestock keepers who depend on these resources to secure their livelihoods [11]. There is little quantified information on the diversity of indigenous farm AnGR of Ethiopia, effects of crossbreeding on the conservation animal genetic resources and effectiveness of AI and breeding programs in the region. The extent to which the exotic genotypes have diffused into the indigenous populations and the level of dilution was not objectively assessed. Therefore, the objective of the study was to evaluate the effect of crossbreeding on Performance of Crossbred Dairy Cows (F1 and F2) and indigenous cattle genetic resources in the north western Amhara, Ethiopia.

2. MATERIALS AND METHODS

2.1 Study Area Descriptions

The study was conducted in three districts of Amhara National Regional State in 2013 (ANRS) namely, Farta, Gondar zuria and Bahir Dar zuria districts. Farta district is found South Gonder zone. The mean annual rainfall is 1651 mm. The mean monthly average temperature is 18.4°C. The altitudes range from 1500 - 4135 meters above sea level. Gondar zuria district is also found in ANRS, the North Gonder zone and has also tipid moist to cool mountains. The altitude ranges from 1966 - 2133 meters above sea level. The mean annual rainfall is 1161 mm. The average temperature is 19.1°C. The third study area, Bahir Dar zuria district, is found in West gojjam zone of ANRS which is tipid moist to cool plains with altitude ranging from 1786 - 1969 meters above sea level. Mean annual rainfall of 1,224 mm and the mean annual daily temperature recorded is 18.5°C. The main crops produced in these three study areas are barely, wheat, teff, and other pulse crops. The average length of growing period of the plants in all study sites ranges from 120 -270 days. The estimated total population of 3.5 million of dairy cows in approximately 3 million smallholdings [12,13] suggests that this sub-sector employs many Ethiopians who derive a regular source of cash income and balanced nutrition.

2.2 Sampling Strategy and Procedures

Informal and formal field surveys were conducted on productive and reproductive performance of crossbred dairy cows and the effect of crossbreeding on indigenous cattle genetic resources in north-west Amhara. 360 cows were concerned by this study of which 52% F1 and 48% F2. About 101 households with crossbred cows were visted in three districts. The specific localities in region were chosen using a purposive sampling method giving due consideration of phenomic traits for cattle populations. Major ecological zones, the distribution of crossbred cattle populations and their socioeconomic importance, accessibility, and representatively considered.

2.3 Data Collection and Analytical Methods

A single –visit –multi- subject formal survey method was used based on ILCA [14]. Representative peasant associations, villages, towns and households were selected for milk and reproductive performances data collection based on random sampling methods following Ayalew and Rowlands [15]. Indigenous cattle populations traditionally recognized by ethnic and/or geographic nomenclatures and their crosses based on their blood level were considered. Sampled from areas where crossbreed dairy traits are predominantly found. Collection of secondary data, desk reviews of different documents and studies, focus group discussions and key informants interviews were used.

The data was subjected to SAS Version 9.1 and SPSS 16 [16]. Descriptive statistics such as means, frequency distribution, percentages, coefficients of variation and variances were used. X^2-test was used to examine the differences between levels of significances in milk yield and reproductive performances. Indexes were used to see the intensity of causes threatening diversity of indigenous cattle genetic resources and Likert scale was also used to quantify the extent in which the causes for causes threatening diversity are known by the respondents.

3. RESULTS

The mean daily milk production for 50% Holstein Friesian and 50% indigenous cattle crosses in the Farta (9.14±4.32), Bahir Dar zuria (6.95±2.32) and Gondar zuria (6.27±2.75) districts differed significantly ($P<0.001$). At the same time, the mean daily milk production for 75% Holstein Friesian and 25% indigenous cattle crosses shown a dramatic decrease (6.99±3.49, 6.90±2.48, 6.46±2.03 for Farta, Gondar Zuria and Bahir Dar zuria districts, respectively). Due to favorable agro-ecology, the milk production at Farta district is higher than at Gondar and Bahir districts (Table 1).

The reproductive performances of the crossbreed cattle were also differed from district to district as well as from blood level to blood level. The AFS for 50% Holstein Friesian and 50% indigenous cattle crosses were found to be 1. 86±0.43, 2.16±0.40, 2.03±0.36 for Farta, Gondar Zuria and Bahir Dar Zuria Districts, respectively. Mean while, the Calving Interval

(CI) were also found to be 1.58±0.36, 1.54±0.37, 1.51±0.37 for Farta, Gondar zuria and Bahir Dar zuria districts, respectively (Table 1).

From focused group discussions and key informants interviews, issues which causes the losses of genetic diversity as a result of crossbreeding between indigenous cattle with different blood level of exotic cattle breeds, mainly from Holstein Friesians were raised. Pair-wise ranking was conducted and indexes were estimated for different parameters which were considered as causes.

In the result, it was indicated that indiscriminate mating of indigenous cattle with exotic breeds, the existing extensive production system, poorly designed crossbreeding and absence of herd registration and recoding systems are the major causes threatening diversity if indigenous cattle in the study districts, with index value of 0.18, 0.12, 0.11 and 0.11, respectively (Table 2).

About 31.68% of the respondents also agree that crossbreeding of indigenous cattle with exotic dairy cattle can improve the genetic potential of the indigenous zebu cattle, and subsequently will

Table 1. The mean productive and reproductive performances of crossbreed cattle

Districts	N. Obs	Variable	Mean	Std dev	Variance	Corrected SS	Coeff. of variation	Pr>(t)
Farta	101	MYf1	9.1455446	4.3223263	18.6825050	1868.25	47.2615524	<.0001
		MYf2	6.9920792	3.4932702	12.2029366	1220.29	49.9603922	<.0001
		AFCf1	1.8633663	0.4291207	0.1841446	18.4144554	23.0293243	<.0001
		AFCf2	2.0940000	0.4642404	0.2155192	21.3364000	22.1700309	<.0001
		CIf1	1.5870000	0.3656059	0.1336677	13.2331000	23.0375491	<.0001
		CIf2	1.4712871	0.3806144	0.1448673	14.4867327	25.8694853	<.0001
Gonder zuria	101	MYf1	6.2792079	2.7512658	7.5694634	756.9463366	43.8154909	<.0001
		MYf2	6.9059406	2.4835387	6.1679644	616.7964356	35.9623522	<.0001
		AFCf1	2.1613861	0.4096267	0.1677941	16.7794059	18.9520384	<.0001
		AFCf2	1.8891089	0.3282989	0.1077802	10.7780198	17.3785082	<.0001
		CIf1	1.5470000	0.3764413	0.1417081	14.0291000	24.3336353	<.0001
		CIf2	1.4554455	0.3601320	0.1296950	12.9695050	24.7437625	<.0001
Bahir dar zuria	101	MYf1	6.9524752	2.3274275	5.4169188	541.6918812	33.4762430	<.0001
		MYf2	6.4603960	2.0330804	4.1334158	413.3415842	31.4699032	<.0001
		AFCf1	2.0396040	0.3633398	0.1320158	13.2015842	17.8142350	<.0001
		AFCf2	1.9069307	0.2159895	0.0466515	4.6651485	11.3265547	<.0001
		CIf1	1.5128713	0.3799114	0.1443327	14.4332673	25.1119448	<.0001
		CIf2	1.4366337	0.3454628	0.1193446	11.9344554	24.0466878	<.0001

AFS= Age at first Service (years), AFC= Age at First Calving (years) ,CI= Calving Interval (years) , MY= milk yield per day, 1= 50 % crosses , 2= 25 % indigenous and 75% Holstein Friesian

Table 2. Major causes threatening diversity of genetic resources of indigenous cattle

Major causes threatening diversity of indigenous cattle genetic resources	Causes or parameters for genetic diversity loss	Rank 1	Rank 2	Rank 3	Index
	Poorly designed crossbreeding	12	9	12	0.11
	Indiscriminate mating	23	15	11	0.18
	Political instability	3	7	2	0.04
	Selection of high producing cows	3	10	7	0.06
	Absence of herd registration and recoding system	9	16	8	0.11
	Semen quality	7	5	12	0.07
	Improper timing of insemination	3	11	2	0.05
	Absence of legal framework for regulation of AI service importation and distribution of semen	8	3	13	0.07
	Production system	13	11	9	0.12
	Gaps in farmers knowledge	5	3	7	0.05
	Climate change	8	6	9	0.07
	Feed shortage	7	5	9	0.07
		101	101	101	1

Index = sum of (3 X number of household ranked first + 2 X number of household ranked second + 1 X number of household ranked third) given for an individual reason divided by sum of (3 X number of household ranked first + 2 X number of household ranked second + 1 X number of household ranked third) for overall reasons improve the dairy sector in Ethiopia if appropriate techniques and management are applied (Table 3). Farmers' perceptions about the effect of crossbreeding on indigenous cattle genetic resources were taken. The respondents strongly agreed that the indiscriminate crossbreeding with exotic breeds clearly is a major factor contributing to the erosion of locally adapted animal genetic resources. Crossbreeding results inconsistent and rapid loss of genetic diversity by dilution of the autochthonous genetic makeup and poor heat detection/insemination are the major causes, with 54.5, 43.6 and 66.34%, respectively (Table 3).

4. DISCUSSION

From our result it was found that the mean daily milk production for 50% Holstein Friesian and 50% indigenous cattle crosses in the Farta (9.14±4.32), Bahir Dar zuria (6.95±2.32) and Gondar zuria (6.27±2.75) districts differed significantly (P<0.001). At the same time, the mean daily milk production for 75% Holstein Friesian and 25% indigenous cattle crosses shown a dramatic decrease (6.99±3.49, 6.90±2.48, 6.46±2.03 for Farta, Gondar Zuria and Bahir Dar zuria districts, respectively). This implies that how milk yield increases from local zebu breed to F1 and decrease from F1 to F2. This result is different from Mulugeta and Belayneh [17]. The authors reported that the difference in milk production between indigenous and their 50% cross breeds indicateed that 50% cross breeds (1511.5 L) produce more amount of milk than local breeds (457.89 L) per lactation. The milk production potential of the zebu breed in the highlands mixed crop-livestock system of Ethiopia cannot exceed 400-500 kilograms of milk per lactation per cow [18,19]. Belay et al. [4] reported that mean milk production per lactation between Horro and Holstein Friesian was 2333.63 L. This could be either due to complementary or heterosis effect. It was found that as blood level increased, reduction in their performance was observed, for example, slim difference in milk production was observed between 50 and 75% crosses. Furthermore, mean milk production of 50% cross breed was higher than 75% cross breeds. This could be justified as a reduction in epistatic effect or gene segregation effects. A cross breed would retain less than 50% heterosis effect and have an additional loss due to recombination effects. Significant recombination effect would have a negative effect on productivity of cross breeds. In Ethiopia, crossbreeding with exotic breeds clearly is a major factor contributing to the erosion of locally adapted animal genetic resources [20]. Crossbreeding also results inconsistent and rapid loss of genetic diversity by dilution of the autochthonous genetic makeup. Therefore, designing of a crossbreeding program in Ethiopia needs to take into consideration a mechanism that ensures conservation of animal genetic resources [21].

The reproductive performances of 75% were lower than 50% crosses. It is the age at which

Table 3. Farmers' perceptions about the effect of crossbreeding on indigenous cattle genetic resources

Causes for losses of genetic diversity	Strongly disagree	Disagree	Uncertain	Agree	Strongly agree	Total
Indiscriminate crossbreeding	0 (0 %)	7(6.9%)	25(24.8 %)	13(12.9 %)	55 (54.5%)	101
Dilution of the autochthonous genetic makeup	1(0.99 %)	8 (7.9 %)	14(13.9 %)	33(32.7 %)	45(43.6 %)	101
AI and substitution of indigenous genes by exotic genes	2 (1.98)	10 (9.9)	22 (21.78)	42 (41.58)	26 (25.74)	101
Interbreeding among the local populations	9 (8.91)	18 (17.82)	55 (54.46)	11 (1.89)	8 (7.92)	101
Crossbreeding and improved genetic potential	5 (4.95)	7 (6.93)	27 (26.73)	32 (31.68)	30 (29.7)	101
Poor heat detection/insemination,	2 (1.98)	5 (4.95)	5 (4.95)	22 (21.78)	67 (66.34)	101
Improper timing of insemination	2 (1.98)	11 (10.89)	7(6.93)	47 (46.53)	34 (33.66)	101

heifers attain body weight, body condition and sexual maturity for accepting service for the first time. It influences both the productive and reproductive life of the female through its effect on her lifetime calf crop [22]. Horro crossbred heifers have the longest age at first service than other crossbred heifers. Conversely, Eastern Lowlands crossbred heifers need shortest month to reach age at first service. Age at first service is influenced by genotype, nutrition and other environmental factors. An earlier age at puberty is observed for F1 Friesian crosses than for indigenous zebu breeds [22].

5. CONCLUSION

Crossbred cows had a good reproductive performance traits compare to local breeds cows in Ethiopia. In this study, it was found that as the blood level increases, the milk production decreased. The reproductive performance also had shown reduction. This can be due to gene segregation and management effects. The farmers are also abandoning the local animal genetic resources and shifting to exotic germplasm. Subsequently, replacing local breeds by range of high-yielding breeds is widespread. Due to the existing climate change effects and gene segregation especially after third generation, high yielding animals could not be used sustainably. Adapting to present climate change and related factors is a serious challenge to many animal producers. Admixture of genes of indigenous animal population with exotic germplasm of nonspecific's and increasing temperature will trigger loses of animal genetic resources So, using good designed and managed introduction of exotic genetic materials for AI, avoiding indiscriminate mating, inbreeding and well designed management would enhance the productive and reproductive performances.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Cassandro MA, Comin R, Dal Zotto M, De Marchi L, Gallo P, Carnier and bittante G. genetic parameters of milk coagulation properties and their relationships with milk yield and quality traits in Italian holstein cows. Journal of Dairy Science. 2008; 91:371-376.
2. Mason IL. Maintaining crossbred populations of dairy cattle in the tropics; 1974.
3. Desalegn G. Assessment of problems/constraints associated with artificial insemination service in Ethiopia. MSc Thesis, Addis Ababa University, Ethiopia. 2008;124.
4. Belay D, Yisehak K, Janssens GPJ. Productive and reproductive performance of zebu X holstein-friesian crossbred dairy cows in Jimma Town, Oromia, Ethiopia. Global Veterinarian. 2012;8(1):67-72.
5. Negussie E, Brannang E, Banjaw K, Rottmann OU. Reproductive performance of dairy cattle at Asella livestock farm, Arsi, Ethiopia. I. Indigenous cows versus their F1 crosses. Journal of Animal Breeding and Genetics. 1998;115,267– 280.
6. EASE. Ethiopian Agricultural Sample Enumeration (EASA), Addis Ababa, Ethiopia; 2003.
7. Shiferaw Y, Tenhagen BA, Bekana M, Kassa T. Reproductive performance of crossbred dairy cows in different production systems in the central highlands of Ethiopia. Tropical Animal Health and Production. 2003;35:551-561.
8. Lyimo C, Nukya R, Schoolman L, Van Eerdenbutg FJ. Post-partum reproductive performance of crossbred dairy cattle on smallholder farms in sub humid coastal Tanzania. Tropical Animal Health and Production. 2004;36:269-279.
9. Kahi Alexander K. Crossbreeding systems and appropriate levels of exotic blood: Examples from Kilifi Plantations; 2002.
10. Fedlu Hassen, Endashaw Bekele, Workneh Ayalew, Tadelle Dessie. Genetic variability of five indigenous Ethiopian cattle breeds using RAPD markers. African Journal of Biotechnology. 2007;6(19): 2274-2279. (Retrieved January 10, 2012)
11. Kefyalew Alemayehu. Threats, attempts, and opportunities of conserving indigenous animal genetic resources in Ethiopia. African Journal of Agricultural Research. 2013;8(23):2806-2813.

12. BoARD (Bureau of Rural Development). Rural household socio-economic baseline survey of 56 woredas in the Amhara Region. Rural infrastructure and mass media. Bahirdar, Ethiopia; 2003;12.
13. CSA (Central Statistics Authorithy). Ethiopian agricultural sample enumeration, 2001/02 1994 E.C. Part II, Livestock. Addis Ababa, Ethiopia; 2003;4.
14. ILCA (International Livestock Centers for Africa). Livestock systems research. Ketema Hizkias and Tsehay Redda, 2004. Dairy production system in Ethiopia, Ministry of Agriculture, Addis Ababa, Ethiopia; 1990.
15. Ayalew W, Rowlands J (eds). Design, execution and analysis of the livestock breed survey in Oromiya Regional State, Ethiopia OADB (Oromiya Agricultural Development Bureau), Addis Ababa, Ethiopia, ILRI (International Livestock Research Institute), Nairobi, Kenya; 2004.
16. SPSS (Statistical Package for Social Sciences). Release 16, SPSS Inc, Chicago, USA; 2007.
17. Mulugeta Ayalew, Belayeneh Asefa. Reproductive and lactation performances of dairy cows in Chacha Town and nearby selected kebeles, North Shoa Zone, Amhara Region, Ethiopia. World Journal of Agricultural Sciences. 2013;1(1):008-017. Available:http://wsrjournals.org/journal/wjas ISSN 2329-9312 ©2013 World Science Research Journals.
18. EARO. Livestock research strategy (unpublished), Addis Ababa, Ethiopia; 1999.
19. Zelalem Yilma, Inger. Milk production, processing, marketing and the role of milk and milk products on the small holder farm's income in the Central Highlands of Ethiopia, Pastoralism and Agropastoralism. Which way foreword proceeding of the 8th Annual Conference of ESAP, 24-26 August, Addis Ababa, Ethiopia; 2000.
20. Köhler-Rollefson I. Farm animal genetic resources. Safeguarding National Assets for Food Security and Trade. A summary of workshops on farm animal genetic resources held in the South African Development Community (SADC). GTZ, BMZ, FAO, CTA, SADC. Eschborn, Germany; 2004.
21. Aynalem H, Azage T, Workneh A, Noah K, Tadelle D. Breeding strategy to improve Ethiopian Boran cattle for meat and milk production. Working Paper. 2011;26:56.
22. Alberro M. Comparative performance of F1 friesian X zebu heifers in Ethiopia. Animal Production Science. 1983;37:247-252.

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