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GENE SEGREGATIONS, LINEAR BODY MEASUREMENTS AND PERFORMANCE EVALUATION OF DAIRY CATTLE CROSSBREEDING IN NORTHWESTERN ETHIOPIA

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ABSTRACT: An investigative research work was delivered to address the objective of characterizing the cross breeding effects on dairy cattle performances in North West Ethiopia (North Gondar, South and west Gojam). In the same time, exploratory field survey and multistage sampling technique was conducted to collect the polygenic traits and improvement effects of cross breeding in the study areas. Blood level like F_1 (50E:50L), F_2 (25E:75L), F_3 (75E:25I) and F_4 (12.5E:87.5I) dairy cattle characterization work was conducted from north Gondar, south Gondar and west Gojam zone. The interaction effect of body weight and other liner body measurements for all dairy cows with different blood levels were highly significant ($P<0.01$). Body weight and body length at F_3, F_2, F_1 and F_4 blood levels of the cows were indicated that none, little and significant ($P<0.01$) reduction were observed on the measurable trait values across the blood levels like body weight least square mean value of 405.86, 405.72, 401.38 and 346.13 (kg) and 184.78, 182.32, 178.68 and 169.59^b (cm) for body length, respectively. Whereas, performances of cows were reduced as exotic blood levels were increased. So, this work remarked that F1 generation of an animal had superior in different aspects, while the gene segregation effect was observed at F3 (75E:25I) generation. Similarly, the factorial ANOVA indicated that peak milk yield (12.83lt/day) was measured from parity three and F_1 generations. Therefore, gene segregation and down crossing effect could be the causes of economic losses and should be flew the bloods through generations. In addition, characterization of the randomly disseminated genetic resources should be employed to evaluate and know the breeding practices and effect of the merit or demerits of cross breeding in the country.

Keywords: Measurable Traits, Crossbreeding, Genetic Improvement, Cattle, Amhara

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INTRODUCTION

Ethiopia is believed to have the largest livestock population in Africa, of roughly 53.99 million animals out of this total cattle population, the female cattle constitute about 55.48% and the remaining 44.52% are male cattle. In Ethiopia, large livestock population plays an important socio economic roles and contributing about 12% of the Gross Domestic Product (GDP). According to FAO (2005) and CSA (2011) in Amhara region, about 28% of the animal population was females of which about 55% of Ethiopian total cattle population and produces about 3.2 and 0.82 billion liters of milk per year in Ethiopia and in Amhara region, respectively are produced The average lactation milk production for the indigenous cows is ranged from 494–850 liters per 1.5 years with 1.54 liters per cow per day (CSA, 2007).

Performance potentials of local cattle are relatively low and crossbreeding with *B. Taurus* was recommended to improve their productive and reproductive performances. Consequently, in Ethiopian history, domestication and the use of conventional livestock breeding techniques for genetic improvement of dairy cattle to enhance milk

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production of local breeds is over about six decades (Leakey, 2009). It also appears important to estimate the expected level of hetrosis for traits of economic interest in dairy cattle in order to evaluate the profitability of crossbreeding (Mauro et al., 2009). This program was launched during the invention of Ethiopia by Italy with importation of exotic dairy cattle breeds.

Later on, the first livestock development project (1958-1963) created the Dairy Development Agency (DDA) that was concerned mainly with the development of commercial dairy farms in Addis Ababa (Fekadu, 1990). Following this Chilalo Agricultural Development Project (CADU), an integrated project established jointly by the Ethiopian and Swedish Governments, in Arsi region initiated intensive small scale dairy development in Ethiopia in 1967/68 was established (Kiwuwa et al., 1983). This was followed by the Wolaita Agricultural Development Project (WADU) that was established in 1971 and funded by the World Bank, applied the CADU program (Hailemariam, 1994). The focus of the program was on increasing the milk productivity of local breeds through crossbreeding and distribution of F_1 heifers to farmers (EARO, 2001).

Linear body measurement has positive correlation to evaluate the performance improvement trends of dairy cattle. In addition, crossbreeding has resulted in good improvements in production of milk especially when supplemented with adequate management levels in terms of nutrition and disease controls. In spite of, the presence of large and diverse animal genetic resources, the productivity of livestock remains low in many regions of the country (Fikre, 2007). However, genetic improvement effect and gene segregation trend on different blood level with the phenotype of the animal is not identified. Therefore, the extents of exotic genotypes have been diffused into the indigenous populations, significance importance on dairy genetic improvement, and its progress and the level of dilution is not independently assessed. The objective of the study was to put a bench mark on the gene segregations effects, linear body measurements and performance evaluation of dairy cattle crossbreeding in North West Ethiopia.

MATERIALS AND METHODS

Description of the study area

The study was conducted in three zones and 9 districts of Amhara regional state from 2015 to 2016. Amhara National Regional State (ANRS) is located in the north-western part of Ethiopia. Geographically, it is situated between latitude 9°–13°45'N and longitude 36°–40°30'E. It is bounded by the Afar, Benishangul, Oromiya and Tigray regions in the east, south-west, south and north, respectively, and by Sudan in the west. The total area of the region is estimated at 170,152 km^2, which is about one-sixth of the country's total area (Gizaw et al, 2013). The region ranges from 600 m.a.s.l (meter above sea level) at Metema and 4520 m.a.s.l at Ras Dashen, North Gondar, which is also Ethiopia's highest point. The wide range of altitude is a major factor in determining the temperature range of the region. Generally, lowland areas (<1500 m a.s.l.) experience hot temperatures, while highland areas (>1500 m a.s.l.) experience relatively cooler temperatures. For example, in the hot to warm sub moist agro-ecological zone, where the altitude ranges from 600 to 1400 m a.s.l., the mean annual temperature range is 21–27°C while in the cold to very cold moist zone, where the altitude ranges from 2800 to 4200 m a.s.l., the mean annual temperature varies from 7.5°C to 16°C (CSA, 2007).

Exploratory approach as a study design and multistage sampling techniques like both purposive and random sampling methods were considered. Based on the blood levels and crossed dairy cattle potential, the 3 zones were selected. From the total 180 households about 150 matured crossed dairy cattle were used for the study (FAO, 2011). Both qualitative like blood level of dairy cattle, parity and sex of the owners and quantitative data like body length (BL), body weight (BWT), tail length (TL), heart girth circumference (HGC), high at weather and high at hip (HAH) were considered. Similarly, systematic simple random sampling technique was used to select the crossed dairy cattle owners. General liner model was developed using meter and heart girth as a measurable tool for linear body measurements and body weight of an animal with the fixed effect of blood level and parity. While, data were analyzed using SAS software (SAS, 2002).

Model: 1. $Y_{ijk} = \mu + A_i + D_j + AD_{ij} + e_{ijk}$

Y_{ijk} = the observed milk yields of the cattle
μ = overall mean
A_i = fixed effect of i^{th} type (n = cattle blood levels)
D_j = the effect of k^{th} parity (j = 1-4)
AD_{ji} = the fixed effect interaction i^{th} of blood level with j^{th} of parity
eij_k = random residual error

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RESULTS AND DISCUSSIONS

Performance of hybrid dairy cattle

Average productive and reproductive performance of different blood levels of dairy cattle in the region were characterized under different production systems using measurable traits. About 25, 20.1 and 20%of the interviewed owners were females from north Gondar, west Gojam and south Gondar zone, respectively. While the majority of the respondents about 75% were fully involved in small scale mixed crop-livestock in per urban and urban types of crop-livestock production systems and used cattle as source of income for immediate expenses such as purchasing of salt, coffee, clothe and animals' medicine. Most of the cows held on peri urban and urban farms were lactating during the study period, while higher percentages of dry cows were observed on rural small scale farms. Milking, processing, cleaning and selling of dairy products such as milk and butter was performed by adult males and females. Most of the information was generated from males which indicated that mainly men are responsible for rearing of dairy cows.

According to the respondents' point of view good performance of dairy cows could be attributed to genetic and non-genetic factors such as blood level, supplementary feed and care of farmers to their animals. The present finding discovered that parity had significant cause of variation for the performances of milk production with the least square mean value of 4.90±0.34, 6.56±0.44, 8.58±0.71 and 8.55±1.12 litter/day for P1-P4, respectively. While blood level was one of the fixed effects of dairy cattle performances with the average peak milk yield and gene segregation signs average mean value of 12.8^{a,}, 12.0^{a}, 11.07^{a} and 8.57 ^{b} litters of milk per day for F_1, F_2, F_3 and F_4 generation, respectively.

Average productive and reproductive performances of hybrid dairy cattle and their significant difference were estimated under existing farmers' management condition (Table 1). In this result, average milk yield of F_1 hybrid dairy cattle was much higher than 5.9 and 6.4 litter/day reported by Addis et al (2015) and Belay et al (2012), respectively. The performance of milk yield in the hybrid dairy cattle obtained from the present study was higher in F_1 (9.59 litters/cow/day) but smaller in 6.82 litters/cow/day where gene segregation was observed from F_2 and F_3 even if hetrosis effect is expressed on the local dairy cows like 9.12 and 8.15 litters/day/crossed breed than 1.54 litter/day/local cows, respectively. However, higher milk yield performance was record from monitored cows in F_1 generation reported by Addis et al (2015) with F_1 daily milk yield of 11 liters. Another study conducted in North Showa zone indicated that 50% cross breeds were produced 1511.5 litter of milk per lactation which was more amount of milk than local breeds (457.89 L) (Mulugeta and Belayneh, 2013).

This variation from the pure breed is indicative for the better performance of the hybrid and existence of variability in milk production could be an indication of the potential for genetic improvement through cross breeding followed by selection with selected indigenous superior dairy cattle.

Table 1. Current production systems and Performance aspect of dairy cattle in different blood levels in Amhara Ethiopia (least square mean)

Blood Level	Milk Yield				Overall
	P1	P2	P3	P4	
F1	5.63^{bc}	9.43^{a}	12.83 ^{a}	10.45 ^{a}	9.59
F2	6.71^{a}	9.10^{a}	12.0 ^{a}	8.65 ^{b}	9.12
F3	6.02^{ab}	7.64^{b}	11.07 ^{a}	7.88 ^{b}	8.15
F4	4.90^{c}	6.55^{b}	8.57 ^{b}	7.25 ^{b}	6.82
Overall Mean	4.90-0.34	6.56-0.44	8.58-0.71	8.55-1.12	8.42

F_1= 50E:50L, F_2= 25E:75L, F_3= 75E:25l, F_4= 12.5E:87.5l, P= parity

Interaction effect of fixed factors to quantitative parameters

From the total sampled dairy cattle with 8 measurable parameters such as BWT (kg), BL (cm), HGC (cm), HAG (cm), HAH (cm), TL (cm) and teat length in cm for different blood level were considered. The GLM least squares mean of body weight and liner body measurements of F_1, F_2, F_3 and F_4 hybrid dairy cattle with their variations and comparison test was stated. The overall mean square of body weight obtained for F_1 - F_3 hybrid dairy cattle were significantly ($P<0.05$) heavier in body weight than F_4 generations. Whereas, F_1 dairy cattle generations had better different aspects than other blood levels. Even if the hetrosis effect is dominant at the interaction effect indicated that serious gene segregation effect was observed at F_4 generation.

Thus, F_1 in body length associated with milk yields were found to significantly long with the value of 184.78^{a} which is relatively taller than the report of Yan et al. (2009) who stated that the body length of F_2 crossed one was 146.37 cm. However, F_2 and F_3 had bigger body weight 405.72 and 405.86 than F_1 and F_4 generations,

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respectively. The overall mean for body weight trend obtained for mature cows at F_1 up to F_4 generations were 389.77 (kg), which was heavier than other Ethiopian local cattle.

Table 2 - Comparison least square mean (Lsm) of body weight (kg) and linear body measurements (cm) of the hybrid dairy cattle in Amhara Ethiopia

Blood level	BL	BWT	TL	HGC	HAW	HAH	Teat length
F1	184.78^{a}	401.38^{a}	87.38^{b}	166.50^{ab}	130.50^{ab}	133.88^{a}	7.38^{a}
F2	182.32^{a}	405.72^{a}	125.18^{a}	170.77^{ab}	132.27^{a}	135.09^{a}	6.77^{ab}
F3	178.68^{ab}	405.86^{a}	85.18^{b}	173.77^{a}	133.22^{a}	134.09^{a}	6.36^{b}
F4	169.59^{b}	346.13^{b}	84.81^{b}	164.86^{b}	127.22^{b}	123.79^{b}	7.04^{ab}
Over all hybrid	178.84	389.77	95.64	168.97	130.80	131.71	6.89

F_1= 50E:50L, F_2= 25E:75L, F_3= 75E:25l, F_4= 12.5E:87.5l, BL= body length, BWT= body weight, TL= teal length, HGC= heart girth circumference, HAW= high at weather and HAH= high at hip

CONCLUSION AND RECOMMENDATIONS

The overall trends of cattle crossbreeding and its effect on body measurement via dependant variables on local dairy cattle in North West Ethiopia was stated. Following that the performance of local dairy cows are reached at peak at F_1 blood level and gene segregation effect is started at F_3 generations. Therefore, the breeding strategy of the country is better to assess the breeding program and focused on the levels of gene segregation effects.

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Author's contribution

All authors contributed equally to this work.

Competing Interests

The authors declare that they have no conflict of interest with respect to the research, authorship or publications of this article.

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