Comparison of Dairy Performance of F_1 (Borana X Holstein-Friesian) Crossbred Heifers under On-Farm and On-Station Management

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Abstract

This study was conducted to compare the dairy performance of F_1 (Borana x Holstein-Friesian) crossbred heifers reared at Holetta Agricultural Research Centre (HARC) with their contemporaries distributed to smallholders (SH) in Walmara district. The experimental animals were born during 2010 to 2013 at HARC and distributed within the same time frame. Fifty two SH (42 male and 10 female) purposively identified were involved in the on-farm study. The overall least squares mean of age at first calving (AFC) was 37.7 months while that of on-farm and on-station were 42.09 ± 1.04 and 33.55 ± 1.01 months, respectively. The AFC of crossbred heifers reared on-farm was delayed by 9 months compared to the on-station result ($p<0.001$). The overall daily milk yield (DMY) was 9.5, 7 and 4.5 kg at early, mid and late lactations, respectively. The average on-farm daily milk yield was 9.67 ± 0.18, 7.3 ± 0.16, and 5.49 ± 0.17 kg while that of the on-station result was 9.30 ± 0.17, 6.7± 0.15 and 4.13 ± 0.16 kg respectively, during early, mid and late lactations. The milk yield of crossbred heifers did not show significant difference between on-farm and on-station during the early stage of lactation ($p = 0.1446$). However, there was about 8.2% to 23.5% higher milk yield ($p<0.001$) under on-farm condition from mid to late lactation, which may be attributed to better management by farmers in order to maximize their benefit from milk. The initial body condition score (BC) of heifers was 3.29 which was closer to the on station value (3.49). Loss of BC after calving (2.82±0.09) is a reflection of level of management. This study showed that first calving of crossbred heifers was more delayed under the management of SH compared to those managed on-station. This results in longer periods to bring the heifers into production (calf, milk) at smallholder's level of management. Hence, it can be inferred that sending young crossbred heifers to SHs at earlier ages (< 18 months) as technology transfer scheme is less desirable.

Key words: Crossbred heifer, smallholder farmers, technology transfer

Introduction

Potential for dairy development in Ethiopia could be expressed by large cattle population, favorable climate conditions for improved dairy cows, and the relatively less disease occurrence for dairy production. Dairy development in Ethiopia has a considerable advantage for smallholder income generation which can contribute significantly to food security and poverty reduction. Reviews on the development of dairy sector in Ethiopia shows that there is a need to focus on integration of crossbred dairy to the smallholder sector through improving their access to improved technology (Hiskiyas and Tsehay, 1995; Amanuel and Tesfahun, 2006; Azage et al., 2010). Dairy technology transfer and dissemination in Ethiopia has lagged behind due to various reasons including limited number of exotic breeds and their crosses, high cost of dairy inputs combined with poor livestock extension system in the country. Mulugeta and Belayeneh (2013) suggested the need for attention to be given to strong extension service and training of farmers in breeding, feeding, health care, and housing as intervention measures in order to exploit the potential of dairy cattle by improving the lactation performances.

The number of highly productive exotic breeds (0.13%) and their crosses with local breeds (0.64%) that currently exist does not even reach 1% of the total cattle population of the country (CSA, 2011). Reports before ten years confirm similar data indicating that closer to half a million heads of cattle in Ethiopia is exotic or crossbred dairy cows (Muriuki and Thorpe, 2001).

Dairy development projects implemented in Ethiopia in minimum package program (MPP, 1972-1980) was aimed to raise the income and agricultural output of smallholder farmers with minimum reliance on scarce resources. The project has dealt with distribution of crossbred heifers, bull and AI service to selected farmers almost all over the country except the lowlands. However, it did not succeed to establish sustainable improved dairy production system in the country.

Searching for proven technologies and management options with the smallholder dairy farmers can have contributions in realizing increased supply of crossbred dairy cows in the country. Accelerated heifer rearing method can be applied to bring heifers to early puberty for milk production and improved reproduction performances. Various management options can be used to improve and maintain post weaning management level for better daily growth rate until early puberty is reached. Studies made in Ethiopia have proved that heifers fed on diet with high

concentrate to roughage ratio came in heat earlier than those fed on diets with lower concentrate to roughage supplementation ratio.

Age at first heat of crossbred heifers have reached 14.7 to 17.86 months by ensuring the level of concentrate feed in the daily ration (Yohannes et al., 2010). Similarly, heifers that had 1 kg of concentrate supplement per day in addition to grazing and 2 kg of hay showed estrus at a younger age than those that had only 2 kg of hay supplement in addition to grazing. The objective of this study was therefore to compare the performances of crossbred heifers distributed to smallholders at younger age with the ones managed at on station conditions in high dairy potential areas in the central highlands of Ethiopia.

Materials and Methods

Study site selection

This study was conducted in Walmara district at selected villages around Holetta Agricultural Research Centre (HARC) which is located 30 km west of Addis Ababa, Ethiopia. The study area is located at 3°24'N to 14°53'N and 33°00'E to 48°00'E with an average altitude of 2400 masl; annual rainfall of 1100mm; and average minimum and maximum temperatures of 6°C, 24°C, respectively. The area experiences two major seasons, the wet season (June to September) and the dry season (October to May). A total of seventy two smallholder farmers selected from five villages in the vicinity of HARC were initially considered. Preliminary field visits were made by a team of researchers to locate the specific sites. Purposive sampling technique was used to select study sites considering accessibility for monitoring and data collections and willingness of the farmers to participate in the verification of the technology.

Animals and management at on farm and on station

On station management: Recommendations were made from research centre to realize different management options for dairy cattle production and management in the highlands (Zelalem et al., 2006; Yohannes et al., 2007). During the pre-weaning period, all F_1 crossbred calves produced from Boran dam breeds were allowed to suckle freely and are weaned at approximately 6 months of age. Heifers were left to grazing from early morning (8:00 AM) to 4:00 PM in the

afternoon and are fed with natural pasture hay as required at night. After weaning, they are fed on hay free choice and are supplemented with concentrate, based on body weight change as already recommended until the age of 9 months. Concentrate mixture composed of wheat middling (32%), wheat bran (32%), noug (*Guizocia abyssinica*) cake (34%), and salt (2%) was supplemented to the heifers based on their body weight changes. Prior to distribution to smallholder farmers, the heifer claves attained 9 months of age and weighed between 90 to 110 kg.

On farm management: At on farm, heifer calves were expected to be managed with the farmer as recommended and guided during the trainings. However, farmers use all possible means of supplementations and native grass hay, wheat, barley and teff straws for their cows and heifers. In most cases participant farmers use different improved forage crops (mainly of oats/vetch mixture). Moreover, almost all farmers use native grass hay. Some farmers use easily available concentrate feeds like wheat bran and noug cake. However, many farmers refrain from using concentrates because of its high cost. The farmers were properly oriented with the basic principles and necessary requirements including feed production and utilization, housing, health care and product handling before introduction of the heifers.

Packages

The comparison trial constitutes full packages of young crossbred heifers reared with appropriate breeding methods and managed under on station improved management conditions before distribution. Feeds and feedings incorporating forage development and animal health management practices were also employed.

Farmer selection

Fifty two enlightened farmers were selected purposively with full participations of the district agricultural offices, researchers and development agents based on resource ownership (land, feed etc), physical accessibility (both for market and monitoring) and ability to keep records at household level.

Trainings

Farmers were trained on all aspects of heifer management practices, including estrus detection, feeding, husbandry practices, health management and related reproductive management systems prior to distribution of the heifers. Moreover, the farmers had exposure to management practices related to previous on station recommendations.

Table 1. Number and status of heifers used for the trial at 6 sites

Site	Status and number of heifers				
	Distributed	Calved	Still open	Died	sterile
Guntuta	10	8	2	0	0
Galgal	12	6	5	1	0
Walmara	10	6	0	3	1
Mada gudina	3	3	0	0	0
Bshan Dimo	13	11	0	1	1
Saadmo	4	3	0	1	0
Total	**52**	**37**	**7**	**6**	**2**

Note: - A total of 153 F_1 (50%) crossbred heifers were born and maintained at on station contemporary to those distributed to the smallholders. Out of those heifers, 37 were randomly picked and used for comparison with the ones managed under smallholders management

Data collection

- Heifers' body condition once in three months (in wet and dry seasons)
- Reproduction data (service date, PD and calving date)
- Age at first calving
- Milk production in early, mid and late lactation periods

Statistical Analysis

Data collected on milk yield (DMY), age at first calving (AFC) and body condition (BC), were subjected to statistical analysis using the General Linear Model (GLM) procedure of the

Statistical Analysis System (SAS, 2002). The independent variables considered in the study include AFC, DMY and BC both on farm and on station.

Results

Age at first calving

The overall least square means (LSM) of age at 1st calving (AFC) was 37.7 months in the present study (Table 2). The LSM for age at first calving at smallholder (on farm) condition was 42.09 ± 1.04 months, while the age at first calving during the same period under on-station management was 33.55 ± 1.01 months. In previous study, AFC was attained at an earlier age of 28 months (Figure 1). Significantly ($p < 0.001$) more prolonged age at first calving was recorded under smallholder management level. Young heifers distributed to farmers for evaluation had eight and half (8.54) months delay in age at first calving than those managed on-station during the same period.

Replacement pure bred heifers should be bred to calve at 24 months of age in order to maximize lifetime productivity of breeding stocks. For heifers to achieve puberty at earlier age, adequate nutrition is required to provide better rates of gain such that heifers can achieve a critical body weight prior to achieving puberty. In general, the on-station study showed that underfeeding results in prolonged age at first calving.

Table 2. Least square means ± se ± se of age at forst calving for crossbred heifers on-farm and on-station

Treatments	N	Age at first calving Ls means ±se
Overall	72	37.7
On-farm	35	42.09 ± 1.04 a
On-station	37	33.55 ± 1.01b

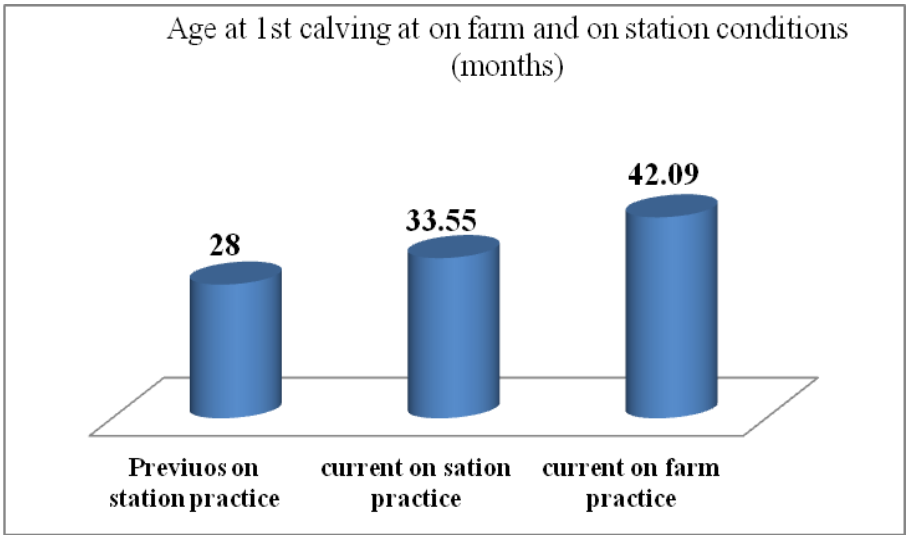

Figure 1. Age at first calving on-farm versus on-station

Milk production

Least square means of daily milk yields (DMY) recorded at on farm and on station from this study are presented in Table 3. The daily milk yield at on farm and on station did not significantly vary ($p > 0.05$). However, better daily milk yield was obtained during early lactation stage at on farm (9.67± 0.18 kg) than at on station (9.30 ± 0.17 kg).The data for milk production did not take into account the amount supplied to calves during each milking. Most smallholder farmers in the study area use partial suckling methods during milking, while very few farmers practice bucket feeding of calves.

Table 3. Least square means ± se of daily milk yield (kg) of crossbred heifers under on farm and on station management

Treatments	N	Lactation stage		
		Early lactation	Mid lactation	Late lactation
Overall	72	9.47	6.99	4.67
On farm	35	9.67± 0.18	7.3±0.16	5.49 ±0.17 [a]
On station	37	9.30 ± 0.17	6.7± 0.15	4.13 ± 0.16 [b]
P value		0.1446	0.0108	0.0001

Body condition scores of crossbred heifers under smallholders' management

Least square means and standard errors (LSM± se) of body condition scores of heifers at initial and subsequent quarters of the year for animals that are kept and fed under shade during most of their time (better managed group) and those that are sent out for grazing with other herd (poorly managed group) under on farm condition is presented in Table 4.

Table 4. Body conditions of heifers from distribution to early calving at smallholders` management

Scoring Interval	Overall	Better managed group BCS (N=27)	Poorly managed group BCS (N=25)
At Initial score	3.29	3.49 ±0.14a	3.10±0.15a
After 3 -6 months	3.15	3.29 ±0.83a	3.01±0.85a
After 6 - 9 months	3.4	3.47±0.10a	3.22±0.11a
After 9 – 12 months	3.39	3.61±0.10a	3.17±0.11b
After > 12 months	3.39	3.67±0.12a	3.11±0.13b
After calving	3.30	3.27±0.09a	2.82±0.09b

The overall BC sore of crossbred heifers was 3.29 (ranging from 3.10 ± 0.15 to 3.49 ± 0.14) during initial stages of distribution. The conditions of the two groups were maintained under similar BC from initial stage to 9 months ($p>0.05$). A significant change in BC score has appeared after the heifers have stayed with the farmer from 9 months onwards. Better body condition scores were observed with the farmers who kept their heifer separately around the homestead with concentrate supplementation.

Figure 2. F_1 Crossbred heifer calved at smallholder farms

Discussion

The ultimate goal of heifer rearing is to economically raise the heifers to bring them to proper weight (size) and body condition for first service and calving at earlier age. The current management level being practiced at the smallholders and even at on station condition needs further improvement. Nutritional manipulation of crossbred dairy heifers in the post-weaning period at HARC (on station management) accelerated the growth rate and improved reproductive performance of the heifers enabling them to calve at the age of less than 30 months (27 to 29 months) (Yohannes et al., 2010).

Early reproductive performances of crossbred heifers at the smallholder level of management seem to delay more than expected. Even though no adequate information was generated on some reproduction performances of crossbred heifers at farmers' management, comprehensive data collected at on station from Assella, Debre Zeit and Holletta showed that AFC in Holstein Frisian (HF) crosses to be 42.6 months (Million et al., 2006). In a study conducted at Metekel Ranch by Andassa Agricultural Research Centre, AFC for Fogera crosses (Fresian x Fogera) was reported to be 40.46 ± 0.93 months (Addisu et al., 2003). Data collected for the period of 30 years (1974 to 2005) at Holetta on Frisian crosses showed AFC of 43.4 ± 0.6 months (Kefena et al., 2011).

Compared to these results, early reproductive performances of Frisian Boran (FB) crossbred heifers under smallholders management is prolonged (42.09 months) compared to previous on station result (40.32 months). From the current study it could be noted that AFC did not improve at smallholders' management, rather it was delayed by 20.3% compared to the on station result which is 33.55 months in the current study.

Despite the inadequacy of information on milk production under smallholders management, some data at on-farm evaluation of crossbred dairy cattle owned by smallholder farmers around Holetta, Debre Zeit, Arsi and Bako previously indicated that the level of milk production of crossbred cows was lower than that of on-station yield even under improved management (Gryseels and De Boodt, 1986; Kiwuwa et al., 1983; Tesfaye, 1993). This might be due to low awareness that the farmers had in the past than the present scenario.

The current result of DMY (9.67± 0.18 kg) at on farm is better than the figure reported by Million et al., 2010 in central highlands of Ethiopia. The authors reported a lactation milk yield of 2520 litters in 321 lactation length (LL) which equates to 7.85 kg/day. It could be noted that in

the central highlands of Ethiopia, because of the favorable environmental and climatic conditions, selected crossbred cows can continue to out-yield earlier crosses provided that appropriate husbandry practices and technological supports, trainings and other interventions are made.

Body condition score is a management tool that can be used to evaluate the nutritional status of an animal. It indicates the energy reserves of calf, heifer and cow, as a vital indicator of excessive loss of weight while the animal is under considerable nutritional pressures to influence subsequent reproductive and growth performance.

Conclusion and Recommendations

The study revealed that the AFC of heifers under farmers' management was delayed by 9 months compapred to those managed on-station (42 vs 33.6 months). Delayed AFC has negative economic impact on the smallholder gains from production of calves and milk at earlier age, and subsequent contribution for genetic improvement. For smallholder farmers to keep profitable crossbred heifers, provision of improved management practices, sustainable inputs (feed, health care, AI delivery system etc), workable extension services and farmers training are important requirements. It was, therefore, concluded that sending young crossbred heifers to smallholders during their active growing periods (< 18 months) may not be desirable as it takes longer periods to bring the heifers into production (calf, milk) under such management. Hence, beginner farmers should be well trained and evaluated for their preparedness to ensure that they could properly deal with dairy technology. Moreover, it is more feasible to distribute heifers with confirmed pregnancy to smallholders than distributing under age heifers.

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