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# Communal Use of Breeding Bulls on Bull Stations, Natural Mating and Artificial Insemination in Ethiopian Smallholder Dairy Farming Systems

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## Abstract

The study was carried out to characterize Ethiopian smallholder farmers' practice and indigenous knowledge on bull station service and adoption of different mating systems. A total of 62 respondents were selected from the smallholder dairy farming communities representing three districts in the Oromia region. A multistage sampling procedure was used to select sampling areas and respondents. A standardized questionnaire was used to collect qualitative and quantitative data using person to person interview. Data were analyzed using descriptive statistical procedures of SPSS. According to the findings of the study, Ethiopian smallholder dairy farmers are using both bull service and artificial insemination for dairy cattle breeding. The bulls used for mating are either those bulls kept for communal use at bull stations or bulls belong to individual farmers. The sources of all those bulls were research centers (15.5%), NGOs (37.5%), cooperatives (7.8%), born and grown at farmers' own farms (10%) and other sources (29.2%). About 79% of the interviewed respondents were participants of bull station service and above 63% of them started to participate in less than a decade ago. In bull station, one bull did serve 3 to 30 females per week. In addition to the bull service, considerable numbers of farmers were using artificial insemination. The study revealed that both natural mating and artificial insemination methods are acceptable as appropriate mating systems and have their own advantage and disadvantages. So, bull service can be further adopted as an option for improving dairy production and productivity at smallholder farmers' level particularly in areas where there is limited access for an efficient AI service. The study provided valuable information that can support the importance of using bull station services and adopt different mating systems to improve dairy cattle production and productivity in smallholder dairy farming systems in Ethiopia.

**Keywords:** Artificial insemination; Bull station; Dairy farming; Natural mating.



## 1. Introduction

Ethiopia is one of the sub-Saharan African countries rich in cattle population with latest estimated figure of 60.39 million heads, of which 98.24% are indigenous cattle, 1.54% crosses and 0.22% exotic breeds [1]. As the indigenous cows are low milk producer, the country has been implementing crossbreeding programs to improve milk production and productivity of the animals. Exotic breeds such as Holstein Frisian and Jersey have been intensively used in the country for crossbreeding with local ones. Like in other African countries, both natural mating and artificial insemination methods have been intensively used to mate dairy herds in Ethiopia Eklundh [2], Makuza, *et al.* [3].

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Considerable number of smallholder farmers in Ethiopia use artificial insemination method to mate their dairy animals and those farmers get artificial insemination service through the extension system which is implemented and centrally coordinated by the country's Ministry of Agriculture and Natural resources. The district level extension personnel provide the artificial insemination (AI) service at farmers' gate and/or in the clinic. For this, the extension personnel get conventional semen of those exotic breeds either from local producing center like the National Artificial Insemination Center (NAIC) and/or from private suppliers like Addis Livestock Production and Productivity Improvement Service PLC (ALPPIS) which import conventional and sexed semen from the World Wide Sires Company in USA. On the other hand, some other farmers are using breeding bulls to mate their cattle through natural mating systems. The bulls used for natural mating are either those bulls kept for communal use at bull stations or individually owned farmers' bulls kept at farmers' own dairy farms.

Artificial insemination known to speed up genetic progress as compared with the natural mating system Foote [4], Yitayih, *et al.* [5], however, several limitations have been reported on its success in smallholder dairy farming systems Yitayih, *et al.* [5], Valergakis, *et al.* [6], Morrell [7], Rasouliazar and Fealy [8], Mwanga, *et al.* [9]. Among those limitations, low accessibility, low conception rate, and defects in born calves are the major problems. Because of those reasons, AI service is not always preferable and less adopted in smallholder dairy farming system Eklundh [2], Yitayih, *et al.* [5], Mugisha, *et al.* [10]. More surprisingly, there are cases where some farmers in Ethiopia have not yet developed confidence to use AI service as the main matting system. According to previous studies, application of AI service in smallholder dairy farming systems is not an easy task and its success is affected by several factors observed in the value chain and there is no single factor to be blamed as a sole factor for low success of AI service in the country. Because of the aforementioned reasons, considerable numbers of smallholder farmers are showing high interest to use natural mating for crossing their herds. This created high demand for improved breeding bulls in the country but there is critical shortage of improved breeding bulls to distribute to the farmers. As a strategy to solve the problem, the Ethiopian government and some NGOs are introducing bull station service where selected bulls are kept at specific farms (bull stations) for communal use in targeted smallholder dairy communities. The bull station service works in such a way that farmers who have good experience to handle bulls and who have enough feed and other resources are chosen to keep the bulls at their farms. Afterwards, other participating farmers who are living in the vicinity of the bull station are getting the bull service for their cows on payment bases. This system is working in some parts of the country. Additionally, there are some other farmers who are using only their own private bulls to mate their female herds. On the other hand, there are other farmers who are using both AI and natural mating systems. So, what really exists on the ground regarding dairy cattle mating system in Ethiopian smallholder farming communities is not highly strategic. It is just a mix-up of every source. This requires extensive studies on existing mating systems, farmers' practices and indigenous knowledge in the area. Furthermore, a decision on which mating system is appropriate for a given farming system needs research based evidence focusing on farmers' indigenous knowledge and practices. However, there is critical shortage of such information in the country.

Therefore, this study was conducted with the intention of characterizing the indigenous knowledge and practices of Ethiopian smallholder dairy farmers on bull station service and dairy cattle mating systems. Specifically, the study emphasized: 1) the acceptability of bull station service and different mating systems by farmers; 2) the reasons behind choosing a specific mating system; 3) the rate of adoption of the different mating systems; 4) progeny performance in each mating system; and 5) constraints observed in the different mating systems.

# 2. Materials and Methods

## 2.1. Description of the Study Area

The study was conducted in three selected districts (Ada, Lume and Adama Zuria) of Oromia region ($3^{o}$N to $10.5^{0}$N latitude; $34^{0}$ E to $43^{0}$ E longitudes) in Ethiopia. Most of the study sites were representing midland altitudes ranging 1,500 - 2,300 m.a.s.l. and had an annual rainfall of 800 - 1,200 mm with annual temperature of 17.5-20 °C. Mixed crop-livestock farming was the dominant type of agriculture practised in the study areas.

## 2.2. Sampling Techniques and Data Collection

A multi-stage sampling procedure was employed to choose a total of 62 respondents in rural, urban and peri-urban smallholder dairy farming communities of selected districts of Oromia region in Ethiopia. The selected respondents includes: 1) farmers who were using bulls that are kept for communal use at bull stations; 2) farmers who were using their own bulls; and 3) farmers who were using artificial insemination; 4) farmers who were using both artificial insemination and natural mating. Person to person interview was made to collect qualitative and quantitative data on standardized questionnaires. The studied parameters were focusing on the socio-economic features of the households, source of bulls used for breeding purpose, herd size on breeding bulls, management of bulls on bull station, characterization of bull service delivery system, number and distribution of bull services, farmers' perception on use of natural mating vs. artificial insemination and bull management related constraints in smallholder dairy farming systems of the selected districts.

## 2.3. Statistical Analyses

The collected data were coded and stored on SPSS database. Descriptive statistics such as percentages and frequencies were performed using cross-tabulation procedure of descriptive statistics in SPSS [11] software package [11]. Chi-square test was performed to determine differences in the frequency distribution of the studied variables.

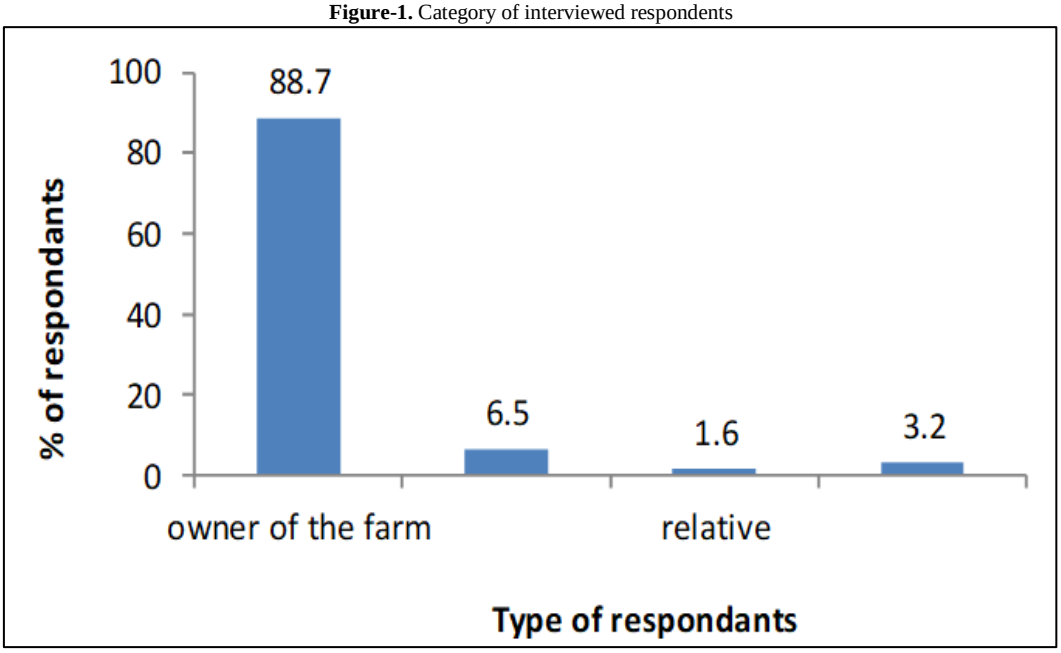
Alpha level of 0.05 was used to reject the null hypothesis of no difference among different classes. Quantitative measurement variables and their values were exported into Excel sheets to be analyzed using [12]. Proc Means procedure of SAS was employed to quantify the means and standard errors of the quantitative variables.

# 3. Results and Discussion

## 3.1. Socio-Economic Features of Interviewed Respondents

A total of 62 respondents, of which, 56.5% male and 43.5% female were selected and interviewed to collect quantitative and qualitative data on the studied parameters. Among the interviewed respondents, most (88.7%) of them were owners of the visited farms and the remaining 6.5, 3.2 and 1.6% were employed personnel, representative of dairy cooperatives and farm owner relatives, respectively (Fig. 1).

**Figure-1.** Category of interviewed respondents




## 3.2. Bull Station Characteristics, Natural Mating Vs. Artificial Insemination

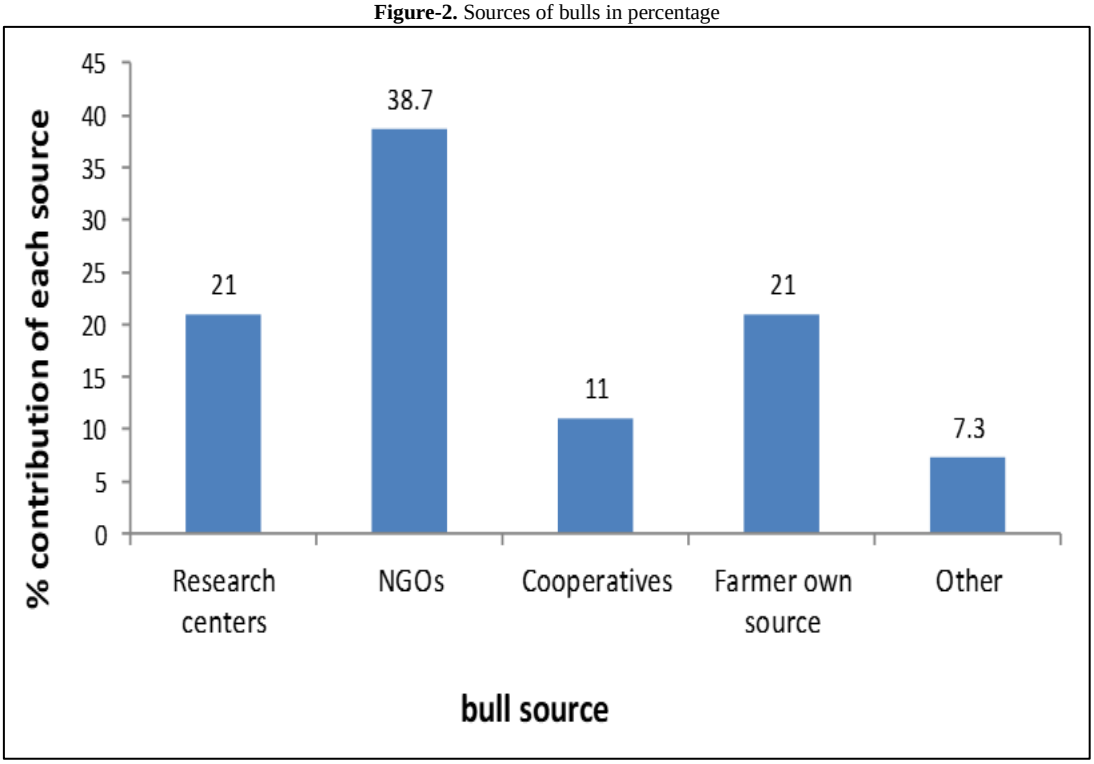
As presented in Table 1, about 79% of the interviewed respondents were participants of bull station service and above 63% of them started to participate very recently which is in less than a decade ago. Regarding breeding bull ownership, individual farmers and cooperatives were the main owners; where, farmers took the majority (63%) ownership. In 92% of the cases, smallholder farmers were the main beneficiary of the bull station services. Keeping bulls for communal use at bull stations was successful and this was supported by 71% of the interviewed respondents. Although the smallholder dairy farmers use bulls for natural mating as an alternative option, the majority (71%) of them were still using artificial insemination. About 76% of the interviewed respondents responded that bull service is very helpful for mating their dairy cattle. Almost 100% of the interviewed households had interest to continue using bull station service for natural mating. However, in conditions where there is very good access for artificial insemination, 43.5% of the households preferred to adopt artificial insemination, 37.1% natural mating and the remaining 19.4% interested for using both natural mating and artificial insemination services (table 2).

**Table-1.** Characterization of bull service ownership, beneficiary groups, and future tendency on degree of utilization

| Studied variable | Responses |
|---|---|
| Do you participate in bull station program? | Yes (79%) No (21%) |
| Since when do you participate in bull station Program? | Before 2000 E.C. (2%), Between 2000 – 2005 E.C. (8%), Since 2005 E.C (63%) |
| Who is the owner of the bull stations? | Farmers (63%), cooperatives (31%), Other (6%) |
| Who is making use of the bull station services? | Smallholder farmers (92%), others (2%) |
| Do you think bull station service is successful? | Yes (71%), no (29%) |
| Do you use also AI service? | Yes (71%), no (26%) |
| How helpful is bull service for your farm? | Very helpful (76%), less helpful (24%), not helpful (0%) |
| Do you have an interest to continue using bull service? | Yes (100%), NO (0%) |
| In the future which mating system would you like to practice? | Bull service (37.1%), AI (43.5%), both (19.4%) |

As described in Fig. 2, the bulls used for breeding purpose came from various sources such as research centers (15.5%), NGOs (37.5%), cooperatives (7.8%), born in farmers' farm (10%) and the remaining 29.2% from other sources.

**Figure-2.** Sources of bulls in percentage




As reveled by this study, the main production objective for using bulls for natural mating in the smallholder community was milk production (table 2). This was true at 90.3% of the interviewed household dairy farms. Only in 9.7% of cases, the production objective was found to be both for milk and beef. Regarding breed and genotype category in use, the majority (88 %) of the bulls that were kept for communal use at bull stations were Holstein Friesian breed, among which 72% of them were high-grade and 16% pure breed. The remaining 12% were Jersey and their crosses.

The study further pointed out that neither mating with bull nor using artificial insemination could show 100% conception rate (table 2). Only 43.5% of the interviewed households responded that there are cases where cows/heifers could conceive just with a single service using natural mating, but the remaining respondents said that in most cases, cows/heifers tend to conceive with two or more services.

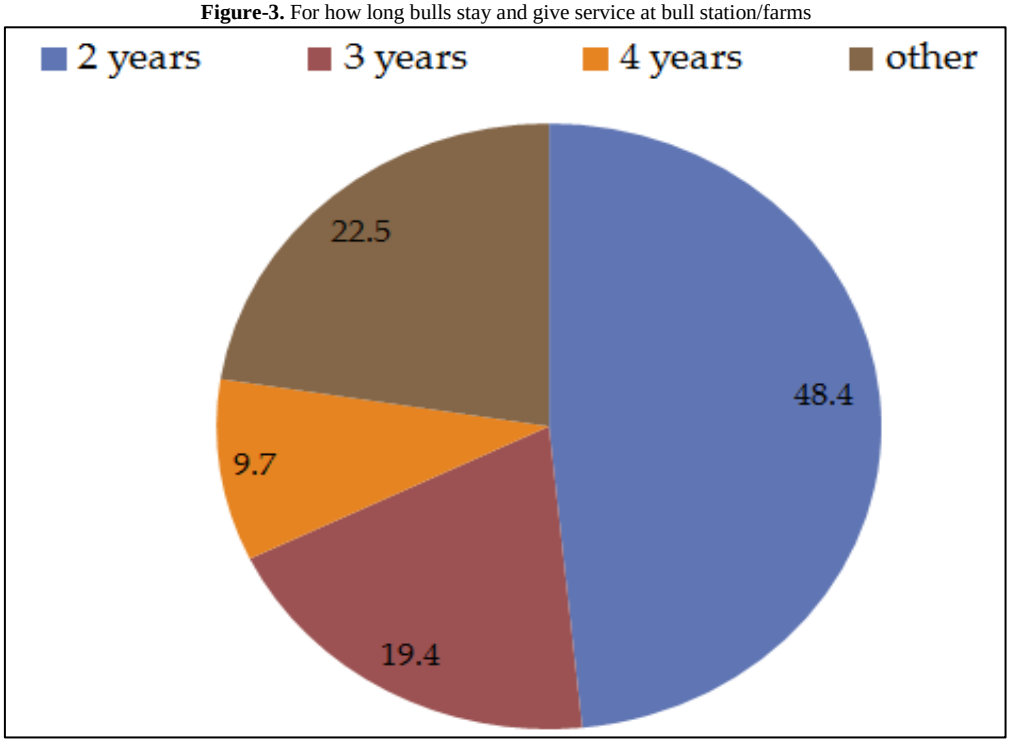
After the service year, most households (71%) cull their bulls by selling them in the local markets for beef (table 2). Although bull station service is highly benefiting the farmers, the major challenge in the system was reported to be the cost of feed. According to 70% of the respondents, feed cost accounts for the major expense in the system. Regarding extension service on management of breeding bulls in the bull station, only 43.5% of the visited farms had access for the service (table 2).

**Table-2.** Objective of bull station, source genotype, culling practices, major costs and extension service

| Studied variable | Responses |
|---|---|
| What is the purpose of bull station service? | For Dairy (90.3%) , for dual purpose (9.7%) |
| What is the blood level of the bulls kept at bull stations? | Pure HF (16%), high grade crosses (72%), others (12%) |
| Did your cow/heifer conceive with a single mating using bull service? | Yes (43.5%), no (40.3) |
| How do you cull the bulls after their serving time at bull station is over? | Sold for Slaughtering in local markets (71%), Other (29%) |
| What is the major cost at bull station | Feed (70%), other (30%) |
| Is there health extension support on bull station service? | Yes (43.5), no (53.2%), |

According to the information obtained from the respondents, the service year of breeding bulls in bull station ranged from 2 to 4 years with most frequent (48.4%) one is 2 years (Fig. 3).

**Figure-3.** For how long bulls stay and give service at bull station/farms




## 3.3. Herd Size and Performance

As presented in Table 3, on average 53.2% of the 62 interviewed dairy farmers used bull service for mating their female animals. There were on average two bull stations per farmer association. There were two breeding bulls that are kept per bull station. One bull station was serving on average for 28 households, of which 25% of them were female headed. The farmers travel long distances taking 1 to 3 hours to bring their female animals (by tracking) and mate with the breeding bulls kept at bull station. A single breeding bull mates on average six females animals per week. The farmers pay on average 89 birr for a single service, i.e. for mating one female using one breeding bull. The service life of breeding bulls in bull station ranges from two to four years.

**Table-3.** Mean and STD of the number of bulls kept in bull station, number of beneficiary, and cost per service

| Variable | N | Mean | STD |
|---|---|---|---|
| On average how many farmers use bull service to mate their cows? | 20 | 32.6 | 47.1 |
| How many households get bull service per bull station? | 31 | 27.7 | 33.5 |
| How many of those farmers getting service from bull station are female headed? | 28 | 6.7 | 12.9 |
| How far is the distant farmer travel to come and get bull service from bull station? | 51 | 1.8 | 1.0 |
| How much bull stations do you know in your area? | 44 | 1.8 | 1.7 |
| How many bulls are kept on average per bull station? | 52 | 2.1 | 1.1 |
| How much do you pay per bull service? | 43 | 88.9 | 33.6 |
| For how many cows a bull at bull station give service per week? | 27 | 6.4 | 7.3 |

Where N stands for number of respondents and STD represents standard deviation

The study generated information also on the overall effect of bull stations in terms of changing crossbred herd size, herd structure, reproductive performance and milk yield in the studied dairy farming communities. As described in Table 4, the crossbred progeny of those bulls kept at bull stations were distributed to several farms in the studied areas. On average a herd size of 2.5, 1.4, 1.0, and 2.5 calves, heifers, young bulls and cows per farm, respectively, were the progeny of bulls kept at bull stations. In addition, the same households had an average herd size of 3.1, 1.7, 1.5, and 5.3 calves, heifers, young bulls and cows, respectively, that were produced through AI service. Utilization of breeding bulls for natural mating at bull stations and also application of AI service could improve both milk production and lactation length. According to the data provided in Table 4, average lactation length of 8 $\pm$ 1 months was recorded for crossbred cows that were produced both through natural mating and artificial insemination. However, an average lactation milk yield was observed to be 2583 $\pm$ 1363 and 3862 $\pm$ 1933 liters per head of crossbred cows that were produced through natural mating and artificial insemination, respectively. These milk yield values of crossbreed cows are by far greater than the milk yield performance of local cows. In other words, taking 500 liters of milk per head as an average lactation performance of local cows, there was a 2 to 8 fold increment in lactation milk yield of crossbreed cows that were produced through natural mating as compared with the average lactation milk yield performance of local cows. Similarly, there was a 4 to 12 fold increment in average lactation milk yield of crossbreed cows that were produced through artificial insemination as compared with the average lactation milk yield performance of local cows.

**Table-4.** Herd size, lactation length and milk yield of progeny herds born though natural mating using bulls kept at bull stations

| Variable | N | Mean | STD |
|---|---|---|---|
| Calves of breeding bulls kept at bull station | 13 | 2.5 | 0.5 |
| Calves obtained through AI service | 18 | 3.1 | 1.2 |
| Heifers of breeding bulls kept at bull station | 11 | 1.4 | 0.9 |
| Heifers obtained through AI service | 17 | 1.7 | 2.2 |
| Young bulls of breeding bulls kept at bull station | 5 | 1.0 | 0.0 |
| Young bulls obtained through AI service | 6 | 1.5 | 0.8 |
| Cows of breeding bulls kept at bull station | 4 | 2,5 | 0.7 |
| Cows obtained through AI service | 8 | 5.3 | 1.4 |
| Average lactation length of cows born with AI | 33 | 8 | 1.3 |
| Average lactation length of cows born with NM | 6 | 8 | 1.2 |
| Average milk yield per crossbred cow per year AI | 33 | 3862 | 1933 |
| Average milk yield per crossbred cow per year NM | 6 | 2583 | 1363 |

Where: AI refers to artificial insemination, NM stands for natural mating. Herds produced with AI are not progeny of bulls kept at bull station. They were added just for comparison purpose

Our study showed that besides natural mating, artificial insemination is very well accepted by many farmers in Ethiopia. This finding is in agreement to the findings of Makuza, *et al.* [3], who reported the high acceptance of the artificial insemination service by the Rwandan farmers. Similarly, Rasouliazar and Fealy [8], stated that almost 80% interviewed cattle ranchers in Iran, had a positive attitude towards the use of artificial insemination as appropriate mating system for dairy cattle. Furthermore, according to Valergakis, *et al.* [6], AI service was found to be more cost effective than the natural mating system in Greece. Those authors concluded that even under less than average management conditions, artificial insemination is more profitable than the best natural mating scenario. On the other hand, Yitayih, *et al.* [5], reported that even though artificial insemination service has been in operation for over 30 years with different levels of intensification in Ethiopia, its efficiency remained at a very low level due to infrastructural, managerial and financial constraints, poor heat detection, improper timing of insemination and embryonic death. Similarly, Mugisha, *et al.* [10] and Eklundh [2] reported low adoption of artificial insemination service in Uganda. Mugisha, *et al.* [10], stated that adoption of AI service is highly dependent on availability of extension services, record keeping practice, and availability of milk markets. According to Eklundh [2], the most important reasons for low adoption of AI service in Uganda are: 1) the poor pregnancy result from AI; 2) poor herd management and heat detection; 3) incorrect handling of semen by AI technicians; and 4) Poor administration of AI activity at national level. However, the most limiting factors for wider adoption of AI service in Rwanda were availability of few inseminators, less availability and expensive nature of sexed semen and high prices of artificial insemination services [3].

# 4. Conclusions

The study revealed that bull station service was adopted by the majority of interviewed farmers and it was positively perceived by participant communities. Regarding adoption of alternative mating systems, both artificial insemination and natural mating systems are acceptable as appropriate dairy cattle mating system in Ethiopian smallholder farming communities. However, the rate of utilization of natural mating is high in areas where there are limitations for AI service. Farmers perceive several advantages of natural mating as compared with the AI service. For instance, they believe that adopting natural mating system makes heat detection easier and improve conception rate and fitness of new born calves. Because of this, farmers are showing high interest to continue using natural mating system. The study also showed that, despite the type of mating system, crossbreeding of local animals with exotic breeds could improve milk yield per head of cow by 2 to 5 folds as compared with the performance of local breeds. Furthermore, the efficiencies of both the AI and natural mating systems were affected by several factors. Thus, those prevailing factors need to be further investigated in order to enhance the efficiencies of both mating systems. Although, both mating systems can be applied in smallholder dairy farming communities, the importance of natural mating is high in areas where there is limited access for AI service.

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