The effect of mating system and herd size on reproductive performance of dairy cows in market oriented urban dairy farms in and around Addis Ababa

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SUMMARY

A retrospective data analysis and a cross sectional survey was conducted to study the effect of mating system and herd size, on reproductive performances of cows in smallholder market oriented urban dairy farms in Addis Ababa milk shed. Thirty three dairy farms comprising 232 cows were visited and data on reproductive performance, cow attributes, type of mating, body condition score and general farm management practices were collected. The mean (±SD) age at first service (AFS), age at first calving (AFC), service per conception (NSC), calving to conception interval (CCI), and duration after last calving (DALC) were 23.1±6.4 months, 33.2±6.7 months, 2.0±1.2, 176.8±79.0 days, and 172.2±159.3 days, respectively. Both AFS and AFC were significantly different (P<0.05) between farms and mating systems. There was a significant difference (P<0.05 in the NSC between farms and between the mating systems (P<0.001). The first service conception rate for pregnant cows (n=77) was 45.5% for all farms, 60.0% for AI (Artificial Insemination) farms, and 40.0% for NS (Natural service) farms with significant difference (P<0.05) between mating methods. DALC was significantly longer (P<0.05) in small farms. Effect of mating system-herd size interaction was not significant on all performance parameters. The prevalence of reproductive health problem was 27.2% and the major reproductive health problems were retained fetal membrane (33.3%) and abortion (22.3%). In conclusion, the present study showed that both the herd size and the method of mating were important risk factors that affect the reproductive performance. To minimize the cost of bull keeping in small farms and mitigate the poor AI delivery system prevailing in Ethiopia, establishing a bull service station for collective use should be considered.

Keywords: Herd size, smallholder urban dairy, natural service, AI, reproductive performance.

RÉSUMÉ

Influence du système de reproduction et de la taille du troupeau sur les performances reproductives des vaches laitières de la région d’Addis Ababa

Une analyse rétrospective et une enquête ont été conduites pour évaluer l’effet du système de reproduction des vaches des petites exploitations d’Addis Ababa. Trente trois exploitations comprenant 232 vaches ont été visitées et les données concernant les performances reproductives, les caractéristiques des vaches, le système de reproduction, les conditions corporelles et les pratiques d’élevage ont été collectées. L’âge moyen à la première saillie (AFS), l’âge moyen au premier vêlage (AFC), le nombre de saillies par conception (NSC), l’intervalle vêlage-conception (CCI) et l’intervalle vêlage-vêlage (DALC) ont été de 23.1±6.4 mois, 33.2±6.7 mois, 2.0±1.2, 176.8±79.0 jours et 172.2±159.3 jours, respectivement. Les valeurs de l’AFS, l’AFC et le NSC ont été significativement différentes selon les exploitations et le système de reproduction. Le taux de conception à la première saillie (n=77) a été de 45,5 % pour toutes les exploitations, de 60,0 % dans les cas d’insémination artificielle et de 40,0 % lors de saillies naturelles, la différence en fonction du système de reproduction étant significative. DALC a été significativement plus long dans les exploitations de petite taille. L’interaction entre les effets du système de reproduction et la taille du troupeau n’a pas été significative pour l’ensemble des paramètres examinés. La prévalence des troubles de la reproduction a été de 27,2 % et les principaux troubles ont été des rétentions placentaires (33,3 %) et des problèmes d’avortement (22,3 %). En conclusion, la présente étude a montré qu’à la fois la taille du troupeau et la méthode de reproduction étaient des déterminants importants des performances reproductives. Ces observations montrent l’intérêt pour l’Éthiopie de mettre en place une coopérative d’insémination artificielle qui permettrait de limiter le coût de l’entretien d’un taureau dans les petites exploitations et d’améliorer le système actuel d’insémination artificielle éthiopien.

Mots clés : Taille du troupeau, petites exploitations, saillie naturelle, performances reproductives.

Introduction

Even with very few crossbreds (0.5%) and pure exotics breeds (0.1%), dairy production is becoming an essential component of the agricultural sector contributing to the alleviation of malnourishment through the production of milk and milk by-products in Ethiopia. However, dairy production is at its lowest compared to other countries [4, 17]. As one option to improve the genetic potential of the indigenous breeds of cattle, a cross breeding program was introduced in Ethiopia at a wider scope in the late 1960’s [6]. As a result of this urban dairying is flourishing in many small towns and big cities with different level of intensification from less than 1% to over 40% growth [16]. Artificial insemination (AI) has been used to disseminate exotic blood since the early eighties and the technology has been well adopted by dairy farms in urban and periurban areas. However, AI practices have been constrained by a number of factors including technical, system related, financial, and managerial problems [4, 16]. Among the technical problems are poor heat detection skills by farmers, lack of timely insemination due to communication and transportation problems, poor semen handling practices, infertility problems in cows and inefficiency of AI technicians.
Because of inefficiency in AI services and consequently reproductive inefficiency, there has been a wide belief among dairy producers that dairy animals perform better when bulls are used than AI. Moreover, there is a challenging complaint about a poor reproductive performance in animals using AI than natural service (NS). This, contrary to the dairy development plan, is hampering the use of AI to upgrade the production and dairy producers are becoming increasingly skeptical of the use of AI. On the other hand, variation in production efficiency of dairy farms has been attributed to herd size and type of feeding system, which in most developing countries also determine the production system [5]. Management systems and environmental conditions under which cattle are maintained could also alter the incidence of reproductive health problem [17].

Most of the available information pertaining to the reproductive performance of dairy cattle in Ethiopia is based on research station or institutional herds [2, 13, 22, 30]. The majority of these studies confirmed the performance of cross-breeds to be better than the indigenous Zebu for the major reproductive traits considered. However, reports on the influence of herd size (scale of farming) and mating system are virtually absent. The objectives of this study were to determine the reproductive performances of dairy cows in different farm sizes that use different mating systems.

Materials and Methods

STUDY AREA

The study was conducted in Addis Ababa, located at 9° 2’ N and 38° 42' E with an elevation of about 2400m above sea level. All the farms were located within Addis Ababa milk shed, an area covering the city itself and its surrounding 30 km outskirts and supplying their entire milk product to Addis Ababa. The area receives a mean annual rainfall of 1800mm in bimodal pattern. The long rainy season extends from June to September followed by a dry season ranging from October to February. The short rainy season falls between March and May. The average minimum and maximum temperature were 10.7°C and 23.6°C, respectively.

STUDY ANIMALS

The study animals comprised crossbred dairy cows (Holstein Friesian X Zebu) with in Addis Ababa milk shed with a history of at least one calving. All the cows receive routine deworming and vaccination against anthrax, black leg, foot and mouth disease, and lumpy skin disease. The cows were kept indoor, hand feed and watered in-house. The farms practiced either NS using hired or home grown bull or AI. Animals were fed mainly grass hay and crop residue supplemented with varying amount of home made concentrate mixture of mainly cereal grain and oil seed cake depending on season, lactation status, milk yield and percentage of exotic genes. Cows were hand milked twice a day and calves were fed bucket milk after manual milking.

STUDY DESIGN

A total of 33 dairy farms (comprising of 232 cows) were randomly selected from the study area. Farms with no recording system were not included in the study. The farms were then classified according to their herd size into small farms (1-10 animals), medium farms (11-20 animals) and large farms with more than 20 animals. Accordingly, 16 were small, 9 were medium and 8 were large farms. Farms were also classified based on the mating method they employ as NS or AI farms. Six medium farms (n = 55 cows), 14 small farms (n = 41 cows) and 1 large farms (n = 40 cows) used AI while 2 small farms (n = 7 cows), 3 medium farms (n = 20 cows) and 7 large farms (n = 69 cows) used NS.

All the farms were visited to collect relevant information regarding the reproductive histories of the cows and herd management (housing, feeding and breeding). Information was collected either through personal interview of owners or from individual animal record. An individual cow attributes such as age, parity, and breed were recorded. Age at first calving (AFC), calving to conception interval (CCI), number of services per conception (NSC), and first service conception rate were used to determine reproductive performance. The length of the duration after last calving (DALC) was taken in cows that were not pregnant at the time of the visit to determine reproductive performance as described in LOBAGO et al (2006). Average was considered for cows with more than one parities. Moreover, cows were clinically examined to determine the prevalence of major reproductive disorders and pre-weaning calf mortality. Body condition score (BCS) was also determined as described in EDMONSON et al (1989).

DATA ANALYSIS

Data was stored in Microsoft excel. All computations were performed using computer software (STATISTICA 6.0, 2003). Descriptive statistics were computed for all variables. Proportions were compared using Chi square. The effects of farm size and mating methods on reproductive performance were computed using ANOVA. The effects of farm size-mating methods interaction was analyzed using factorial ANOVA. The model used was:

\[
Y_{ijk} = \mu + M_i + F_j + (MF)_{ij} + e_{ijk}
\]

Where \(Y_{ijk}\) = AFC, DALC, CCI and NSPC; \(\mu\) = the overall mean; \(M_i\) = the fixed effect of the ith mating system (i = AI and NS); \(F_j\) = the fixed effect of the jth farm size (j = small, medium, and large farms); \(MF_{ij}\) = the effect due to the interaction of the fixed factors (mating system and farm size); \(e_{ijk}\) = the random error. Because of inconsistencies in the farms record, percent of exotic gene was not included in the model. \(P\)-values <0.05 was considered as showing significant difference between variables.

Results

Out of the total 232 cows examined, 77 (33.2%) and 155 (76.8%) were pregnant and open cows, respectively at the day
of examination. Summary of the reproductive performance for the different farm sizes and for different mating methods is given in Table 1. The mean (±SD) body condition score of all cows was 2.9 ±0.59. BCS for small, medium, large farms, and AI and NS farms were 3.1± 0.52, 3.2±0.53, 2.8±0.61, 3.1±0.57 and 2.9±0.61, respectively. Both AFS and AFC were significantly different (P<0.05) between the different farms and mating systems. Large farms and farms using AI were known to have the longest AFS and AFC (Table 1 and Figure 1).

There was a significant difference (P<0.05) in the NSC between the different farms with small farms having the highest NSC (2.4) compared with 1.8 and 1.9 of medium and large farms, respectively. NSC was also significantly different (P<0.001) between the mating systems with farms using NS having lower values (1.7) compared with those that use AI (2.1). The first service conception rate for pregnant cows (n=77) was 45.5% for all farms, 60.0% for farms using AI, 40.0% for farms using NS, 20.0% for small farms, 42.9% for medium farms and 37.1% for large farms. This was not different between the mating methods but a significant difference (P<0.05) was found among the farms with small farms having the lowest first service conception rate compared with medium and large farms.

The CCI was not statistically different both between the farms and the mating methods. DALC, however, was significantly longer (P<0.05) in small farms (244 days) compared with 142 and 160 days for medium and large farms, respectively. But, there was no statistical difference in DALC for the two mating systems. The data for DALC was further truncated only to the cows beyond 60 days after last calving at the time of the visit (n=115). Computed values were 218.0±161.2 days, 314.±202.0 days, 172.3±113.2 days, 204.9±152.3 days, 248.7±173.7 days, and 182.2±138.4 days for all farms, small farms, medium farms, large farms, AI farms and NS farms, respectively. A significant difference (P<0.05) was found in the DALC, and NSC between the three farm sizes and the two mating methods. DALC was longer in small farms compared with medium and large farms. The mean NSC was higher in AI farms (2.9) than in bull farms (1.7). Analysis of herd size-mating system interaction did not show any significant effect on all parameters of reproductive performance.

Out of the total of 232 dairy cows examined the incidence of reproductive health problem was 27.2%. Table 2 presents the summary for the different farms sizes and mating methods.

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### Table 1: Descriptive statistics of reproductive performance of study cows by farm size and type of mating (n=232).

<table>
<thead>
<tr>
<th>Factor</th>
<th>N</th>
<th>Parity</th>
<th>NSC</th>
<th>AFS [months]</th>
<th>AFC [months]</th>
<th>CCI [days]</th>
<th>DALC [days]</th>
</tr>
</thead>
<tbody>
<tr>
<td>All farms</td>
<td>232</td>
<td>2.6 (±1.6)</td>
<td>2.0 (±1.2)</td>
<td>23.1 (±6.4)</td>
<td>33.2 (±6.7)</td>
<td>176.8 (±79.0)</td>
<td>172.2 (±159.3)</td>
</tr>
<tr>
<td>Small farms</td>
<td>48</td>
<td>2.5 (±1.3)</td>
<td>2.4 (±1.5)</td>
<td>23.1 (±7.8)</td>
<td>32.6 (±7.7)</td>
<td>217.6 (±102.5)</td>
<td>244.0 (±132.3)</td>
</tr>
<tr>
<td>Medium farms</td>
<td>75</td>
<td>2.2 (±1.1)</td>
<td>1.8 (±1.1)</td>
<td>20.5 (±4.3)</td>
<td>30.8 (±4.6)</td>
<td>171.4 (±68.5)</td>
<td>142.0 (±112.0)</td>
</tr>
<tr>
<td>Large farms</td>
<td>109</td>
<td>2.9 (±1.8)</td>
<td>1.9 (±1.1)</td>
<td>24.0 (±6.3)</td>
<td>34.2 (±6.8)</td>
<td>161.1 (±69.6)</td>
<td>160.1 (±149.8)</td>
</tr>
<tr>
<td>AI farms</td>
<td>136</td>
<td>2.4 (±1.4)</td>
<td>2.1 (±1.3)</td>
<td>23.4 (±7.0)</td>
<td>33.7 (±7.2)</td>
<td>187.0 (±85.9)</td>
<td>185.7 (±173.6)</td>
</tr>
<tr>
<td>NS farms</td>
<td>96</td>
<td>2.9 (±1.8)</td>
<td>1.7 (±0.9)</td>
<td>22.6 (±5.4)</td>
<td>32.3 (±5.9)</td>
<td>159.1 (±62.6)</td>
<td>154.9 (±138.2)</td>
</tr>
</tbody>
</table>

BCS=Body condition score; NSPC=Number of service per conception; AAFS=Age at first service; AAFC=Age at first calving; CCI=Calving to conception interval; DALC= Duration after last calving; AI= Artificial insemination; NS= Natural service.

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**Discussion**

The mean AFC (33months) found in the present study agree with previous finding [13] that reported 32.7 months for F1 Boran x Friesian crosses. It is, however, lower than the 36.2 months in a more recent study [9]. Other authors also indicate 58.3 and 36.8 months for cross bred dairy heifer at two locations in small holder dairy farms in Zimbabwe [19] and 43.2 - 53.6 months for different cross breeds in Sudan [1]. On the other hand, analysis of over one million records indicated AFC for Holstein-Friesian heifers to be 28.1 month [25]. Farm size has
been indicated to significantly affect AFC in dairy animals [16]. Unlike farms using AI, farms using NS have a better chance of detecting estrus and getting heifers or cows pregnant at the first opportunity. Farms using AI have to go through the difficulties of estrus detection required for proper insemination which are both the number one problems in the success of AI in Ethiopia. Moreover, a number of previous works confirmed that management factor especially nutrition determines prepubertal growth rates and reproductive development. The better managed and well-fed heifers grew faster, serves earlier and resulted in more economic benefit in terms of sales of pregnant heifers and/or more milk and calves during the life time of the animal [17, 19, 22, 28].

The mean CCI estimated for all farms in the present study (176.8 days) is with in the range of 113 - 319 days reported for cross bred and local zebu cattle in different management systems in Ethiopia [17, 18, 28]. Larger farms (157.2 days) and farms using NS (163.9 days) were known to have a significantly shorter CCI compared with small farms (180.1 days) and farms using AI (179.7 days). Though the present finding shows an unfavorable estimate compared with the optimum CCI recommended (80-85 days) to achieve the target 365 days of calving interval [24]. The use of NS has been confirmed to reduce the CCI [20]. The post partum anoestrus interval and service period of the CCI are also influenced by feeding and housing system, method and efficiency of heat detection, type and efficiency of breeding services used, efficiency of recording system and extra nutritional demands for lactation and/or growth of younger animals which are all in turn related to the scale of farming.

The mean DALC (172.2 days) of the present study is slightly higher than (148.4 days) for cross bred dairy cows around Debre Zeit [15], but lower than the 201 days recently reported for Selale, both in Ethiopia [17]. Results of DALC for cows that were not pregnant for more than 60 days further showed a much higher overall mean (218 days). Smaller farms and farms using AI clearly showed a significant increase in the DALC. Smaller farms often opt for the use of AI because of the cost or difficulty of keeping a breeding bull. Several factors associated with the success of AI particularly detection of heat, efficiency of inseminator, communication and transport problems, quality of the semen may have also similarly affected smaller farms [16, 27].

The present finding on NSC is with in the range of previous reports although there seems to be great variation ranging from 1.6 to 2.6 among authors for different farms under different production managements [2; 16, 17, 21]. As herd size increases, problems with estrous detection become more important in affecting the reproductive performance of dairy cows [29]. Many dairy farmers use NS to overcome problems associated with estrous detection [26]. In the present study, smaller farms that do not have the ability to keep a breeding bull have to rely on AI service. As also reported in other study [16], accessing an AI service has many technical and logistic hurdles contributing to the failure of the timely service of estrous cows hence results in poor reproductive performance. The conception rate to first service (45.5%) is with in the range of earlier estimates reported in Ethiopia, which ranged from 41% to 56% [2, 17, 21, 28]. Higher NSC, reproductive diseases and parity are risk factor for lower conception rate [7, 23]. The same studies also reported that cows that were artificially inseminated several times were found to be less likely to conceive than cows inseminated once. The sample size taken for the current study, however, is relatively small. It is therefore imperative to suggest that the results of the reproductive performance and the factors affecting them have to be further verified in future studies using larger sample sizes.

The prevalence of RFM and abortion found in the present study are higher than reports for countries like UK [10, 12] while incidences of dystocia, endometritis and repeat breeder are closely similar to other studies [11, 14] who also found 5-15% repeat breeder, 9% dystocia and 15-22% endometritis, respectively. The high prevalence rate of RFM (33.3%) is linked to the high prevalence of abortion (22.3%), a known predisposing factor for RFM [3]. The higher prevalence of reproductive health problems among AI using farms is probably due to microbial contamination resulting from poor hygiene during AI service [12, 28].

**Conclusion**

The present study showed that farm size and method of mating are important factors that influence the reproductive performances of small holder urban dairy farms under consideration. Generally, there were extended CCI in pregnant cows, longer DALC in non pregnant cows and very low first service conception rate. Larger farms and farm using NS were relatively better than smaller farms and than those that used AI. The prevalence of the major reproductive diseases, particularly the prevalence of RFM and abortions, were also higher.
In conclusion, both farm size and the method of mating are important risk factors that play a role in determining the reproductive performance of small holder urban dairy farms. Smaller and medium farms that could not keep a breeding bull must consider the use of a bull service station for collective use of breeding bulls as a back up in cases of failure of AI delivery. Many small holders’ farms are run as a sideline business and are often disadvantaged with regards to proper management. Improvements in management systems (such as housing, feeding and health care), heat detection and proper reproductive health management could help minimize reproductive health problems and improve the reproductive performance.

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References