Factors influencing the success of on-farm estrus synchronization of dairy cattle in North Shewa Zone, Amahara Region, Ethiopia

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To increase the efficiency of artificial insemination (AI) and improve reproductive performance of dairy cattle, different governmental organizations (GOs) and non-governmental organizations (NGOs) have been conducting field level estrus synchronization followed by AI in different locations in Ethiopia. However, success rates varied from low to moderate between locations. North Shewa Zone of Amhara Region was among the areas where on-farm estrus synchronization was applied and resulted with very poor success. Therefore, this study was undertaken to assess factors that influenced the success of previously implemented field level estrus synchronization programs. A total of 144 smallholder dairy producers (121 men, 23 women) were interviewed to identify certain factors which affected the previous on-farm estrus synchronization programs. Nearly 64% of respondents had participated in the studied dairy cattle estrus synchronization program which was implemented in 2013 and 2014. Participation of farmers in estrus synchronization program was positively affected by the advancement of educational level being 57.5% illiterates, 64.3% reading and writing, 67.6% 1 to 6th grade and 68% above grade 7. About 53% of respondents did not have awareness in dairy cattle estrus synchronization technology at the time of implementation. About 59.72% of farmers who have awareness about estrus synchronization gave negative feedback towards the technology. The proportion of respondents who gave negative feedback towards the technology attributed to 88.3, 6.98 and 4.65% for poor pregnancy rate, poor heat response and unavailability of the service, respectively. Due to lack of awareness and feed resources, the majority of farmers (68.48%) do not supplement breeding cows/heifers. Inaccessibility of AI and improved bull service; heat detection problems; lack of awareness of farmers and poor cattle management systems were the major factors which are causing low pregnancy rate (20.18%) of the studied synchronization program.

Key words: Awareness, dairy cattle, estrus synchronization, pregnancy rate.

INTRODUCTION

Improved reproductive technologies have the potential to improve genetics of the local breeds of cattle rapidly.
The technologies include: “artificial insemination (AI), embryo transfer, in vitro fertilization, embryo cryopreservation, sexing of semen and embryos, cloning, transgenesis, stem cell technology, embryo genomics, micro and nanotechnology” (Verma et al., 2012). AI is simple, economic and is seen as the most successful and important assisted reproductive technology in developing countries (Rodriguez-Martinez, 2012). It is also among the successful reproductive technologies to produce a sustained genetic improvement in the dairy farming where technical advancement has been achieved (Vishwanath, 2003).

Ethiopia has introduced AI service on dairy since 1938 to improve the genetic potential of the local breeds. However, AI on cattle has been met with little success because of the various technical, organizational and socioeconomic constraints (Gizaw et al., 2016). Haque et al. (2015) reviewed that management factors (such as methods of husbandry, feeding, estrus detection, semen handling and cow management) and cow-level factors (such as age, body condition score, post parturient problem, disease events, milk yield and genetics) influence the efficiency of AI program in dairy herd. According to Patterson et al. (2016), the problem of heat detection in dairy cattle AI service program can be minimized by effective estrus synchronization.

In the past few years, governmental organizations (GOs) and non-governmental organizations (NGOs) in Ethiopia applied estrus synchronization programs in different areas to bring a large percentage of a group of dairy cows into estrus at a short, predetermined time, and increased the efficiency of AI by increasing estrus detection efficiency. Even though estrus synchronization under on-farm condition has been reported to be successful in different parts of the country (Gizaw et al., 2016), North Shoa Zone of Amhara Region was among the areas where on-farm estrus synchronization was implemented in 2013 and 2014, and resulted in very low conception rate (farmers communication). So, this study was designed to assess factors that influenced the success of previously implemented field level estrus synchronization program.

MATERIALS AND METHODS

Study area

The study was conducted in North Shewa Administrative Zone (in Basona Worana and Angolelana Tera districts) of the Amhara National Regional State, located in the Central Northern Highlands of Ethiopia where field level estrus synchronization program was implemented in 2013 and 2014. The capital town of the zone (Debre Berhan) is located 125 km North East of Addis Abeba. The altitude of the study area ranges between 2800 and 2845 m above sea level. The annual average rainfall is 874 mm, and the annual temperature ranges between 5 to 23°C (Ermias, 2007). Frost is common in the area particularly between October and December when temperatures fall below average (Akkilu and de Graaff, 2006). The area is one of the areas identified as milk shed area in Ethiopia with 1,482,346 heads of cattle in the administrative zone (CSA, 2017).

Synchronization protocol used

At the beginning, farmers were told by the respective District Livestock and Fishery Development Bureaus to present candidate cows/heifers for hormonal estrus synchronization treatment in November 2013 and 2014. Candidate cows/heifers presented by farmers were examined to be non-pregnant, and to have normal reproductive tract. Cows/heifers which were non-pregnant and have normal reproductive tract received single injection of 5 ml of Synchromate® intramuscularly (IM). Fixed AI after 72 hrs post injection of hormone was conducted.

Data collection

After the rapid informal field survey and consultation with the respective Livestock and Fishery Development Bureau Officers, two peasant associations (here after Kebeles) were selected from each district. Bakelo and Wushawshegn from Basona Worana, and Cheki and Angolela from Angolelana Tera district were selected for sampling. During selection of the study Kebeles; dairy cow estrus synchronization experience, production potential of the dairy cattle, and accessibility were considered. Semi-structured questioner was prepared, pre-tested and a total of 144 dairy farmers (121 men, 23 women) were interviewed. Information such as: respondents educational level, number of local and cross breed dairy cattle owned, access for breeding bull, awareness on dairy cow estrus synchronization and participation, number of dairy cows/heifers synchronized, induced in to heat, inseminated and gave birth, management system, perception towards dairy cattle hormonal estrus synchronization and downsides of implemented dairy cattle hormonal estrus synchronization program were gathered. In addition to the questionnaire survey, discussions were made with Kebeles AI technicians and development agents (DAs) on the previous dairy cattle estrus synchronization program hormone administration, candidate cow selection, management, output gained, etc.

Data analysis

Data analyses (frequencies, percentages) were computed using the descriptive statistics procedures of Statistical Analysis System (SAS, release 9.2, 2008). Chi-square test was computed using SAS (2008) to see if proportions for different categorical variables are significantly different or not.

RESULT AND DISCUSSION

Estrus synchronization in the study area compared with different locations

Figure 1 shows performance of estrus synchronization in the present survey, and in other locations as reported by different authors. Based on the result of the present survey, the average proportion of cows showed heat sign after synchronization was 74.48%. However, it was lower as compared with the results reported by other authors (Tewodros et al., 2015; Fantahun and Admasu, 2017).

In breed group, crossbred cows’ heat response rate
was 70.4% while 100% being for local breed cows. Similarly, Azage et al. (2012) reported 100% heat manifestation in local breed cows/heifers treated with single injection of PGF$_2$α. Out of the total number of cows received hormone treatment, 75.17% (pooled) cows were inseminated. By breed, 77.6% of crossbred and 60% of local breed cows were inseminated. Unlike the other field level estrus synchronization activities in Ethiopia, the proportion of crossbred cows/heifers which manifested heat were not inseminated. This result indicates that there were cows inseminated without showing heat sign, and farmers were not able to present all cows/heifers which showed heat sign for AI service. If maximum conception is desired, AI should be complemented with heat detection and cows that manifest clear heat sign should only be inseminated (Gupta et al., 2008).

Despite the promising estrus response rate obtained, very low pregnancy rate (20.13%) was achieved which was much lower than the recommended rate (60%) by Gaines (1989). In agreement with this result, higher heat response and low pregnancy rate was reported by different authors in field level experiments (Adebabay et al., 2013; Tewodros et al., 2015; Fantahun and Admasu, 2017). As a consequence of this low efficiency, farmers have little confidence in AI, particularly synchronized one. In contrast, Azage et al. (2012) reported pregnancy rate which is equivalent with the recommendation of Gaines (1989). Therefore, poor estrus detection and reproduction management may have negatively affected the success of the studied estrus synchronization program (Kouamo and Sawadogo, 2012).

**Educational level of farmers versus estrus synchronization program participation**

Despite reports by different studies (Lishan, 2007; Tesfaye, 2010) in different parts of Ethiopia stating majority of Ethiopian livestock producers to be illiterate, the present study revealed that studied farmers who can at least read and write are significantly ($\chi^2$=28.444; P<0.0001) higher than illiterates. However, there is no significance difference (P>0.1) between the levels of education (Table 1). Out of those farmers who were able to read and write, 25.7% completed 6$^{th}$ grade while 17.4% were above 7$^{th}$ grade. Since education creates a favorable mental attitude for the acceptance of new practices especially of information-intensive and management-intensive practices (Caswell et al., 2001), this can be taken as a good opportunity in order to practice community-based breed improvement using estrus synchronization.

Nearly 64% of respondents participated in on-farm estrus synchronization program which was implemented by Zonal Livestock and Fishery Development Office. Lack of information on hormonal estrus synchronization technology and unavailability of candidate animals at the time were mentioned as major reasons for non-
Table 1. Educational level of interviewed farmers

| Level of education        | Number of respondents | Percentage | $\chi^2$ | $P$-value |
|---------------------------|-----------------------|------------|---------|-----------|
| Illiterate                | 40                    | 27.8       |         |           |
| Reading and writing       | 42                    | 29.2       |         |           |
| Grade 1-6                 | 37                    | 25.7       | 4.833   | ns        |
| Grade $\Delta$7           | 25                    | 17.4       |         |           |
| Total                     | 144                   | 100        |         |           |

$\chi^2$ = Chi-square; ns = non-significant at 0.1 level of significance.

Figure 2. Participation of farmers in estrus synchronization program versus level of education.

participation for the rest 36% of studied households. As compared with the present study, Legesse (2016) reported lower proportion of farmers’ participation (32.2%) in dairy cattle estrus synchronization program in Southern Ethiopia.

The participation of majority of farmers in the studied synchronization program implied that they were interested in dairy cattle estrus synchronization technology at the beginning of the program. While non-participation was seen as of lack of information about the technology which indicates the limitation in information dissemination, and the need of extension work prior to the implementation of new programs. Access to extension services creates the platform for acquisition of the relevant information that promotes the technology adoption. Access to information through extension services reduces the uncertainty about a technology’s performance hence may change individual’s assessment from purely subjective to objective over time thereby facilitating adoption (Akudugu et al., 2012).

Education is very important in determining the adoption of modern agricultural technologies practices. Even though, its effect on technology adoption is yet to reach a consensus, different studies have shown the positive effect of education on the acceptance of different agricultural innovations and technologies by farmers (Prokopy et al., 2008; Howley, 2012; Mwangi and Kariuki, 2015).

In agreement with other studies, the participation of farmers in the studied dairy cattle estrus synchronization program was positively affected by the level of education (Figure 2). This means the number of participant farmers...
Table 2. Proportion of farmers who have access and shortage of Holstein Friesian (HF) cross breeding bull.

| Access for HF crossbreeding bull | Number of respondents | Percentage (%) | $\chi^2$ | $P$-value |
|----------------------------------|-----------------------|----------------|----------|-----------|
| Yes                              | 82                    | 65.94          |          |           |
| No                               | 62                    | 43.06          | 2.778*   | 0.0956    |
| Total                            | 144                   | 100            |          |           |

$\chi^2 =$ Chi-square; *Significant at 0.1 level of significance.

Table 3. Frequency and percent of respondents’ awareness on estrus synchronization.

| Awareness on estrus synchronization | Number of respondents | Percentage (%) | $\chi^2$ | $P$-value |
|-------------------------------------|-----------------------|----------------|----------|-----------|
| Yes                                 | 68                    | 47.22          |          |           |
| No                                  | 76                    | 52.78          | 0.444ns  | 0.5050    |
| Total                               | 144                   | 100            |          |           |

$\chi^2 =$ Chi-square; ns= non-significant at 0.1 level of significance.

Access for improved breeding bull (Holstein Friesian cross)

Table 2 examines the proportion of farmers who have access and shortage of Holstein Friesian (HF) cross breeding bull. The study results revealed that 65.94% of farmers replied no access to HF cross breeding bulls are significantly higher ($P<0.1$) than those who have access (43.06%) either from neighbors or own farm (unknown genetic level). According to Duncan et al. (2013), AI forms a minor share of overall breeding methods in Ethiopia, and this reflects the dysfunctional nature of the AI system in the country. Poor infrastructure, managerial and financial constraints, poor heat detection and AI technicians’ efficiency are among the factors which contributed to the unsuccessful implementation of AI in the country (Shapiro et al., 2015). With those problems farmers let pass cows in heat without breeding them or they use natural mating with local bulls in which they are not interested. This significantly contributed to low efficiency of the on-farm estrus synchronization program. Therefore, for the successful on-farm synchronization program, natural bull mating will play vital role in the future in Ethiopia where AI service is not well addressed. The implication of this is that improved bulls should be accessible for farmers through community participatory breeding approaches.

Farmers’ awareness on estrus synchronization and mass insemination

About 53% of studied farmers claimed that they have no awareness on dairy cattle estrus synchronization technology at the time of implementation of the program in the study area whereas 47% of the respondents got information/awareness through either DAs or their neighbors with less satisfaction (Table 3). Even though the proportion of farmers (64%) who participated in dairy cattle estrus synchronization program in the study area was higher than (numerically) the proportion of farmers who have no information/awareness about dairy cattle estrus synchronization, the difference was statistically not significant ($P>0.1$). This result indicates that there were farmers who participated in the dairy cattle estrus synchronization without awareness of the technology. Similarly, Tegegne et al. (2016) reported the participation of farmers and experts in estrus synchronization without understanding of the concept. As stated by Gizaw et al. (2016) consideration of skill upgrading and other factors affecting estrus response could improve mass artificial insemination by hormonal estrus synchronization.

Farmers’ perception on estrus synchronization

Farmers were asked about their perception on dairy cattle hormonal estrus synchronization technology. Chi-square test depicted highly significant difference ($P<0.001$) of farmers’ feedback on estrus synchronization being significantly higher ($P<0.001$) for poor pregnancy rate (Table 4). Among those farmers who had information about estrus synchronization, 59.72 and 24.31% gave negative and positive feedback towards the technology, respectively. But 15.97% of informed respondents preferred not to answer the question. Among those farmers who have negative feedback on dairy cattle estrus synchronization practice, more than three quarters (88.37%) reported poor pregnancy rate, followed by poor heat response (6.98%) and unavailability of the service (4.65%) as the main reason for non-acceptance of the...
Table 4. Distribution of farmers according to their feedback on estrus synchronization and reasons.

| Variable                        | Level      | Number of respondents | Percentage (%) | $\chi^2$ | $P$-value |
|---------------------------------|------------|-----------------------|----------------|---------|-----------|
| Feedback towards estrus         | Positive   | 35                    | 24.31          | -       | -         |
|                                 | Negative   | 86                    | 59.72          | 46.625***| 0.0001    |
|                                 | Neutral    | 23                    | 15.97          | -       | -         |
|                                 | Total      | 144                   | 100            | -       | -         |
| Reasons for negative feedback   | Poor to induce heat | 6                  | 6.98           | -       | -         |
|                                 | Poor pregnancy rate | 76                 | 88.37          | 117.302***| 0.0001    |
|                                 | Not accessible | 4                   | 4.65           | -       | -         |
|                                 | Total      | 86                    | 100            | -       | -         |

$\chi^2 = $ Chi-square; ***Significant at 0.1 level of significance.

Table 5. Proportion of respondent farmers on dairy feed availability and supplementation.

| Feed                             | Variable                  | Number of respondents | Percentage (%) | $\chi^2$ | $P$-value |
|----------------------------------|---------------------------|-----------------------|----------------|---------|-----------|
| Is feed enough throughout the year| Yes                       | 83                    | 57.64          | -       | -         |
|                                  | No                        | 61                    | 42.36          | 3.361*  | 0.0668    |
|                                  | Total                     | 144                   | 100            | -       | -         |
| Do you supplement synchronized cows | Yes                       | 29                    | 31.52          | -       | -         |
|                                  | No                        | 63                    | 68.48          | 12.565***| 0.0004    |
|                                  | Total                     | 92                    | 100            | -       | -         |
| Do you supplement milking cows   | Yes                       | 124                   | 86.11          | -       | -         |
|                                  | No                        | 20                    | 13.89          | 75.111***| 0.0001    |
|                                  | Total                     | 144                   | 100            | -       | -         |

$\chi^2 = $ Chi-square; *** Significant at 0.01; * Significant at 0.1 level of significance.

technology. Correspondingly, Gizaw et al. (2016) reviewed low perception/satisfaction for most of the farmers included in the estrus synchronization program in different locations in Ethiopia. The same authors stated that farmers’ perception/satisfaction with hormonal estrous synchronization technology is determined by the conception/pregnancy rates achieved rather than by the rate of response to hormone treatment.

Dairy cows feeds and feeding system

Table 5 presents number and percentage of respondent farmers on dairy feed availability and supplementation. When asked on feed resource availability and management, 57.64% of the respondent farmers reported that sufficient feed availability throughout the year, while 42.36% faced feed shortage particularly in April, May and June. Combination of grazing and stall feeding are the most important feeding systems for crossbred milking cows in the area.

Among those respondents who have participated in the field level hormonal estrus synchronization program, only 31.52% did supplementation of hormone treated cows/heifers with different feed staff combinations. Lack of awareness and feed resources were the main reasons for non-supplementation of breeding cow/heifers by most of the respondents (68.48%). However, majority of the (86.11%) farmers claimed supplementation of milking cows at the time of milking (morning and evening). The respondents use common supplementation feeds including wheat bran, barley and wheat straw, oil seed cake (few farmers), “atela”, home mixed concentrate derived from locally available grains and other ingredients based on availability.

In general, milking cow supplementation practiced more in the study area but not for synchronized cows/heifers. Farmers’ improper feeding trend is among the major obstacles which can negatively affect success rate of estrus synchronization (Day and Greay, 2005; Gizaw et al., 2016). This necessitates awareness creation as well as development and dissemination of synchronized cow feed supplementation strategies (Adebabay et al., 2013).
CONCLUSION AND RECOMMENDATIONS

Even if encouraging estrus response rate obtained (74.48%) in the studied on-farm estrus synchronization program, very low pregnancy rate (20.13%) was recorded. The low success rate attributed to inaccessibility of AI and improved bull service; heat detection problem; lack of awareness of farmers on the technology and cattle management (particularly feeding).

The low efficiency has led farmers to lose their confidence on the synchronized AI. Lack of confidence on synchronized AI also forced farmers to pass cows in heat without breeding or to use local bulls in which they are not interested for. From this, it is concluded that revision of the existed estrus synchronization operation is necessary and the following sets of recommendations are forwarded to stockholders that implement interventions to improve the success of on-farm estrus synchronization in dairy cattle.

Since AI service is not well addressed in Ethiopia, improved bull services should be accessible parallelly for farmers using community participatory breeding approaches. Management of dairy cattle is one of the major factors affecting the results of synchronization and AI, strengthening the capacity of farmers and DAs on the handling, and management of dairy cows/heifers should be done. Awareness creation should be done towards changing the negative attitude of farmers on estrus synchronization.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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