# On-farm evaluation of female calf production through assisted reproduction in improving smallholder dairying in Mirab Azerinet woreda, South region, Ethiopia

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# Abstract

# *In dairy industries production of a heifer for herd replacement and to increase income is key component. This study was planned to compare AI efficiency through using sexed (sex sorted) semen and conventional semen types and to develop ideas in the production scheme of replacement female calves. Data had been gathered from January 2018 up to December 2019 on 846 inseminations in non-pregnant indigenous cows and heifers. There become a significantly different (P<0.05) conception rate between sexed and conventional semen which was 48.22% and 77.78% correspondingly. Using sexed semen 76.96% of cows gave birth to female calves while the female calves were 33.43% from the conventional semen. There was a lower risk of calving difficulty (dystocia) in sexed semen (23.52%) than conventional semen (47.72%). Using sexed semen can improve the dairy sector by producing female calves required by the majority of the smallholder farmers. In the current situation of the study area the expensiveness and inaccessibility of sexed semen result reduction in income. Even though lower conception rate but a lower risk of calving problem (dystocia) and higher production of female calves; sexed (sex-sorted) semen could be suggested for insemination of indigenous cows and heifers to increase the number of cross bred cows and boost the dairy sectors in general. The concerned bodies should work together to increase the supply of sexed semen and intervene to get smallholders by reasonable price.*

***Keywords****: Conventionalsemen; Dystocia; Mirab Azerinet; Sexed semen; Heifer;Calving; Dairy sector;Semen;Calves;Insemination*

**Introduction**

Artificial insemination, multiple ovulation and embryo transfer (MOET) and semen sexing are powerful implements to achieve higher levels of genetic improvement in dairies than the natural method (Galma B, 2021). Female calf production is one of the impediments for the wider dissemination of heifers and or cows in crop-livestock mixed systems of southern Ethiopia. Efforts were done to improve the scenarios using conventional artificial insemination (AI) in the past 40-50 years in Ethiopia. Despite the efforts, several improved heifers/cows are limited supply and is costly to be afforded by smallholder farmers.

Sex-sorted semen or embryo mediated livestock production along with other genomic technologies offers a promising breeding strategy to meet the increased demand for food production (Rath ***et al.,*** 2013). Determination of sex at the first stage will scale back the management value through selective management of superior bulls or cows. Use of sexed semen fastens the genetic progress and permits the farm through to extend selectively the amount of heifers or steers supported the necessity of the farm (Seidel, 2007).

Using sexed semen has been proven to produce genetically superior daughters, rapidly increase desired traits within a herd, and subsequently create more opportunities to use dairy genetics. Improving herd bio-security and herd turnover rate, reducing the incidence of dystocia, improvement of genetic progress and the reduced price for superior replacement heifers are among the main advantages of using sex sorted semen in virgin heifers (De Vries ***et al***., 2008). In our condition, except few attempts and applications for research purposes, the isolation and preparation of sorted semen and even usage of imported sexed semen due to availability and cost are still not widely used.

The regional government has been implementing massive genetic improvement through estrus synchronization. Nowaday awareness and demand of using crossbreed animals at the farmer level is increasing at large. The occurrence of the male calf from mass synchronization based artificial insemination largely complaining under field observation while the farmer needs a female calf. Although, farmers have less attention for male calves, so, poor feeding, calf mortality and early selling are observed problems. Our hypothesis was that hundred percent female calves produced from cows/heifers inseminated with sexed semen, and it would satisfy smallholders who require female calves. Therefore, the objectives of the study were to make success comparison between sexed and conventional semen and to develop ideas in the production scheme of replacement female calves.

# Materials and Methods

## An explanation of the research area

## The research was carried out in Mirab Azerinet Woreda, an area in the heart of Ethiopia's Southern Nation Nationalities and Peoples Regional State. It is located 223 kilometers from Hawassa and 258 kilometers from Addis Abeba. Geographically, the region is located at latitude 7044’46’’and longitude 7053’43’’. The region uses a system of mixed crop and livestock production. Field pea, wheat, maize, enset, potato, barley, faba bean, fruits, and vegetables are some of the major crops grown there. Cattle, sheep, goats, chickens, equines, and bee species are among the livestock species present in the Woreda(SZFEDDept., 2017).

## Selection and management of cows/heifers

## Eight hundred fourty six (846) indigenous cows were assigned into three parity levels (i.e. two hundred Eighty two (282) heifers, two hundred Eighty two (282) parity one and two hundred eighty two (282) parity two) was selected, synchronized and inseminated by sexed and conventional semen. Conventional semen which we have used was from National Artificial Insemination Centre (NAIC), Debrezeit, Ethiopia and source of sexed semen was from Alpis (The only sexed semen importer organization in Ethiopia). Each group of parity was inseminated with two semen types (conventional and sexed semen). Selected animals were checked about their health status and fitness to carry cross-breed calf and pregnancy. Those healthy and negative from pregnancy were selected for the insemination. The animals were treated for internal and external parasites, ear-tagged for identification and protected from natural mating. The animals were assigned randomly to each semen type (sexed and conventional) by separating in parity level to see the effect of parity on response parameters. The equipment used were a drenching gun, Nitrogen jar, insemination gun, nitrogen level meter, forceps, sexed semen, conventional semen, liquid nitrogen, arm length gloves and thermo flask. The owners of the selected heifers/cows were oriented about the heat sign. Selected heifers/cows were inseminated after their commenced time of heat sign. The place of insemination was conducted at one center (Woreda insemination center). Inseminated animals were checked for pregnancy diagnosis after three months of insemination and again repeated after one month. All necessary data were collected from January 2018 up to December 2019 on 846 inseminations in non-pregnant indigenous cows and heifers.

## Data analysis

## Data were analyzed by SPSS version 20 and summarized by using simple descriptive statistics. Effects of semen type and parity were evaluated using the X2 (Chi-square test) at 95% of the confidence interval. The model for statistical analyses:

Yij = µ + Ai +Bj+eijk;

Where:Yij=conception rate, calving difficulties and calf sex, µ = overall mean;

**Ai**=effect of **ith** semen type (i=sexed and conventional), **Bj**=the effect of **jth** parities (j=heifers, parity1, parity2), and **eijk =** random error.

# Results and Discussion

The result indicated that the conception rate was higher in cows and heifers inseminated by Conventional semen (77.78%) than sexed semen (48.22%) (Table1). The percentage of the result was higher than Razmkabir (2018) who reported that the conception rate of sexed and conventional semen was 42.65% and 54.85%, correspondingly. According to Anelise ***et al.*** (2016), the conception rates of artificial insemination with conventional semen were 70% and sexed semen 48% which was comparable with the current result. Also, Norman ***et al.*** (2010) for heifers was 56% under conventional semen and 39% for sexed semen; the equivalent conception rates for cows were 30% and 25%, respectively which was lower than the current study. Similarly, conception rates are reduced by 10-30% in sex-sorted semen as compared to conventional semen (Galma Boneya, 2021).

#### Table 1 Conception rate across semen type

Semen Type N Pregnant cow X2 P-value

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Conventional | 423 | 329 (77.78%) |  13.55 | 0.0041 |
| Sexed | 423 | 204 (48.22%) |  |  |

* N-total number of inseminated; X2 (chi-square) test at P<0.05.

**Conception rate at different parity levels and semen used**

The conception rate in the case of heifers for sexed semen (66.67%) and conventional semen was (88.64%), and it was statistically significant between the two groups. In the case of parity 1 the conception rate for conventional semen is significantly higher (78.01%) as compared to that of sexed semen counterpart (44.68%) and similarly in parity two cases conception rate was significantly greater for conventional semen (66.67%) as compared to that of sexed semen. The result in Table 2 also indicates that as the parity increases there is a reduction in the conception rate of cows for sex-sorted semen.

#### Table 2. Conception rate across parity

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Parity of cows** | **Semen type** | **No of****inseminated animal** | **No of pregnant****cows** | **%Conception****rate** | **X2** | **P- value** |
| **Heifers** | Sexed | 141 | 94 | 66.67 |  |  |
|  | Conventional | 141 | 125 | 88.64 | 4.77 | 0.03 |
| **Par 1** | Sexed | 141 | 63 | 44.68 |  |  |
|  | Conventional | 141 | 110 | 78.01 | 11.3 | 0.001 |
| **Par 2** | Sexed | 141 | 47 | 33.33 |  |  |
|  | Conventional | 141 | 94 | 66.67 | 13.56 | 0.001 |

* ***X2 (chi-square) test at P<0.05.***

As showed in (Table 3) there is an association with the conception rate of sexed (sex-sorted) semen with parity level. The conception rate in the case of heifers was significantly higher as compared to parity one and two. This result indicated that heifers are preferable for the effectiveness of sexed semen as compared to that parity 1 and parity 2 cows. In the case ofl conventional semen, there was also association between conception rates at different parities levels. According to the dairy knowledge portal statement (2021) in view of the high fertility rate of the heifers, it is suggested that sex- sorted semen should be castoff only in virgin heifers for a better conception rate. Though, it can also be used in cows up to the third parity with an excellent reproduction history.

#### Table 3 Effect of parity on conception rate of sexed and conventional semen

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Semen type | Parity | N | Conception | %conception X2 P-valuerate |
| Sexed | Heifer | 141 | 94 | 66.67a |
|  | Parity 1 | 141 | 63 | 44.68b 13.95 0.0043 |
|  | Parity 2 | 141 | 47 | 33.33b |
| Conventional | Heifer | 141 | 125 | 88.64 |
|  | Parity 1 | 141 | 110 | 78.01 3.67 0.021 |
|  | Parity 2 | 141 | 94 | 66.67 |

* **N- total number of inseminated cows; X2=chi-square test; Different super script letters indicate the significance(P<0.05).**

## Comparison of sex ratio by using different semen type

A statistically significant variation exists between the calves' generated semen type and sex (Table 4). When sexed semen was used for insemination, there were 76.96% female calves and 23.03% male calves, compared to 33.43% and 66.56% for conventional semen. This shows that employing sexed semen rather than regular semen boosted the production of female calves.These results are in agreement with Saheren ***et al.*** (2017) sexed (sex-sorted) semen yielded an average female calf ratio of 91.1%. Due to the greater availability of replacement heifers due to the high ratio of female calves, dairy producers will benefit from lower pricing for dairy heifer purchases and sales as well as simpler within-herd growth. (Weigel, 2004).

#### Table 4. Sex proportions by semen type

Semen type Calf sex Number of calves born X2 P-value

|  |  |  |  |
| --- | --- | --- | --- |
| Sexed | Male | 47 (23.03%) |  |
|  | Female | 157 (76.96%) | 21.11 | 0.0002 |
| Conventional | Male | 219(66.56%) |  |  |
|  | Female | 110 (33.43%) |  |  |

## Calving difficulties about semen type

Current study shows statistically significant differences in calving difficulty between those inseminated by sexed and conventional semen types. Dystocia during birth occurred in animals inseminated with sexed semen (23.52%) was lower than the conventional semen type (47.72%) and also a normal presentation at birth was higher in animal’s inseminated sexed semen (76.47%) in the study area (Table5). The result was in accordance with those of Weigel (2004) and Seidel (2003) reported that a higher frequency of female calves from inseminated semen and a consequent smaller calf size would be expected to reduce the incidence of dystocia. These results contradict Tubman et al. (2004) did not report a discernible effect of semen type on calving difficulty. As Norman et al., 2010, higher frequency of female calves from female semen and consequently smaller calf size should reduce the incidence of dystocia, especially in virgin heifers (Weigel, 2004; Seidel, 2014).

Table 5. Calving difficulties at the birth of a calf

|  |  |  |  |
| --- | --- | --- | --- |
| Semen type | **N** | Normal | Dystocia |
| Sexed | 204 | 156 (76.47%) | 48 (23.52%) 6.31 0.0474 |
| Conventional | 329 | 172 (52.28%) | 157(47.72%) |
| * **N- Number of birth**
 |  |  |  |

Presentation status at birth X2 P-value

## Economic consideration

The economic consideration was established on the result of the current study. The materials used for insemination purposes and labour cost for both sexed and conventional types of semen were common except for semen type difference. Therefore, the costs of common items for semen type, feed, health and hormone costs were not considered for this economic consideration. The conception rates for conventional and sexed semen were 77.78 and 48.22% (Table 1) and the rate of dystocia recorded for the current result was 47.72 and 23.52% for conventional and sex-sorted semen, respectively (Table 5). Also, sex ratios were 33.43 and 76.96% female for conventional and sexed semen, in that order (Table 4). Selling age of calf in the study area was mostly after 2.5 years (personal observation). This age is mainly the time of age at first mating for crossbreed cattle (Ebadu Areb, 2016). Therefore, consider a single smallholder farmer who has 846 cows that are ready for insemination and if his plan will be to sell his 50% HF calf at their 3 years of age. This is an example to show the income comparison for type of semen.

**Table 6 Estimated economic consideration result (ETB)**

|  |  |  |
| --- | --- | --- |
| **Variables** | **Conventional semen** | **Sexed semen** |
| Number of inseminated cow | 423 | 423 |
| Number of cows will be pregnant | 329 | 204 |
| Number of cows that will get dystocia | 157 | 48 |
| Estimated number of male | 219 | 47 |
| Estimated number of female | 110 | 157 |
| Cost of semen per straw | 0 | 3,000 |
| Number of straws for the first service | 423 | 423 |
| Total cost for straws | 0 | 423\*3000 = 1,269,000 |
| Cost of labuor | 6000 | 6000 |
| Cost semen transport | 0 | 15000 |
| Total cost | 6000 | 1,269,000+6000+15000 = 1290,000 |
| The estimated selling age of calves | 3 years | 3 years |
| The estimated selling price of male | 13,000 | 13,000 |
| The estimated selling price of female | 20,000 | 20,000 |
| Total income from male | 219\*13,000 = 2847000 | 47\*13,000 = 611000  |
| Total income from female | 110\*20,000 =2200000  | 157\*20,000 = 3140000 |
| Total income | 2847000+2200000=50,47,000 | 611000+3140000=3751000 |
| Net income | 5047000 - 6000= 5041000 | 3751000 - 21000=3730000 |
|  |  |  |

In Ethiopia, government provides semen and skilled artificial insemination technician for farmers freely. The reason for lower price for males is mostly not preferred by farmers due to their voracious feeding habit whereas heifers are mostly at selling age before they are pregnant or ready for breeding age which results high demand from the society. Based on (Table 6) a farmer who uses conventional semen gets 5041000ETB whereas 3730000ETB for sexed semen users. This indicates that 1311000ETB more income was obtained from conventional semen type than sexed semen users. This result indicates that with a lesser conception rate and the high price of sexed semen, use of this technology by the small holder is not advisable.

# Conclusion and recommendation

We can conclude that, the study provides insights into the conception rate using sexed and conventional semen under different parity levels. It showed that sexed semen gives good conception in heifers than multiparous cows. The results also indicate that sexed semen is the best option available to farmers to generate replacements for female calves. There was a lower risk of calving difficulties (dystocia) in sexed semen than conventional semen due to the lower body size of calves. Therefore, sexed semen is the means to get more female calves and helps to keep the bio-security of the herd. Inaccessibility and expensiveness of sexed (sex-sorted) semen results in unability to get heifers and reduction of income. Due to ease of calving and fast replacement of heifers sexed semen is suggested for usage in smallholder dairying. And also government and private sector should focus and prioritize the use of sexed semen if only concerned bodies improve accessibility and cost intervention to boost the dairy sector.

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