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The performance of artificial insemination delivery system in Amhara, Oromia, SNNP and Tigray Regions of Ethiopia

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The study was conducted in Amhara, Oromia, Southern Nations Nationalities and Peoples and Tigray regions of the country to provide information on the performance of Artificial Insemination (AI) service delivery system, its seasonality and effectiveness. Semi-structured questionnaire was prepared to interview AI technicians (on their performance and related issues) and farmers (about the outcome of AI services). Data on field performance were received directly from AI technicians using a pre-restructured reporting format. A follow-up calving survey for AI services were provided to farmers was conducted in March 2019 to know the outcome of insemination services provided to farmers. Peak season falls from August to December when AI technicians on average perform 6.7 inseminations per day. January, February, June, and July were categorized as regular season with daily average insemination of 3.8. March, April, and May are off-season with an average of only 2.2 inseminations per day. The seasonal variation is mainly associated with availability of feed. Field level actual performance data showed significant difference (P<0.05) in the number of inseminations provided per AI technician per month among regions and between male and female AI technicians with an overall average insemination of 39.3. The highest AI services reported in the month of October. The Service per Conception (SPC) reported by AI technicians was not significantly different among regions (P>0.05) with mean SPC of 2.13. About 2.6 SPC obtained from a follow-up survey conducted with farmers who received AI service in a specified period. About 62% conception rate and 82% calving rates are obtained in this study.

Key words: Cattle, farmers, performance, technicians, semen.

INTRODUCTION

In a country, such as Ethiopia, where there is huge cattle population, the dairy sector can significantly contribute to the wellbeing of the dairying households, the nutrition of consumers, and the economy of the country at large. However, the sector is challenged by technical, infrastructural and policy constraints (Wytze et al., 2012). With the available 60.4 million cattle population (CSA, 2018), the country is not self-sufficient in milk production, rather it has been investing a significant sum of foreign currency for importing milk and milk products.

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Figure 1. Map of Amhara, Oromia, SNNP and Tigray regions.

To fill the gap between demand and supply, improving the productivity of dairy cattle through genetic improvement is of paramount importance. As proven in many countries, an effective and efficient strategy to improve dairy cattle productivity is to breed dairy cows using proven semen via Artificial Insemination (AI).

Though it is now close to seven decades since crossbreeding activities started in Ethiopia, the proportion of both hybrid and exotic breeds is not greater than 2% out of 60.4 million cattle population (CSA, 2018). This indicates a crossbreeding program that has been implemented in the country over the last several decades through the application of AI technology is quite ineffective (Nuraddis et al., 2014). This can mainly be justified by the availability of an insignificant proportion of crossbred cattle population. One major factor contributing to such inefficiency is the very low conception rate and the accompanied high age at first calving ranged between 34 months (Hunde et al., 2015) and 44 months (Effa et al., 2006).

AI is predominantly provided by the government with a highly subsidized price (less than 10 birr or 0.4 USD) from the public side. The private sector involvement both in terms of input supply and service delivery is not significant as compared to other East African countries such as Kenya (Dickson et al., 2018). Several contributing factors are mentioned in various reports (Gebregiorgis et al., 2016; Tessema and Atnaf, 2015; Zerihun et al., 2013; Desalegn et al., 2009) for the

inefficiency of AI service delivery system in the country. The main reasons for this include lack of the necessary inputs and equipment, unreliable supply of liquid nitrogen, poor quality of semen, Moreover, lack of proper record-keeping at farm level is also be considered as an important factor affecting the country's dairy cattle breeding and improvement. Though several scholars tried to identify major factors for inefficient AI delivery system in different parts of the country, the performance of the AI delivery system is not quantified sufficiently. Therefore, the objective of this study is to provide information on the performance of AI delivery system in terms of the number of inseminations, service per conception, conception rate and calving rates.

MATERIALS AND METHODS

Study areas

The study was conducted in Amhara, Oromia, Southern Nations Nationalities and Peoples (SNNP) and Tigray Regions. These regions were purposively selected due to their potential for dairy production and huge government and other development partners' efforts in improving the dairy sector in these regions. About 16.1, 24.4, 11.9 and 4.8 million cattle reported to be available in Amhara, Oromia, SNNP and Tigray regions, respectively (CSA, 2017, 2018) (Figure 1).

Study components

The study was mainly undertaken using: questionnaire survey, filed

level performance recording and calving survey two methods.

Questionnaire survey

AI technicians' interview was conducted in July and August 2017 with randomly selected AI technicians operating in Amhara, Oromia, SNNP and Tigray regions. The interview was focused mainly on their performance-related issues and seasonality of AI service. A total of 161 AI technicians from the four regions (49 from Amhara, 53 from Oromia, 36 from SNNP and 23 from Tigray regions) were randomly selected and interviewed using a structured questionnaire. Both qualitative and quantitative data collected through this structured questionnaire.

AI technicians field-performance recording

Data on field-performance of AI technicians in Amhara, Oromia, SNNP and Tigray regions received from technicians from October 2016 through December 2018 to measure the actual performance of AI technicians using a format prepared for this study.

Calving survey

A follow-up calving survey for AI services provided to farmers was conducted in March 2019 in the four studied regions to better understand the performance of AI technicians in terms of conception and calving rates. For this purpose, the list of farmers who received AI service between February and May 2018 was purposefully selected and prepared to be used as a sampling frame. The data is mainly used for the purpose of conception rate (percentage of conceived animals from the total number of inseminated), calving rate from conceived animals (percentage of calved animals from the total conceived) and calving rate from all inseminated animals (percentage of calved animals from the total inseminated animals).

Then, a multi-stage random sampling system was followed to select woredas, kebeles, and farmers from each of the four target regions. Sample farmers were then selected randomly from each woreda and kebele using assigned random numbers. Sample size was estimated at 90% significance level in each region. As suggested by Suresh and Chandrashekara (2012) and Daniel (1999), the following formula was used to determine the sample size for each region since the population size for all region is known.

Sample Size = [z2 * p(1-p)] / e2 / 1 + [z2 * p(1-p)] / e2 * N]

Where:
N = population size, z = z-score, e = margin of error, p = standard of deviation.
A total of 1,083 farmers (268 from Amhara, 274 from Oromia, 269 from SNNP and 272 from Tigray regions) were interviewed on the outcome of AI services provided to them.

Data analysis

Primary data collected from AI technicians and farmers through the survey tools entered in Microsoft Excel and Statistical Package for Social Science (SPSS) version 20 (SPSS, 2011). For data analysis, Statistical Analysis System (SAS - Version 9) (SAS, 2004) was used based on the type of variable. For quantitative data, the General Linear Model (GLM) of the SAS was used and means within the same category were separated using the Least Significant Difference (LSD) for those F tests that declared

significance ($P<0.05$).

RESULTS AND DISCUSSION

Number of AI services provided

As per the interview result with AI technicians, significant ($P<0.05$) difference was observed in the number of AI services provided during regular, peak and off-seasons among the four regions (Table 1). An overall average of 3.76, 6.70 and 2.23 inseminations provided per day per AI technician during regular, peak and off-seasons, respectively (overall average 4.23 inseminations per day per AI technician). In all cases, AI technicians in SNNP region were providing the highest number of inseminations per day followed by Oromia and Tigray regions.

In contrast to this survey-based result, much lower field level actual performance is obtained in the four studied regions (Table 2). Field level actual performance data showed significant difference ($P<0.05$) in the number of inseminations provided per AI technician per month among regions and between male and female AI technicians with an overall average insemination of 39.3 (nearly1.5 inseminations per day if the average 6.6 working days per week as reported by AI technicians are considered). This is 47% lower than the survey-based performance report (4.23 inseminations/day/AI technician). The average performance of AI technicians reported in both cases of the present study is higher than Camilla (2013) who reported 11-25 inseminations per month per AI technician in Uganda. Though private AI technicians were expected to provide a greater number of inseminations per month, the difference between public and private AI technicians was not significant ($P>0.05$). Public AI technicians were providing a higher number of inseminations (40) per month than that of private AI technicians (32). This might be related to the small number of private AI technicians considered in this study.

Seasonality of AI service

Artificial Insemination (AI) technicians requested to categorize months of a year into regular, peak and off-seasons based on the number of inseminations they provided daily. The study confirms the delivery of AI service followed a seasonal pattern. As shown in Figure 2, an overall average of 6.7 inseminations is reported per day per AI technician during peak season which is 26.7% more than the number of inseminations provided during regular season (3.8 inseminations/day/AI technician). The peak season lies between August and December when availability of ample feed resources is secured as these months fall immediately after the long rainy season and in the harvesting season for most cereal crops. Green pasture is available for grazing purpose and animals can

Table 1. Average number of AI services provided per day during regular, peak and off-season in Amhara, Oromia, SNNP and Tigray regions.

Row labels	N	Number of AI services provided per day during		
		Regular season (Mean±SE)	Peak season (Mean±SE)	Off-season (Mean±SE)
Amhara	49	2.65 ± 0.30^b	5.18 ± 0.50^b	1.31 ± 0.16^c
Oromia	53	4.42 ± 0.56^a	7.47 ± 0.67^a	2.51 ± 0.36^{ab}
SNNP	36	4.56 ± 0.39^a	7.81 ± 0.73^a	3.43 ± 0.62^a
Tigray	23	3.39 ± 0.41^{ab}	6.43 ± 0.84^{ab}	1.74 ± 0.23^{bc}
Total	**161**	**3.76±0.24**	**6.70±0.34**	**2.23±0.20**

Means with different superscripts in the same column significantly different ($P<0.05$).

Table 2. Average number of AI services provided per month and per day.

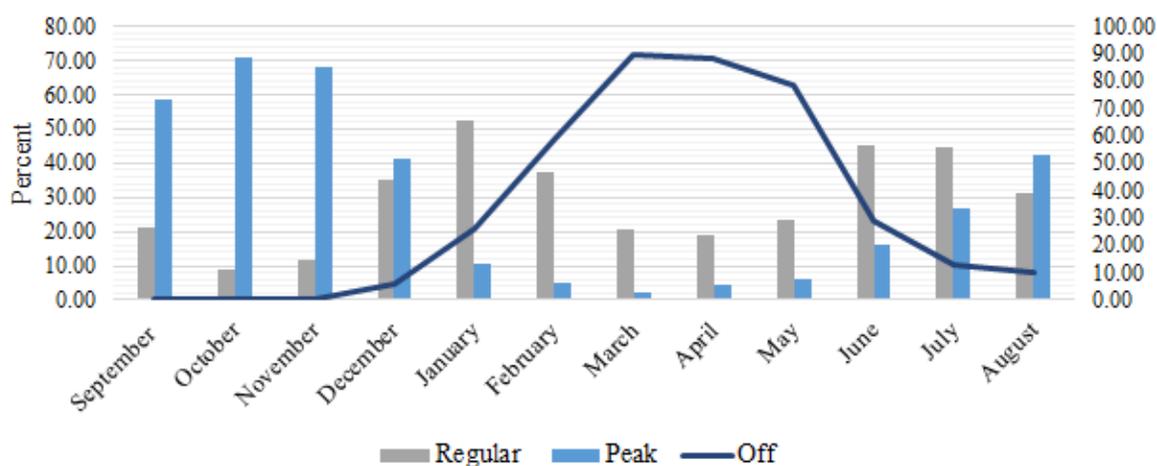|	Number of AIs/Month/AI tech	Number of AIs/day/AI tech	N
Region	***		
Amhara	34.87 ± 3.00^c	1.16 ± 0.10^b	105
Oromia	34.48 ± 2.07^c	1.15 ± 0.07^b	145
SNNP	53.15 ± 3.64^a	1.77 ± 0.12^a	69
Tigray	42.42 ± 3.55^b	1.41 ± 0.12^b	65
Type			
Public	40.27 ± 1.54^{NS}	1.34 ± 0.52^a	341
Private	31.52 ± 4.85^{NS}	1.05 ± 1.61^a	43
Gender	***		
Male	41.80 ± 1.61^a	1.39 ± 0.05^a	331
Female	23.59 ± 2.88^b	0.79 ± 0.10^b	53
Overall	*39.29±1.48*	*1.31±0.05*	*384*

N: Number of respondents.

Figure 2. Seasonality of AI service provision in Amhara, Oromia, SNNP and Tigray regions.

easily fulfill their energy requirement during these months of the year.

The regular season falls in January, February, June, and July when AI technicians provided daily average

Figure 3. Overall seasonality of AI service based on the number of AI services provided from October 2016 to December 2018.

insemination of 3.8. In January and February green pastures normally dry, however a significant amount of crop residues are available in most parts of the country as these months fall immediately after the harvesting season. June and July are part of the long rainy season and are just immediately after the short rainy season when green feed especially of green pasture is available to a significant extent in the field. March, April and May are off-season when on average only 2.23 inseminations per day is provided. Information on seasonality of AI service can be used to allocate the required input and logistic for AI service delivery instead of allocating such inputs and logistics regularly throughout the year. AI service delivery system can strategically be planned and implemented based on this information.

To support the questionnaire survey result regarding seasonality of AI service provision, performance data (between October 2016 and December 2018) received from AI technicians on the number of AI services provided and the result is shown in Figure 3. For ease of data management and presentation, months of a year were grouped into quarters following the Ethiopian budget year. June, July and August were classified as Quarter 1, September, October and November as Quarter 2; December, January and February as Quarter 3 and March, April and May as Quarter 4. The result of data collected on-field performance strongly agrees with the survey result and confirmed the seasonality of AI service delivery system. Peak service was delivered in Quarter 2 (September, October and November) and the service reached its lowest level in Quarter 4 (March, April and May).

Service per conception

AI technicians participated in this study were interviewed on their performance regarding service per conception (SPC) based on their available performance data in their case book. The SPC reported by AI technicians was not significantly different among regions (P>0.05) with mean SPC of 2.13. The highest (2.24) SPC reported from SNNP region followed by Amhara region (2.17), Oromia (2.11) and Tigray region (1.95).

To support the AI technicians' interview regarding service per conception, in March 2019 a follow-up survey was conducted with 1,083 farmers who received AI service between February and May 2018 in the study regions. About 2.6 inseminations were required for a cow to conceive. Data received from NAIC on total inseminations and confirmed pregnancies from 2009/2010 to 2013/2014 revealed resulted in a 2.42 SPC. The SPC in this study is much higher than Desalegn et al. (2009) and Ali et al. (2013) who reported 1.88 and 1.55, respectively. It is also higher than the SPC reported in Kenya (1.9) under a controlled environment (Kinyua, 2016)

Conception and calving rates

Under normal conditions, collecting information on conception and calving has various challenges. Time constraint is among the major factors for AI technicians to follow and collect information on the outcome of AI services they provided. Thus, calving survey was undertaken in March 2019 to evaluate the performance of

Table 3. Number of cows inseminated, conceived and calved; conception and calving rates in Amhara, Oromia, SNNP and Tigray Regions.

Region	Number of			Conception rate (%)	CR -from conceived (%)	CR - from inseminated (%)
	Cows inseminated	Conceived	Calved			
Amhara	268	173	143	64.6	82.7	53.4
Oromia	274	199	165	72.6	82.9	60.2
SNNP	269	156	129	58.0	82.7	48.0
Tigray	272	142	115	52.2	81.0	42.3
Overall	**1,083**	**670**	**552**	**61.9**	**82.4**	**51.0**

CR= Calving rate.

AI service in terms of conception and calving rates. The result of the survey is presented in Table 3.

Overall average of 62% conception rate, 51% (from all received AI) and 82% (from conceived) calving rates are reported in this study. The limitation in undertaking such a follow-up survey was improper animal identification, lack of record-keeping, lack of basic farmer related information to properly identify the location of farmers and infrastructural problem. These challenges suggest the importance of proper animal and farm identification system and record-keeping to successfully undertake a follow-up survey. If this is in place different conception and calving rates would be obtained. The five years data received from NAIC, on the other hand, revealed a 45% conception rate (from total inseminations). The conception rate reported in this study is higher than Ali et al. (2013), Desalegn et al. (2009), Gebregiorgis et al. (2016), and Tatek et al. (2011) who reported 48.3, 40.9, 27 and 56%, respectively. It is also higher than Mwambilwa et al. (2013) who reported a 48% conception rate in Zambia. The calving rate in this report is also higher than Gebregiorgis et al. (2016) who reported 37% in Tigray region, Ethiopia. The discrepancy among the different reports is related to the method of data collection. The NAIC data is based on direct reports obtained and synthesized from regional bureaus and may not reflect the exact performance of the crossbreeding program.

CONCLUSION AND RECOMMENDATION

The performance of AI technician (especially of the number of inseminations provided per AI technician) seems low to bring the desired impact in the multiplication of crossbreds and then to improve productivity. The performance is relatively better in Tigray region when compared to other three regional states. Due attention should be given to improve AI technicians' performance through availing necessary inputs, logistics, and infrastructures. Establishment of a strong monitoring system to follow-up the performance of their AI technicians is also very essential. Result based carrier structure, promotion and recognition system need to be established to motivate AI technicians to perform a greater number of inseminations.

All performance-related results reported in this study suggests the importance of establishing proper and structured data collection and reporting system. There should be a strong linkage, network and communication among regional, zonal and woreda level breed improvement, animal health and extension offices to implement the envisaged reporting system.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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REFERENCES

Ali T, Lemma A, Yilma T (2013). Reproductive performance of dairy cows under artificial insemination in south and northwest part of Ethiopia. Livestock Research for Rural Development 25 (12):191.

Camilla E (2013). The use of artificial insemination in dairy farms in urban/peri-urban Kampala, Uganda – a study of knowledge, attitude and practices. Swedish University of Agricultural Sciences, Faculty of Veterinary Medicine and Animal Science, Degree project, Veterinary Program, Uppsala 2013.

CSA (2017). Federal Democratic Republic of Ethiopia Central Statistical Agency. Agricultural Sample Survey, 2016/17 [2009 E.C.], Volume II, Report on Livestock and Livestock Characteristics (Private Peasant Holdings). Statistical Bulletin 585. April 2017.

CSA (2018). Federal Democratic Republic of Ethiopia Central Statistical Agency. Agricultural Sample Survey, 2017/18 [2010 E.C.], Volume II, Report on Livestock and Livestock Characteristics (Private Peasant Holdings). Statistical Bulletin 587. April 2018.

Daniel WW (1999). Biostatistics: A foundation for Analysis in the Health Sciences: 7th Edition. New York: John Wiley & Sons.

Desalegn G/M, Merga B, Azage T, Kelay B (2009). Status of artificial

insemination service in Ethiopia. In: The 17th Annual Conference of the Ethiopian Society of Animal Production (ESAP), Sept 24-26, 2009 Addis Ababa, Ethiopia, pp.87-104.

Dickson NK, Gideon O, John N (2018). Estimating pastoralists' willingness to pay for artificial insemination in arid and semi-arid lands of Kenya. Journal of Development and Agricultural Economics 10(8):262-270.

Effa K, Hegde BP, Tesfaye K (2006). Lifetime production and reproduction performances of Bos taurus x Bos indicus crossbred cows in the central highlands of Ethiopia. Ethiopian Journal Animal Production 6(2):37-52.

FAO (2002). World Agriculture 2030. Main findings. http://www.fao.org/english/newsroom/news/2002/7833-en.html

Gebregiorgis A, Alemselam B, Tadesse G (2016). Status of Artificial Insemination in Tigray Regional State, "Constraints and Acceptability under Field Condition. Journal of Dairy Veterinary and Animal Research 3(3):00078.

Hunde DGM, Tadelle D, Getnet A, Million T, Johan S (2015). Milk Yield and Reproductive Performance of Pure Jersey Dairy Cattle in the Central Highlands of Ethiopia. Livestock Research for Rural Development 27 (130).

Kinyua J (2016). Evaluation of Artificial Insemination Services Performance in a Smallholder Dairy Herd Under Extensive Management: A Case Study of KALRO- Lanet Herd, Kenya. Weber Agricultural Research and Management 2(191):692-694.

Mwambilwa K, Yambayamba KE, Joseph S (2013). Evaluation of the reproductive performance and effectiveness of artificial insemination on smallholder dairy farms in Zambia. Scholarly Journal of Agricultural Science 3(10):391-400.

Nuraddis I, Reta H, Abidu M (2014). Assessment of Problems Associated with Artificial Insemination Service in Selected Districts of Jimma Zone. Journal of Reproduction and Infertility 5(2):37-44.

SAS (2004). Users Guide. Version 6.12. Statistical Analysis System (SAS) Institute, Inc. Carry, NC.

SPSS (2011). Statistical Procedures for Social Sciences (SPSS). IBM® SPSS® Statistics 20. IBM Corp. Chicago, USA.

Suresh KP, Chandarashekara S (2012). Sample Size Estimation and Power Analysis for Clinical Studies. Journal of Human Reproductive Science 5(1):7-13.

Tessema R, Atnaf A (2015). Assessment of Problems Associated with Artificial Insemination Services in and Around Gondar Town, North West Ethiopia. Journal of Reproduction and Infertility 6(2):22-26.

Tatek W, Yoseph T, Aynalem H (2011). Factors affecting conception rate in artificially inseminated cattle under farmers' condition in Ethiopia. Journal of Cell and Animal Biology 5(16):334-338.

Wytze B, Dawit M, Binyam K, Mahlet Y, Jan van der L (2012). The Major Ethiopian Milk sheds. An assessment of development potential Milk value chain, stakeholders, production potential, market potential, and possible intervention areas. Wageningen University and SNV Ethiopia.

Zerihun B, Malede B, Tewodros F (2013). Assessment on Problems Associated with Artificial Insemination Services in West Gojjam Zone, Ethiopia. Advances in Biological Research 7(2):59-66.