

Research Article

# Major Reproductive Disorders Causing Infertility of Dairy Herds in West Shoa Zone, Ethiopia

Gemeda Tuntuna Wake<sup>\*</sup> , Mosisa Dire Babura 

Debre Zeit Agricultural Research Center, Bishoftu, Ethiopia

## Abstract

Reproduction is a complex process in which individuals produce their offspring to perpetuate life. Breeding efficiency depends on the normal function of the reproductive system. Reproductive disorders are the most common problems affecting the reproductive efficiency and productivity of dairy cows. Although, major reproductive disorders are greatly responsible for high economic losses in dairy herds, there is a scarcity the research done and consistent information on the prevalence and relative importance of these problems causing infertility in dairy herds in the West Shoa Zone. Therefore, the current study was conducted in the West Shoa Zone of Oromia regional state to assess the major reproductive disorders of dairy cows in the areas. These districts, namely Adeaberga, Ambo, and Walmera were purposively selected based on their accessibility and potential for dairy production. A total of 180 dairy producers (60 households from each) were randomly selected for individual interviews using a semi-structured questionnaire. The major reproductive disorders found were 82.2% repeat breeding, 22.2% calf mortality, 27.2% retention of the fetal membrane, 23.3% abortion and 16.3% stillbirth. The prevalence of reproductive problems showed a significant difference within the woredas. The prevalence of repeat breeding, retained fetal membrane and calf mortality were severe in Walmera districts compared to the remaining two districts whereas the prevalence of abortion and stillbirth were severe in Adeaberga. Repeat breeding shows a higher prevalence whereas the stillbirth rates show a lower prevalence. The ultimate goal of dairy herd production is to increase milk yield and manipulate early first service and calving, lower the calving interval and days open and decrease the number of services per conception. However, repeat breeding, retained fetal membrane, abortion, calf mortality and stillbirth were the major causes of infertility in dairy cows in the study areas. Proper breeding strategies and keeping the health conditions of dairy cattle should be employed to ensure improvements in fertility traits.

## Keywords

Dairy, Herds, Infertility, Prevalence, Reproductive Disorders, West Shoa Zone

## 1. Introduction

Despite the large livestock resources in the Ethiopia, livestock productivity remains marginal in due to various reasons, among which is the low genetic potential of indigenous cattle for milk and meat production [16]. Among the constraints

mentioned, reproductive disorders have been found to be one of the major reasons for decreased reproductive efficiency in cattle and consequently reproductive efficiency is the major determinant of lifetime productivity of cows [9].

<sup>\*</sup>Corresponding author: gemedatuntuna@gmail.com (Gemeda Tuntuna Wake)

**Received:** 15 March 2024; **Accepted:** 3 April 2024; **Published:** 10 May 2024



Copyright: © The Author(s), 2024. Published by Science Publishing Group. This is an **Open Access** article, distributed under the terms of the Creative Commons Attribution 4.0 License (<http://creativecommons.org/licenses/by/4.0/>), which permits unrestricted use, distribution and reproduction in any medium, provided the original work is properly cited.

Reproduction is a complex process in which individuals produce their offspring to perpetuate life. Breeding efficiency depends on the normal function of the reproductive system. To breed regularly, cows must have functional ovaries, display estrous behaviour, mate, conceive, sustain the embryo through gestation, give birth, continue the estrous cycle and restore uterine function after calving. Each of these aspects of reproductive function can be affected by management, disease and the genetic make-up of the animal. The ability to mate, conceive and nurture the embryo, deliver viable offspring at the conclusion of a normal gestation period, have functional ovaries, accurately display estrous behavior, resume the estrous cycle, and restore uterine function are all necessary for successful reproduction [7]. When the function of the reproductive system is impaired, cows fail to produce a calf regularly.

Reproductive disorders are the most common problems affecting the reproductive efficiency and productivity of dairy cows. Among the major reproductive disorders that have direct impact on fertility of dairy cows are abortion, dystocia, retained fetal membrane (RFM), metritis, prolapse (uterine and vaginal), anoestrus and repeat breeding. Most form of functional infertility is very common in dairy production in which calving interval of 12 to 13 months is generally considered to be economically optimal, but often it's difficult to achieve due to infertility of which reproductive disorders as common constraints hindering production and productivity in dairy cows. Infertility in lactating dairy cows is also predisposed to disturbed or aberrant immune function that leads to reduced immune competency and is consequently more susceptible to disease, particularly invasive pathogens that cause reproductive health problems [10].

Reproductive disorders in dairy cattle have been broadly studied throughout the world, but studies in Ethiopia are limited. Although, major reproductive disorders are greatly responsible for high economic losses in dairy herds, there is a scarcity the research done and consistent information on the prevalence and relative importance of these problems causing infertility in dairy herds in the West Shoa Zone. Therefore, the present study has been planned to access the prevalence of major reproductive disorders of dairy cattle in the West Shoa Zone, Ethiopia.

## 2. Materials and Methods

### 2.1. Description of Study Areas

Assessment of the major reproductive disorders causing infertility in dairy herds was conducted in three districts of West Shoa Zone Oromia regional state namely, Adeaberga, Ambo and Walmera.

Adeaberga located between 9°12' to 9°37'N and 38°17' to 38°36'E and about 107 km northeast of zonal town Ambo and 60 km west of Addis Ababa. The mean annual rainfall of the district is 1290 mm and the mean annual minimum and

maximum temperatures, respectively, lie between 12 °C and 25 °C. The altitude ranges from 1166 to 3238 meter above sea level. The agricultural production system in the study area is of mixed crop and livestock production.

Ambo woreda is located 114 km away west of Addis Ababa lying between 8°47' to 9°21' North latitude and 37°32' to 38°3' East longitude with the altitude of 2100 meter above sea level. The main rainy season is the period from June-September and the short rainy season is the period from March to the end of April. Mean annual rainfall is ranging from 1600 to 500 mm. The maximum and minimum temperature ranges from 10 to 28 °C.

Walmera is located 35km to the west of Addis Ababa along the main road to Ambo. Geographically, the district is found at 9°0' 0' to 9° 10' 0' N latitude and 38°25'0' to 38°30'0' E longitudes. The study area has an altitude of 2400 meter above sea level and receives an average annual rainfall of about 1100mm. The mean minimum and maximum temperatures, respectively, are 6 and 24 °C. The area obtains a short rainy season (March to May), long rainy season (June to September), and dry season (October to February).

### 2.2. Study Design and Population

A retrospective study was employed to identify the major reproductive disorders in dairy herds in the study areas. Semi-structured questionnaires were used to gather information from dairy producers under smallholder conditions in a single visit interview. Accordingly, information abouts household's characteristics, breeding practices and reproductive disorders like abortion, retained placenta, stillbirth, calf mortality, anestrus, repeat breeding were collected. The target population for this study was smallholder dairy producers. The local, cross and exotic breeds of cows was also used in this study.

### 2.3. Sample size and Sampling Procedures

The three districts were purposively selected, from the West Shoa Zone, based on the availability of dairy technologies and the population of dairy cows. A simple random sampling procedure was implemented to identify dairy farms and individual's dairy cows producers based on milk production potentials and dairy technologies accessibility. A total of 180 samples of households (HH) (15 from each kebeles and 60 from each district) were selected. Sample size was determined using the formula for survey studies:

$$N = 0.25/SE^2$$

Where N = sample size SE= Standard error of the population.

### 2.4. Data Analysis

The collected survey data was analyzed using Statistical

Packages for the Social Sciences (SPSS) version 26. Descriptive statistics by cross-tabulation such as percentage, mean, and standard deviation were used to present the results.

### 3. Results

#### 3.1. Household Characteristics

The results relating to educational level of the respondents and the gender of household head are summarized in (Table 1). The educational level of the respondents ranged from totally illiterate to those with higher education. Overall, 36.7%

of the respondents were totally illiterate and 63.3% had attended different levels of formal education. The proportion of respondents who attended formal education was higher in Ambo than other two districts in which out of the respondents interviewed 53.3% in Adeaberga were totally illiterate, 28.3% in Ambo had attended primary school and can read and write, 11.7% in Walmera had attended secondary school and 6.7% in Ambo had attended the higher education.

On average, 87.8% of the total the respondents were male headed households and the rest 12.2% were female headed households. Ambo has a higher proportion of female-headed families than the other two districts.

**Table 1.** Educational level (%) and gender of the HH head of respondents (%).

Parameters	Study areas							
	Walmera		Adeaberga		Ambo		Total	
	N	%	N	%	N	%	N	%
Education's level								
Illiterate	22	36.7	32	53.3	12	20	66	36.7
Read and write	15	25	16	26.7	17	28.3	48	26.7
Primary School	16	26.7	9	15	17	28.3	42	23.3
Secondary school	7	11.6	3	5	7	11.7	17	9.4
Higher Education	0	0	0	0	4	6.7	4	2.2
Diploma	0	0	0	0	3	5	3	1.7
Total	60	100	60	100	60	100	180	100
Gender of HH head								
Male	52	86.7	56	93.3	50	83.3	158	87.8
Female	8	13.3	4	6.7	10	16.7	22	12.2
Total	60	100	60	100	60	100	180	100

N= Number of respondents

The average family size of the study areas was  $6.84 \pm 2.17$ . The overall average age of the respondents was 45 years and ranged from 20 to 79 years. The details result of family size and age of the respondents were shown in table 2 as follows.

**Table 2.** Family size mean ( $\pm$ SD) and age of respondents mean ( $\pm$ SD).

Parameters				
Study areas	Age of the respondents	Male (Family size)	Female (Family size)	Overall mean
Walmera	$44.7 \pm 10.1$	$3.4 \pm 1.1$	$3.3 \pm 1.3$	$6.7 \pm 1.6$
Adeaberga	$46.5 \pm 10.5$	$3.7 \pm 1.5$	$3.4 \pm 1.6$	$7.1 \pm 2.7$
Ambo	$45.4 \pm 11.2$	$3.2 \pm 1.6$	$3.4 \pm 1.3$	$6.7 \pm 2.2$

Parameters				
Study areas	Age of the respondents	Male (Family size)	Female (Family size)	Overall mean
Total	45.5±10.6	3.4±1.4	3.4±1.4	6.8±2.2

SD = Standard Deviation

Overall, 75% and 12.2%, respectively, of the respondents were farmers and dairy producers while the rest were mentioned others types of job as their main occupations. The

13.3% from Walmera, 15% from Ambo and 8.3% from Adeaberga of dairy farm owners stated that dairy production was their main occupation.

**Table 3.** Occupational status of the respondents in study areas (%).

Parameters	Study areas							
	Walmera		Adeaberga		Ambo		Total	
	N	%	N	%	N	%	N	%
Major Occupation								
Farmers	51	85	47	78.3	37	61.7	135	75
Business man	0	0	3	5	2	3.3	5	2.8
Employed	1	1.7	1	1.7	6	10	8	4.4
Retired	0	0	1	1.7	2	3.3	3	1.7
Farmers and business man	0	0	1	1.7	1	1.7	2	1.1
Pensions	0	0	2	3.3	3	5	5	2.8
Dairy producers	8	13.3	5	8.3	9	15	22	12.2
Total	60	100	60	100	60	100	180	100

N= Number of respondents

### 3.2. Mating System

The survey result showed that farmers in the study areas use a diversified mating type (Table 4). The survey results revealed that the main breeding method of dairy producers in the study area was Artificial insemination where 35.6% of

the respondents reported to use only A.I. compared to that of natural mating (5.6%), however, 58.6% of the respondents reported making use of both A.I. and natural mating. Significant variation observed between the districts in using A.I. where the majority (46.7%) of the respondents from Ambo reporting adopting the technology as opposed to the other districts.

**Table 4I.** Types of mating system in the study areas.

Parameters	Study areas							
	Walmera		Adeaberga		Ambo		Total	
	N	%	N	%	N	%	N	%
Types of mating								
Natural mating only	1	1.7	5	8.3	4	6.6	10	5.6

Parameters	Study areas							
	Walmera		Adeaberga		Ambo		Total	
	N	%	N	%	N	%	N	%
Types of mating								
AI only	17	28.3	19	31.7	28	46.7	64	35.6
Both AI and Natural mating	42	70	36	60	28	46.7	106	58.9
Total	60	100	60	100	60	100	180	100

N = Number of respondents

### 3.3. Major Reproductive Disorders

As revealed by the survey results the major reproductive disorders observed in the present study were repeat breeder,

retained fetal membrane, abortion, calf mortality and stillbirth. In the present study, repeat breeding has shown a higher prevalence whereas stillbirth recorded a lower prevalence in the study areas.

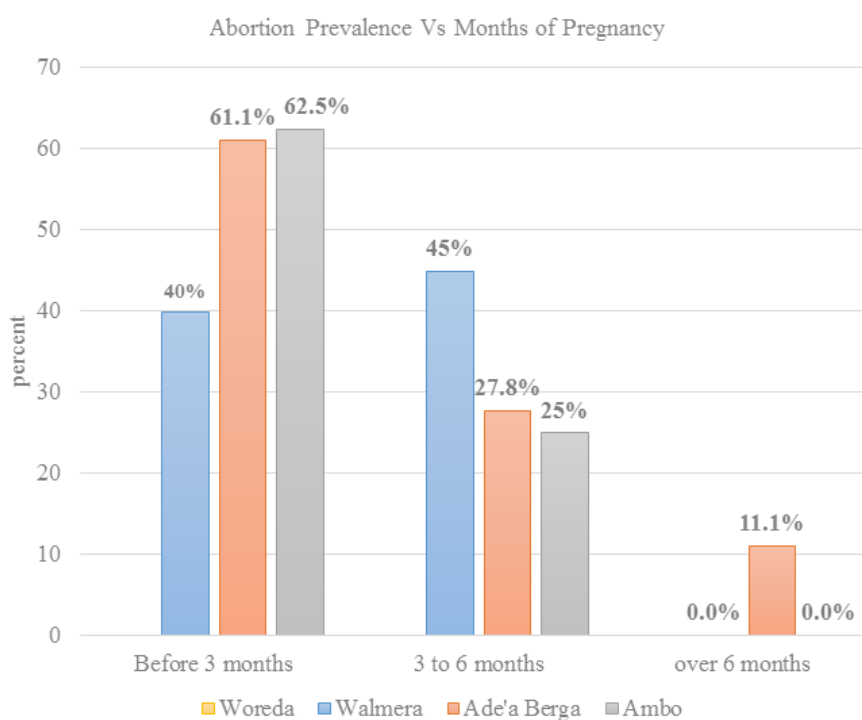


Figure 1. Abortion Prevalence Vs Months of Pregnancy in dairy cows within study areas.

Table 5. Reproductive disorders in dairy cattle in the study areas.

Parameters	Study areas							
	Walmera		Adeaberga		Ambo		Total	
	N	%	N	%	N	%	N	%
Repeat breeding								
Yes	54	90	45	75	49	81.2	148	82.2

Parameters	Study areas							
	Walmera		Adeaberga		Ambo		Total	
	N	%	N	%	N	%	N	%
No	6	10	15	25	11	18.8	32	17.8
Total	60	100	60	100	60	100	180	100
Calf mortality								
Yes	19	31.7	9	15	13	21.7	41	22.8
No	41	68.3	51	85	47	78.3	139	77.2
Total	60	100	60	100	60	100	180	100
Retained fetal membrane								
Yes	20	33.3	11	18.3	18	30	49	27.2
No	40	66.7	49	81.7	42	70	131	72.8
Total	60	100	60	100	60	100	180	100
Abortion								
Yes	17	28.3	18	30	7	11.7	42	23.3
No	43	71.7	42	70	57	88.3	138	76.7
Total	60	100	60	100	60	100	180	100
Stillbirth								
Yes	6	10	14	23.3	10	16.7	30	16.7
No	54	90	46	76.7	50	83.3	150	83.3
Total	60	100	60	100	60	100	180	100

N =number of observations or frequency; % = Prevalence of disorders

The prevalence of abortion was varying at different stage of pregnancy in this study. As indicated in [Figure 1](#) the occurrence of abortion was increased in dairy cows before three months of pregnancy whereas decreased after six months of pregnancy in all study areas. The 62.5%, 61.1% and 40% of respondents, respectively, from Ambo, Adeaberga and Walmera stated that their cows were experiencing abortion before three months of pregnancy and only 11.1% of respondents in the Adeaberga said their cows aborted after six months of pregnancy.

## 4. Discussions

### 4.1. Household Characteristics

The highest educational level of the respondents in the current study was higher education which might be related to the availability of different agricultural institutions. Similarly, the author [\[1\]](#) reported that the first degree was the highest educational level achieved by household heads in the central

highlands of Ethiopia.

The highest percentages of male household heads observed in the current study were similar to the report of [\[18\]](#), who found 86.7% male and 13.3% female in the central highlands and [\[11\]](#), who reported 84.4% male and 16.6% female in the central highlands.

The average family size of the study areas was comparable with the observation of [\[17\]](#), who reported 7.4 and 6.0 persons per household, respectively, from shashamene and Dilla. The average family sizes of the three districts were also higher than the national average family size of 4.8 persons per HH [\[6\]](#). The higher family size may be useful for different routine dairy farm activities such as feeding, cleaning, herding, milking and milk processing. However, the average family size revealed in this survey was somewhat larger than the finding of [\[1\]](#), who reported 4.4 persons per HH from different areas of central Ethiopia.

Overall survey results of dairy farm owners stated dairy production as their major occupation in the present study was comparable with the report of [\[15\]](#), who found that 13.7% of farmers were involved in dairy production in the Sebeta

Awasa area. However, the current result of this study was lower than the finding of [13], who reported that 29.2% of respondents in Shashamane were dairy cow producers. The variation observed in the current study from others could be due to differences in the demand for dairy production.

## 4.2. Mating System

As revealed by the survey result, artificial insemination solely and artificial insemination with natural mating was commonly practiced in the study areas. Contrary to this finding [5] indicated that natural service (100%) was the widely used breeding method and A.I. service was uncommon. There was a tendency that mating practices have shifted from natural mating to improved mating system in the study areas.

## 4.3. Major Reproductive Disorders

Out of 180 respondents 82.2%, 27.2%, 23.3%, 22.8% and 16.7%, respectively, stated that the major reproductive disorders that affected dairy cows were repeat breeding, retained fetal membrane, abortion, calf mortality and stillbirth. This result was comparable with the finding of [3], who reported abortion, repeat breeding and RFM as the major reproductive disorders in Hossana, Southern Ethiopia and [12], who reported abortion, repeat breeder, RFM and anestrus were the major reproductive disorders in Central Ethiopia.

The prevalence of repeat breeding observed in Walmera, Adeaberga and Ambo in the present study were comparatively higher than the findings by [3, 4], who reported 13.08% and 21%, respectively. Farmers in the study areas practice different options to reverse failure on conception. If AI service did not bring conception, most respondents practice natural mating while some used AI repeatedly. Some respondents stated that for their cow's failure to conceive they offer compounded or improved feeds with high salt content and quarter kilogram of *Bikil* every morning for three days to get them in heat again. Cows fed *Bikil* every morning for three days shown heat sign within a week or ten days as mentioned by some of the respondents in the study areas. Some of dairy producers stated that cows offered compounded or improved feeds with high salt content shown heat sign soon than cows offered compounded or improved feeds without salts. As indicated by survey result the reasons for failure of insemination in the study areas were late timely inseminations or heat detection problems, poor semen quality, inappropriate semen handling, poor genetic performance and poor efficiency of AI technicians. This is in line with the result of [8] in Ethiopia.

The prevalence of retained fetal membrane (RFM) observed in the current study areas in Walmera and Ambo was higher than the report of [2] in the Addis Ababa milkshed. The variation in prevalence of RFM might be difference in feed supply and management practices. However, the prevalence

of RFM observed in Adeaberga was nearly agreed with the report by [12] in central Ethiopia. The respondents in the study areas said that they call animal health technicians or veterinarians to treat their cows encountered with retained fetal membrane. According to some dairy producers in the study areas, they traditionally aid or treat their cows encountered RFM by grinding lean seed cake and diluting it with water, then drinking the cows that fail to shed the fetal membrane.

The prevalence in the current study of abortion in Walmera, Adeaberga and Ambo were greater than the findings of [14] in Asela town. This variation could be due to nutritional deficiencies. As stated by the respondents in the present study, the occurrence of abortion was higher before three months of pregnancy in Walmera, Adeaberga and Ambo. In this study, the occurrence rate of stillbirth in the current study areas was higher than the findings of [2] for crossbred dairy cows under a smallholder in Addis Ababa milk shed. This variation could be due to the poor management during pregnancy and parturition.

## 5. Conclusion and Recommendation

Regular breeding depends on the normal function of the reproductive system. The major reproductive disorders that were causes of infertility observed in the present study were repeat breeder, retained fetal membrane, abortion, calf mortality and stillbirth. Repeat breeding shows a higher prevalence whereas stillbirth rate a lower prevalence. The ultimate goal of dairy herds production is to increase milk yield and manipulate early first service and calving, lower the calving interval and days open and decrease the number of services per conception. However, repeat breeding, retained fetal membrane, abortion, calf mortality and stillbirth were the major causes of infertility in dairy herds. Therefore, there is a need for further investigation into the causes of the noted reproductive disorders and also proper breeding strategy and keeping the health conditions of dairy cattle should employed to ensure improvement in both fertility and productive traits.

## Abbreviations

AI: Artificial Insemination  
CSA: Central Statistical Agency  
HH: Households  
RFM: Retained Fetal Membrane  
SE: Standard Error  
SD: Standard Deviation  
SPSS: Statistical Packages for Social Sciences

## Author Contributions

**Gemeda Tuntuna Wake:** Conceptualization, Resources, Data curation, Software, Formal Analysis, Supervision,



Funding acquisition, Validation, Investigation, Writing - original draft, Methodology, Writing - review & editing

**Mosisa Dire Babura:** Conceptualization, Data curation, Methodology

## Conflicts of Interest

The authors declare no conflicts of interest.

## References

- [1] Abebe Bereda, Zelalem Yilma, Mitiku Eshetu, Mohammed Yousu and Getenet Assefa (2017): Socio-economic characteristics of dairy production in the selected areas of Ethiopian central highlands. *Journal of Veterinary Medicine and Animal Health*, 9(8): 193- 203.  
<http://dx.doi.org/10.5897/JVMAH2017.0588>
- [2] Abreham Haile, Tesfu Kassa, Mulugeta Mihret and Yikal Asfaw (2010): Major Reproductive Disorders in Crossbred Cows under Smallholding in Addis Ababa Milkshed, Ethiopia. *World Journal of Agricultural Science.*, 6(4): 412–418.
- [3] Adane Haile, Yisehak Tsegaye, Niguse Tesfaye (2014): Assessment of Major Reproductive Disorders of Dairy Cattle in Urban and Peri Urban Area of Hosanna, Southern Ethiopia. *Animal and Veterinary Sciences*. 2(5): 135-141.  
<https://doi.org/10.11648/j.av.s.20140205.11>
- [4] Alemselem Birhanu Mekonnen, Christopher R. Harlow, Giotom Gidey, Desalew Tadesse, Gidena Desta, Tadesse Gugssa, Simon C. Riley (2015): Assessment of Reproductive Performance and Problems in Crossbred (Holstein Friesian × Zebu) Dairy Cattle in and Around Mekelle, Tigray, Ethiopia. *Animal and Veterinary. Science.*, 3(3): 94-101.  
<https://doi.org/10.11648/j.av.s.20150303.14>
- [5] Belay Duguma and Geert Paul Jules Janssens (2016): Smallholder Dairy Farmers' Breed and Cow Trait Preferences and Production Objective in Jimma Town, Ethiopia. *European Journal of Biological Sciences* 8(1): 26-34.  
<https://doi.org/10.5829/idosi.ejbs.2016.8.01.10385>
- [6] Central Statistical Agency (2018/19): Agricultural sample survey; Livestock and Livestock characteristics Private Peasant Holdings), volume II Addis Ababa, Ethiopia.
- [7] Sisay Ayane Dabale, Gemechu Berhanu Kerorsa and Wahid M. Ahmed (2020): Prevalence of Major Reproductive Disorders of Dairy Cows in Hawassa City, Ethiopia. *Journal of Reproduction and Infertility* 11: 8-13.  
<https://doi.org/10.5829/idosi.jri.2020.08.13>
- [8] Desalegn Gebermedhin, (2008): Performance of artificial insemination: challenges and opportunities presented by Desalegn G/medhin Ethiopian meat and dairy technology institute workshop on “alternatives for improving field AI delivery system. MSc Thesis, Addis Ababa University, Bishoftu, Ethiopia.
- [9] R. P. Del Vecchio, D. J. Matsas, T. J. Inzana, D. P. Sponenberg, G. S. Lewis (1992): Effect of intrauterine bacterial infections and subsequent endometritis on prostaglandin F2α metabolite concentrations in postpartum beef cows. *Journal of Animal Science*, 70(10): 3158–3162  
<https://doi.org/10.2527/1992.70103158x>
- [10] Fair T., (2015): The contribution of the maternal immune system to establishment of pregnancy in cattle. *Front. Immunol.* 6(7). <https://doi.org/10.3389/fimmu.2015.00007>
- [11] Fekede Feyissa, Shiv Prasad, Getnet Assefa, Getu Kitaw and Seyoum Bediye (2013): The status of production, conservation and utilization of natural pasture hay for feeding dairy cattle in the greater Addis milkshed, central highlands of Ethiopia. *Journal of Agricultural Research and Development* 3(6): 082-093. <http://www.e3journals.org>
- [12] Gashaw, Abebaw, Worku, Fikre. and Mulugeta, Shiferaw. (2011): Assessment of small holder dairy production system and their reproductive health problems in Jimma town South West Ethiopia, Jimma University College of Agriculture and veterinary medicine, Jimma, Ethiopia. *International Journals of Applied Research.*, (9): 80-86.
- [13] Girma Chalchissa, Yoseph Mekasha. and Mengistu Urge (2014): Feed Resources Quality and Feeding Practices in Urban and Peri-urban Dairy Production of Southern Ethiopia. *Tropical and Subtropical Agroecosystems*, 17(3): 539–546.
- [14] Hunduma Dinka, (2013): Reproductive performance of crossbred dairy cows under smallholder condition in Ethiopia. *International Journal of Livestock Production*, 3(3): 25-28.
- [15] Shibru Dereje and Mekasha Yoseph (2016): Performance evaluation of crossbred dairy cows in urban and peri-urban dairy systems of Sebeta Awas woreda, Oromia, Ethiopia. *Academic Research Journal of Agricultural Science and Research*, 4(5): 184-196.  
<https://doi.org/10.14662/ARJASR2016.024>
- [16] Jirata Shiferaw, Belachew Bacha, Nebiyu Mojie, Eliyas Temesgen and Morka Amante (2016): Major reproductive health problems of dairy cows at Horro Guduru Animal Breeding and Research Center, Horro Guduru Wollega Zone, Ethiopia. *Journal of Reproduction and Infertility*.7(3): 94-101.  
<https://doi.org/10.5829/idosi.jri.2016.7.3.104152>
- [17] Sintayehu Yigrem, Fekadu Beyene, Azage Tegegne and Berhanu Gebremedhin (2008). Dairy production, processing and marketing systems of Shashemene -Dilla area, South Ethiopia. Working Paper 9. International Livestock research Institute, Addis Ababa, Ethiopia.  
<https://cgspace.cgiar.org/handle/10568/485>
- [18] Zewdie Wondatir (2010): Livestock production systems in relation with feed availability in the highlands and central rift valley of Ethiopia. MSc Thesis, Haramaya University, Ethiopia.