



## REPRODUCTIVE AND PRODUCTIVE PERFORMANCE OF DAIRY CATTLE IN CENTRAL ZONE OF TIGRAY, NORTHERN ETHIOPIA

<sup>a</sup>Gebrekidan Tesfay Weldeslasse, <sup>b</sup>Zelege Mekuriaw Zelege and <sup>c</sup>Gangwar, S.K.

<sup>a</sup>Deptt. of Animal Science College of Agriculture, Aksum University, Aksum, Ethiopia

<sup>b</sup>Deptt. of Animal Science College of Agriculture, Bahir Dar University, Bahir Dar, Ethiopia

<sup>c</sup>Deptt. of Animal, Rangeland and wildlife Sciences, College of Agriculture, Mekelle University, Mekelle, Ethiopia

### ABSTRACT

The purpose of this study was to explore the reproductive and productive performances of dairy cattle in central Tigray Zone, Northern Ethiopia. A total of 160 dairy holding households were selected by systematic random sampling technique for the study. The age at first calving, calving interval and lactation length for the exotic breed cows was  $2.26 \pm 0.9$ ,  $1.28 \pm 0.32$  and  $8.82 \pm 1.97$ , respectively, for the urban areas and  $2.85 \pm 1.24$ ,  $1.48 \pm 0.28$  and  $6.60 \pm 3.20$ , respectively, in the peri-urban areas. Hence, the higher grade exotic cows performed significantly ( $P < 0.05$ ) better in terms of age at first calving, calving interval and lactation length in the urban areas than the peri-urban areas. But no significant difference was obtained in these reproductive parameters for the local cows across the location. The average daily milk yield of exotic cows was  $8.78 \pm 2.76$  and  $5.83 \pm 0.57$  for the urban and peri-urban areas respectively. In addition to this, the average daily milk yield of local cows was  $2.56 \pm 1.12$  and  $1.87 \pm 0.79$  for the urban and peri-urban areas respectively. Therefore, the average daily milk yield of both local and exotic cows indicated significantly higher in the urban areas than the peri-urban areas. Consequently, training and awareness creation should be given particularly to the peri-urban farmers to increase the reproductive and/or productive performances of the dairy cattle and livelihood of the dairy farmers.

**KEY WORDS:** Urban; peri-urban; farm size; Dairy cattle; reproductive; productive performance

### INTRODUCTION

The urban and peri-urban dairy production has been developed in response to the fast growing demand for milk and milk products. During the past two decades, rapidly increasing urban population has created better markets and growth of demand for dairy products. Currently, the price of milk in major towns of northern Ethiopia, including the study area, has increased from 3 to 6 Ethiopian birr (ETB) per liter over the last two years. Moreover, comparable increase in prices of processed dairy products such as butter, hard cheese and fermented milk has been observed in the region (Negussie, 2006). This situation is an opportunity and potential for development of milk production and processing industry in urban and peri-urban areas of the region.

However, little research efforts have been made in Ethiopia in general and in central Tigray in particular on urban and peri-urban areas as most of the efforts are directed towards rural agricultural activities. The few studies made so far are concentrated in and around Addis Ababa, the capital city of the country. This has led to overlooking urban and peri-urban dairying from incorporating into the country's research agenda and to the overall agricultural development program. This picture has to be changed as urban dairying is becoming an important agricultural activity around major urban and peri-urban centers. Hence, in order to design relevant dairy development strategies and implement context specific interventions for future development of the urban and peri-

urban dairying, performance evaluation of existing dairying is important. The scientific information regarding the aforementioned parameters helps as a starting point for further development endeavors in dairy enterprise in the nation. Therefore, this study was instigated to explore the reproductive and productive performances of dairy cattle in urban and peri-urban areas of central Tigray Zone, Northern Ethiopia.

### MATERIALS AND METHODS

The study was carried out in central zone of Tigray region, Northern Ethiopia. The Central Tigray Zone is one of the five zones in Tigray National Regional State. The zone approximately extends between  $13^{\circ}15'$  and  $14^{\circ}39'$  North latitude, and  $38^{\circ}34'$  and  $39^{\circ}25'$  East longitude. The altitude of the zone mainly falls within the category of 2000 to 3000 masl. The larger part of the zone receives mean annual rainfall ranging from 400 to 800mm. The mean monthly maximum and minimum temperatures of the zone are  $30^{\circ}\text{C}$  and  $10^{\circ}\text{C}$ , respectively (NMSA, 1996). Central Tigray zone is bounded by Eritrea in the north, East Tigray zone in the East and south east, West Tigray zone in the west and Amhara National Regional State in the south. The zone with its capital in the ancient city of Aksum encompasses ten woredas. The zone has the largest human population in the region. The specific study sites were Adwa & Aksum urban and peri-urban areas with 1006 & 1024 kilometers far from Addis Ababa, respectively. These two districts were selected purposively

based on their conducive agro-ecological conditions for dairy production and for existence of large human population. A cross-sectional survey was used in order to collect data on reproductive and/or productive performances of the dairy cattle. Pre-tested formal questionnaire was used in the cross sectional survey. The collected data included age at first calving, calving interval, lactation length, average daily milk yield per cow per day. A multi-stage sampling technique was used in the cross-sectional survey. First, cattle holding households were clustered in to urban and peri-urban. Aksum and Adwa, the larger towns in the zone, were considered as urban. The smaller towns of Wukro, Dura, and Mahiber-selam are found around Aksum. The remaining small

towns of Bete-Hanis, Debre-genet and Gendebta and Mariam-shewito are found around Adwa. These small towns found within a radius of 20km from the centers of the two larger towns. Hence the small towns were considered as peri-urban. Then farms were categorized in to large (> 10 dairy cattle), medium (5-10 dairy cattle) and small (<5 dairy cattle) according to the guideline of IRLI (1996). Finally, based on the sampling frame obtained from the district office of Agriculture, a total of 160 cattle holding households were chosen using systematic random sampling technique (Table 1). Analysis of variance (ANOVA) and t-test were employed to analyze the data using SPSS 16.0 (SPSS, 2007) software.

**TABLE 1.** Sample households with respect to location (urban and peri-urban) and farm size (large, medium and small)

Location		Farm size			Total
		Large	Medium	Small	
Urban	Axum	9	15	16	40
	Adwa	7	13	20	40
	Total	16	28	36	80
Peri-urban	Axum	0	9	31	40
	Adwa	5	11	24	40
	Total	5	20	55	80
Total		21	48	91	160

**Table 2.** Average AFC, CI and LL across the different locations in the study area

Parameters	variables	Urban	Peri-urban	p-value
		Mean $\pm$ S.D	Mean $\pm$ S.D	
AFC	Local	3.41 $\pm$ 0.70	3.63 $\pm$ 0.69	0.277
	Cross	2.92 $\pm$ 0.65	2.97 $\pm$ 0.67	0.697
	Exotic	2.26 $\pm$ 0.90	2.85 $\pm$ 1.24	0.028
CI	Local	1.77 $\pm$ 0.52	1.93 $\pm$ 0.56	0.315
	Cross	1.31 $\pm$ 0.50	1.62 $\pm$ 0.53	0.017
	Exotic	1.28 $\pm$ 0.32	1.48 $\pm$ 0.28	0.029
LL	Local	6.5 $\pm$ 1.63	7.20 $\pm$ 2.50	0.301
	Cross	7.48 $\pm$ 1.69	7.89 $\pm$ 2.05	0.239
	Exotic	8.82 $\pm$ 1.97	6.60 $\pm$ 3.20	0.005

AFC= Age at first calving (Year) CI= Calving interval (Year) LL= Lactation length (months)  
S.D= standard deviation

## RESULTS AND DISCUSSION

### Reproductive and Productive Performance of Dairy Cattle

#### Age at first calving

It is the period between birth and first calving and influences both the productive and reproductive life of the female, directly through its effect on her lifetime calf crop and milk production and indirectly through its influence on the cost invested for up-bringing (Perera, 1996). The average age at first calving in this study found to be insignificant ( $P>0.05$ ) for the local breed as well as their crosses across the locations whereas the high-grade exotic cows showed significantly ( $P<0.05$ ) longer age at first calving in peri-urban areas than urban areas (Table 2). Similar to the locations, the age at first calving was also indicated no significance difference ( $P>0.05$ ) for the local

and their crosses among the farm sizes. But the age at first calving for the exotic breeds indicated significantly ( $P<0.05$ ) longer in the small farms than the large and medium farms (Table 3). The value obtained in the current study is less than the average value reported by Tesfaye (2007) in Metema district, Negussie (2006) in Mekelle city and Addisu (2003) in Metekel ranch. But there is similarity with the mean age at first calving ( $29 \pm 3.5$  months), ranging from  $27.5 \pm 1.0$  in large peri-urban to  $30.6 \pm 4.7$  in secondary town dairy farms in Addis Ababa milk shed (Yoseph, 1999). The shorter age at first calving in urban areas and larger farms might be due to better overall management in the larger farms found in urban areas. Hence, efficient heat detection and timely insemination as well as supplementing the poor quality feeds may improve the age at first calving, especially for the peri-urban farms.

**TABLE 3.** Least Square Means (LSM) and standard deviation (SD) for the average AFC, CI and LL across the different farms sizes

Parameters	variables	Large	Medium	Small	p-value
		Mean $\pm$ S.D	Mean $\pm$ S.D	Mean $\pm$ S.D	
AFC	Local	3.32 $\pm$ 0.53	3.56 $\pm$ 0.76	3.60 $\pm$ 0.68	0.76
	Cross	2.92 $\pm$ 0.51	2.77 $\pm$ 0.59	3.08 $\pm$ 0.72	0.075
	Exotic	2.11 $\pm$ 0.98 <sup>a</sup>	2.29 $\pm$ 0.73 <sup>a</sup>	2.83 $\pm$ 1.29 <sup>b</sup>	0.03
CI	Local	1.77 $\pm$ 0.26	1.89 $\pm$ 0.45	1.90 $\pm$ 0.63	0.907
	Cross	1.48 $\pm$ 0.63	1.48 $\pm$ 0.50	1.45 $\pm$ 0.52	0.962
	Exotic	1.33 $\pm$ 0.42	1.27 $\pm$ 0.25	1.34 $\pm$ 0.29	0.87
LL	Local	5.75 $\pm$ 0.50	7.19 $\pm$ 1.19	7.05 $\pm$ 2.58	0.523
	Cross	7.60 $\pm$ 1.14	7.35 $\pm$ 2.28	7.86 $\pm$ 1.72	0.405
	Exotic	9.25 $\pm$ 2.07 <sup>a</sup>	8.81 $\pm$ 1.72 <sup>a</sup>	7.22 $\pm$ 2.90 <sup>b</sup>	0.016

Within each row, values followed by the same superscript letter, do not differ from each other significantly ( $P>0.05$ ).

### Calving interval

It is the period between successive parturitions and should ideally be one year long. In the present study, calving interval (CI) for local cattle did not differ significantly ( $P>0.05$ ) across the locations. However, CI found to be significantly ( $P<0.05$ ) longer in peri-urban areas than in the urban areas for both crossbred and high-grade exotic breeds (Table 2). But the CI did not differ significantly ( $P>0.05$ ) among breed types across the farm size (Table 3). In all cases, CI decreased as the exotic blood level increased. This might be because of the genetic difference between the indigenous and exotic breed and less attention given to the indigenous breeds as compared to the exotic one. The value obtained in the present work is comparable to the result reported for Zebu cattle (between 12.2 and 26.6 months) (Solomon Abrha, 2006). Similarly, the present finding was comparable to the average CI of Boran x Holstein- Friesian F1 crossbred dairy cows (534.5 days) in Abernosa Ranch (Ababu et al., 2006).

Similar results were presented by Omar (2008) who indicated CI of 15.4 $\pm$ 0.75, 15.0 $\pm$ 3.0, 14.2 $\pm$ 0.49 and 14.08 $\pm$ 0.62 months for Local, Sahiwal x Local, Friesian x Local and Jersey x Local, respectively. By contrast, the overall mean CI of local cows in the present study was higher than the respective values of 12.2 months reported for Horro and 12.9-15.1 months reported for Arsi cattle type (Mukasa-Mugerwa, 1989). It is also quite comparable with the average value (15.3 $\pm$ 0.33 months) reported by Negussie (2006) in Mekelle city. Shorter CI was obtained from high-grade exotic cows reared in urban than the other breed types. The CI in this study particularly in the peri-urban areas was generally longer than the recommended interval of 12 months on different literatures. If at all possible, CI should be in the range of 12 to 13 months for cattle (Kiwuwa et al., 1983) in order to maximize reproductive efficiency and profitability in a dairy herd. The longer CI in this study particularly the peri-urban area could be due to poor heat detection and less access to AI services and poor feeding practices.

### Lactation length

It is the time period through which a cow continues giving milk in one parturition. The result in this study indicated that lactation length (LL) for the high-grade exotic breed showed significantly ( $P<0.05$ ) longer in urban areas than peri-urban areas (Table 2). No significant difference

( $P>0.05$ ) in LL was obtained for the local cows and their crosses across the location. Significantly ( $P<0.05$ ) longer LL was obtained in larger farms than medium and small farms for the high grade exotic breeds (Table 3). This might be due to the reason that the high-grade exotic breeds are more sensitive to management practices than the local and their crosses and hence shorter LL in the peri-urban areas and small farms than urban and large farms.

The result obtained in this study is lower than the generally accepted 305 days of LL for crossbred and high-grade cows. But the mean LL obtained in this study was slightly longer than (5.9 $\pm$ 0.14 months) reported by Tesfaye (2007) in Metema district. Moreover, the LL of the indigenous cows observed in this study was almost similar with the national average (7 months) (CSA, 2005), while the LL in crossbred cows observed in this study was shorter than the LL of 11.7 months reported for crossbred cows in the Central Highlands of Ethiopia (Zelalem and Ledin, 2001). Moreover, Belete (2006) in Fogera reported the average LL for the local and cross breed cows was 8 and 10 months, respectively, in peri-urban areas which is longer than the values obtained in the present study. Similarly, longer mean LL (11.67 months) of crossbred cows was reported from Asela research station (Enyew *et al.*, 2000). But the result in this study is comparable to the LL of high-grade cows (7.3 months) in Ethiopia (Getachew and Gashaw, 2001).

Shorter average LL was obtained for the high-grade exotic breeds in peri-urban area as compared to the urban area. The LL increased as the exotic blood level increased in urban areas whereas in the peri-urban areas, the exotic breeds showed relatively shorter LL as compared to the local and their crosses. This means the exotic breeds are more sensitive to management and hence indicated decreased LL in peri-urban areas where there was less awareness and poor management practices as compared to the urban areas.

### Average daily milk yield

The mean milk yield in the urban and peri-urban areas in the different lactation stage is presented in Table 4. The mean milk yield for local cows and their crossbreds decreases from the beginning of lactation to late lactation both in the urban and peri-urban areas.

The average daily milk yield (AVDMY) for the local breed cows during mid and late stage of lactation indicated significantly ( $P<0.05$ ) higher in urban areas than peri-urban areas. At early lactation, AVDMY for exotic breed was found to be significantly ( $P<0.05$ ) higher in urban areas than peri-urban areas. No significant difference ( $P>0.05$ ) in AVDMY was obtained for the cross bred cows during all stages of lactation across the location.

Average daily milk yield for local cows during mid stage of lactation was significantly ( $P<0.05$ ) higher in large farms than medium and small farms (Table 5). During the

late stage of lactation, AVDMY was significantly ( $P<0.05$ ) higher in larger farms than small farms but no significant difference ( $P<0.05$ ) was obtained between large and medium as well as medium and small farms for the local breed cows. The AVDMY from crossbred cows was found to be significantly ( $P<0.05$ ) higher in larger farms than the medium and small farms during all stages of lactation. For the high-grade exotic breed cows, AVDMY was significantly ( $P<0.05$ ) lower in small farms than large and medium farms.

**TABLE 4.** Average daily milk yield (liters) at different stage of lactation across the different location

Breed type	Stages of lactation	Location		p-value
		Urban	Peri-urban	
		Mean $\pm$ S.D	Mean $\pm$ S.D	
Local	Beginning	3.39 $\pm$ 2.0	2.6 $\pm$ 1.1	0.1957
	Mid	2.8 $\pm$ 1.3	2.0 $\pm$ 0.97	0.0134
	Late	1.5 $\pm$ 0.62	1.0 $\pm$ 0.53	0.0384
	Mean	2.56 $\pm$ 1.12	1.87 $\pm$ 0.79	0.018
Cross	Beginning	9.0 $\pm$ 3.9	9.0 $\pm$ 4.0	0.992
	Mid	7.4 $\pm$ 2.7	7.0 $\pm$ 2.9	0.4178
	Late	4.3 $\pm$ 1.9	4.4 $\pm$ 2.3	0.777
	Mean	6.83 $\pm$ 2.5	6.82 $\pm$ 2.8	0.992
Exotic	Beginning	10.3 $\pm$ 4.3	6.5 $\pm$ 1.0	0.0014
	Mid	10.2 $\pm$ 3.7	8.25 $\pm$ 2.3	0.218
	Late	6.0 $\pm$ 1.8	5.5 $\pm$ 1.3	0.50
	Mean	8.78 $\pm$ 2.76	5.83 $\pm$ 0.57	0.047

S.D= standard deviation

Similar to the local cows, the mean milk yield for the cross bred cows also tend to decrease as the lactation length advances both in urban and peri-urban areas and across the farm sizes. The same trend continued in urban areas for the high-grade exotic breeds that milk yield decreased as the stage of lactation increased but in the case of peri-urban areas, the peak yield fall at the mid lactation and then decreased thereafter.

Even though greater milk yield is expected during early lactation, AVDMY from the exotic high grade cows during mid lactation period in the peri-urban areas showed an increasing trend. The lower AVDMY during the beginning stage of lactation in peri-urban areas might be due to less management given for the pregnant cows during their steaming-up period and due to the practice of incomplete milking during early lactation. Regarding the farm sizes, higher mean milk yield for exotic breed cows was observed in the medium farms during the beginning and mid lactation as compared to the large and small farms (Table 5). The highest value was found in high-grade exotic cows in medium farms (11.1  $\pm$  4.0 liters) and for the local breed cows the highest milk yield was 4.16  $\pm$  2.3liters in large farms.

The increased daily milk yield per cow from local to high-grade cows could be a reflection of increased use of the Holstein blood level in high grade dairy type cows. However, the potential of local cows for higher yield if they are kept under ideal conditions shouldn't be underestimated. The mean milk yield obtained in this study was nearly comparable to the report of Negussie (2006) in Mekelle which is 4.46, 7.48 and 10.38 liters for local, crossbred and high-grade exotic breeds,

respectively. Similarly, Yoseph *et al.* (2003) based on a study conducted in the Addis Ababa dairy shed, reported mean daily milk yield of crossbred milking cows as 6.9 kg per cow for small herd size, 9.38 kg for medium, and 8.73kg for large herd size with an overall mean yield of 8.63  $\pm$  2.6 kg/cow/ day.

Smith (1998) reported that many local indigenous breeds of cattle to Africa have developed adaptive traits for disease resistance, heat tolerance and ability to utilize poor quality feeds. This adaptation to the natural environment is often not accompanied by high performance traits, and neither have these breeds been selected for high milk production. Low genetic potential for milk production is therefore a limiting factor, which could be, and is being addressed on a short-term basis by crossbreeding with proven milk producing breeds. This short-term action must, however, be accompanied by longer-term selection and breeding plans that incorporate the conservation of desirable indigenous germplasm. Such crossbred animals benefit from the local breed adaptation to local feeds, diseases and the climatic conditions of the area. Similarly, Kiwuwa *et al.* (1983) indicated that one way of improving tropical cattle for milk production is through crossbreeding with *Bos taurus* dairy breeds. This has been widely used in order to combine the high milk yield potential of exotic breeds with the adaptability of the local ones. The first crossbred generation (F1), usually from native females mated with exotic males, has been a success in most cases. The F1 crosses can produce up to three times more milk, and have longer lactation and shorter calving intervals than the local breeds. In this study also the crossbred cows performed better than the local breeds. Therefore, the

distribution of the crossbred heifers to the farmers has to be encouraged.

**TABLE 5.** Least Square Means (LSM) and standard deviation (SD) for the average milk yield (liters) at different stage of lactation across the different farm sizes in the study area

Breed type	Stage of lactation	Farm size			p-value
		Large Mean ± S.D	Medium Mean ± S.D	Small Mean ± S.D	
Local	Beginning	3.5±1.3	3.2±1.8	2.5±1.2	0.239
	Mid	4.16±2.3 <sup>a</sup>	2.4±1.1 <sup>b</sup>	1.9±0.7 <sup>b</sup>	0.003
	Late	2.0±1.0 <sup>a</sup>	1.3±0.58 <sup>ab</sup>	1.0±0.4 <sup>b</sup>	0.016
Cross	Beginning	11.0±4.8 <sup>a</sup>	8.9±3.5 <sup>b</sup>	8.4±3.7 <sup>b</sup>	0.033
	Mid	9.0±3.1 <sup>a</sup>	7.2±2.8 <sup>b</sup>	6.7±2.4 <sup>b</sup>	0.011
	Late	5.8±2.4 <sup>a</sup>	4.0±1.4 <sup>b</sup>	4.1±2.1 <sup>b</sup>	0.004
Exotic	Beginning	10.1±3.6 <sup>a</sup>	11.0±5.3 <sup>a</sup>	7.6±2.2 <sup>b</sup>	0.024
	Mid	9.8±2.7	11.1±4.0	8.5±3.6	0.331
	Late	6.6±2.0	5.9±1.9	5.3±1.0	0.384

Within each row, values followed by the same superscript letter, do not differ from each other significantly (p<0.05).

## CONCLUSIONS

The high-grade exotic breed cows performed better in urban areas and large farms than the local breeds. This might be due to the overall management difference across the locations. Therefore, training and awareness creation should be given particularly to the peri-urban farmers to increase the reproductive and/or productive performances of the dairy cattle and livelihood of the dairy farmers through improved management practices.

## REFERENCES

Ababu Dekeba, Workneh Ayalew, P.B. Hegede and Zerihun Taddes (2006) Performance of the Abernosa Ranch in the Production of Ethiopian Boran X Holstein Crossbreed Dairy Heifers in Ethiopia. In: Ethiopian Journal of Animal Production (EJAP). Volume: 6(1), 33-55.

Addisu Bitew and Prabhakar Hagde (2003) Reproductive and growth performance of Fogera cattle and their F1 Friesian crosses at Metekel ranch, Ethiopia. In: Challenges and opportunities of livestock marketing in Ethiopia. Proceedings of the 10th annual conference of the Ethiopian Society of Animal Production, held in Addis Ababa, Ethiopia, 22-24 Aug 2002. Ethiopian Society of Animal Production, Addis Ababa (Ethiopia) ESAP, pp111-117.

Belete Anteneh (2006) *Studies on cattle milk and meat production in Fogera District: Production systems, constraints and opportunities for development*. MSc. Thesis, University of Hawassa, Awassa, Ethiopia.

Central Statistical Authority (2005) Federal Democratic Republic of Ethiopia Agricultural sample survey. Livestock and livestock characteristics bulletin, Volume II. Addis Ababa, Ethiopia.

Enyew Negussie, Brannang E, Benjaw, K. and Rottman, O. J. (2000) Reproductive performance and herd life of cross-bred dairy cattle with different levels of European inheritance in Ethiopia. In: Livestock production and the environment—implications for sustainable livelihoods.

Proceedings of the 7th conference of the Ethiopian Society of Animal Production, held in Addis Ababa, Ethiopia, 26-

27 May 1999. Ethiopian Society of Animal Production (ESAP), Addis Ababa, Ethiopia. pp. 65-76.

Getachew Feleke and Gashaw Geda (2001) The Ethiopian dairy development policy. A draft document. In: Mohammed A.M. Ahmed, Simeon Ehui and Yemsrach Assefa, 2004. Dairy development in Ethiopia. Environment and production technology division (EPTD), No. 123. International food policy research institute, Washington, DC, USA 43p

ILRI (1996) International livestock research institute. Annual project report. ILRI Addis Ababa, Ethiopia.

Kiwuwa, G. H., Trail, J. C. M., Kurtu, M. Y., Worku, G., Anderson, F. M. and Durkin, J. (1983) Crossbred dairy cattle productivity in Arsi region, Ethiopia. ILCA Research Report No. 11, ILCA, Addis Ababa, Ethiopia.

Mukasa-Mugerwa, E. (1989) A review of reproductive performance of *Bos indicus* cattle. ILCA Monograph No. 6, Addis Ababa, Ethiopia.

National Meteorological Service Agency of Ethiopia (1996) Climatic and Agro climatic Resources of Ethiopia, volume 1, No. 1 Addis Ababa, Ethiopia.

Negussie Gebreslasie (2006) *Characterization And Evaluation Of Urban Dairy Production System In Mekelle City, Tigray Region, Ethiopia*. MSc. Thesis, University of Hawassa, Awassa, Ethiopia

Omar, F. (2008) Productive and reproductive performance of crossbred and indigenous dairy cows under rural conditions in Comilla, Bangladesh Univ. j. zool. Rajshahi Univ. Vol. 26, 2007. pp. 67-70

Perera, O. (1996) Management of reproduction. In: Falvey L and Chantalakhana C (eds) 1999. Smallholder dairying in the tropics. ILRI, Nairobi Kenya pp1-18.

Smith (1998) Opportunities and constraints. Peri-Urban Livestock Production Systems CFP Report 24.

Solomon Abrha (2006) Reproductive Performance of Indigenous and Crossbred Dairy Cattle under Traditional System Northeastern Amhara Region, South Wollo Zone, Ethiopia. MSc Thesis, Addis Abeba University faculty of Veterinary Science, Ethiopia.

Tesfaye Mengsitie (2007) *Characterization of cattle milk and meat production, processing and marketing system in metema district, Ethiopia*. M.sc. Thesis, Hawassa university, Ethiopia.

Yoseph Mekasha (1999) *Impact of feed resources on productive and reproductive performance of dairy cows in the urban and peri-urban dairy production system in the Addis Ababa milk shed and evaluation of non-conventional feed resources using sheep*. Msc. Thesis, Alemaya University, Ethiopia.

Yoseph Mekasha, Azage Tegegne and Alemu Yami (2003) Evaluation of the general farm characteristics & dairy herd structure in urban and peri-urban dairy production system in the Addis Ababa milk shed. In: Challenges and opportunities of livestock marketing in Ethiopia. Proceedings of the 10th annual conference of the Ethiopian Society of Animal Production, held in Addis Ababa, Ethiopia, 22-24 Aug 2002. Ethiopian Society of Animal Production, Addis Ababa (Ethiopia) ESAP, pp39-144

Zelalem Yilma and Ledin Inger (2001) Milk production, processing, marketing and the role of milk and milk products on smallholder farmers' income in the central highlands of Ethiopia. pp. 139-154. In: Proceedings of the 8th Annual Conference of the Ethiopian Society of Animal Production (ESAP). 24-26 August, 2000, Addis Ababa, Ethiopia.