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International Journal of Livestock Production

Table of Contents: Volume 5 Number 4 April 2014

ARTICLES

Research Articles

Post-thawed and fresh spermatozoa motion characteristics of Sahiwal bulls under computer-assisted semen analyser (CASA) 65
Ulfina Galmessa, T. K. Mohanty, V. S. Raina, A. K. Gupta and Shiv Prasad

Socio-economic characteristics of poultry production in lowland and midland agro-ecological zones of central Tigray, Ethiopia 71
A. T. Alem, G. T. Yayneshet and A. H. Aklilu

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Full Length Research Paper

Post-thawed and fresh spermatozoa motion characteristics of Sahiwal bulls under computer-assisted semen analyser (CASA)

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In this study, motion characteristics of spermatozoa was assessed by computer assisted semen analyser (CASA) for evaluating fertility potential of Sahiwal bulls. Twelve bulls were selected and grouped into two on the basis of age (AGI < 50 months old; AGII > 50 months old) and scrotal circumferences (SCI < 33 cm; SCII > 33 cm). The following CASA parameters i.e., velocity average path (VAP, µm/s), velocity straight line (VSL, µm/s), velocity curvilinear (VCL, µm/s), amplitude of lateral head displacement (ALH, µm), motility (%)(the percentage motile cells of the total) and straightness (STR) were recorded. Results of the study revealed that there is no significant different (p>0.05) in progressive motility either in age or Sc groups of bulls. However, significantly (p<0.05) higher mean post thaw motility was observed after 24 h cryopreservation for the younger (76.40±3.07) than the older (65.00±3.50) bulls and for larger SC than smaller SC bulls (65.56±3.78 vs. 56.56±3.78, p<0.05). Similar trends observed at 0 h after freezing were not significantly different (p>0.05) for both age and SC groups. In most motion characteristics especially in motility and linearity of the motion, younger bulls and bulls with larger SC performed better than older bulls and bulls with smaller SC indicating the possibility of selecting bulls at an early age on the basis of testis size to save the money, space and time which otherwise spent on rearing such inferior bulls. This study also clearly indicated that CASA is a good supplementation to aid for selection of breeding bulls.

Key words: Sahiwal bull, computer-assisted semen analysis (CASA) parameters, spermatozoa motion characteristics.

INTRODUCTION

Sahiwal is one of the indigenous breeds of South Asia, and has its origin in Montgomery district of Pakistan, and is distributed in certain herds of Punjab and Rajasthan in India. The importance of this breed is evident from the fact that Sahiwal animals were imported by other countries (like Kenya, Tanzania, Australia, West Indies and Bangladesh etc.), either for crossbreeding with their local breeds or for incorporating some zebu genes in crossbred animals for developing synthetic strains like Jamaica Hope, Australian milking zebu and Australian

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Friesian Sahiwal (Joshi et al., 2001). Because of indiscriminate crossbreeding with exotic breeds, the pure breed of Sahiwal is considerably declining in number (Dahlin et al., 1998). However, it has also been recognized that crossbred animals have poor adaptability to the local environment (Rehman et al., 2006; Garcia et al., 2003; Joshi et al., 2001). Hence, it is extremely important to focus on further evaluation, selection and propagation of superior germplasm of Sahiwal cattle. Conventionally, sperm motility estimation is done by visual approximation of progressively moving spermatozoa using phase contrast microscope. The progressive motility estimation is only an assessment of quantity of moving spermatozoa. Even though an accurate and objective laboratory test for assessing the potential fertility of a bull only based on some specific semen characteristics have still not been successfully achieved (Raja and Rao, 1983), the assessment of quality of motility in terms of velocity, swimming pattern, sperm head behaviour etc., may help in better understanding of the possible function.

In this respect, the advent of Computer-assisted semen analysis (CASA) has brought a new dimension to semen evaluation. CASA is a recent laboratory tool for evaluating semen samples objectively and provides an opportunity to assess sperm kinetics more precisely, rapidly and accurately. The CASA technique yields repeatable and highly reliable results on kinematics of ejaculates based on measurements of individual sperm cells.

Adoption of CASA technique has been reported as the potential tool for improvements in evaluation of semen to enhance fertility (Sundararaman et al., 2012). Hence, it is of great interest to use a combination of semen motion characteristics which can predict bull of high fertility performance more accurately than a single test. Moore and Akhondi (1996) indicated that CASA provided significant information for determining sperm fertilizing capacity and will be a useful technique for reproductive toxicology. Methodologies for application of this technique in clinical evaluation have been described for spermatozoa of human, bull and stallion (Mohaney et al., 1989; Gokcen et al 1991; Broekhuijse et al., 2012). Therefore, the current study was carried out to assess sperm motility coupled with kinetic measurements during various stages of cryopreservation that would help in better evaluation of semen quality.

MATERIALS AND METHODS

Description of the study site

The study was carried out at Artificial Breeding Research Centre, National Dairy Research Institute, Karnal Hariana - India. The farm is situated at an altitude of 250 m above the mean sea level on 29.42°N latitude and 77.42°E longitude. The climate of the farm is sub-tropical nature. The range of atmospheric temperature varies from near freezing point (0°C) in winter months to about 45°C in summer months. The average annual rainfall is approximately 760 to 960 mm, which is received mostly during months of July to August. Relative humidity varies from as low as 41% to as high as 85%.

Animals and semen collection

Twelve breeding Sahiwal bulls were selected and were grouped into two on the basis of age groups (AGI < 50 months old; AGII > 50 months old) and scrotal circumferences groups (SCI < 33 cm; SCII > 33 cm). Semen samples (180) were collected in the morning hours between 8:00 to 9:00 am using dummy bull. The bulls were thoroughly washed, cleaned and dried at least 15 to 30 min before collection. Two consecutive ejaculates were taken weekly, using Danish Model standard Artificial Vagina (AV) (14 inches). The temperature of AV was maintained at 45°C with sufficient pressure and lubrication. The semen was kept in water bath maintained at 31°C and was evaluated for physical attributes and fertility parameters immediately after collection and the important seminal attributes for all the bulls were recorded.

After the subjective assessment of sperm for progressive motility, the fresh diluted semen samples were subjected to CASA ("Cell track/s", Automated Sperm Analysis, Santa Rosa, Ca., 1994). An aliquot of diluted semen was placed on the clean grease-free slide maintained at 37°C and covered slip. The slide was observed at 20X magnification and phases 1 (P1) combination under Olympus phase contrast microscope attached to CASA system. For post-thaw examination of frozen semen, cryopreservation of semen was performed using the semen samples having mass activity 3.5 and above.

Glycerolization, equilibration time and storage

Tris-citric egg yolk cryodiluter was used for cryopreservation. The diluent was divided into two parts (Parts A and B). Part A was mixed with semen and Part B was mixed with glycerol at the rate of 7% of total diluent. Both the Parts A and B were cooled from 30 to 5°C. When both parts reached 5°C, they were mixed together and 0.25 ml of French straws was used for storage. After packing on average 30 million progressive motile spermatozoa in each dose, the straws were sealed with polyvinyl alcohol powder. The sealed straws were kept in cold handling cabinet at 5°C for 4 h for equilibration to avoid cold shock. After completion of equilibration, the straws were placed horizontally in freezing rack. The rack along with straws was kept in the liquid nitrogen vapour for 10 min for cryopreservation and were transferred to goblets and immersed into liquid nitrogen.

Thawing and examination of frozen semen

Immediately after removing from the liquid nitrogen, the straws were placed in water bath at 37°C for 15 to 30 s. Post-thaw sperm motility was examined using subjective sperm motility assessment and objectively by CASA, at interval of 0 and 24 h after freezing. The normal range for the CASA setup parameters were: VSL > 25.8 Microns/s, VCL > 40.8 Microns/s, LIN > 40.0 Microns/s, ALH > 3.0 Micron and VAP > 40.0 Microns/s. The CSA calibration setup used in this study is given as follows:

CASA calibration setup

Frame rate (Frames/ sec) – 30; Duration of data capture – 15; Minimum motile speed (microns/s) – 28; Maximum burst speed (microns/s) – 600; Distance scale factor (microns/s) - 7.5071; Cent. Cell size minimum (Pixiles) – 6; Cent. Cell size maximum (Pixles) - 13; Number of cell to be find per well - 100; Minimum number of fields per sample – 3.

Table 1. Least square means ± SE of CASA parameters in fresh semen of Sahiwal bulls by age and SC group.

Motion characteristics	Age group		Scrotal circumference group	
	AG I	AG II	SC I	SC II
MOT (%)	77.12 ± 2.85	79.49 ± 2.83	77.12 ± 2.85	82.10 ± 2.10
VSL (µ/s)	29.40 ± 3.68	27.85 ± 3.66	28.31 ± 1.70	28.73 ± 1.54
VCL(µ/s)	107.94 ± 4.92	104.88 ± 4.89	112.26 ± 6.86	110.0 1 ±2.96
LIN (%)	27.78 ± 1.68^{b}	37.04 ± 3.27^{a}	27.76 ± 1.67^{b}	37.04 ± 3.22^{a}
ALH (µ)	6.36 ± 0.37	6.56 ± 0.37	6.34 ± 0.37	6.58 ± 0.35
VAP (µ/s)	60.59 ± 2.80	62.76 ± 2.76	62.91 ± 2.79	60.44 ± 2.68

Within age or SC group row values bearing different superscripts are statistically significant.

A brief description of CASA motion parameters

Percent motility (MOT %)

The number of motile cells divided by the number of cells analyzed, expressed as a percent. Here, for every analysis, a total of 200 cells were analyzed. A cell was considered motile if its average straight-line speed (VSL) met or exceeded the minimum motile speed parameter.

Straight line speed (VSL)

This is defined as the average velocity measured in a straight line from the beginning to the end of the track. It is a measure of the cell's foreword progression and is computed by multiplying the curvilinear velocity (VCL) times the mean linearity (divided by 100). This measure is computed as the average for all motile cells. This has been adapted from the manual method of calculating the speed of a cell or group of cells.

Curvilinear velocity (VCL)

This is computed as the average scalar velocity (or speed) for all motile paths. It is calculated by computing the total distance travelled along each path and dividing by the time interval. The population VCL is computed only for motile cells (these with an average VSL > threshold speed), and is achieved by averaging the mean values from each individual cell.

Mean linearity (LIN)

The distance a cell travels along its normal (or un-smoothed) path is referred to as its gross displacement. The straight-line distance from its straight point to its current X-Y position (as the crow flies) is referred to as net displacement. The ratio of these two measures (time 100) is the linearity measure. It is evaluated at the end of each of the motile paths, and all of the motile path values are averaged to form the single number for the report. A cell that swam in a straight line has a value of 100; a cell that had just completed a circle had an instantaneous value of zero.

Lateral head displacement (ALH)

For each cell, the distance between the actual curvilinear path and the smoothed (or average) path is computed. These values are sometimes referred to as RISERS. This measure computed twice the maximum value of the RISER for each motile path, and then computed as the average value of all of the individual maxima as the single value to include in the report.

Velocity of the average path (VAP)

This is defined as the average velocity over the smoothed cell path. This parameter is used to characterize the overall trajectory of the sperm cell.

Statistical analysis

Data on motility of spermatozoa using subjective judgement as well as objective evaluation of CASA motion parameters were subjected to analysis of variance (ANOVA). All data from the experiment were analysed using the General linear model (GLM) procedure of SAS (SAS Institute, 2000) with the following model:

$$Y_{ijk} = \mu + A_i + S_j + e_{ijk}$$

Where, µ = overall mean, A_i = fixed effect of age groups; S_j = fixed effect of Scrotal circumference groups, e_{ijk} = random error effect.
The average scrotal circumference, 33 cm and the average age, 50 months of the experimental bulls were used to divide the group into two SC groups and two age groups, respectively. Significance was declared at $P \leq 0.05$ and a trend at $0.05 < 0.10$, unless otherwise stated. When a significant F-test was detected, multiple comparisons were done using a Turkey's adjustment for the probability.

RESULTS AND DISCUSSION

CASA motion parameters in frozen semen

The overall mean percent motility of fresh semen from Sahiwal bulls in different ages and scrotal circumferences (SC) was 78.49 ± 17.27% (Table 1). Though there is a trend which indicated higher percent motility in older (79.49 ± 2.83) than younger bulls (77.12 ± 2.85) and in larger SC (82.10 ± 2.10) than smaller SC (77.12 ± 2.85) group the difference was not significant ($p > 0.05$). In contrary, Ulfina et al. (2005) reported significantly higher mass motility for younger than the older age groups for indigenous Ethiopian Horro cattle breed. However,

Table 2. Least square means ± SE of CASA parameters in Frozen-thawed Sahiwal bulls semen in different freezing time and age group.

Parameter	Thawing time interval			
	After freezing at 0 h		After freezing at 24 h	
	AG I	AG II	AG I	AG II
MOT (%)	70.83 ± 3.36	66.70 ± 3.94	76.40 ± 3.07[a]	65.00 ± 3.50[b]
VSL (µ/s)	24.60 ± 3.68	30.41 ± 3.34	25.20 ± 4.36	32.18 ± 2.91
VCL(µ/s)	94.45 ± 5.66	90.72 ± 3.07	94.90 ± 15.31	97.06 ± 2.74
LIN (%)	26.98 ± 6.4[b]	40.64 ± 5.40[a]	28.86 ± 6.38[b]	41.20 ± 4.67[a]
ALH (µ)	5.28 ± 0.47	5.83 ± 0.38	4.94 ± 0.70	6.24 ± 0.33
VAP (µ/s)	58.26 ± 6.00	58.30 ± 3.64	53.22 ± 6.67	54.86 ± 1.75

Within age or SC group row values bearing different superscripts are statistically significant

Keshava (1996) reported significantly lower (65.22%) mean motility than the current study for the same breed of bulls but with high variability within the range of 39.4 for Frieswal to 86.2% in Karan Fries (KF) crossbred dairy bulls. Table 1 depicts the least square means ± SE of VSL, VCL, LIN, ALH and VAP for the two ages and SC groups of Sahiwal bulls. The mean straight-line velocity (VSL) as measured by CASA was 28.54 ± 8.28 µ/s. There was no significant variation in straight-line speed between age and SC groups. The trend shows higher VSL with the advancement of age and larger scrotal circumference. Keshava (1996) also observed similar trends in KF crossbred bulls and slightly higher values for Sahiwal. The higher mean values of curvilinear velocity (µ/s) for younger bulls (AGI, 107.94 ± 4.92 vs AGII, 104.88 ± 4.89) and for smaller SC (SCI, 112.26 ± 6.86 vs SCII, 110.01 ± 2.96) were not different ($p > 0.05$). But the mean linearity between bulls of different age (AGI, 27.78±1.68 vs. AGII, 37.04 ± 3.27) and SC(SCI, 27.76 ± 1.67 vs SCII, 37.04 ± 3.22) groups were significantly different ($p < 0.05$). Linearity of spermatozoa, which was reported (Christensen et al., 2005) to have strong correlation with non-return rate, is one of the main interests of this study. In agreement to this finding, Farrell et al. (1998) reported highly significant correlations (0.99) between bull fertility, 59 day non-return rate to first service, and CASA motility parameters. The slight increase with older age groups and larger SC in amplitude of Lateral Head Displacement (ALH µ) were not significant ($p > 0.05$). The overall mean value of VAP was 61.62 ± 15.07 µ/s. The difference between bulls of different age and SC were not significant. Similarly, Keshava (1996) reported mean value of 62.28 µ/s for the same breed of bulls, but lower mean values in Karan Fries crossbred bulls (50.22 µ/s).

CASA motion parameters in frozen semen

The mean post-thaw motility of Sahiwal bull spermatozoa was 69.62 ± 14.23 and 65.61 ± 11.13 at 0 and 24 h after freezing, respectively. Similar reports were available (Keshava, 1996) for different breeds of cattle. In contrary, Muhammad et al. (2010) reported lower post thaw percentage of Sperm motility of Sahiwal bull epididymal spermatozoa at 0 (50.6 ± 1.5), 2 (33.8 ± 0.9) and 4 (18.1 ± 1.3) h post-thaw, which might be attributed to less matured epididymal spermatozoa in the latter. Raina (1999) also reported lower values (ranging from 43.00 ± 6.25 to 62.57 ± 4.59) than the current results using different freezing rates in buffalo semen. Similar to fresh semen percent motility discussed above, there was no significant difference in post thaw percent motility of spermatozoa either between age or SC groups after 0 h freezing. But after 24 h freezing, the percent post-thaw motility of spermatozoa in younger bulls (AGI, 76.40 ± 3.07) and in larger SC (56.56 ± 3.78) were significantly ($P < 0.01$) higher than in older bulls (AGII, 65.00 ± 3.50) and smaller SC (56.56 ± 3.78) group. This could probably indicate the significance of age in freezability of spermatozoa. However, further study which accommodate more number of bulls with more age variation as well as in longer freezing periods than the current study are warranted.

Least square means ± SE of VSL, VCL, LIN, ALH and AVP for the two age and SC groups are presented in Tables 2 and 3. The overall mean of VSL was 28.75 ± 12.04 at 0 h after freezing and 30.24 ± 10.52 at 24 h after freezing. There was increasing trends as age advances and for larger SC bulls at the two test hours. Similar reports were available for KF crossbred bulls (25.95 ± 0.68 µ/s) (Keshava, 1996) and Murrah buffalo spermatozoa (26.76 ± 1.58 to 33.74 ± 2.10) (Raina, 1999). The mean curvilinear Velocity (VCL µ/s) of post-thaw spermatozoa at 0 h after freezing was higher for younger bulls (AGI, 94.45 ± 5.66 vs AGII, 90.72 ± 3.07) and for smaller SC (SCI, 94.48 ± 6.86 vs SCII, 91.32 ± 2.94). After 24 h freezing it was higher for older bulls (AGI, 94.90 ± 15.31 vs AGII, 97.06 ± 2.74) and for larger SC bulls (SCI, 91.32 ± 2.94 vs SCII, 95.02 ± 2.73). But there was no significant difference $P > 0.05$) after either of the two freezing time. The current results are at par with Raina (1999) who reported a mean VCL ranging

Table 3. Least square means ± SE of CASA parameters in frozen thawed Sahiwal bulls semen in different freezing time and SC group.

Parameter	Thawing time interval			
	After freezing at 0 h		After freezing at 24 h	
	SC I	SC II	SC I	SC II
MOT (%)	66.56 ± 4.04	67.56 ± 3.78	56.56 ± 3.78[b]	65.56 ± 3.78[a]
VSL (µ/s)	30.18 ± 3.13	30.18 ± 3.13	25.20 ± 4.36	31.17 ± 2.91
VCL(µ/s)	94.48 ± 6.86	91.32 ± 2.94	91.32 ± 2.94	95.02 ± 2.73
LIN (%)	28.40 ± 7.65[b]	39.34 ± 5.22[a]	28.86 ± 6.38[b]	40.20 ± 4.65[a]
ALH (µ)	5.22 ± 0.57	5.81 ± 0.36	4.85 ± 0.71	6.24 ± 0.33
VAP (µ/s)	54.72 ± 5.93	59.40 ± 3.56	53.22 ± 6.67	57.86 ± 1.77

Within age or SC group row values bearing different superscripts are statistically significant

from 92.90 ± 8.59 to 126.67± 9.21 for post-thawed buffalo spermatozoa frozen at various freezing rates. Keshava (1996) reported also similar result (87.10 ± 4.08) in KF bulls. The overall mean linearity was 33.74 ± 2.22 percent at 0 h after freezing and 34.82 ± 1.52% after 24 h of freezing in Sahiwal bulls. The higher percent linearity for older age group as well as larger scrotal circumference was significantly different ($P < 0.05$). Similar values within the range of 23.87 ± 2.12 to 34.74 ± 3.31 were reported (Raina, 1999) in linearity of post-thawed buffalo spermatozoa frozen at various freezing rates. Keshava (1996) also reported similar result (34.48 ± 2.48) in KF crossbred bulls. The mean average of ALH (µ) for post-thawed frozen semen were 5.68 ± 0.40 at 0 hr after freezing and 5.88 ± 0.92 at 24 h after freezing in Sahiwal bulls. Higher values than in the current study have been reported (Keshava, 1996; Raina, 1999). The difference in ALH either in age or SC groups of post-thaw frozen semen did not reach statistically significant level ($p > 0.05$). Overall mean of VAP (µ/s) for post-thawed frozen Sahiwal bull spermatozoa were 58.29 ± 13.85 at 0 h after freezing and 56.58 ± 9.26 at 24 h after freezing. The present result is in agreement with Keshava (1996) who reported 52.03 ± 1.93 for KF bulls and Raina (1999) who reported a VAP values ranging from 58.82 ± 3.03 to 73.32 ± 5.12 for Murrah buffalo bulls.

Conclusions

Based on the results, it is concluded that significantly high sperm kinetic characteristics of CASA, especially higher sperm linearity is recorded for bulls with larger SC which may indicate the possibility of including this sperm parameter in routine evaluation of bulls for better judgement of bulls for fertility and also the probability of culling bulls based on testicular size, especially at an early age without spending money, space and time on rearing of such inferior bulls. Moreover, this study also clearly indicated that CASA is a good supplementation to aid genetic selection in breeding bulls. Nonetheless, further study which could encompass different age groups as well as longer freezing periods than the current study is worth to mention.

Conflict of Interests

The author(s) have not declared any conflict of interests.

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Full Length Research Paper

Socio-economic characteristics of poultry production in lowland and midland agro-ecological zones of central Tigray, Ethiopia

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The study was conducted to explore the socio-economic characteristics of poultry production in lowland and midland agro-ecological zones of central Tigray, Northern Ethiopia. Two districts were selected using systematic random sampling method from midland and lowland agro-ecology. Out of the total chicken keepers in the area 160 sample farmers, 80 from each district were selected randomly using lottery method. Data like purpose of chicken production, social and cultural value of chickens, labour division and ownership and use pattern were collected and analyzed using JMP5 (SAS, 2002). The main purpose of chicken rearing in the area was for meat consumption followed by egg production. There was significant difference (P<0.01) in production purpose between the households living in lowland and midland agro-ecology. The proportion of ownership in the family of male and female headed households was significantly different (P<0.05) in both agro-ecologies. In male headed households decisions like home consumption of chickens (65%) was done by the husband. In lowland 91.2% of the respondents and 78.7% in midland agro-ecology gave especial focus to Finding of the Cross day festivity than other festivals to slaughter chickens for sacrifice. Chicken meat consumption was significantly higher (P<0.0001) in lowland than midland agro-ecology. It was also higher in male headed households (P<0.001) than in female headed households but egg consumption was significantly higher (P<0.05) in female headed households than male headed households. Backyard poultry production in Ethiopia plays an important role in the economy, nutritional and socio-cultural values in the livelihoods of the rural households.

Key words: Chickens, ownership, consumption, egg.

INTRODUCTION

Poultry production is an important sector in Ethiopia where chickens and their products are important sources of food and income. Backyard poultry production in Ethiopia represents a significant part of the national economy in general and the rural economy in particular, and contributes 98.5 and 99.2% of the national egg and

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(Farooq et al., 2004) and chicken kept on small farms under extensive management system considerably contributed to the cash income of the rural families in most of the third world countries (Farooq and Mian, 2001). Village poultry in extremely poor areas of the country play important economic, nutritional and socio-cultural roles in the livelihoods of the rural households. There is no exact figure indicating the number of people raising chickens at the household level. However, it is believed that all the estimated agricultural households are engaged in small-scale household poultry production using indigenous chickens in different parts of the country depending on climatic conditions. For instance, 97.82% of the population consists of local breed types under individual farm household management and the remaining 2.18% of birds are mainly in state-run modern production systems, with a very small proportion in private units (Berihun, 2007). Several rural households in Ethiopia keep birds for various purposes like household consumption, sale and reproduction purposes including other social and cultural values (Tadelle and Peter, 2003).

Backyard poultry production contributes significant role to food security, poverty alleviation especially for the poorer members of the community by diversifying agricultural production including increased distribution of resources through involvement of women and ecologically sound management of natural resources. It is also a source of employment for underprivileged groups in many local communities (Mengesha et al., 2008). Moreover, indigenous chickens are known for their merits such as broodiness behavior with high fertility and hatchability, disease resistance thermo tolerant, good egg and meat flavor, hard eggshells, productivity at zero or minimal feed supplementation and high dressing percentage (Abera, 2000) that matches with the poor family poultry production systems.

MATERIALS AND METHODS

Description of the study areas

The study was conducted in central Tigray, Northern Ethiopia. Two sample districts, Adwa from midland and Merebleke from lowland agro-ecologies, were selected using systematic random sampling method. The average elevation of Adwa and Merebleke was 1907 and 1350 m above sea level respectively. The study area receives annual rainfall ranging from 400 to 650 mm with maximum and minimum daily temperature of 27 and 12°C in Adwa and 40 and 18°C in Merebleke.

Sampling and data collection methods

The study area (central zone of Tigray) was stratified into two agro-ecologies as midland and lowland based on their altitude and as customarily used by the local administration and bureau of agriculture. A total of 160 sample farmers, 80 from each district, 40 male and 40 female headed households were selected randomly using lottery method from those households reared at least one chicken in the year.

Data like purpose of chicken production, social and cultural value of chickens, labour division and ownership and use pattern were collected using semi structured questionnaire. In addition four focus group discussions with an average group size of 16 individuals were conducted with key-informants (model farmers, elders, women association leaders, experts from Bureau of Agriculture and Rural Development, administrative bodies, youths and extension workers) in both agro-ecological zones. Tape recorder was used to record the forwarded ideas during the group discussion.

Statistical analysis

Descriptive statistics such as mean, range and percentile were used. Chi- square test was employed for ordinal and nominal data such as chicken and egg consumption, purpose of production and social and cultural value of chickens. Ranking was also used to prioritize the production purpose of the households. All data were analysed using JMP5 (SAS, 2002).

RESULTS AND DISCUSSION

Purpose of poultry production

In the rural areas of central Tigray, farmers reared chickens for different purposes (Table 1). For example, about 50 and 40% of the male and female headed households in lowland areas reared chickens for home consumption, about 22.5 and 35% of them reared for egg production, 17.5 and 7.5% of the male and female respondents cited parent stock replacement as their priority, and only 5 and 10% of the male and female headed households used chicks to generate additional income source, respectively. There was significant difference ($P<0.01$) in production purpose of the households living in lowland and midland agroecology. The large numbers of respondents in lowland agroecology who used chickens for home consumption is in sharp contrast with the report of Sonaiya and Swan (2004) who revealed that poultry consumption by the household was rare, as most birds are sold for income generation. About 55 and 72.5% of the male and female headed farmers respectively, in the midland reared chickens for egg production, about 22.5 and 10% of the male and female respondents keep birds for home consumption, and 12.5 and 10% of the male and female headed households reared chickens for sale as additional income source. About 57.5%, of the male headed households and 42.5% of the female headed households in lowlands and 50 and 37.5% of the male and female headed households in midland used the eggs for hatching whereas 47.5 and 60% of the male and female headed households in midland agroecology used the eggs for sale. This indicates that poultry production in midland areas used as important source of income mainly for female headed households. In line with this Aklilu et al. (2007) reported that farmers attach greater

Table 1. Production purpose of chickens and eggs in male and female headed households in the lowland and midland agroecological zones of central Tigray.

Production purpose	Lowland (n=80)						Midland (n=80)					
	MHH (%)			FHH (%)			MHH (%)			FHH (%)		
Rank	**1st**	**2nd**	**3rd**	**1st**	**2nd**	**3rd**	**1st**	**2nd**	**3rd**	**1st**	**2nd**	**3rd**
Chicken production purpose												
For sale	5	7.5	17.5	10	12.5	7.5	12.5	30	15	10	37.5	22.5
For egg production	22.5	17.5	37.5	35	22.5	15	55	37.5	7.5	72..5	2.5	5
Home consumption	50	32.5	17.5	40	22.5	25	22.5	10	42.5	10	12.5	40
For replacement	17.5	25	15	7.5	22.5	40	10	20	17.5	7.5	12.5	30
For ceremonies	-	10	7.5	7.5	7.5	-	-	2.5	7.5	-	10	-
For entertain guest	5	7.5	5	-	12.5	12.5	-	-	10	-	5	2.5
Total	100	100	100	100	100	100	100	100	100	100	100	100
Egg production purpose												
For sale	10	12.5	77.5	20	30	50	47.5	25	27.5	60	22.5	17.5
For consumption	32.5	55	12.5	37.5	32.5	30	2.5	45	52.5	2.5	25	72.5
For hatching	57.5	32.5	10	42.5	37.5	20	50	30	20	37.5	52.5	10
Total	100	100	100	100	100	100	100	100	100	100	100	100

n, Number of respondents; MHH, male headed households, FHH, female headed households.

importance for generating cash income from eggs and birds. Similarly, Mekonnen (2007) in Southern Ethiopia reported that about 76.3% of the off take from the flock was attributed to sales indicating the fact that the primary purpose rearing of chicken is for sale. In addition Fisseha et al. (2010) reported that the purpose of rearing village chicken was sale as source of cash income accounted for 51%, egg hatching for breeding/replacement stock (45%), home consumption (44%), use of chicken for cultural and/or religious ceremonies (36.4%) and egg production (40.7%). Halima et al. (2007) also reported that in the rural areas of north-west Ethiopia, chickens are kept and used as a source of income in addition to providing eggs and meat for home consumption.

In lowland agroecology however, the use of chickens for home consumption and the use of eggs for hatching were the primary purposes of rearing chickens (Table 1). Similarly Tadelle et al. (2003) reported that in the Tepi region of southern Ethiopia eggs produced were used for hatching, home consumption and sale while chicks produced were used for sale, replacement and consumption respectively, in decreasing order of importance. Such prioritization may contribute to improving the nutritional status of the poor households mainly in lowland area. On the other hand chicken and egg sale for income source was considered as third priority in this area. This might be attributed to the poor access of urban market and other market outlets to poultry producers found in lowland areas. Long distance and remoteness of the area by itself might have an impact on shaping the attitude of the farmers towards the importance of poultry and poultry products.

Poultry consumption

Chicken meat consumption

There were no any cultural/religious taboos against consumption of chicken meat and egg in the study area. One of the most important reasons for engaging in poultry production was chicken and egg consumption. For example about 45% of the households in lowland and 16.25% in midland kept poultry for the purpose of home consumption (Table 1). According to the interviewed households on the study area chicken meat and egg consumption was high in the time of cultural and religious festivals like New Year, Finding of the Cross (*Meskel*), Ethiopian Easter and St. Mary's day. Average consumption of chicken per household per year in lowland agroecology was 5.4 and 4.4 chickens in male and female headed households while in midland agroecology 3.9 and 2.9 chickens in male and female headed households respectively. This result is lower than the value 5.9, annual consumption of chickens per household in Southern Ethiopia (Mekonnen, 2007). Chicken meat consumption was significantly higher ($P<0.0001$) in lowland than in midland agro-ecology (Table 2). This might be related to market access in the area. Farmers live in very far distance from urban markets may give more attention to consumption and replacement purpose than for sale. Chicken consumption in male headed households was also significantly higher ($P<0.001$) than in female headed households. This also might be due to the difference in wealth status of the households. Usually due to the difference in land holding

Table 2. Chicken and egg consumption of the male and female headed households in lowland and midland agroecological zones of central Tigray.

Variable	Lowland		Midland		X^2 value	P value
	MHH (%) (n=40)	FHH (%) (n=40)	MHH (%) (n=40)	FHH (%) (n=40)		
Consumption preference for chicken breeds in %						
Chicken breeds						
Local breed	95	90	85	82.5		
Cross breed	5	10	10	15	7.00	0.3201
Exotic breed	-	-	5	2.5		
Different breed eggs						
Local breed egg	52.5	42.5	42.5	55		
Cross breed egg	35	37.5	42.5	37.5	3.83	0.6991
Exotic breed egg	12.5	20	15	7.5		
Number of chicken and eggs consumed/year						
Annual chicken consumption	5.4	4.4	3.9	2.9	57.14	<0.0001
Annual egg consumption	39.4	44.9	33.6	35.8	23.95	<0.0001

capacity, livestock ownership, labor and other cultural influences, male headed households were wealthier than female headed households. This is in line with the report of Aklilu et al. (2007) who stated that, in female headed households chicken consumption per household were lower than in male headed households. Even in the male headed households priority was given to men in consumption of chicken meat than any other members of the family. No wife had slaughtered chicken in the absence of her husband. According to the interviewed households 1st, 2nd and 3rd priority was given to husband, male youth and children respectively in chicken meat consumption in both agroecologies. The meaning of priority was expressed by the farmers in terms of quality and amount of meat given to a specific person. Such prioritization had its own cultural bases for which every household heads mainly the women know which part of the poultry meat will given to husband, wife and children. For example the limb parts like femur and tibia locally called "*hatsaro and newoho*", the keel (breast parts) locally called "*feresegna*" and the gizzard were for husband while the skin, the humerus part locally called "*melhach*" were for wife and the rest carcass parts like the skull, neck, wings, thorax parts, and the tail bones were for children. Similar with this Aklilu et al. (2007) reported that, the meatiest and nutritious parts of the carcass were for men, like for example the gizzard, drumsticks, and breast bones, but the lower-quality parts like the neck, wings and skin were meant for women and children. Mengesha et al. (2008) also reported that around 75% of the respondents from Debreguracha were giving priority for adults in consuming of poultry products among the family members. But in contrast with this Bogale (2008) reported that, priority in consuming poultry products in Fogera woreda was given based on the rank: Children (1st), pregnant women (2nd), women involved in breast feeding (3rd), adults (4th) and elderly people (5th). About 95 and 90% of the male and female headed households in lowland and 85 and 82.5% of the male and female headed households in midland agroecology preferred local breed chickens for consumption whereas 5 and 10% of the male and female headed households in lowland and 10 and 15% of the male and female households in midland preferred cross breed chickens. The rest 5 and 2.5% of the male and female headed households in midland agroecology preferred exotic breed chickens for consumption. The reasons of those households who preferred local chickens were tastiness, flavor and aroma of the meat. On the other hand big size of meat was the main criteria for those farmers preferred exotic and cross breed chickens. In line with this Aklilu et al. (2007) reported that free-ranging and local birds in Southern zone of Tigray are taken to have tastier meat than confined and exotic breeds.

Egg consumption

Annual average egg consumption of the households in lowland agroecological zones of the study area was 39.4 and 44.4 eggs in male and female headed households respectively and in midland agroecology 33.6 and 35.8 eggs in male and female headed households respectively. Egg consumption in lowland was higher ($P<0.0001$) than in midland agro-ecology and there was higher egg consumption ($P<0.05$) in female headed households than male headed households mainly in lowland agro-ecology. This could be attributed to income source of the households. Mostly female headed households had not diversified income sources and do

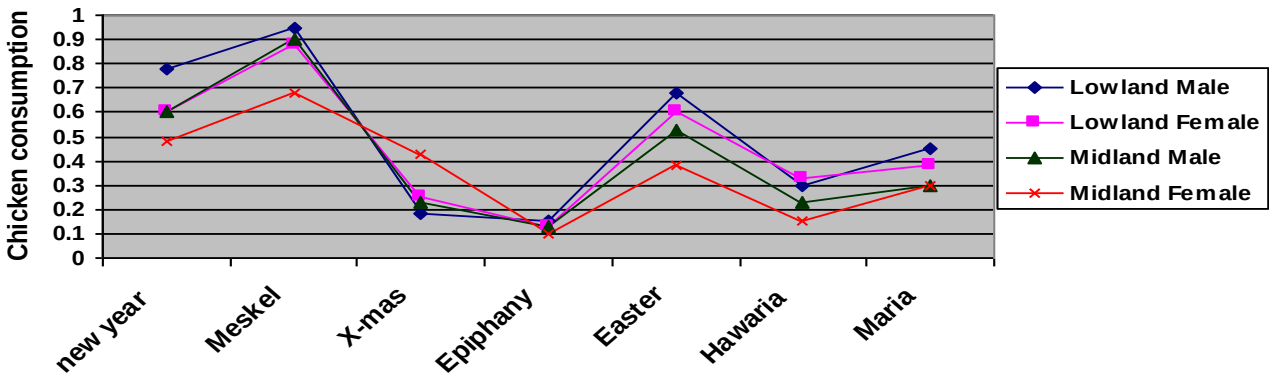

Figure 1. Chicken consumption of the households in different festivals in the year 2010/2011.

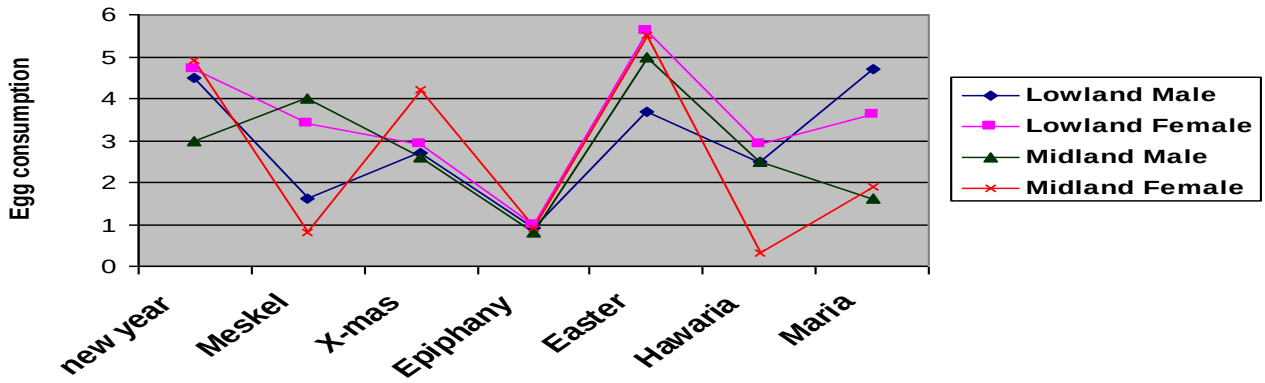

Figure 2. Egg consumption of the households in different festivals in the year 2010/2011.

not have the capacity to purchase chicken and other large animals for consumption. Therefore the most affordable protein source to female headed households could be chicken egg. Regarding to egg consumption preference 52.5 and 42.5% of the male and female headed households in lowland 42.5 and 55% of the male and female headed households in midland preferred local breed eggs, 35 and 37.5% of the male and female headed households in lowland and 42.5 and 37.5% of the male and female headed households in midland preferred cross breed eggs the remaining households in both agroecology preferred exotic type of egg for consumption respectively (Table 2). Similar to chicken meat consumption 1st, 2nd and 3rd priority of egg consumption was given to husband, male youth and children, respectively in male headed households.

In female headed households, however, women, male youth and children have got the first, second and third priority for egg consumption in both agro-ecological zones. Chicken and egg consumption of the households in different cultural and religious festivals throughout the year is shown in Figures 1 and 2.

Chicken consumption is highest in the Finding of True Cross (*Meskel)* followed by New Year and Easter religious festivals. Chicken consumption during religious festivals is high in male headed households in both agroecologies. According to Figure 1, chicken consumption is high in lowland agroecology during religious festivals. Figure 2 illustrated that egg consumption is highest during Easter, New Year, X-mas and *Meskel* in descending order.

Labour division and chicken ownership

Labor division among the family members with in the households is displayed in Table 3. Except for the construction of chicken house and treatment of sick chickens women took the major share in management activities related to poultry production. In female headed households, even construction of house for chickens was done by women (52.4 and 51.9%) and some of them paid for laborer to construct chicken house (14.3 and 18.5%) but the rest share was covered by eldest male youth (33.3% and 29.6%) in lowland and midland agroecoloogical zones, respectively. In men headed households, however, chicken house was constructed by the husband both in lowland and midland agro-ecology

Table 3. Labor division and ownership of male and female headed household members in lowland and midland agroecological zones of central Tigray.

Activities	Family members	Lowland		Midland		X^2 value	P value
		M HH (%) (n=40)	FHH (%) (n=40)	MHH (%) (n=40)	FHH (%) (n=40)		
Chicken house construction	Men	100	0	100	0	144.97	<0.0001
	Women	0	52.4	0	51.9		
	Laborer	0	14.3	0	18.5		
	Children	0	33.3	0	29.6		
	All family	0	0	0	0		
Cleaning of chicken house or overnight shelter	Men	0	0	0	0	2.42	0.4895
	Women	82.5	80	70	82.5		
	Children	17.5	20	30	17.5		
	All family	0	0	0	0		
Provision of supplementary feed	Men	20	0	25	0	40.08	<0.0001
	Women	67.5	77.7	65	77.5		
	Children	-	15	7.5	17.5		
	All family	12.5	7.5	2.5	5		
Provision of water	Men	2.5	0	2.5	0	17.97	0.0355
	Women	40	55	42.5	57.5		
	Children	57.5	45	42.5	42.5		
	All family	0	0	12.5	0		
Selling of chickens	Men	27.5	0	10	0	53.92	<0.0001
	Women	45	75	62.5	70		
	Children	2.5	17.5	12.5	30		
	All family	25	7.5	15	0		
Selling of eggs	Men	12.5	0	12.5	0	33.95	<0.0001
	Women	60	65	57.5	57.5		
	Children	5	25	5	32.5		
	All family	22.5	10	25	10		
Treatment of sick chickens	Men	62.5	0	80	0	122.34	<0.0001
	Women	37.5	87.5	20	82.5		
	Children	0	12.5	0	17.5		
	All family	0	0	0	0		
Ownership	Men	17.5	0	15	0	25.24	0.0003
	Women	32.5	77.5	25	70		
	Men and women	42.5	0	47.5	0		
	Children	7.5	22.5	12.5	30		

(100%). In line with this report Mekonne (2007) reported that, except in chicken house construction, which is left for men (53.1%) and male youth (9.4%), women take the lion share in accomplishing other perspectives of poultry management activities including cleaning house (74.4%), provision of supplementary feed (65%), and providing water (73.8%). Similarly, Tesfu (2006) in Dere Dawa reported that, women were responsible to perform most of the activities in chicken rearing while men's dominate in the preparation of night resting place. Okitoi et al. (2007) from Western Kenya also reported that, men and children mainly did construction of poultry sheds while women and children did most of the daily routines in rural poultry management. The study of Mapiye and Sibada (2005) in the Rushinga District of Zimbabwe also revealed that women were responsible for feeding (37.7%), watering (51.2%), and cleaning (37.2%).

According to the key informants in the group discussion, though, there has been a work division among family members in poultry production, mostly male headed households considered poultry production as secondary and part time work and because of its nature of production system, practiced at home it was believed as the major activity of women and children. This traditional supposition might be the main reason for the over load work of poultry management practices on

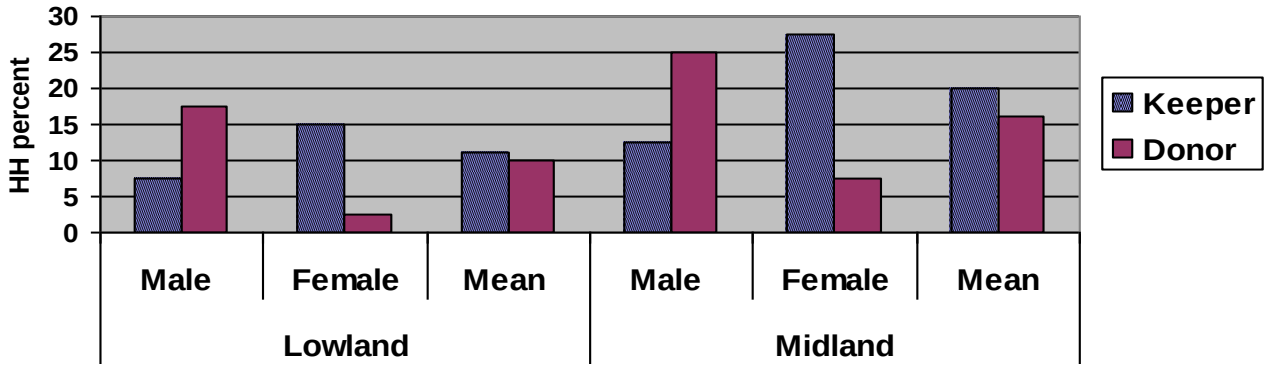

Figure 3. Shared ownership chickens among keeper and donor households in lowland and midland agroecology.

women and could be an obstacle for the development effort of the government on poultry production.

Regardless of the workload, out of the total male headed household's ownership of women on poultry products was only 32.5% in lowland and 25% in midland agroecology while the largest portion was covered by common ownership among the husband and the wife (42.5 and 47.5%) of the households in lowland and midland agroecology, respectively (Table 3). The proportion of ownership in the family of male and female headed households was significantly different ($P<0.05$) both in lowland and midland agroecologies. This is more or less similar with the report of Bogale (2008) in Fogera woreda, most of the chickens (50.77%) were owned by fathers, mothers and the whole family (23.88%). Similarly Alemu et al. (2008) reported that ownership of village chickens is shared among the different gender categories in the farm household of African countries. According to Yisehak (2008), women in Ethiopia own a small proportion of chickens. But except for the female headed households, this disagreed with the reported more than 70% of chicken owners in rural Sub-Saharan Africa were women (Gueye, 1998) and birds were owned mostly by women and children (Goromela et al., 2006).

In female headed households, however, ownership of chickens was dominated by women (77.5 and 70%) while ownership of children accounted for 22.5 and 30% of the respondents in lowland and midland agroecology, respectively (Table 3). The value of shared ownership within the family is lower than the reported 57% by Mengesha et al. (2008) in South Wollo. Ownership refers to the possession of chickens by individuals or group members of the family. Although village chickens move freely about the whole village, they are all attached to a specific household (Kitalyi, 1997).

On the other hand chickens were owned in share with other households on the bases of inter agreement between the two households in the village. According to the respondents, 11.25% of the households in lowland and 20% in midland agro-ecology reared chickens for share with other households (Figure 3).

The study also revealed that, about 10% of the households in lowland and 16.25% in midland agro-ecology gave chickens to other farmers for share to be kept and reared there. In the process of share ownership male headed households were more involved in donating while female headed households were more involved in receiving (keeping) the chicken.

This finding is in line with the report of Aklilu et al. (2007) poor households use sharing arrangements to acquire the benefits of keeping poultry in Northern Ethiopia. More often, the female-headed households were sharers whereas the male-headed households were owners. In addition Bogale, (2008) reported that, most of the household members (55.6%) in Fogera woreda own the chickens themselves while a significant proportion of surveyed households (36.1%) also shared with other households.

The main reason for the donor (owner) households for sharing chickens was to prevent crops and vegetables from damage by chickens particularly during sowing and flowering time whereas the reason for the recipient (keeper) households was to acquire starter flock and get additional income at the same time. Decision making regarding to input and output of poultry production was usually depend on the extent of ownership of the individual or group members of the household.

The result of the study revealed that, in male headed households decisions like home consumption of chickens (65%), purchase of feed and drug (80%) and purchase of foundation flock (71.25%) was the domain of men while selling of eggs (50%) and chickens (68.75%) was done by the common decision of husband and wife whereas in female headed households almost all decisions were under the control of women in both agro-ecology (Table 4). Children specially the students took their decision role in selling of eggs (16.9%) and chickens (12.5%) to use the money for purchase of stationery materials. This report was somewhat in different with the report of Muchadeyi et al. (2004) who stated that, Women, even in those households headed by men, were responsible for most of the decision-making on chicken production.

Table 4. Decision making of the household members in lowland and midland agro-ecology.

Activities	Family members	Lowland (80)		Midland (80)		X^2 value	P value
		MHH (%)	FHH (%)	MHH (%)	FHH (%)		
Selling eggs	Men	27.5	0	17.5	0	118.42	<0.0001
	Women	20	80	17.5	70		
	Children	7.5	20	10	30		
	Men and women	45	0	55	0		
Selling chickens	Men	22.5	0	12.5	0	156.95	<0.0001
	Women	10	82.5	7.5	77.5		
	Children	5	17.5	5	22.5		
	Men and women	62.5	0	75	0		
Home consumption of eggs	Men	40	0	12.5	0	85.53	<0.0001
	Women	35	77.5	57.5	70		
	Children	0	22.5	5	30		
	Men and women	25	0	25	0		
Consumption of chickens	Men	62.5	0	67.5	0	149.02	<0.0001
	Women	15	100	17.5	97.5		
	Children	0	0	15	2.5		
	Men and women	22.5	0	0	0		
Purchase of feed and drugs	Men	77.5	0	82.5	0	222.12	<0.0001
	Women	0	100	0	100		
	Children	0	0	0	0		
	Men and women	22.5	0	17.5	0		
Purchase of foundation flock	Men	70	0	72.5	0	221.87	<0.0001
	Women	0	100	0	100		
	Children	0	0	0	0		
	Men and women	30	0	27.5	0		

Table 5. Male and female headed households in lowland and midland agroecology slaughtered chickens in different holidays.

Holy days	Lowland		Midland		X^2 value	P value
	MHH (%) (n=40)	FHH (%) (n=40)	MHH (%) (n=40)	FHH (%) (n=40)		
New Year	77.5	60	60	47.5	7.95	0.0470
Meskel	95	87.5	90	67.5	12.79	0.0051
X-mass	17.5	25	22.5	47.5	6.96	0.0733
Epiphany	15	12.5	12.5	10	0.46	0.9276
Easter	67.5	60	52.5	37.5	8.02	0.0457
Appostle day	30	32.5	22.5	15	4.16	0.2445
St. Mary day	45	37.5	30	30	2.68	0.4438

Social and cultural value of poultry

In addition to their use as income source, mainly for the poor households to cover some house and school expenses, poultry had also social and cultural values. According to the key informants in the discussion, social relationship in the area was more expressed by chickens in the form of gift to relatives and newly established households, preparing especial dish (*Doro wot*) for the prestige of bride and bride groom at the time of wedding and in the form of entertaining special guests like son in-law, father in-law, father figure, soul father (priest), brother, uncle and other relatives. For instance about 2.5, 10 and 8.7% of the total households in lowland agro-ecology kept chickens as 1st, 2nd and 3rd purpose respectively for entertaining respected guests. In line with

this Bogale (2008) revealed that about 33% of the households in Fogera woreda engaged on poultry production for purpose of social functions. Similarly, Aklilu et al. (2007) reported that poultry are used for strengthening marriage partnership in Tigray. Different reports also showed that, farmers in rural area invite special guests to partake of the popular dish "*doro wat*", which contains both chicken meat and eggs (Sonaiya, 1990; Sonaiya, 2000; Solomon, 2008). Sacrifice during the time of religious and cultural festivals was also among the major importance of chickens in the area. The study revealed that no farmer pass the holy days without slaughtering a chicken at least once per year (Table 5). About 91.2% of the respondents in lowland and 78.7% in midland agroecology gave especial focus to finding of the Cross (*Meskel*) day festivity than other festivals to slaughter chickens for sacrifice followed by New Year (68.7 and 53.7%) and Easter (63.7 and 45%) of the respondents in lowland and midland agroecology, respectively. The higher chicken price at the time of religious festivals also indicated the extent of festivity how much chickens are used for sacrifice at individual household level.

According to the key informants in the group discussion chickens were also used for spiritual activities to cure a sick person by using a pure white or sometimes deep black feathered bird kneaded or gyrated over the body of the sick person and eventually believed that, the evil spirit will diverted to the bird and the sick person will cure. Most of the time people did not bought pure white or deep black feathered birds at market for consumption in order to not expose themselves to evil spirit. Farmers mainly the women bought such birds with high price from neighbors or known chicken producers when they want to use them for spiritual purposes. Though most of the farmers were not willing to tell the fact about the mystical use of chickens, 40 and 13.3% of the interviewed female headed households in lowland and midland agro-ecology, respectively, admitted that they used such ritual practice in their life to cure sick person. And they revealed that such practice was more attached with females than any other members of the family. Such believe was higher ($P<0.05$) in people living in lowland than people living in midland areas. Distance from urban areas, less access to media and absence of health institution like hospitals may contribute to the dependency on such spiritual believes in the area. This finding is in line with the report of Aklilu et al. (2007) who stated that poultry (mainly local) have mystical uses and farmers in the remote areas of Southern Tigray attached more importance to such functions. In general village poultry in extremely poor areas of the country play important economic, nutritional and socio-cultural roles in the livelihoods of the rural households (Solomon, 2008).

Conclusion

Production purpose of the households in the area varied with agro-ecology. Social relationship in the area was more expressed by chickens in the form of gift to relatives and newly established households, preparing especial dish for the prestige of bride and bride groom and in the form of entertaining special guests. No any cultural/religious taboo against consumption of chicken meat and egg in the study area but individual chicken meat consumption is influenced by culture. Chicken meat and egg consumption was high in the time of cultural and religious festivals. In spite of their work load women were not took the leading share of ownership and decision making in poultry production but the common ownership of the husband and the wife could be considered as affirmative action.

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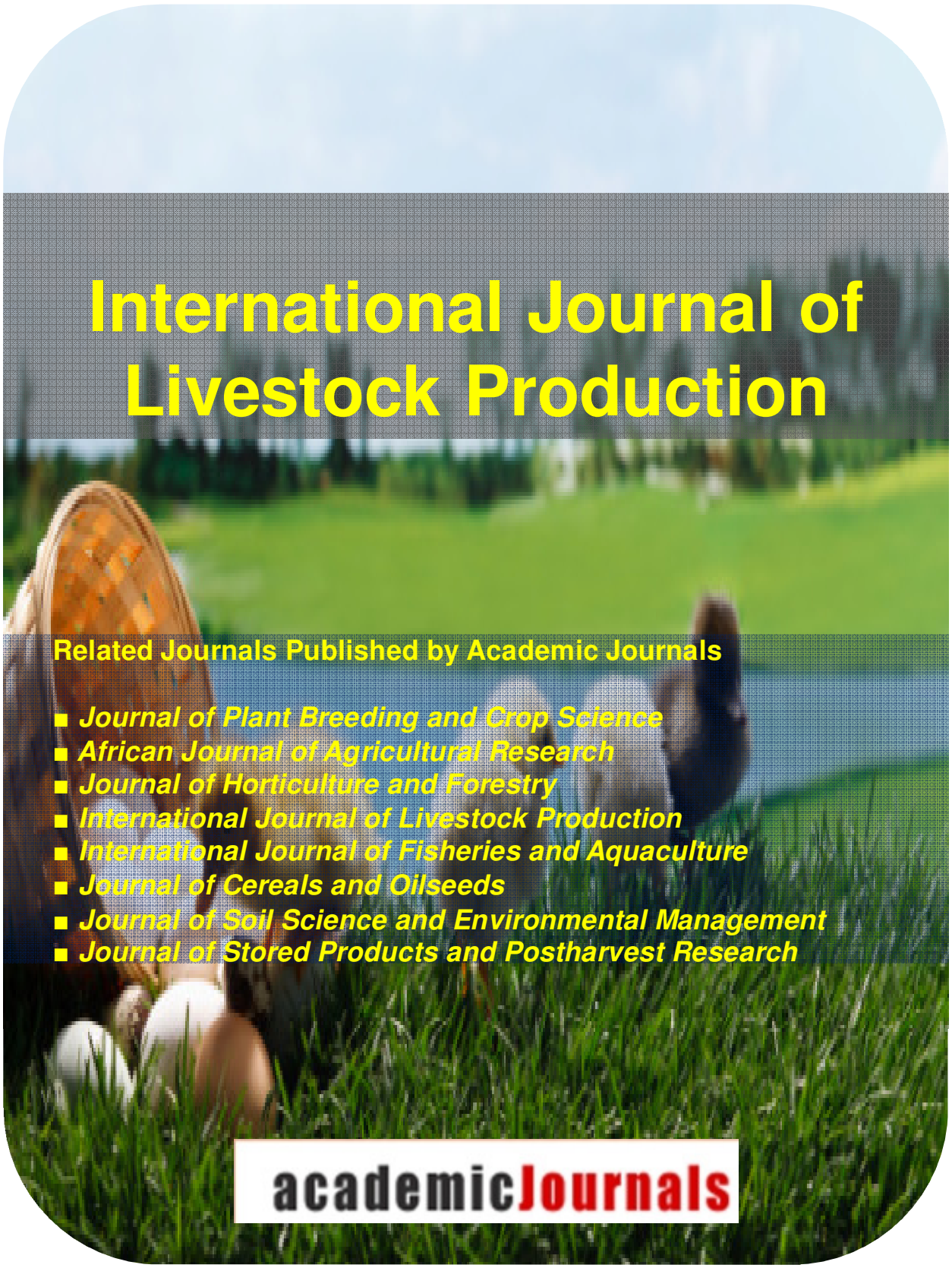

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