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*Full Length Research Paper*

# Production Objectives and Selection Criteria of Indigenous Sheep Types in East Gojjam Zone, North Western Ethiopia: Implication for Designing Community Based Breeding Strategies

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***Abstract***
*This study was aimed to generate basic information on production objectives and selection criteria of indigenous sheep types under farmer's management condition in East Gojjam zone. Multistage purposive sampling was employed based on the potential of sheep production. Accordingly three districts were considered purposively. About 270 households (90 from each district) were used for household survey. Statistical Package for Social Sciences (SPSS 16.0 2007) was used to analyze the data. The main objectives of keeping sheep were for income generation followed by meat consumption across the districts compared. Appearance, mothering ability, twining ability and lambing interval were most important traits considered by farmers in Gozamen and Sinan to select their ewes. Appearance, progeny performance, mothering ability and coat color were most preferred traits according to their importance to select ewe in Hulet eju district. In the districts farmers give due attention to appearance to select their breeding ram.*

***Keywords***: *Production objectives, Selection criteria, East Gojjam zone*

## Introduction

Small ruminants (sheep and goats) have a unique niche in smallholder agriculture from the fact that they require small investments; have shorter production cycles, faster growth rates and greater environmental adaptability as compared to large ruminants (Helen et al, 2013) . They are important protein sources in the diets of the poor and help to provide extra income and support survival for many farmers in the tropics and sub-tropics (Notter, 2012).The livestock sector in Ethiopia play significant role in the national economy. It contributes 15-17% and 35-49% of the total and agricultural Gross Domestic Product (GDP), respectively and provides livelihood for 37-87% of the population (CSA, 2016). The sector also accounts for 12–15% of total export earnings, the second in order of importance. Hides, skins and leather products made up 7.5% of the total export value whereas live animals accounted for 3.4%. However, in recent years official export has been declining while illegal export has been increasing (CSA, 2016).

Ethiopia's sheep population, estimated to be 28.89 million heads, is found widely distributed across the diverse agro-ecological zones of the country (CSA, 2016). In order to make best use from sheep keeping operation, it is important and a prerequisite to have a comprehensive understanding of the whole situation through assessing the production environment (climate, feed availability, and disease prevalence); the production system (production practice, preferences, socio-economic circumstances and level of input use); and productive and adaptive characteristics of the sheep breeds (Sisay, 2010). East Gojjam zone, where this study has been done, possess most diversified sheep populations. But further information is scanty to show the sheep production objectives and selection criteria, found in East Gojjam zone. Thus, the objective of this study was to describe the sheep production objective and selection criteria in the study area.

## Materials and Method

### *Description of the Study Area*

The study was conducted in East Gojjam zone. It is 298 km from Addis Ababa and 265 km from the capital city Bahir Dar. The three districts (Gozamen, Hulet eju and Sinan) of East Gojjam zone were selected based on the potential of sheep distribution in their production environment. Gozamen is situated at an altitude of 2498 *masl,* longitude 37 $^{o}$ 43$^{'}$ 47.2$^{''}$ E and latitude 10 $^{o}$ 20' 19.7'' N. Agro ecologically the district is traditionally divided into four climatic zones; 41.41% *Woinadega*, 35.55% *Dega*, 15.72% *Kolla* and 5.32% *Wurich* (RDOEGZ, 2016). The mean annual average temperature and rain ranges 7.5-25 $^{o}$C and 900-1800 mm, respectively.

Hulet eju is located at 196 km distance from Debre Markos, the capital of east Gojam Zone and 320 km from Addis Ababa. The altitude of the district ranges from below 2433 to 2468 *masl* and it is located between $11^{O}$ 04' 48.4'' N and $37^{O}$ 52' 45.8'' E. The district has annual temperature of 7.5 – 22.5 °C. The amount of rainfall generally varies with altitude but the average ranges between 900 to 1500 mm (RDOEGZ, 2016). Sinan district is found 27 km from Debre Markos, the capital of East Gojjam Zone. The altitude of the district ranges from 2949 to 2975 *masl* and it is located between $10^{O}$ 32' 28.2'' N and 37 $^{O}$ 46'14.7'' E. The mean annual rain fall distribution of the area is 1342 mm and the mean annual temperature of the district ranges from 7.2 °C -27.7 °C.

**Data Collection**

***Sampling method***

The sampling method employed for this study was multistage purposive sampling technique, which was based on the potential of sheep production in the zone. East Gojjam Zone has 18 districts from which three districts (Gozamen, Hulet eju and Sinan) were selected purposively based on distribution of Sheep population. From each districts, three Peasant Associations (total of 9 Peasant Association) were selected based on the sheep population potential. 30 household per Peasant Association (total of 270 households) were selected through systematic random sampling for the interview from within the selected Peasant Associations having similar production system.

A rapid reconnaissance survey was made prior to the actual survey work to locate the distribution of sheep and their production system. Nomination of respondents was made together with the local Ministry of Agriculture and Rural Development staffs and PA (Peasant Association) administrators. Discussions were held with zonal and district agricultural experts and development agents about the distribution of East Gojjam sheep types. They were also participated in the identification of sampling units and data collection activities. This allowed in identifying the major potential area of East Gojjam sheep types in the study area. Finally, the distribution of East Gojjam sheep population potential were used to select sample districts and Peasant Associations (PA) for administration of semi structured questionnaires. The actual survey included single visit to a sampling site during which qualitative and quantitative data were made from selected respondents.

**Table 1.** Summary of the sampling procedure

| District | Peasant association | Sampled household for the survey | Number of group discussions held |
|---|---|---|---|
| **Gozamen** | Wenka | 30 | 1 |
| | Enarata | 30 | 1 |
| | Yenebirna | 30 | 1 |
| **Sinan** | Yeted | 30 | 1 |
| | Gedamawit | 30 | 1 |
| | Sinanmariam | 30 | 1 |
| **Hulet eju** | Ayenbrian | 30 | 1 |
| | Bezabizuan | 30 | 1 |
| | Ebreselam | 30 | 1 |

***Data Analysis***

Statistical Analysis System (SAS 9.2., version, 2008) was used to analyze the data. Chi-square ($\chi^2$) and Tukey-kramer test were carried out as they are appropriate to assess the statistical significance among categorical and numerical variables, respectively. An index was calculated to provide overall ranking for qualitative data such as purpose of keeping sheep, selection criteria of females and males according to the following formula: Index = Σ of [3 for rank 1 + 2 for rank 2 + 1 for rank 3] given for particular qualitative variables divided by Σ of [3 for rank 1 + 2 for rank 2 + 1 for rank 3] for all qualitative variables considered.

The rate of inbreeding from effective population size for a randomly mated population was calculated as $Ne = (4N_mXN_f)/N_m+N_f)$; where Ne = effective population size, $N_m$ = number of breeding males and $N_f$ = number of breeding females. The rate of inbreeding coefficient (ΔF) was calculated from Ne as $\Delta F = ½XNe$ (Falconer and Mackay, 1996).

**Results and Discussions**

***Purpose of Sheep Production***

As reported by the respondents sheep was primarily kept by the farmers for income followed by meat for household consumption across all the districts studied (Table 2). Sheep was also produced for saving as live bank in both Sinan and Hulet eju districts. This study also demonstrated that some respondents prefer sheep production for skin production and manure across the three districts. Similar result was also reported by Bosenu (2012) for sheep around Selale area. According to Helen et al (2013), Milk production was the primary objective in agro-pastoral (0.40) and pastoral (0.36) production systems followed by income generation (0.35 and 0.28, respectively). In the mixed crop-livestock system, income generation (0.52) was the primary objective followed by meat production

(0.18) and wealth accumulation (0.13). Similarly, the main purpose of sheep production in north wollo is to drive income (Tassaw et al., 2014)

**Table 2.** Purpose of sheep production in the study area

| Descriptors | District | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Gozamen | | | | Sinan | | | | Hulet eju | | | |
| | 1st | 2nd | 3rd | index | 1st | 2nd | 3rd | index | 1st | 2nd | 3rd | index |
| **Income** | 88 | 2 | 5 | 0.51 | 69 | 19 | 2 | 0.46 | 45 | 40 | 5 | 0.41 |
| **Consumption(meat)** | 2 | 58 | 6 | 0.24 | 13 | 51 | 19 | 0.30 | 40 | 29 | 13 | 0.35 |
| **Manure** | 0 | 0 | 33 | 0.06 | 0 | 9 | 20 | 0.07 | 1 | 2 | 19 | 0.05 |
| **Skin** | | 30 | 35 | 0.18 | 0 | 3 | 23 | 0.05 | 2 | 1 | 22 | 0.06 |
| **Saving** | 0 | 0 | 5 | 0.00 | 5 | 7 | 24 | 0.10 | 2 | 18 | 16 | 0.11 |
| **Prestige** | 0 | 0 | 6 | 0.01 | 3 | 1 | 2 | 0.02 | 0 | 0 | 15 | 0.02 |

*Index = Σ of [3 for rank 1 + 2 for rank 2 + 1 for rank 3] given for particular qualitative variables divided by Σ of [3 for rank 1 + 2 for rank 2 + 1 for rank 3] for all qualitative variable considered, R1, R2 and R3= Rank1, Rank 2 and Rank 3.*

**Selection Criteria and trait preference**

***Selection of ewes***

According to the respondents, about 87(96.67%) of the farmers in Gozamen select their ewes and 3(3.33%) did not select ewes to be parents of the next generation. In similarly, 88(97.78%) and 83(92.22%) farmers in Sinan and Hulet eju district did select their ewes to be parents of next generation but 2(2.22%) and 7(7.78%) farmers did not select their ewes, respectively which might be due to lack of knowledge about selection of best performing animal to be the parents of the next generation.

The best selection criteria in the study area was the appearance of the animal with (index=0.22, 0.29 and 0.27) for Gozamen, Sinan and Hulet eju districts, respectively. This implies that farmers are highly interested in the appearance to select their breeding ewes. Mothering ability in Gozamen with (index=0.20 and in Sinan with index=0.16 and performance of the progeny in Hulet eju with index=0.17) were the second preferred traits. Also it can be observed that twining ability in Gozamen (index=0.17), Sinan (index=0.15) and mothering ability in Hulet eju (index=0.16) were important preferred traits. According to Wossnie (2012) across all the study districts, appearance, tail type and color were the most important traits for the farmers in East Hararghe zone.

**Table 3.** Selection criteria for ewes

| Selection criteria | District | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Gozamen | | | | Sinan | | | | Hulet eju | | | |
| | R1 | R2 | R3 | index | R1 | R2 | R3 | Index | R1 | R2 | R3 | index |
| **Appearance** | 21 | 19 | 12 | 0.22 | 33 | 23 | 10 | 0.29 | 27 | 20 | 15 | 0.27 |
| **Coat color** | 5 | 4 | 1 | 0.04 | 5 | 11 | 10 | 0.09 | 8 | 16 | 10 | 0.13 |
| **Progeny performance** | 10 | 9 | 7 | 0.11 | 7 | 10 | 16 | 0.11 | 10 | 18 | 17 | 0.17 |
| **Mothering ability** | 18 | 11 | 30 | 0.20 | 14 | 13 | 17 | 0.16 | 12 | 9 | 21 | 0.16 |
| **Lambing interval** | 17 | 11 | 11 | 0.16 | 13 | 8 | 16 | 0.13 | 11 | 7 | 9 | 0.11 |
| **Twining ability** | 5 | 27 | 19 | 0.17 | 11 | 19 | 11 | 0.15 | 9 | 10 | 9 | 0.11 |
| **Age at first lambing** | 11 | 6 | 7 | 0.10 | 5 | 4 | 8 | 0.06 | 6 | 3 | 2 | 0.05 |

*Index = Σ of [3 for rank 1 + 2 for rank 2 + 1 for rank 3] given for particular qualitative variables divided by Σ of [3 for rank 1 + 2 for rank 2 + 1 for rank 3] for all qualitative variable considered R1, R2 and R3= Rank1, Rank 2 and Rank 3.*

***Selection of rams***

Of physical characteristics, farmers base their selection on color, body length, tail size and appearance, horn presence and appearance and ear size and shape, ranked in decreasing order of importance in souther Ethiopia (Tadesse et al., 2015). According to the respondents, about 35(38.89%) of the farmers in Gozamen select their breeding rams and 55(61.11%) did not select their breeding rams. But most of the farmers 82(91.11%) and 60(66.67%) in Sinan and Hulet eju had the concept to select their breeding ram. In another case 5(5.56%) and 16(17.78%) in Sinan and Hulet eju did not select their breeding rams to be parents of the next generation, respectively. In addition to these the average age of selecting breeding rams according to the respondents were 10.84, 8.78 and 9.94 months in Gozamen, Sinan and Hulet eju districts, respectively indicating that rams in Sinan districts were selected earlier than Gozamen and Hulet eju district which may be due to good management activities of farmers in Sinan than in Gozamen and Hulet eju districts. In all the district farmers also give due attention to appearance to select their breeding ram as described in Table 4. Large body size, red or brown coat color, tail with long, broad and twisted at the end are the most preferred traits by most of the farmers in

Adiyo Kaka. Similar traits were preferred for males by the farmers in Horro in western and south-western Ethiopia (Zewdu et al., 2012).

**Table 4.** Selection criteria for rams

| Selection criteria | District | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Gozamen | | | | Sinan | | | | Huleteju | | | |
| | R1 | R2 | R3 | Index | R1 | R2 | R3 | Index | R1 | R2 | R3 | index |
| **Appearance** | 18 | 12 | 4 | 0.39 | 44 | 18 | 12 | 0.37 | 25 | 23 | 10 | 0.36 |
| **Coat color** | 5 | 7 | 11 | 0.19 | 8 | 19 | 13 | 0.15 | 13 | 12 | 23 | 0.24 |
| **Horn** | 0 | 0 | 2 | 0.01 | 6 | 6 | 7 | 0.07 | 3 | 1 | 3 | 0.04 |
| **Ram growth** | 5 | 3 | 7 | 0.13 | 8 | 12 | 14 | 0.13 | 8 | 15 | 9 | 0.18 |
| **Mating ability** | 7 | 9 | 6 | 0.20 | 7 | 16 | 15 | 0.14 | 5 | 7 | 14 | 0.12 |
| **Adaptation** | **0** | **0** | 0 | 0 | 5 | 6 | 9 | 0.07 | 3 | 1 | 0 | 0.03 |
| **Age at first mating** | 0 | 4 | 5 | 0.06 | 4 | 5 | 12 | 0.07 | 3 | 1 | 1 | 0.03 |

*Index = Σ of [3 for rank 1 + 2 for rank 2 + 1 for rank 3] given for particular qualitative variables divided by Σ of [3 for rank 1 + 2 for rank 2 + 1 for rank 3] for all qualitative variable considered R1, R2 and R3= Rank1, Rank 2 and Rank 3.*

***Sheep Flock Composition***

Sheep flock composition observed in the current study (Table 5) were relatively comparable with 5.7 reported for Haraghe highland sheep in Metta, 5.2 in Gorogutu and 6.2 in Deder (6.2) (Wossenie, 2012) . The number of ewes observed in Gozamen was higher ($p<0.05$) than Sinan and Hulet eju districts, but the number of rams was higher ($P<0.05$) for Hulet eju than Gozamen and Sinan districts which implies that higher rate of inbreeding would be observed in both Gozamen and Sinan districts as compared to Hulet eju by reducing effective population size. There was not significance difference ($p>0.05$) in number of young ewes across the districts compared. The average number of ewes 5.45 obtained in this study was lower than Chifra district of Afar 28.1 (Anwar and Yayneshet, 2014).

**Table 5.** Mean ± SE Sheep flock composition

| Sheep flock structure | District | | | |
|---|---|---|---|---|
| | Gozamen | Sinan | Hulet eju | Overall |
| **Ewes (≥ 1PPI)** | $5.82 \pm 0.36^{a}$ | $5.29 \pm 0.36^{b}$ | $5.24 \pm 0.36^{b}$ | 5.45 ±0.36 |
| **Rams (≥ 1PPI)** | $0.28 \pm 0.05^{b}$ | $0.38 \pm 0.06^{b}$ | $0.92 \pm 0.08^{a}$ | 0.53±0.06 |
| **Castrate** | $0.13 \pm 0.03^{b}$ | $0.27 \pm 0.05^{ab}$ | $0.36 \pm 0.06^{a}$ | 0.25±0.05 |
| **Young ewe (≤ 1PPI)** | $0.33 \pm 0.08^{a}$ | $0.39 \pm 0.07^{a}$ | $0.5 \pm 0.08^{a}$ | 0.41±0.07 |
| **Young ram (≤ 1PPI)** | $0.01 \pm 0.01^{b}$ | $0.21 \pm 0.05^{a}$ | $0.17 \pm 0.05^{a}$ | 0.13±0.03 |
| **Lambs(both sex ≤ 6month)** | $2.02 \pm 0.22^{a}$ | $0.60 \pm 0.13^{ab}$ | $1.22 \pm 0.13^{b}$ | 1.28 ±0.16 |

*NB: Means with different superscripts within same row are statistically different at 0.05*

***Reproductive and productive performance of sheep***

Reproduction performance is the best mechanism in evaluation of live animal. The overall lambing interval of ewe in East Gojam zone was reported to be 8-10 months (71.11%) and also about 26.29% of the sample population reported that the overall lambing interval was 11-13 months as shown in Table 6. This result is lower than Wossenie (2012) reported for Haraghe high land sheep (6.5±0.7) but comparable with the lambing interval of sheep in Goncha Siso Enesie district which was 9.64±0.105 (Bamlaku, 2012). Litter size per lambing in this study was single lamb (87.03%) followed by twin lambing (12.96%) (Table 6). The overall number of lambs in life time production of ewe was eight (66.67%) and some sample respondents replied five lambs (12.22%) and seven (9.62%). Lambing many number of lambs is common during September to November (53.33%) due to availability of feed (92.59%) during this period.

**Table 6.** Reproductive and productive performance

| Reproduction performance | | Districts | | | |
|---|---|---|---|---|---|
| | | Gozamen N (%) | Sinan N (%) | Hulet eju N (%) | overall N (%) |
| **Lambing interval of Ewe** | 8-10 m | 55(61.11) | 54(60.0) | 83(92.22) | 192(71.11) |
| | 11-13 m | 33(36.67) | 31(34.4) | 7(7.78) | 71(26.29) |
| | 14-16 m | 2(2.22) | 4(4.44) | - | 6(2.22) |
| | 17-20 m | - | 1(1.11) | - | 1(0.37) |
| **Number of lambs per lambing** | only one | 87(96.67) | 79(87.7) | 69(76.67) | 235(87.03) |
| | Twin | 3(3.33) | 11(12.2) | 21(23.33) | 35(12.96) |

| | | | | | |
|---|---|---|---|---|---|
| **Number of lambs per production life time** | Eight | 77(85.56) | 44(48.8) | 59(65.56) | 180(66.67) |
| | Three (triple) - | | | 5(5.56) | 5(1.85) |
| | Five | | 26(29.2) | 7(7.78) | 33(12.22) |
| | Six | 5(6.49) | 13(14.6) | 8(8.89) | 26(9.62) |
| | Seven | 8(10.39) | 7(7.87) | 11(12.22) | 26(9.62) |

Average age at sexual maturity for young ewes in the study area were 8.27 month, 8.03 month and 6.34 month for Gozamen, Sinan and Hulet eju, respectively indicating that young ewes in Hulet eju were faster in breeding age than in Gozamen and Sinan (Table 7). This statement was also true in the case of young male ram with average breeding age of 7.32 month, 7.33 month and 6.84 month for Gozamen, Sinan and Hulet eju, respectively. The average age at first lambing of young ewes were relatively higher in Gozamen 13.28 month but for Sinan and Hulet eju district average age was 13.24 and 11.50 month, respectively Which is comparable with 12.07, 13.8 and 14.7 for mixed crop livestock, agro pastoral and pastoral production system in Eastern Ethiopia (Helen et al., 2015).

**Table 7.** Age at sexual maturity and age at first lambing of young ewes

| | District | | |
|---|---|---|---|
| **Descriptors** | **Gozamen (Mean ± SE)** | **Sinan (Mean ± SE)** | **Huleteju (Mean ± SE)** |
| **Age at first mating of young ewe (month)** | $8.27\pm0.14^{a}$ | $8.03\pm0.33^{a}$ | $6.34\pm 0.21^{b}$ |
| **Age at first lambing (month)** | $13.28\pm0.22^{a}$ | $13.24\pm0.31^{a}$ | $11.50\pm0.25^{b}$ |
| **Average productive life time of ewe (year)** | $6.42\pm0.10^{b}$ | $6.90\pm 0.19^{b}$ | $7.71\pm0.21^{a}$ |
| **Mating age of ram (month)** | $7.32\pm 0.15^{a}$ | $7.33\pm 0.41^{a}$ | $6.84\pm 0.31^{b}$ |

*NB: Means with different superscripts within same row are statistically different at 0.05.*

**Effective Population Size and Level of Inbreeding**

Utilization of breeding ram/s born within the flock, uncontrolled mating, lack of awareness about inbreeding and small flock size may lead to accumulation of inbreeding and decreased genetic diversity (Falconer and MacKay, 1996). The effective population size (Ne) and the rate of inbreeding coefficient (ΔF) calculated for Gozamen, Sinan and Hulet eju sheep population are presented in Table 8. When sheep flock of a household were not mixed (separate herding), ΔF for sheep in Gozamen, Sinan and Hulet eju districts were 0.47, 0.36 and 0.16, respectively. The value was higher than the maximum acceptable level of 0.063 (Armstrong, 2006).

The rate of inbreeding (ΔF )obtained for Gozamen sheep populations were 0.47 and this value is higher than the report of Amelmal (2011) for Tocha (0.17), Mareka (0.2) and Konta sheep (0.18) but relatively similar to Wossenie's (2012) result 0.36, 0.40 and 0.13 for Metta, Gorogutu and Deder districts, respectively.

**Table 7.** Effective population size and level of inbreeding

| **Districts** | $N_F$ | $N_M$ | $N_e$ | **ΔF** |
|---|---|---|---|---|
| **Gozamen** | 5.82 | 0.28 | 1.1 | 0.47 |
| **Sinan** | 5.29 | 0.38 | 1.4 | 0.36 |
| **Hulet eju** | 5.24 | 0.92 | 3.1 | 0.16 |

*NB: $Ne = (4N_m X N_f) / (N_m + N_f)$; Where Ne = effective population size, $N_m$ = number of breeding males and $N_f$ = number of breeding females .The rate of inbreeding coefficient (ΔF) was calculated from Ne as ΔF = 1/2Ne (Falconer and Mackay, 1996).*

**Conclusion**

The main purpose of sheep production in East Gojjam Zone is for income generation with an index value of 0.51, 0.46 and 0.41 followed by meat for household consumption with an index value of 0.24, 0.30 and 0.35 for Gozamen, Siana and Hulet eju districts, respectively. In East Gojjam Zone Household heads preferred appearance of their sheep to select their breeding ewes and rams with higher index value across the three districts compared. The difference in age at first mating of young ewes were found to be significantly ($p<0.05$) higher in Gozamen and Sinan than Hulet eju district while average productive life time of ewes shorter in Gozamen and Sinan as compared to Hulet eju disrtcit. Rate of inbreeding is the major problem in the study area with 0.47, 0.36 and 0.16 values which are higher than other researchers finding.

**Recommendation**

Training should be given to increase the proportion of breeding male in line with selection and culling of genetically inferior rams with controlled breeding. Mixing and herding together sheep flocks of different households is recommended in this study area to decrease the rate of inbreeding by increasing the effective population size. Appearance and coat color are important as selection

criteria in most of the farmers for rams and ewes. Therefore, such traits should be well considered while conservation and improvement programs are undertaken. Breeding strategy in East Gojjam sheep population should be in line with the trait preference of the community

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