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Production Objectives, Reproductive Performance and Selection Criteria of Indigenous Sheep Types in Meket and Gidan Districts, North Wollo Zone, Ethiopia

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Abstract: This study was aimed to generate comprehensive information on production objectives, reproductive performance and selection criteria of indigenous sheep types under farmer's management condition in Meket and Gidan districts, North Wollo Zone. Ethiopia. Multistage purposive sampling was employed based on the potential of sheep production. Accordingly 6 rural kebeles (3 from each district) were considered purposively. About 240 households (120 from each district) were used for household survey. Statistical package for social sciences (SPSS 16.0 2007) was used to analyze data. The main objectives of keeping sheep were for income generation followed by meat consumption across the districts compared. Sexual maturity age of Meket ram was 9.04 months whereas Gidan ram was 8.51 months. The average age at first lambing, lambing interval and lifetime lamb crop of Meket Sheep were 16.04 months, 9.14 months and 8.92 lambs, respectively. The corresponding values for Gidan Sheep were 15.57 months, 8.66 months and 9.77 lambs, respectively. Color, growth character and appearance were the most important traits considered by farmers to select breeding rams in both study districts. Ages at first sexual maturity, color, lamb growth and pedigree were the most important trait in choosing of breeding ewes in Meket district. Whereas Ages at first sexual maturity, color, tail type/length and pedigree were the most important trait in choosing of breeding ewes in Gidan district. Therefore, this finding was put baseline for understanding about production objective, Reproductive performance and selection criteria of Sheep and serve as a base for designing a sustainable breeding programme and selection strategies in the study area.

Keywords: North Wollo, Production Objective, Reproductive Performance, Selection Criteria

1. 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 [1]. 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 [2]. Ethiopia's vast sheep population, estimated at about 30.70 million heads, is found widely distributed across the diverse agro-ecological zones of the country [3]. 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 [4]. Even though the study areas are rich in livestock resources including small ruminants, information is scanty to show the reproductive

performances of the existing sheep breed, the production objectives and selection criteria in the study area. Thus, more comprehensive information specific to production objectives, reproductive performance and selection criteria of indigenous sheep should be made available. Thus, the overall objective of this study was to assess sheep production objectives, reproductive performance and selection criteria in the study area.

2. Materials and Methods

2.1. Description of the Study Areas

The study was conducted in Meket and Gidan districts, which are geographically located in North Wollo Zone, Amhara Regional State, Ethiopia. The administrative center of Meket district is Filakit, and is situated at about 660 km from Addis Abeba and 139 km from Weldiya. The altitude ranging between 1500 and 3500 meters above sea level. 65% of the total area of the district is consisting of gorges and valleys. While, 7% is mountains and the remaining 28% is plain land. Ninety two percent of the people earn their livelihood from agriculture. The district has three ecological or climatic regions: 25% lowland, 55% midland and 20% high land. The temperature of the district varies 22°C to 7°C. The total sheep population in Meket district was 139287 [5]. The administrative center of Gidan district is Muja, and is situated at about 595 km from Addis Ababa. The total area of the district is about 1,110.93 km^2. The topography of the area is mountainous having steep slopes. It is full of hills, mountains and deeply dissected gorges. There are large altitudinal variations in Gidan district. The altitude ranges from below 2000 m.a.s.l in the Tekeze valley to 4000 m.a.s.l at Abuhoy Gara. The district has three ecological or climatic regions: 30% lowland, 50% midland and 20% high land [5].

2.2. Sampling and Data Collection Method

The sampling method employed for this study was multistage purposive sampling technique, which was based on the potential of sheep production. Accordingly sampling sites or rural '*kebeles'* (lowest local administration unit in Ethiopia) each representing different agro-ecology were selected in each district, based on sheep flock size per household, suitability of the area for sheep production and accessibility. From each rural *kebeles,* 40 household heads having indigenous sheep breed were randomly selected for interview. Generally, 240 households were selected from the sex sampling sites (rural kebeles) from the two study districts.

A modified questionnaire was prepared by adopting a questionnaire prepared by ILRI (International Livestock Research Institute)-OADB (Oromiya Agricultural Development Bureau) for survey of livestock breeds in Oromiya [6]. The questionnaire was pre-tested before administration and some re-arrangement, reframing and correcting in accordance with respondent perception were done. The questionnaire was administered to the randomly selected household heads or representatives by a team of enumerators recruited and trained for the purpose with close supervision by the researcher.

For focused group discussions, 10 household heads were selected in each rural *kebeles* and group discussion was conducted with extension workers and Developmental Agents (DAs) since it is believed that such individuals have better information about the overall production potential of the breed as well as the production constraints, information regarding the origin of breed, trend in population, special characters of the breed, selection criteria, production system, husbandry practice, breeding methods and major constraints to maintain the breed and purpose of keeping sheep were collected from group discussions.

Table 1. *Summary of the sampling procedure.*

Districts	*Rural kebeles*	*Agro-ecology*	*Sampled households for survey*	Number of *group discussion held*
	Estaysh	Highland	40	1
Meket	Mokera	Mid-altitude	40	1
	Walina	Lowland	40	1
	Kebero-meda	Highland	40	1
Gidan	Kul-wuha	Mid-altitude	40	1
	Tilk-anba	Lowland	40	1

2.3. Data Management and Statistical Data Analysis

The data collected from each study site was checked for any error and corrected during the study period, coded and entered into computer for further analysis.

Questionnaire Data: Data collected through questionnaire was described by descriptive statistics using Statistical Package for Social Sciences (SPSS version 20.0. [7]). Chi-square was employed when required to test the independence of categorical variables and to assess association between levels of categorical variables. Ranked data were evaluated based on calculated indices. An index was calculated to provide overall ranking for qualitative data such as constraints of sheep production, 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 = (4Nm Nf) / (Nm + Nf) Where, Ne = effective population size, Nm = number of breeding males and Nf = number of breeding females. The rate of inbreeding coefficient (ΔF) was calculated from Ne as ΔF = 1/2Ne [8].

3. Results and Discussions

3.1. Purpose of Sheep Production

The purposes of keeping sheep by farmers in the study area are presented in Table 1. The primary reason for keeping sheep in Meket district was for generating income (index = 0.35) followed by saving (index = 0.26) and meat (index = 0.25). In Gidan, like that of Meket, the primary purpose of keeping sheep was for generating income (index = 0.33), saving (index = 0.27) and meat (index = 0.22). This indicates that sheep are the major sources of income through the study area and highly valued and reared mainly for income, saving and meat production. Based on the reasons for keeping sheep, the main breeding goal has been defined as increasing meat production (improve growth rate and conformation), increasing the household income and for saving. 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) [1]. In the mixed crop-livestock system, income generation (0.52) was the primary objective followed by meat production. Similarly, the main purpose of keeping sheep in east gojjam zone is to drive income followed by meat consumption [9].

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

Purpose of keeping sheep	Districts							
	Meket				Gidan			
	Rank				Rank			
	1st	2nd	3rd	Index	1st	2nd	3rd	Index
Meat	33	21	38	0.25	26	21	40	0.22
Wool/hair	0	3	7	0.02	1	3	9	0.03
Skin	0	22	10	0.08	3	19	16	0.09
Income	56	31	20	0.35	53	26	24	0.33
Manure	0	15	10	0.06	2	16	12	0.07
Saving	31	28	35	0.26	35	35	19	0.27

index= sum of (3 for rank 1 + 2 for rank 2 + 1 for rank 3) give for each purpose of keeping sheep divided by sum of (3 for rank 1 + 2 for rank 2 + 1 for rank 3) for all purpose of keeping sheep.

3.2. Selection of Breeding Stocks

According to the report of the respondents, about 110 (91.67%) of the farmers in Meket district were practice selection of breeding ram/s and ewes, while 10 (8.33%) did not select their breeding rams and ewes to be parent for the next generation. Whereas 120 (100%) in Gidan district were select breeding rams and ewes as a parent for the next generation. The mean (standard error) selection age of breeding rams in Meket and Gidan districts were 8.7 (0.22) months and 10.5 (0.23) months, respectively. Whereas the mean (standard error) selection age of breeding ewes in Meket and Gidan districts were 12.9 (0.33) months and 16.7 (0.40) months, respectively.

3.2.1. Selection Criteria of Ewes

Selection criteria of breeding ewe are summarized in Table 3. In both study districts, most of the farmers were selected breeding ewes based on age at sexual maturity, color, lamb growth, lambing interval, pedigree and tail type/ length. According to the respondents, age at first sexual maturity was ranked first to select breeding ewe in Meket (index=0.18) and Gidan (index=0.20) districts. Color and lamb growth of breeding ewe were ranked second for Meket district sheep owners with an index of 0.14. Pedigree was ranked third with an index of 0.13. Color and tail type/length of breeding ewe were ranked second for Gidan district sheep breeders with an index of 0.17. According to the information obtained from group discussion, the most preferred color in the study area was white followed by red while black color was not wanted because the market value of sheep in the study area was depends on the coat color of sheep. Pedigree was ranked third with an index of 0.13. Across all the study districts, appearance, tail type and color were the most important traits for the farmers in East Hararghe zone [10].

Table 3. *Selection criteria of breeding ewes in Meket and Gidan district.*

Selection criteria of breeding ewes	Districts							
	Meket				Gidan			
	Rank				Rank			
	1st	2nd	3rd	Index	1st	2nd	3rd	Index
Appearance/conformation	6	11	9	0.07	7	3	14	0.06
Color	15	20	16	0.14	22	13	29	0.17
Lambing interval	15	16	10	0.12	12	18	6	0.11
Lamb survival	7	7	1	0.05	1	2	0	0.01
Lamb growth	16	18	14	0.14	11	14	7	0.09
Age at first sexual maturity	30	7	22	0.18	23	22	28	0.20
Twining ability	8	10	3	0.07	8	6	6	0.06
Tail type/length	1	22	34	0.11	19	30	8	0.17
Pedigree	22	9	11	0.13	17	12	22	0.13

Index= sum of (3 X number of household ranked first + 2 X number of household ranked second + 1 X number of household ranked third) give for each selection criteria divided by sum of (3 X number of household ranked first + 2 X number of household ranked second + 1 X number of household ranked third) for all selection criteria for a production system.

3.2.2. Selection Criteria of Breeding Ram

Selection criteria of breeding rams in the study area are described in Table 4. According to the respondents, color was ranked first in Meket and Gidan district for selecting breeding ram with an index 0.23 and 0.33, respectively. Growth character was ranked second in Meket and Gidan district with an index of 0.20 and 0.24, respectively. Appearance and libido was ranked third in the study districts with an index of 0.17 in Meket district and 0.16 in Gidan district, respectively. While adaptability ranked last (index=0.01) in both study districts. In Both study districts, breeding rams were selected based on their coat color, growth character, appearance and libido. Similarly appearance, color and mating ability were the most preferred traits by farmers to select breeding rams in east gojjam zone [9]. Similar traits were preferred for males by the farmers in Horro in western and south-western Ethiopia [11].

Table 4. *Selection criteria of breeding rams in Meket and Gidan district.*

Selection criteria of breeding rams	Districts							
	Meket				Gidan			
	Rank				Rank			
	1st	2nd	3rd	Index	1st	2nd	3rd	Index
Appearance/conformation	5	3	7	0.17	3	3	9	0.16
Color	33	34	31	0.23	58	21	18	0.33
Growth character	28	34	25	0.20	20	42	27	0.24
Adaptability	2	0	4	0.01	0	0	6	0.01
Libido	21	15	25	0.17	21	12	27	0.16
Pedigree	4	2	6	0.16	6	0	6	0.03
Tail type/length	20	24	16	0.06	12	30	18	0.07

Index= sum of (3 X number of household ranked first + 2 X number of household ranked second + 1 X number of household ranked third) give for each selection criteria divided by sum of (3 X number of household ranked first + 2 X number of household ranked second + 1 X number of household ranked third) for all selection criteria for a production system.

3.3. Reproductive Performance

Age at puberty: In this study, reproductive performance of indigenous sheep breed is summarized in Table 5. The average age at puberty of male lambs in Meket and Gidan district were 9.04±0.13 months and 8.51±0.13 months, respectively. Whereas average age at puberty of female lambs in Meket and Gidan districts were 10.14±0.13 months and 9.83±0.13 months, respectively. Age at puberty observed for male sheep in the current study are lower than the values 11.05±1.6, 10.88±1.7 and 9.5±1.4 months reported for males in Tocha, Mareka and Konta districts, respectively [12].

Age at first lambing: The average age at first lambing (AFL) obtained in the current study is presented in Table 5. The reported value (16.04±0.14 and 15.57±0.14) months in Meket and Gidan districts are comparable with the value obtained for Menz sheep (470.1 days or 15.7 months) [13]. However, it is relatively higher than the value reported for Bonga sheep (14.9±3.1) months and Horro sheep (13.3±1.7) months [18].

Lambing interval: The average lambing interval (LI) obtained in the present study was 9.14±0.11 months and 8.66±0.16 months in Meket and Gidan districts respectively. The value obtained is shorter than the value from the previous finding (11.62±3.8, 10.33±4 and 11.02±3.8) months for indigenous sheep breeds in Tocha, Mareka and Konta districts respectively [12]. The current result was longer than the report of [16], 255 days (8.5 months) for Menz sheep.

Reproductive lifespan: The average reproductive life span of male obtained in the current study were 6.95±0.12 and 6.53±0.11 years in Meket and Gidan district, respectively. Whereas the average reproductive life span of ewes were 7.46±0.01 and 7.72±0.08 years in Meket and Gidan districts respectively. Relatively the current result was shorter than the report of [12] for Tocha (9.17±1.70 years), Mareka (9.82±1.51 years) and Konta (9.28±1.62 year) for ewes studied in the respective districts. The value obtained in the current study is comparable with the value obtained for Horro and Bonga ewes (7.9±3.1 years and 7.4±2.7 years), respectively [14].

Lifetime lamb crop: The average lifetime lamb crop obtained in the current study was 8.92±0.14 and 9.77±0.11 lambs in Meket and Gidan district, respectively. The value obtained is lower than the value from the previous finding (13.47±1.76) lambs for Gumuz sheep in Metema area [15]. Similarly the current result is lower than the report of [18] who reported that the lifetime lamb crop for Bonga and Horro sheep were 12.2±1.8 and 15.3±4.3 lambs, respectively. Relatively the current result is comparable to the report of [1] how reported that, 8.57±3.9, 8.62±4.1 and 10.78±4.7 lambs for Tocha, Mareka and Konta ewes, respectively.

Table 5. *Reproductive performance of indigenous sheep in the study area.*

Reproductive performance of indigenous sheep in the study area	Districts			
	Meket	Gidan	Test	
	Mean±SD	Mean±SD	F	P
Average age at puberty of male (month)	9.04±1.45	8.51±1.47	7.90	0.005
Average age at puberty of female (month)	10.14±1.45	9.83±1.42	2.94	0.088
Average age at first lambing (month)	16.04±2.11	15.57±1.57	3.83	0.051
Lifespan lamb crop (number)	8.92±1.53	9.77±1.70	16.57	0.000

Reproductive performance of indigenous sheep in the study area	Districts			
	Meket	Gidan	Test	
	Mean±SD	Mean±SD	F	P
Lambing interval (month)	9.14±1.23	8.66±1.26	8.94	0.003
Average reproductive lifetime of ram (year)	6.95±1.27	6.53±1.26	6.66	0.01
Average reproductive lifetime of ewe (year)	7.46±1.10	7.72±0.89	4.01	0.046

SD=standard deviation.

3.4. Effective Population Size and Level of Inbreeding

The effective population size (Ne) and the rate of inbreeding coefficient (ΔF) calculated for Meket and Gidan sheep are presented in Table 6. When sheep flock of a household were not mixed, ΔF for sheep in, Meket and Gidan were 0.12 and 0.14, respectively. According to the information obtained from the respondents, many of the sheep flocks were herded together (on average 6.84 and 7.56 in Meket and Gidan district, respectively). When flocks were mixed the rate of inbreeding coefficient (ΔF) was reduced by 85% in Meket and 87.2% in Gidan sheep flocks and the value was lower than the maximum acceptable level of 0.063 [16]. Based on the current results, it can concluded that, the small number of breeding rams per household and utilization of breeding rams born in the flock is believed to increase the level of inbreeding. However, communal herding practiced by many of the sheep owners in both study area obtained in this study allows breeding females to mix with males from other flock and this can minimize the risk of inbreeding by increasing the effective population size.

Table 6. *Effective population size and level of inbreeding.*

Districts	When sheep flocks are not mixed				When sheep flocks are mixed			
	NF	Nm	Ne	ΔF	NF	Nm	Ne	ΔF
Meket	6.76	1.19	4.05	0.12	46.44	8.14	27.70	0.018
Gidan	5.15	1.10	3.63	0.14	38.93	8.32	27.36	0.018

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

4. Conclusions

The main purpose of sheep production in the Meket district was for generating income (index = 0.35), saving (index = 0.26) and meat (index = 0.25). Similarly, in Gidan district, the primary purpose of keeping sheep was for generating income (index = 0.33), saving (index = 0.27) and meat (index = 0.22). Color, growth character, appearance and libido were the most preferred traits for farmer to select breeding rams in both study districts. Whereas, age at sexual maturity, color, lamb growth, lambing interval, pedigree and tail type/ length were the most important trait for farmer to select breeding ewes in both study districts. The productivity and reproductive performance of sheep in the study districts was constrained by diseases, drought, feed and water shortage, predator and lack of veterinary service. The small number of breeding rams per household and utilization of breeding rams born in the flock is believed to increase the level of inbreeding.

5. Recommendations

Age at first sexual maturity, color, lamb growth and tail type are important as selection criteria in most of the farmers for ewes, while growth character, color, libido and appearance are preferred traits as selection criteria in most of the farmers rams. Therefore, such traits should be well considered while conservation and improvement programs are undertaken.

To improve sheep productivity and reproductive performance of that particular area appropriate community based genetic improvement program is important.

Mixing and herding together sheep flocks within the village by organizing farmers based on common grazing land is recommended in this study area. This helps to reduce the risk of inbreeding by increasing the effective population size and to facilitate utilization of selected rams in group.

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