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Assessing the Reproductive and Productive Performance of Indigenous Chickens in Gash-Barka region of Eritrea

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ABSTRACT

The study was conducted in three sub-zones (Shambqo, Molqi and Logo-Anseba) of Gash-Barka region of Eritrea with objective of assessing the productive and reproductive performance of indigenous chickens (IC) of Eritrea kept under traditional/ village condition. A total of 111 chicken rearing smallholder farmers were interviewed to collect required information using a semi-structured pre-tested questionnaire. The study revealed that, IC production appears to be an important activity in all surveyed sub-zones. This is indicated by the high IC holding per household that is 19.3, 13.3 and 15 for Shambqo, Molqi and Logo-Anseba, respectively. Furthermore, 43.2% of these households rear more than 15 indigenous chickens with sex ratio of four hens to one cock. The effective population size and the rate of inbreeding calculated were 4.87 and 0.11, respectively. The investigation revealed that IC was reared mainly for egg production and earning cash income. The IC production system was a backyard extensive production system. IC ecotypes were managed mainly on scavenging with regular feed supplementation. The average age of male at first mating was 5.46 ± 0.08 months while female at first egg was 6.08 ±0.07 months. The number of clutch per hen per year, eggs per clutch and total eggs produced per hen per year were 3.38±0.05, 11.53±0.27 and 38.88±1.06 eggs, respectively. Significant ($p<0.05$) differences were found among the sub-zone in all the above traits except for cockerels age at first mating. The hatchability and survival rate of chicks were found to be 76.87% and 48.6%, respectively.

INTRODUCTION:

Eritrea is blessed with indigenous chicken genetic resources. Poultry production in Eritrea is almost exclusively traditional or as it is commonly known as the backyard, and it is the most widely practiced both in rural and urban households. Indigenous chickens have lived, adapted and produced for centuries in the Eritrean environment. In this country poultry production plays an important economic activity. Besides its social and cultural benefits, it plays significant role in family nutrition or in sustenance of family economy.

Majority of the Eritrean poultry population are of indigenous breeds, which represent a significant component of the rural household livelihood as a source of cash income for immediate household expenses and almost every household has certain number of these chickens which receives minimal inputs in terms of nutrition and shelter.

However, the population census and distribution pattern is not documented at all. Literature throughout Africa revealed that these creatures are pool of heterogeneous population with remarkable genetic variation both within and between ecotype; this is manifested on their morphologies and on their biological performances. Nevertheless, indigenous chickens have received little or no attention in rural development and food security. They have also been neglected from agricultural extension and development and thus their potential is under exploited and underutilized. Concurrently, our current knowledge about them is almost nonexistent.

MATERIALS AND METHODS:

Description of the study areas: The study was conducted in three sub-zones of Gash-Barka zone of Eritrea, namely Shambqo, Molqi and Logo-Anseba. Gash-Barka is located in the western lowlands of the country bordering Sudan to the west and Ethiopia in the south. It adjoins Debub, Maekel and Anseba zones of the country. It lies between 14^0 25' and 15^0 51' north and between 36^0 44'and 38^0 15'east covering an area of about 33,100 km^2, which is about 27% of the whole country. The region is called the "Bread Basket of Eritrea" as it holds more than 60% of the national's livestock wealth and the major cereal producing region (NFIS, 2005). Gash Barka as a region is sub-divided into 14 sub-zones, 187 Kebabis (local administrative areas) within which there are 837 villages.

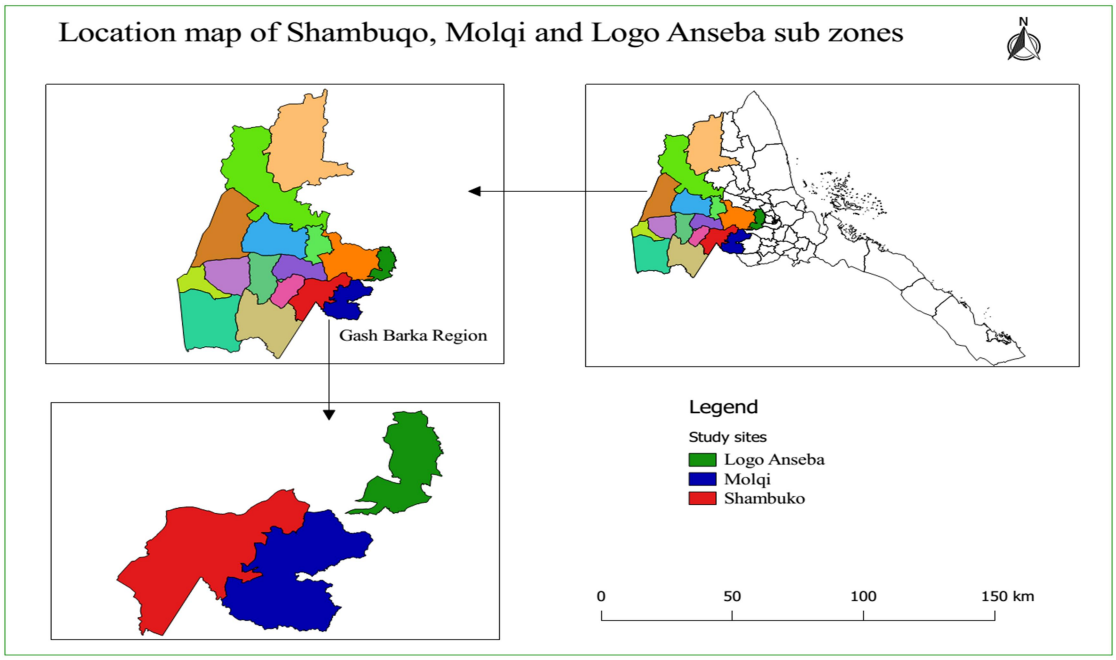

Figure 1: Map of the study area

Sampling Design and Procedure: A rapid reconnaissance survey was made before the main survey to validate the distribution and concentration of indigenous chicken eco-types and accessibility of the study site. The distribution and numbers of indigenous chickens were obtained from office of ministry of agriculture for the state of Eritrea (MOA) in Gash-Barka region before the actual field work. A multi-stage sampling procedure (purposive and random) was employed to select both sampled sub-zones and villages. Three sub-zones (Shambqo, Molqi and Logo-Anseba) and 35 villages (11, 13 and 11 villages from Shambqo, Molqi and Logo-Anseba, respectively) were purposively selected based on accessibility, indigenous chicken population density, less distribution of exotic chicken lines and huge ecological variations. From the 35 villages a total of 111 households having chickens (37 households from each sub-zones) were randomly sampled for interview from the selected villages. Size of households per village was determined upon the size of a village based on images obtained from Google Earth (2017).

Data collection: Description of production system was conducted according to a semi-structured questionnaire based on the general information list of Workneh and Rowlands (2004) and FAO (2012). The questionnaires were pre-tested before final administration, as it is crucial to ensure that the questions being asked are socially appropriate, and that the expected responses are within the projected bounds. Farmers were briefed about the objective of the study before starting the data collection. The interviews and data collection were conducted at the farmers' residences with the assistance of enumerator or representative of village administrator. Focal group discussions were held in each (three per sub-zone) of the selected sub-zone. The groups were composed of women, village leaders/administrator, key informants and socially respected individuals who are known to have better knowledge regarding indigenous chicken production system in that locality.

Ranking using index methods: A program in Microsoft excel (2010) spreadsheet was used to calculate indices. Indices were defined as weighted averages of all rankings for a particular trait. Only traits mentioned in the first three positions were ranked. The indices were calculated based on model described by Bett *et al*. (2009).

Where X_i is the percentage of respondents ranking trait I in the j^{th} rank and k is the sum of ranks for n number of traits.

***Effective Population Size and Inbreeding*:** Effective population size (Ne) and rate of inbreeding size (ΔF) were estimated based on the flocks of farmers who possess their own matured breeding males only for Shambqo, Molqi and Logo-Anseba sub-zones separately, using the following formula developed by Falconer and Mackay (1996).

$$Ne = 4NmNf/(Nm + Nf) \quad \text{... Equation 1}$$

Where, Ne = effective population size,

N_m = number of breeding males

N_f = number of breeding females.

For inbreeding estimation, effective

$$I_i = \binom{3}{2}{}_{1}\left[\sum_{j=1}^{3} X_i\right]_i \Big/ \sum_{k=1}^{n}\left[\binom{3}{2}{}_{1}\sum_{j=1}^{3} X_j\right]_k$$

population size (Ne) was used because it is the most common description for assessing the expected inbreeding in a population. Inbreeding levels (ΔF) for each study site and total population was estimated using the effective population size data in equation (1) following the model adopted from (Frankham *et al.,* 2004).

The rate of inbreeding coefficient (ΔF) was calculated as

$$\Delta F = 1/2Ne \ldots\ldots \text{Equation 2}$$

Statistical analysis: The collected data were subjected to the General Linear Model (GLM) of Statistical Package for Social Sciences (SPSS) Version 23 (2015) for statistical analysis. Simple descriptive statistics was used to observe frequency, percentage, mean and standard deviations. Chi-square test was used to see if there is any significant difference between the categorical variables. This analysis followed the procedure of Marascuilo (1966) to determine which pairs of sub-zone have statistically differing in qualitative traits proportions. The annual egg production per hen was estimated as a function of number of eggs/clutch and number of clutches/hen. Hatchability was calculated as the percentage of the number of eggs incubated and the number of chicks hatched while survival rate was computed as a percentage of the number of chicks weaned and those hatched (Okeno *et al.,* 2012). Results were summarized and presented in tables and graphs.

RESULTS AND DISCUSSION

Overview information: A demographic characteristic of the respondents is presented in (Table1). From the total interviewed households, almost all (92.8%) were females. Regarding educational back ground of the interviewed farmers, majority (63.1%) of the respondents are found to be illiterate. Educational level was highly significantly ($p<0.001$) different among the studied sub-zones, in particular illiteracy is higher in Molqi (91.9%) over the 56.8% and 40.5% of Shambqo and Logo-Anseba, respectively. The overall average ages of respondents were also 44.68 years. This average age indicates the presence of active labor forces, which has positive impact as its availability reduces the labor constraints faced in chicken production.

Table (1) Household characteristics of respondents

Parameter	Sub-zone			Over-all
	Shambqo	Molqi	Logo-Anseba	
Sex of respondent			Frequency (%)	
Male	4(10.8%)	2(5.4%)	2(5.4%)	8(7.2%)
Female	33(89.2%)	35(94.6%)	35(94.6%)	103(92.8%)
χ^2		**1.078**		
p-value		**0.583**		
Average age of respondents (mean ± SE)	42.08±2.082	48.05±2.167	43.92±2.513	44.68±1.316
F-value		**1.830**		
p-value		**0.165**		
Educational background of Respondents			**Frequency, (%)**	
Illiterate	21(56.8%)	34(91.9%)	15(40.5%)	70(63.1%)
1-5 grade	9(24.3%)	3(8.1%)	13(35.1%)	25(22.5%)
6-8 grade	5(13.5%)	-	5(13.5%)	10(9.0%)
9-12 grade	2(5.4%)	-	4(10.8%)	6(5.4%)
χ^2		**23.166**		
p-value		**0.001**		
Marital status of participants			**Frequency, (%)**	
Single	-	-	-	-
Married	30(81.1%)	25(67.6%)	29(78.4%)	84(75.7%)
Divorced	2(5.4%)	5(13.5%)	2(5.4%)	9(8.1%)
Widowed	5(13.5%)	7(18.9%)	6(16.2%)	18(16.2%)
χ^2		**2.833**		
p-value		**0.586**		

χ^2= chi-square, F= frequency, SE= standard error

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Purpose of Keeping Indigenous Chickens: Indigenous chicken production in the context of smallholder farmers had multi-directional purpose. The results of rankings from three sub-zones had shown that chicken as source of egg production was ranked first in both Shambqo (0.36) and Logo-Anseba (0.41) while in Molqi villagers rear chicken primarily for earning cash income (0.34). In particular, women keep chicken as it is considered easy for fulfilling expenditure not covered by household head. The study also indicated that indigenous chickens were kept for consumption, cultural ceremonies and waste minimization next to that of egg production and cash income (Table 2).

Table (2) Purpose of *keeping* indigenous chicken and egg production in the studied sub-zones

Purpose of chickens	Sub-Zone											
	Shambqo				Molqi				Logo-Anseba			
	Rank1	Rank2	Rank3	index	Rank1	Rank2	Rank3	index	Rank1	Rank2	Rank3	index
For sale	10	12	13	0.30	12	15	9	0.34	15	14	7	0.36
For egg production	15	14	6	0.36	10	14	12	0.32	20	14	3	0.41
Consumption	10	11	11	0.28	14	7	14	0.32	1	8	26	0.21
Cultural ceremonies	1	2	6	0.06	-	2	1	0.02	-	1	1	0.01
Waste minimization	-	-	-	-	-	-	1	0.01	1	-	-	0.01

Purpose of egg	Sub-Zone											
	Shambqo				Molqi				Logo-Anseba			
	Rank1	Rank2	Rank3	index	Rank1	Rank2	Rank3	index	Rank1	Rank2	Rank3	index
Cash	20	11	6	0.4	29	5	3	0.45	29	4	4	0.45
Consumption	10	14	13	0.33	2	11	24	0.23	5	13	19	0.27
Hatching	5	12	20	0.27	7	19	11	0.32	3	19	15	0.28

Index=sum of [3 for rank 1 + 2 for rank 2 + 1 for rank 3] for particular trait divide by sum of [3 for rank 1 + 2 for rank 2 + 1 for rank 3] for all traits.

Flock Characteristics and Composition: The overall mean flock size of chicken per household was 15.86. The chicken flock size per household was significantly ($p<0.05$) different between the surveyed sub-zones (Table 3). Highest flock size per household was noticed in Shambqo followed by Logo-Anseba and Molqi with mean flock size of 19.3, 15 and 13.3 bird per household, respectively. In addition, the number of chickens based on age categories varies considerably (Figure 2).

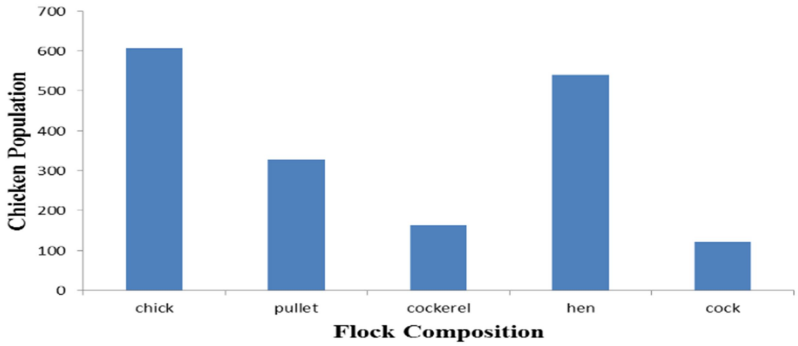

Figure 2: Overall flock structure by number in the study Sub-zone

In this manner, mean indigenous chicken flock size per household in three sub-zones was arranged as chicks (5.52) first followed by hens (4.86), pullets (2.96), cockerels (1.51) and cocks (1.10). The higher number of chicks per household in the studied sub-zones may indicate that farmers are more interested in generating more replacement breeding stock to overcome the high mortality of birds and gain advantage from selling. The number of chick and hen population owned by household was highly significantly ($p<0.01$) different between the studied sub-zones (Table 3). The mean flock size of indigenous chicken per household in the study area is shown in (Table 3). There was a large variation in the flock size ranging from 4 to 60 with a cock to hen ratio of 1:4.97, 1:4.09 and 1:4.22 in Shambqo, Molqi and Logo-Anseba, respectively. The overall mean of cock to hen ratio in these studied sub-zones at 1:4.43 provides better breeding males than the recommended 1:10 ratio of commercial chicken production.

The flock size and structure may vary from season to season depending on different factors like feed shortage, disease and environmental condition. Predators are also factors that cause for decreasing in flock size of chickens. Besides, during cultural and religious festivals flock size fluctuate due to selling and consumption of birds.

Table (3) Flock size per household and category of flock in age and sex

Chicken flock structure	Sub-Zone						Over-all	F-value	P-value
	Shambqo		Molqi		Logo-Anseba				
	Mean ± SE	% (Rang)	Mean ±SE	% (Rang)	Mean±SE	% (Rang)	Mean ± SE		
Chick	8.89±.98[a]	45% (0-26)	4.84±.79[b]	36 % (0-18)	2.92±.7[b]	19% (0-15)	5.52±.54	12.894	0.001
Pullet	3.27±0.6	17% (0-20)	2.49±.39	19 % (0-10)	3.14±.58	21% (0-20)	2.96±.31	0.624	0.538
Cockerel	1.35±0.21	7% (0-5)	1.70±.31	13% (0-7)	1.46±.38	10% (0-11)	1.51±.18	0.330	0.719
Hen	5.11±0.3[a]	26% (2-11)	3.43±.37[b]	26 % (1-10)	6.05±.91[a]	40% (1-30)	4.86±.36	4.972	0.009
Cock	1.03±0.14	5% (0-3)	0.84±.11	6 % (0-2)	1.43±.3	10% (0-10)	1.10±.12	2.318	0.103
Chicken	19.3±1.434[a]		13.3±1.25[c]		15.0±1.73[b]		15.86±.8	4.338	0.01

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/ HH				8	5
Rang	4 – 47	4 -31	4- 60	4- 60	

[a,b,c] means in the same row with different superscripts are significantly different at respected p-value ; HH= household; SE= Standard error

Source of chicken: The study revealed that 45% of the total households were found to buy chicken from market as a source of starting flock followed by gift (29.7%), share (16.2%) and inherited from family (9%). Both in Shambqo (73%) and Logo-Anseba (40%) households primarily acquire source of starter flock from market while in Molqi (40.5%) majority of the household bought chicken as a gift from relatives for starter flock.

Feeds and feeding management of indigenous chicken: According to the results of this study, all of the respondents (100%) reported to practice scavenging system with supplementary feeding. Regarding the quantity of feed supplementation, all interviewed farmers didn't measure or have fixed scale of measurement for the quantity of feed supplemented. In this respect the quantity of supplementation merely depends on individual farmer estimation and availability of feeds in that particular household, which in turn this availability of feed in household depend on season of the year.

Fifteen different combinations of feed supplements were reported in the studied administrative sub-zones. Sorghum with household scraps (36.0%) and sorghum grain alone (22.5%) were reported to be the most common poultry feed in this studied sub-zones. Interviewed farmers explained that they do not crush the grains but give them as they are (whole grain). The type of supplemental feeds varied based on the type of agricultural practice and season. Both in Shambqo and Logo-Anseba combinations of sorghum, maize and household left-overs are the major ingredients for indigenous chicken where as in Molqi finger millet included in the menu (Table 4).

Table (4) Feed resources and Feeding practices for indigenous chicken

Feeds and feeding	Parameter	Sub-zone			Over-all	χ^2	p-value
		Shambqo	Molqi	Logo-Anseba			
Provision of Supplementary feeding	Yes	37(100%)	37(100%)	37(100%)	111(100%)	-	-
	No	-	-	-	-		
Type of supplemented feed	Sorghum	10(27.0%)	10(27.0%)	5(13.5%)	25(22.5%)	64.918	0.001
	Household scraps	1(2.7%)	0	2(5.4%)	3(2.7%)		
	Maize and sorghum	8(21.6%)	2(5.4%)	1(2.7%)	11(9.9%)		
	Sorghum and HH scraps	13(35.1%)	15(40.5%)	12(32.4%)	40(36.0%)		
	Maize, sorghum and HH scraps	3(8.1%)	-	5(13.5%)	8(7.2%)		
	Maize, sorghum and sesame	2(5.4%)	-	-	2(1.8%)		
	Sorghum and Finger millet	-	6(16.2%)	-	6(5.4%)		
	Sorghum, finger millet and HH scraps	-	3(8.1%)	-	3(2.7%)		

	Maize, sorghum and finger millet	-	1(2.7%)	-	1(0.9%)		
	Maize, sorghum and Barley	-	-	4(10.8%)	4(3.6%)		
	Maize and wheat	-	-	1(2.7%)	1(0.9%)		
	Maize, barley and HH scraps	-	-	1(2.7%)	1(0.9%)		
	Sorghum, Barley and HH scraps	-	-	4(10.8%)	4(3.6%)		
	Sorghum, HH scrap and wheat	-	-	1(2.7%)	1(0.9%)		
	Sorghum and barley	-	-	1(2.7%)	1(0.9%)		
Frequency of feeding per day	1time/day	2(5.4%)	3(8.1%)	-	5(4.5%)	9.779	0.044
	2time	25(67.6%)	28(75.7%)	20(54.1%)	73(65.8%)		
	3time/ thrice	10(27.0%)	6(16.2%)	17(45.9%)	33(29.7%)		
Source of supplementary feed	HH	31(83.8%)	22(59.5%)	14(37.8%)	67(60.4%)	16.341	0.001
	HH and market	6(16.2%)	15(40.5%)	23(62.2%)	44(39.6%)		
	Market only	-	-	-	-		
Feeder	Feeder	-	-	5(13.5%)	5(4.5%)	10.472	0.005
	Spreading on floor	37(100%)	37(100%)	32(86.5%)	106(95.5%)		

HH=household, χ^2= chi-square, F=frequency

Both in Shambqo (83.8%) and Molqi (59.5%) majority of the household use home grown feed to supplement their indigenous chicken. Where as in Logo-Anseba sub-zone majority (62.2%) of the household supplement their indigenous chicken flock with feed originated from household along with purchased crop from market (Table 4). Majority of respondents (65.8%) throughout the studied area offer supplementary feed twice a day followed by respondent that provide thrice and once per day at proportion of 29.7% and 4.5%, respectively. Almost all (95.5%) households in these studied sub-zones didn't use feeding trough. The common feeding method used is throwing feed on the ground from where chickens feed.

Majority of the households (92.8%) in the over-all surveyed sub-zones provide especial feed supplement just for chicks for up to two weeks. Only 7.2% of the household supplement feed to both adult and young chickens together. Young chicks are weakest among flocks and as such cannot compete with adult birds for feed available from the scavenging feed resource base. In this respect, households in the studied sub-zones had better understanding in the feeding system of day-old chick. Grinded grain, dough and sesame with pear millet were the commonest feed supplemented to chicks with proportion of 47.6%, 37.9% and 5.8%, respectively (Table 5).

Table (5) Feed resources and feeding practices for indigenous chicks

Feeds and feeding	parameter	Sub-zone			Over-all	χ^2	p-value
		Shambqo	Molqi	Logo-Anseba			

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Feed for day old chick	Yes	33(89.2%)	36(97.3%)	34(91.9%)	103(92.8%)	1.886	0.389
	no	4(10.8%)	1(2.7%)	3(8.1%)	8(7.2%)		
Type of feed for chicks	Grinded grain	10(30.3%)	23(63.9%)	16(47.1%)	49(47.6%)	30.527	0.015
	Dough (flour + water)	11(33.3%)	12(33.3%)	16(47.1%)	39(37.9%)		
	Grinded grain & Sesame	2(6.1%)	-	-	2(1.9%)		
	Dough sesame	1(3.0%)	-	-	1(1.0%)		
	Sesame& pear millet	6(18.2%)	-	-	6(5.8%)		
	Sesame	1(3.0%)	-	1(2.9%)	2(1.9%)		
	Pear millet	1(3.0%)	-	-	1(1.0%)		
	Grinded grain &dough	1(3.0%)	1(2.8%)	-	2(1.9%)		
	Dough& pear millet	-	-	1(2.9%)	1(1.0%)		

χ2= chi- square, F= frequency, %= percentage

Indigenous chicken Housing system: In all the study sub-zones farmers have tendency to practice different housing system. Majority of the household (86.5%) in the studied administrative sub-zones had a separate house for indigenous chicken. While the remaining household keep their chicken at various night shelters in the main house that include perches inside the house (8.1%) and perches in the kitchen (5.4%).

Housing condition was significantly ($P<0.05$) different across the studied administrative sub-zones with highest proportion for separate house for chicken were recorded in Shambqo (97.3%) followed by Logo-Anseba (89.2%) and Molqi (73.0%) (Table 6). Farmers in the study areas had various reasons for accommodating indigenous chicken with family in their main house or fail to construct separate chicken house because risk of predator (40.0%) was ranked as the major reason followed by lack of labor to construct chicken house (33.4%), risk of disease (13.3%) and lack of attention (13.3%). As presented in (Table 6) about 82 % of all respondents in this studied sub-zones, clean chicken house daily. With only 0.9% of the interviewed households clean chicken house weekly. This frequent cleaning of poultry house is an important step in preventing disease and parasite which must be followed by other households throughout the country. Regarding manure disposal, majority of the respondent (57.7%) had no special uses however only 42.3% use chicken manure as a fertilizer.

Table (6) Indigenous chicken housing system

Parameter		Sub-zone			Over-all	χ^2	p-value
		Shambqo	Molqi	Logo-Anseba			
Housing condition	Separate house for chicken	36(97.3%)	27(73.0%)	33(89.2%)	96(86.5%)	10.979	0.027
	Perches in kitchen	1(2.7%)	3(8.1%)	2(5.4%)	6(5.4%)		
	Perches in main house	-	7(18.9%)	2(5.4%)	9(8.1%)		
Reason for not having separate chicken house	Presence of predator	-	4(40.0%)	2(50.0%)	6(40.0%)	7.925	0.244
	Less attention	1(100.0%)	1(10.0%)	-	2(13.3%)		
	Lack of labor	-	4(40.0%)	1(25.0%)	5(33.4%)		
	Disease		1(10.0%)	1(25.0%)	2(13.3%)		

Frequency of cleaning chicken house	Daily	24(64.9%)	32(86.5%)	35(94.6%)	91(82.0%)	15.257	0.018
	Twice/week	11(29.7%)	3(8.1%)	2(5.4%)	16(14.4%)		
	Thrice/week	1(2.7%)	2(5.4%)	-	3(2.7%)		
	Weekly	1(2.7%)	-	-	1(0.9%)		
Chicken manure disposal	No special disposal	34(91.9%)	23(62.2%)	7(18.9%)	64(57.7%)	40.813	0.001
	Use as fertilizer	3(8.1%)	14(37.8%)	30(81.1%)	47(42.3%)		

χ^2= chi- square, F= frequency, %= percentage

Preferred season of incubation of eggs: In general, artificial incubation is not practiced by the respondents of all survey sub-zones because of having no artificial incubator facilities and electricity. Consequently, it was observed that for the hatching of chicken eggs and growing chicks, farmers depended on broody hens. The preferred months for egg incubation and brooding of day-old chicks using broody hen in this studied sub-zones depend on availability of feed in the household, environmental temperature for broody hen, season of the year for day-old chick (as rain, mud and other wet seasons reduce survivability), and predators. As indicated in Figure 3, households in all the studied sub-zones prefer to hatch from September up to December. Even though most of the households in the studied sub-zones believe that there is a high incidence of predator in the selected months for incubation, but the months are predominantly preferred in having suitable environmental temperature, better survival rate for day-old chicks and relatively good availability of feed resources in the household.

Broodiness of a given chicken breed is genetically inherited. A bird has to be broody after laying eggs so that it would incubate, hatch the eggs and raise their young chicks.

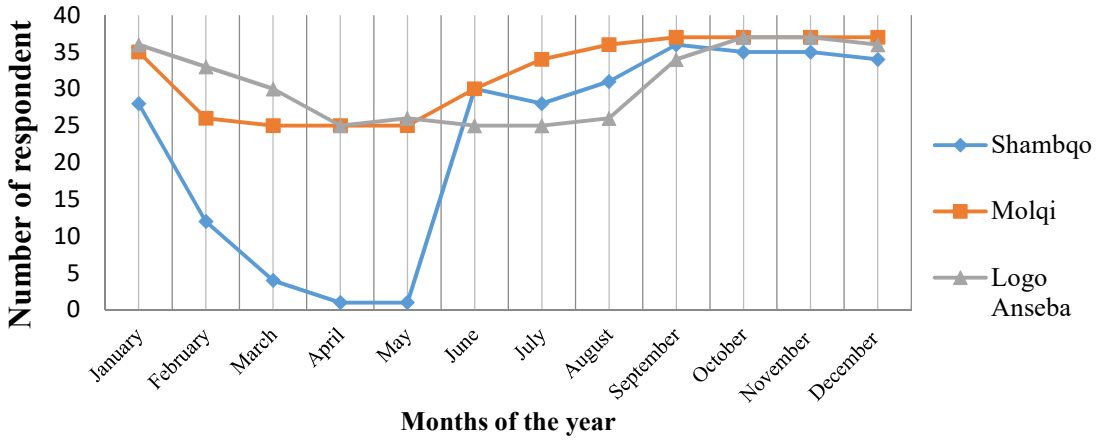

Figure 3: Preferred months for hatching

Egg selection criteria: Generally, large proportions (81.1%) of the farmers in these selected sub-zones purposely select egg before incubation. Very large proportions (80.2%) of the respondents select egg for incubation purposely by looking on the size of the eggs. Few respondents also focus on egg shape and sequence of the egg laid in a single clutch with proportion of

2.7% and 0.9%, respectively (table 7). However, large size egg had lowest hatchability in comparing to medium size eggs. This is mainly due to the increase in yolk size of an egg more than the quantity of albumen (North and Bell, 1990).

Table (7) Traditional egg selection criteria

Parameter	Sub-zones							
	Shambqo		Molqi		Logo-Anseba			
	N	%	N	%	N	%	N	%
Egg selection criteria								
Size egg	26	70.3%	32	86.5%	31	83.8%	89	80.2%
Shape	2	5.4%	-	-	1	2.7%	3	2.7%
Sequence of egg in laying period	1	2.7%	-	-	-	-	1	0.9%
None	8	21.6%	5	13.5%	5	13.5%	18	16.2%
χ^2	**5.697**							
p-value	**0.458**							

N=number of observation, χ^2 chi-square, F= frequency, %= percentage

Traditional Methods of Breaking Broodiness: Traditionally all households attempt to increase egg production by stimulating broody birds to resume lying. Majority of the households (63.6%) use leg tying of indigenous hen as strategy for this purpose. Methods for traditional breaking of broodiness was significantly ($p<0.01$) different across the households in these studied sub-zones. In Shambqo, taking to other place (32.7%), taking brooding nest (13.5%) and hanging upside-down (5.8%) were the main methods to break broodiness following tying leg of indigenous chickens. Households in Molqi exercise methods like taking indigenous chicken to other place (13.6%) and taking brooding nest away from the bird (4.5%) following tying leg as the main technique of breaking broodiness. While in Logo-Anseba, farmers use taking the brooding nest (9.1%) and hanging upside-down (6.8%) as the major methods following tying leg of indigenous chicken. Generally, farmers also apply methods such as fasting (1.4%), tying wing (2.1%) and inserting feather in nostrail (0.7%) of indigenous chicken throughout the selected areas. Broodiness in indigenous chicken is an important trait and essential means of egg incubation and brooding of young chicks, however it is also the major reason for the low egg production in this type of birds. Traditionally all households attempt to increase egg production by stimulating broody birds to resume laying (Table 8).

Table (81)Traditional methods of breaking broodiness in the studied sub-zones

Parameter	Sub-zones						Over-all	
	Shambqo		Molqi		Logo-Anseba			
	N	%	N	%	N	%	N	%
Traditional methods of breaking broodiness								
Fasting	-	-	-	-	2	4.5%	2	1.4%
Tying wing	2	3.8%	-	-	1	2.3%	3	2.1%
Tying legs	23	44.2%	36	81.8%	30	68.2%	89	63.6%
Taking to other place	17	32.7%	6	13.6%	2	4.5%	25	17.9%
Taking brooding	7	13.5%	2	4.5%	4	9.1%	13	9.3%

nest								
Hanging upside-down	3	5.8%	0	0.0%	3	6.8%	6	4.3%
Inserting feather in nostril	-	-	-	-	1	2.3%	1	0.7%
None	-	-	-	-	1	2.3%	1	0.7%
χ^2					31.957			
p-value					0.004			

N=number of observation, χ^2 chi-square, F= frequency, %= percentage

Hatchability and survivability of chicks: Overall mean of eggs incubated, hatched and survival to 8 weeks' age are presented in Table 9. Throughout the studied sub-zones, the average frequencies of brooding in the study sub-zones were 2.81 or hens are coming to brood 2-3 times per year. There was a significant ($p<0.005$) difference in the frequency of brooding per hen per year across the studied sub-zones. Indigenous hens in Shambqo (3.05) brood more than hens in both Molqi (2.76) and Logo-Anseba (2.62). This result indicates that farmers in Molqi and Logo-Anseba sub-zones implement more traditional method of breaking broodiness over farmers in Shambqo with objective to increase egg production. The average number of eggs set to broody hen was 11.02 in the overall studied sub-zones and overall 8.5 eggs hatch which leads to average percentage of hatchability to be 76.87% in the studied sub-zones. This could be explained by the fact that the chicken had free access to green pastures which are rich in vitamins during scavenging and vitamins play a significant role in fertility of animals (Okeno *et al.,* 2012). There was no significant ($p>0.05$) difference in terms of egg set to broody hen, rate of hatchability and average percentage of hatchability across studied sub-zones. This 76.87% of hatchability seems satisfactory based on the report from Sonaiya and Swan (2004) which indicated that hatchability using a broody hen around 80% to be normal, but a range of 75% to 80% is considered to be satisfactory. The differences in hatchability performance of indigenous broody hens might be attributed to the time or season of the year, since hatchability of eggs using broody hens was highly affected by season of incubation. The overall average percent of survival rate of chicks to 8 weeks of age in the study area was 48.6% (Table 9). There was no significant ($p>0.05$) difference between the three administrative sub-zones. This low survival rate of chicks to 8 weeks' age, indicated high mortality of chicks. On the bases of the group discussion, main causes of chicks' death were mainly due to accident, predator, poor management and disease.

Table (9) Hatchability performance of indigenous chicken

Parameter	**Sub-Zone (Mean±SE)**			**Over-all**	**p- value**
	Shambqo	**Molqi**	**Logo-Anseba**		
Average frequency of brooding/hen/year	3.05± 0.11[a]	2.76± 0.09[b]	2.62 ±0.08[b]	2.81 ± 0.06	0.005
Average number of eggs set to broody hen	11.22 ± 0.28	10.54 ± 0.26	11.3 ± 0.19	11.02 ± 0.15	0.067
Average hatch rate	8.81±0.31	8.03 ± 0.37	8.65 ± 0.29	8.5 ± 0.19	0.200
Percentage of hatchability	78.62±2.02	75.54 ± 2.53	76.46 ± 2.14	76.87 ± 1.29	0.608
Survival rate of chicks to	4.11±0.26	3.92 ± 0.28	4.65 ± 0.30	4.23±0.16	0.171

8 weeks age Percentage of Survival rate of chicks to 8 weeks age	45.57±2.33	47.8 ± 2.27	52.43 ± 2.49	48.6 ± 1.38	0.116

a, b, c means in the same row with different superscripts are significantly different at respected p-value; SE= Standard error

Productive Performance of Indigenous chicken: The results of the present study show that the overall mean age at first mating of male indigenous chickens and the age at first egg of female chickens were 5.46 and 6.08 months, respectively. The average age at first lay of indigenous chicken was significantly (P<0.01) different across the sub-zones. Logo-Anseba and Molqi had relatively higher values which are 6.27 and 6.22 months for mean age at first lay, whereas Shambqo had lower value which is 5.76 months for mean age at first lay. As for the average age of cockerels at first mating, there were no statistical differences (P>0.05) between sub-zones. In this regard hens in Shambqo reach maturity relatively faster than hens in Molqi and Logo-Anseba. The variation might be associated with the availability of feed resources for scavenging, supplementation, and/or ecotype of indigenous chicken. In general, this study shows that indigenous chicken ecotypes are late maturing; this is in conformity with the findings of Teketel (1986) and Aberra (2000) that one of the expressions of low productivity of indigenous chicken ecotypes was late maturity. (Table 10)

Table (10) Reproductive and Productive performance of indigenous chicken ecotypes in the study districts

Parameter	Sub-zones (Mean ± SE)			Over-all	p-value
	Shambqo	Molqi	Logo-Anseba		
Average age of cockerels at 1st mating (month)	5.20 ± 0.15	5.51 ± 0.12	5.65 ± 0.13	5.46 ± 0.08	0.055
Average age of pullets at 1st egg (month)	5.76 ± 0.11^{b}	6.22 ± 0.10^{a}	6.27 ± 0.11^{a}	6.08 ±0.07	0.001
Number of clutches/hen/year	3.56 ± 0.09^{a}	3.26 ± 0.07^{b}	3.31 ± 0.07^{b}	3.38 ± 0.05	0.013
Average number of eggs/clutch	12.45 ± 0.54^{ab}	11.46 ±0.44^{bc}	10.68 ± 0.40^{c}	11.53 ± 0.27	0.027
Length of laying phase in a clutch (days)	15.70 ± 0.93	18.40 ± 1.03	16.78 ± 0.96	16.96 ± 0.57	0.148
Clutch length (days)	104.81 ± 2.68^{bc}	113.19 ± 2.41^{a}	110.76 ± 2.18^{ab}	109.59 ± 1.43	0.047
Total egg production potential /hen/year	44.40 ± 2.24^{a}	36.91 ± 1.34^{b}	35.32 ± 1.49^{b}	38.88 ± 1.06	0.001

a, b, c means in the same row with different superscripts are significantly different at respected p-value; SE= Standard error

The average number of clutches per hen per year of indigenous chicken were significantly (P<0.05) different between the study sub-zones. Shambqo chickens had significantly higher (3.56) mean number of clutch per hen per year than Logo-Anseba (3.31) and Molqi (3.26) chickens respectively. Furthermore, result obtained from the survey revealed that clutch length of indigenous chicken was significantly (P<0.05) different between the sub-

zones. Higher clutch lengths in days were noticed in Molqi (113.19) and Logo-Anseba (110.76) chickens over Shambqo (104). Nevertheless, the length of laying phase with in the clutch was not significantly different across the study sub-zones.

The overall mean of egg production per hen per clutch was estimated at 11.53 eggs in the study sub-zones as summarized in Table 10. The number of eggs per clutch found in the current study was significantly ($P<0.05$) different between surveyed sub-zones. The Mean eggs per clutch per hen of about 12.45, 11.46 and 10.68 were calculated for Shambqo, Molqi and Logo-Anseba, respectively. Accordingly, the total egg production per hen per year was estimated to be 44.4, 36.91 and 35.32 in Shambqo, Molqi and Logo-Anseba, respectively indicating significantly ($P<0.01$) higher egg production in chickens of Shambqo. This variation might be attributed to the difference in breed type, management practices and prevalence of disease problems. In addition, the focal group discussion result showed that higher egg production is always expected from additional supplementation of feed and at the time of sowing, and during and after harvesting in which the availability of scavenging feed resource is adequate.

***Effective Population Size and Inbreeding*:** Effective population size was calculated based on the number of breeding male and breeding female in the flocks of farmer's household. As shown in the Table 11, the effective population sizes of the flocks were 4.75, 3.61 and 6.25 in Shambqo, Molqi and Logo-Anseba sub-zones, respectively. This implies that the overall mean (4.87) of effective population size in breeding individual bird is very small. Subsequently the rate of inbreeding is quite high in all sub-zones studied which might be due to the small flock size owned by the households.

The current finding of the level of inbreeding (0.11 in Shambqo, 0.14 in Molqi and 0.08 in Logo-Anseba) was considered to be high as compared to the acceptable level of 1-4% per generation (Henson, 1992). Relatively 8% inbreeding rate per generation in Logo-Anseba was lower than the 11% and 14% inbreeding rate per generation in Shambqo and Molqi. This high level of inbreeding could be explained by the small effective population sizes as the number of cocks per household was very few (Table 11). Utilization of breeding cock hatched within the flock and lack of awareness about inbreeding may lead to the accumulation of problems associated with inbreeding and may decrease genetic diversity. This means that during scavenging different flocks mix and this gives the few cocks an opportunity to mate hens from other flocks; possibly increasing the rate of inbreeding.

Table (11) Effective population size and level of inbreeding

Factors	Sub-Zone			Over all mean
	Shambqo	Molqi	Logo-Anseba	
Nm	1.52	1.19	2.00	1.57
Nf	5.44	3.69	7.15	5.43
Ne	4.75	3.61	6.25	4.87
ΔF	0.11	0.14	0.08	0.11

Nm referred to number of breeding males, Nf number of breeding females, Ne effective population size, ΔF inbreeding coefficient.

However, the estimates on the effective population size as well as rate of inbreeding in the village flocks may not be accurate due to the existing breeding system, which are entirely based on uncontrolled natural mating, and absence of breeding males in many households keeping chickens. Maintaining a number of cocks is counterproductive because they will spend most of the time fighting for dominance.

Major Constraints of indigenous Chicken Production system: The results of the rankings showed that disease, feed shortage and predator were the major and economically important constraints for the existing chicken production system in all three sub-zones (Table 12). Disease (0.37), predators (0.23) and feed shortage (0.12) were ranked the first three challenges in Shambqo, while in Molqi, predators (0.31) ranked as the major constraints followed by both disease (0.25) and feed shortage (0.25). Logo-Anseba farmers ranked feed shortage (0.33) followed by disease (0.32) and predator (0.15) as the top three economically important challenges to indigenous chicken production system. Other indigenous chicken production and reproduction constraints include; lack of labor, lack of capital, land shortage, lack of market demand and water shortage were mentioned by the respondent's as an important constraints of indigenous chicken production system beside disease, predators and feed shortage (Table 12).

Table (12) Constraints of chicken production in the study Sub-Zones

Major challenges	Sub-Zone											
	Shambqo				Molqi				Logo -Anseba			
	Rank1	Rank2	Rank3	index	Rank1	Rank2	Rank3	Index	Rank1	Rank2	Rank3	index
Land shortage	-	1	-	0.01	-	-	-	-	1	1	-	0.02
Disease	25	2	2	0.37	15	3	4	0.25	22	2	-	0.32
predators	5	17	3	0.23	11	15	7	0.31	1	12	6	0.15
Feed shortage	3	5	8	0.12	6	12	14	0.25	11	13	12	0.33
Lack of capital	1	5	7	0.09		2	2	0.03	-	4	5	0.06
Lack of market demand	-	2	4	0.04	-	-	-	-	-	-	-	-
Water shortage	1	2	4	0.05	1	1	1	0.03	-	1	2	0.02
Labor	2	2	10	0.09	4	4	9	0.13	2	2	10	0.1

Index=sum of [3 for rank 1 + 2 for rank 2 + 1 for rank 3] for particular trait divide by sum of [3 for rank 1 + 2 for rank 2 + 1 for rank 3] for all trait.

CONCLUSIONS AND RECOMMENDATIONS

The study indicated that majority of the woman actively participate in poultry production using indigenous ecotypes and apply traditional knowledge of poultry husbandry to generate income. Result of the ranking also showed that disease, feed shortage and predator were the major and economically important constraints for the existing chicken production system in all three studied sub-zones. Broody hens were the sole means of egg incubation and chick brooding in the study sub-zones and farmers in this part of the country prefer to hatch from the month of September up to the month of December. Preference on this period of the year mainly depends on availability of feed in the household, environmental temperature for broody hen, season of the year for day-old chick (as rain, mud and other wet seasons reduce survivability), and predators. All most all households (81.1%) in the study sub-zones select egg before incubation and all of the

farmers use the egg size as a criterion for selection. Traditionally all households attempt to increase egg production by stimulating broody birds to resume lying. Majority of the households (63.6%) use leg tying of indigenous hen as strategy for this purpose. The result of the present study shows that the indigenous hens of Shambqo (3.05) brood more than hens of Molqi (2.76) and Logo-Anseba (2.62). The average number of eggs set to broody hen was 11.02 and out of this 8.5 eggs hatch to give hatchability percentage of 76.87%. However, more than half (51.4%) of the chicks hatched dies before reaching 8 weeks of their age. The study also reveals that the overall mean age at first mating of male indigenous chickens and the age at first egg of female chickens were 5.46 and 6.08 months, respectively. The recorded average numbers of clutches per hen per year was 3.38. While the overall mean of egg production per hen per clutch was estimated at 11.53 eggs. Accordingly, the total egg production per hen per year of indigenous hens was estimated to be 38 eggs. On the other hand, the mean effective population size per household was estimated to be 4.87 with an inbreeding rate per generation of 11%. The level of inbreeding is considered to be high as compared to the acceptable level of 1-4% per generation. This indicates that there is a need to minimize the risk of inbreeding depression.

REFERENCES:

Aberra, M. (2000). Comparative studies on performance and physiological responses of Ethiopian indigenous (*Angete Melata*) chickens and their first generation crosses to long term heat exposure. Ph.D. thesis, Martin-Luther University, Halle – Wittenberg, Germany.

Bett, R. C., I. S. Kosgey, A. K. Kahi and K. J. Peters. (2009). Analysis of productive objectives and breeding practices of dairy goats in Kenya. *Tropical Animal Health and Production* 41: 307-320.

Falconer, D. S. and T. F. C. Mackay. (1996). Introduction to quantitative genetics, 4th ed. Longman Group, Essex, UK.

FAO (Food and Agricultural Organization). (2012). Phenotypic Characterization of Animal Genetic Resources. FAO Animal Production and Health Guidelines No. 11. Rome

Frankham, R., J. D. Ballou and D. A. Briscoe. (2004). Primers of conservation genetics: a brief introduction to the general principles of conservation genetics.1st ed. Cambridge University press, U.K.

Google Earth pro. (2017). Version 7.3.0 Available at: http://www.Earth.Google.com/ down load- earth.htm. [access: 5 May 2017]

Henson, E. L. (1992). In Situ-conservation of livestock and poultry, FAO Animal Production and Health Paper No. 99, FAO. Rome.

Marascuilo, L. A. (1966). Large-sample multiple comparaisons. *Psychology Bulletin*, **65**(1):280-290.

National Food Information System of Eritrea (NFIS). (2005). Baseline Study on Livelihood Systems in Eritrea. Phase I: Preliminary Identification of Livelihood Systems through Research on Secondary Sources (Draft) Zoba (Region) Gash-Barka. January. Available at http://www.fivims.net/documen

ts/pdf/Livelihood%20Systems%20in%20Zoba%20Gashbarkal%20final%20BPS.pdf [accessed 12 may 2017]

North, M. O. and D. D Bell, (1990). Commercial chicken production manual. 4th ed. Van Nostrand Reinhold, New York, USA.

Okeno, T. O., A. K. Kahi and J. K. Peters (2012). Characterization of Indigenous Chicken Production Systems in Kenya. *Tropical Animal Health and Production*, **44**(1): 601-608.

Sonaiya, E. B. and S. E. J. Swan (2004). Manual for small scale poultry production. Technical guide. Available at. www.fao.org/docrep/008/y5169e00.htm. [Accessed 10 September 2017]

SPSS (Statistical Packages for Social Sciences). 2015. IBM SPSS Statistics for Windows, Version 23.0. Armonk, NY: IBM Corporation.

Teketel, E. (1986). *Studies on the Meat Production Potential of some Local Strains of Chickens in Ethiopia*. Ph.D. Thesis, University of Giessen.

Workneh, A. and J. Rowlands (2004). *Design, Execution and Analysis of the Livestock Breed Survey in Oromiya Regional State*, Ethiopia. OADB, Addis Ababa, Ethiopia, ILRI, N, Wiley – Blackwell, A John Wily and Sons Ltd., Publication.

airobi, Kenya.