Production Systems, Productive Performances, Constraints and Rate of Inbreeding of Indigenous Chicken Populations in Kaffa Zone, South Western Ethiopia

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Abstract

The main objective of this study was to describe the production systems, productive performances and associated constraints of indigenous chicken populations in Kaffa Zone. Data on production systems, productive performances and constraints of chickens were collected from 300 purposively selected households using a semi-structured questioner. The results indicated that majority of the respondent were female (71.1%) and 56% of the interviewed farmers were illiterate. The average family size per household was 5.86. Farmers mainly keep their chickens in the kitchen (60.7%) and main houses (30.7 %). Maize (55.7 %) and sorghum (20.3 %) were the major feed supplements provided by the households. The average chicken flock size, age at first egg (months), average egg/hen/clutch (clutch size), clutch number and annual egg/hen/year were 8.68, 6.09, 12.3, 3.6 and 44, respectively. The average hatchability was 80.5%. The major production constraints were predators (72.7 %) and diseases (27.3 %) across the studied districts. The type of predators which are commonly occurring included *Buteo jamaicensis* locally known as *"Gace"*, *Helogale hirtula* locally known as *"Shiifoo"* or "Wociwoco", *Felis silvestris* locally known as *"Haallaro"* and *Felis catus* locally known as *"Kubbi Kullaro"* accounted about 54.6, 24.4, 15.5, and 4.58 % respectively. The effective population size and rate of inbreeding were 486 and 0.111% indicating chicken populations in the study area are not exposed to inbreeding. In conclusion, the current study indicates illiterate female farmers were mainly involved in care and managing of chickens under scavenging system. The performances of chickens were comparable with the national reports under scavenging system; however these performances were influenced by predators and diseases. Therefore, educating and training of women's should be implemented to improve the overall socio economic status of the family and benefit them. In addition successful intervention strategy should be carried out to effectively utilize the existing potentials of indigenous chicken populations in line with predator and disease control programs. Again, conservation of the indigenous chicken populations should also be considered before they have been diluted with exotic breeds.
Keywords; Effective population size, Household Characteristics, Indigenous chicken, Productive performance, Rate of inbreeding.

Introduction

In Ethiopia most of the rural communities keep indigenous chicken populations under scavenging management system (Tadele *et al*., 2018). Due to the presence of various agro-climatic conditions which enables the rural societies to keep a wide varieties of indigenous chicken populations under scavenging management systems (Azage *et al.*, 2010; Tadele *et al*., 2018). In Ethiopia chickens are the most widespread and almost every rural family owns chickens, which provide a valuable source of family protein and income (Tadelle *et al*., 2003). The total chicken population in the country is estimated to be 56.53 million and of these 94.3 % indigenous which are mainly kept by small holder farmers in scavenging environments (CSA, 2017). The most dominant chicken types reared in Ethiopia are local ecotypes, which show a large variation in body conformation, plumage color, comb type and productivity (Halima *et al.,* 2007; Tadele *et al*., 2018). However; the economic contribution of the sector is not still proportional to the huge chicken numbers, attributed to the presence of many productions, reproduction and infrastructural constraints (Aberra, 2000). In the rural areas of Ethiopia indigenous chickens has been mainly kept by the poor due to their significance for source of animal protein, generation of extra cash incomes and religious /cultural (Alders *et al.,* 2009).

Moreover, the indigenous chicken's populations which have been kept by majority of rural farmers in Ethiopia are good scavengers and foragers, well adapted to harsh environmental conditions and their minimal space requirements make chicken rearing a suitable activity and an alternative income source for the rural farmers. In addition, the local chicken sector constitutes a significant contribution to human livelihood and contributes significantly to food security of poor households. Horst (1988) considered the indigenous fowl populations as gene reservoirs, particularly for those genes naked neck (Na) that have adaptive values in tropical conditions. Despite the important roles of local chickens, rearing them can be considered as a side line agricultural activity. However,

the indigenous chicken populations in Ethiopia were neglected for conservation, rather they have been diluting with the imported exotic breeds (Halima *et al.*, 2007).

The indigenous chicken populations which are found in large proportions are often low in their egg production, late in maturation, long broodiness and unimproved (Fisseha *et al.*, 2010; Aberra, 2000). Due to their low genetic potential, incidence of diseases and predators, limited supplementary feed resources, constraints related to institutional, socio-economic and infrastructural as well as poor management practices contributed for the low production and productivity of chickens.

Therefore, the present study was conducted to describe the existing production systems, productive performances and associated constraints of indigenous chicken populations reared in three districts of Kaffa Zone.

Materials and Methods
Description of the study area
This study was conducted in Kaffa Zone which is located between 6°24' to 8°13' North latitude and 35°30' to 36°46' East longitude in South Western part of South, Nation, Nationalities and Peoples Region. The Zone has a total area of 10,602.7 km^2 which accounts 7.06 % of the total area of the region. Administratively, Kaffa Zone is divided into ten districts and has three conventional climatic zones based on variations in altitude and temperature. These are highland (2500 - 3000 m a.s.l), midland (1500 - 2500 m a.s.l) and lowland (500 – 1500 m a.s.l) (KZBoFED, 2014). Out of the total area of the Zone, highland, midland and lowland cover 11.6%, 59.5% and 28.9%. The mean annual temperature of the area ranges 10.1 ^{0}C – 27.5 ^{0}C. The warmest months are February, March and April while the coldest months are July and August. According to the meteorological data obtained from the Zone, the annual rainfall ranges from 1001-2200mm (KZBoFED, 2014). Kaffa Zone is a part of the South West Ethiopian regions which receive the highest amount of rainfall. This is attributable to the presence of the evergreen forest cover on top of the windward location to the moist monsoon winds.

Sampling technique and methods of data collection
The study districts were purposively selected based on their potential for chicken population, accessibility and presence of indigenous chicken production. Before the main survey was commenced, a preliminary assessment was made to identify whether there are pure exotic and/or their crosses in the study areas. From ten districts of Kaffa Zone, three districts namely Decha, Chena and Gimbo districts were selected from which 15 rural kebeles (seven from Decha; four from each Chena and Gimbo district) were randomly sampled. Then, a total of 300 households, 20 households from each rural kebeles, that posses a minimum of 5 matured indigenous chickens were randomly selected. Closely adjacent households were also skipped to avoid the risk of sampling chickens sharing the same cock.
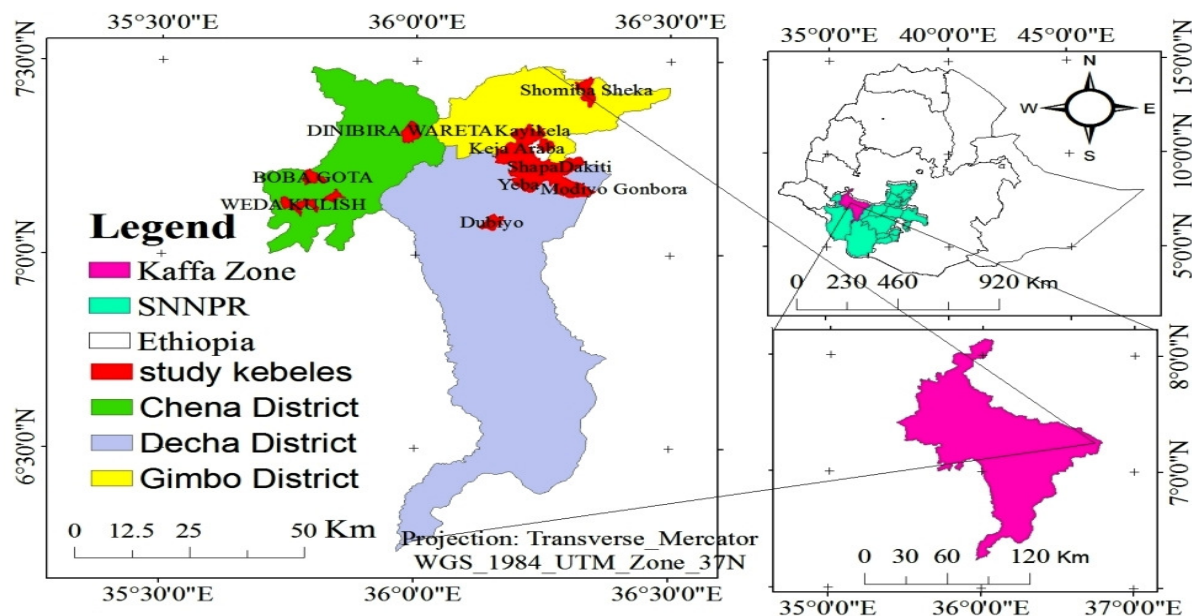

Figure 1. Map of Kaffa Zone displaying study districts and kebeles covered

Effective population size
Data on effective population size was collected from the surveyed chicken populations which were mature male and female. However, pullets and cockerels which are not ready for breeding were excluded from both districts to

estimate the effective population size.

Effective population size for a randomly mated population was calculated following the equation given by Falconer and Mackay (1996).

$$Ne = \frac{4\,(Nm \times Nf)}{Nm + Nf}$$

Where; Ne = effective population size; Nm = number of breeding males and Nf = number of breeding females.

Estimation of rate of inbreeding

Data on the rate of inbreeding was calculated from effective number of breeding indigenous chickens from the studied districts to determine the current status of inbreeding. Effective population size (Ne) was used to estimate the rate of inbreeding in a population. Rate of inbreeding (ΔF) for each studied districts and total populations were estimated from the effective population size data following the model adopted from (Falconer and Mackay, 1996; Maiwashe *et al.*, 2006).

Rate of inbreeding = $\Delta F = 1 / (2\,Ne)$

Where;

ΔF = rate of inbreeding

Ne = effective population size

Statistical Analysis

Data collected on socio economic, production systems, productive performances and constraints of chicken populations were coded and entered into a computer using Microsoft Office Excel 2007. Descriptive statistics were employed to analyze the data in each district and Chi-square (χ^2) test was also employed to compare the significance of district by using Statistical Analysis System (SAS, 2002, ver. 8.2).

Results

Household Characteristics of the Study Areas

The household characteristics of the respondents are presented in Table 1. From the total interviewed indigenous chicken owning farmers, 70.7, 70 and 72.5 % were females in Decha, Chena and Gimbo districts, respectively. Higher proportion of female respondents (71.1%) than males (28.9%) was observed. This indicates that female farmers are mainly involved in managing and caring of chickens in the study districts.

The average age of respondents in the present study was 39.9, 41.3 and 39.2 years in Decha, Chena and Gimbo districts, respectively. The educational level of respondents showed that, about 66.4, 58.7 and 42.5 % in Decha, Chena and Gimbo districts, respectively were illiterate. This might be due to the fact that farmers in rural communities particularly in this area did not have access to education before. Others can read and write and some were involved in formal education such as primary first cycle (1-4th) ; second cycle (5-8th) and high school (9-10th or 12th) and above in all study districts. The average family size in Decha, Chena and Gimbo districts was 5.97, 5.83 and 5.7 persons, respectively with the overall mean family size of 5.86 persons.

Table 1. Household characteristic of respondents in three districts of Kaffa Zone, South   Western Ethiopia (N = 300)

Household characteristics	Decha	Chena	Gimbo	Overall
	N = 140	N = 80	N=80	N=300
Sex of respondents (%)				
Male	41(29.3)	24(30)	22(27.5)	28.9
Female	99(70.7)	56(70)	58(72.5)	71.1
Average age of respondents (years)	39.9	41.3	39.2	40.1
Educational level (%)				
Illiterate	93(66.4)	47(58.7)	34(42.5)	56
Read and write	10(7.14)	7(8.75)	12(15)	10.3
Primary first cycle (1-4)	10(7.14)	10(12.5)	14(17.5)	12.4
Primary second cycle (5-8)	19(13.6)	9(11.3)	12(15)	13.3
High school (9-12 and above)	8(5.71)	7(8.75)	8(10)	8.2
Average family size (number)	5.97	5.83	5.7	5.86

N, Number of observations; Numbers in parenthesis are percentage values.

Livestock ownership and flock characteristics

As presented in Table 2, the overall mean size of livestock populations was 3.4, 2.4, 0.9 and 0.2 heads of cattle, sheep, goat and equine, respectively. The lowest proportions of cattle and sheep were reported from Decha which is significantly lower (*P<0.05*) than Chena and Gimbo districts, respectively.

Table 2. Livestock ownership of households in three districts of Kaffa Zone, South Western Ethiopia (mean ± SE)

Livestock	Decha	Chena	Gimbo	(Mean ± SE)
Cattle	2.97±0.1^b	3.51±0.17^a	3.65±0.18^a	3.4±0.08
Sheep	2.04±0.08^b	2.71±0.21^a	2.57±0.21^a	2.4±1.6
Goat	0.83±0.10	0.88±0.13	1.05±0.14	0.9±1.2
Equine	0.15±0.03	0.18±0.044	0.2±0.045	0.2±0.4

$^{a, b}$ *Row means with different superscript letters are significantly different (P < 0.05)*
SE = Standard error of the mean

The average chicken flock size per household in Decha, Chena and Gimbo districts was 9.02, 8.83 and 8.01, respectively with the overall mean chicken flock size of 8.68 (Table 3). The largest proportions of chicken populations were reported from Decha and Chena districts and which are significantly higher (p<0.05) than Gimbo district.

Table 3. Chicken flock compositions of households in three districts of Kaffa Zone of South Western Ethiopia (mean ± SE)

Flock composition	Decha	Chena	Gimbo	(Mean ± SE).
Chicks	1.3±0.16	1.40±0.22	1.05±0.17	1.26±0.11
Pullets	1.12±0.08	1.01±0.12	0.88±0.12	1.03±0.06
Cockerels	0.54±0.06^a	0.35±0.07^a	0.25±0.06^b	0.4±0.7
Hens	4.36±0.07	4.33±0.09	4.20±0.08	4.3±0.8
Cocks	1.7±0.05	1.74±0.07	1.63±0.06	1.7±0.03
Overall	9.02±0.24^a	8.83±0.34^a	8.01±0.25^b	8.68±0.28

$^{a, b}$ *Row means with different superscript letters are significantly different (P < 0.05); SE,   Standard error of the mean.*

Reproductive and Productive Performance of Indigenous Chickens
The performance of indigenous chicken populations is presented in Table 4. Age at first egg (months) was significantly longer for chickens reared in Gimbo (6.3 months) district than Chena (6.1 months) and Decha (6 months) districts. Egg number per hen per clutch in the present study was 12.3, 12.2 and 12.6 eggs in Decha, Chena and Gimbo districts, respectively. Average number of days per clutch (clutch length) was lower in Gimbo district than, Decha and Chena districts, which had similar values. Eggs incubated per hen/clutch in Decha, Chena and Gimbo districts were 10.2, 10.2 and 10, respectively. The hatchability percentages of chickens reared in Gimbo district was significantly ($P < 0.05$) lower than Decha chickens and has comparable with Chena district chickens. District had no significant effect ($P > 0.05$) on survivability of chicken. In general, the average egg and clutch number per hen per year in the current study were 44 and 3.6, respectively.

Table 4. Performance of indigenous chickens in three districts of Kaffa Zone of South Western Ethiopia (mean ± SD)

Parameters	Decha	Chena	Gimbo	Overall mean
Age at first egg (months)	6.0±0.43^b	6.1±0.55^b	6.30±0.69^a	6.1±0.56
Egg number per hen/clutch	12.3±1.43	12.2±1.64	12.6±2.07	12.3±1.68
Clutch length/hen(days)	21.0±5.1^a	21.0±5.7^a	19.0 ±5.86^b	20.0 ±5.3
Clutch no per hen/year	3.60±0.2	3.60±0.2	3.65±0.21	3.60±0.2
Total egg number per hen/year	44 ±5.3^{ab}	43.4±5.7^b	45.6±7.12^a	44.0±6.0
Eggs incubated per hen	10.2 ±0.94	10.2 ±0.88	10.0 ±1.2	10.2±1.0
Number of chicks hatched	8.34 ±1.1	8.21±0.94	8.0 ±1.44	8.20 ±1.2
Hatchability (%)	81.6 ±7.0^a	80.3 ±5.5^{ab}	78.6 ±8.9^b	80.5±7.3
Number of chick survived	4.10±0.71	4.01±0.88	3.90±0.97	4.00 ±0.8
Survivability (%)	49.1±8.7	48.8±10.0	49.8±10.3	49.2±9.5

$^{a, b}$ *Row means with different superscript letters are significantly different (P < 0.05); SD = standard deviation*

Husbandry Practices of Chickens
Management Systems
Chicken management systems practiced in the three districts is presented in Table 5. The current study has revealed that scavenging/free-ranging as the main production systems practiced in all the study districts.

Housing System
Housing system had significantly differed (p<0.05) among the studied districts. As presented in Table 5, about 60.7 % of households keep their chicken in the kitchen while 30.7 % of them shared their main houses with their

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chicken and other farm animals.

Feed and Feeding Practices
In the current study, supplementary feeding for chickens was provided in all study districts. In Gimbo, all the interviewed households provide supplementary feeds to their chickens, whereas 98.6 and 97.5 % in Decha and Chena districts respectively provide supplementary feeds. The major supplementary feed in the study districts was Maize (55.7 %) followed by Sorghum (20.3 %) and Wheat (10.3 %). The majority (39.7 %) provide feed twice per day.

Watering practices
With regard to provision of water in the current study, all respondents in Gimbo district provide water while 98.6 and 97.5 % of them in Decha and Chena districts, respectively provide water for their chickens. In the study districts river water was the major source of water (69.3 %) followed by Borehole water (22.3 %).

Table 5. Chicken husbandry practices in three districts of Kaffa Zone, South Western Ethiopia.

Parameters	Decha	Chena	Gimbo	Overall (%)	X^2- test
Management system					ns
Scavenging/free-ranging	140(100)	80(100)	80(100)	100	
Housing system					9.7^*
In the kitchen	91(65)	38(47.5)	53(66.3)	60.7	
Main houses	41(29.3)	32(40)	19(23.7)	30.7	
Mud houses	8(5.71)	10(12.5)	8(10)	8.67	
Supplementary feeding					1.9^{ns}
Yes	138(98.6)	78 (97.5)	80(100)	98.7	
No	2(1.43)	2(2.50)	NR	1.33	
Frequency of feeding					38.3^{**}
Once a day	18(12.8)	16(20)	32(40)	22	
Twice a day	49(35)	34(42.5)	36(45)	39.7	
Three or more time a day	71(50.7)	28(35)	12(15)	37	
None	2(1.43)	2(2.50)	NR	1.33	
Feed supplements (%)					35.8^{**}
Maize	74(52.8)	37(46.3)	56(70)	55.7	
Sorghum	27(19.3)	28(35)	6(7.50)	20.3	
Wheat	13(9.29)	4(5)	14(17.5)	10.3	
Barley	21(15)	7(8.75)	2(2.50)	10	
Teff	3(2.14)	2(2.50)	2(2.50)	2.33	
No feed	2(1.43)	2(2.50)	NR	1.33	
Watering Practices (%)					1.9^{ns}
Yes	138(98.6)	78(97.5)	80(100)	98.7	
No	2(1.43)	2(2.50)	NR	1.33	
Source of water (%)					72.8^{**}
Bore hole	10(7.14)	15(18.7)	42(52.5)	22.3	
Well	7(5.00)	12(15)	2(2.50)	7.33	
River	121(86.4)	51(63.7)	36(45)	69.3	
No water	2(1.46)	2(2.50)	NR	1.00	

X^2-test= chi-square test; ns = non- significant; $*p<0.05$; $**p<0.01$; NR, not Reported;
Numbers in parenthesis are percentage values

Production Constraints of Indigenous Chicken in the Study Area
Data pertaining to constraints in chicken production is presented in (Table 6). Predators were the most important problem reported to be affecting poultry productivity in all the study districts accounting for 74.3, 80 and 62.5 % in Decha, Chena and Gimbo districts, respectively. Disease was the second constraint as reported by 25.7, 20 and 37.5 % of respondents in Decha, Chena and Gimbo districts, respectively. In all the production constraints reported, significance differences ($P< 0.05$) were observed among the study districts.

The type of predators commonly occurring in the study districts were significantly differed (P < 0.05) across the different sites. These predators, which are mentioned by their scientific and local name included *Milvus migrants* locally known as "Gace", *Helogale hirtula* locally known as "Shiifoo" or "Wociwoco", *Leptailurvs serval* locally known as "Hallaroo" *and Felis silvestris* locally known as "Kubbi Kullaaro" accounted for about 54.6, 24.4, 15.5, and 4.58 %, respectively. In addition, *Papio anubis* locally known as "Sheexxo" (4%) was also reported from Gimbo districts which cause loss of chickens.

The prevalence of chicken diseases in Decha and Gimbo districts was higher with 98.6 and 97.5 %, respectively and in Chena 88.7 % (Table 6). Season had significant effect ($p < 0.05$) on the occurrence of disease and highest outbreak was recorded on rainy season, as witnessed by 71.8, 53.2 and 52.1 % of respondents in Gimbo, Chena and Decha districts, respectively. This indicates rainy season was more favorable for the growth of disease causing agents across the study districts. Overall, the chi-square test suggests there was significant differences ($p < 0.01$) in the prevalence of disease and in favorable season of disease occurrences ($p < 0.05$) across the study districts.

Table 6. Major production constraints of chicken in three districts of Kaffa Zone, South Western Ethiopia

Parameters	Decha	Chena	Gimbo	Overall (%)	X^2- test
Production constraints (%)					6.5*
Diseases	36(25.7)	16(20)	30(37.5)	27.3	
Predators	104(74.3)	64(80)	50(62.5)	72.7	
Types of predators (%)					19.2*
Milvus migrants (Gace)	63(59.6)	32(50)	25(50)	54.6	
Helogale hirtula (Shiifoo/Wociwocoo)	27(26)	16(25)	10(20)	24.4	
Leptailurvs serval (Hallaroo)	10(10.6)	14(21.8)	9(18)	15.5	
Felis silvestris (Kubbi Kullaaro)	4(3.85)	2(3.13)	4(8)	4.58	
Papio anubis (Sheexxo)	NR	NR	2(4)	0.92	
Prevalence of disease (%)					12.7**
Yes	138(98.6)	71(88.8)	78(97.5)	95.7	
No	2(1.43)	9(11.3)	2(2.50)	4.33	
Favorable season (%)					7.9*
Rainy	75(53.6)	51(63.7))	58(72.5)	61.3	
Dry	65(46.4)	29(36.3)	22(27.5)	38.7	

*X^2- test= Chi- square test; **$p<0.01$; *$p<0.05$; NR, not Reported*
Numbers in parenthesis are percentage values; Names of predators are in their scientific name, and names in brackets are in Kafigna language, official working language of Kaffa Zone.

Effective Population Size and Rate of inbreeding
As presented in Table 7, the overall effective population size (Ne) was found to be 486 while the rate of inbreeding were 0.073, 0.126 and 0.133 % in Decha, Chena and Gimbo districts, respectively with the overall rate of inbreeding 0.111 % across the study areas. In Decha district the percentage value of rate of inbreeding was comparatively lower than Chena and Gimbo districts, however, Chena and Gimbo districts had comparable percentage value. The variation of Ne in the studied district might be due to the small number of cocks kept in the studied households.

Table 7. Effective population size and inbreeding rate of indigenous chicken populations reared in three districts Kaffa Zone, South Western Ethiopia

Study districts	Nm	Nf	N	Nm/Nf (%)	Ne	Ne/N (%)	ΔF%
Decha	238	611	849	39	685.1	80.7	0.073
Chena	139	346	485	40.2	396.7	81.8	0.126
Gimbo	130	336	466	38.7	375	80.5	0.133
Overall	**507**	**1293**	**1800**	**39.3**	**486**	**81**	**0.111**

Ne, Effective population size; ΔF, Rate of inbreeding; Nm = Number of breeding male chicken; Nf = Number of breeding female chicken; Nm/Nf (%) = Ratio of Male: Female chickens in percents; N = Total breeding chicken populations (Nm+Nf); Ne/N (%) = Ratio of breeders contributing efficiently genes to the population.

Discussions
Household Characteristics and Respondents Profile in the Study Area
Household Characteristics of the Study Area
In the present study the highest percentage of females (71.1) than males (28.9) was observed, which was in agreement with the results of various scholars in the country (Moreda *et al.,* 2013; Hailemichael, 2013; Wondu *et al.*, 2013). However, the highest value of males (62%) was reported by Mulgeta and Tebikew (2013). The result on educational level obtained in the current study with higher illiterate (56%) was also in line with the findings of different scholars (Halima *et al.*, 2007; Moreda *et al.,* 2013; Hailemichael, 2013; Wondu *et al.*, 2013). The average family size in the present study (5.86) was in close agreement with the findings of Halima *et al.* (2007), Emebet *et al.* (2013) and Hailemichael (2013). Lower family sizes: 4.5 and 4.06 person per households was reported by Mulgeta and Tebikew (2013) and Solomon *et al.* (2013), respectively. From the present findings and the reports from various parts of the country, it is clear that, female farmers are the main to care and manage chickens. Hence,

it is important to empower women's through better education as they are the most to contribute a significant role in the improvement of indigenous chicken production systems. In line with this Halima *et al.* (2007) also indicated that, educating women will improve the overall socio-economic status of the family and the society.

Livestock Ownership and Flock Characteristics
The average cattle (3.4), sheep (2.4) and goat (0.9) number per household in the study area were comparable with the reports of Hailemichael (2013). However, those reported by Emebet *et al.* (2013) and Solomon *et al.* (2013) are higher than the present study. The result on average chicken flock size (8.68) per household in the current study was comparable with the reports of Nebiyu *et al.* (2013) who reported 8.5 chickens per household in Hallaba districts of Southern Ethiopia. The number of chickens per household reported by Halima *et al.* (2007) in Northwest Ethiopia (7.1), Aberra *et al.* (2013) in Southern region (7.9) and Mulgeta and Tebkew (2013) in Amhara region (7.76) are also in line with the present study. However, the findings obtained by other scholars in various parts of Ethiopia showed higher values than the present study (Tadele *et al.*, 2003; Wondimu *et al.*, 2013; Deneke *et al.*, 2014). There are also reports that show lower values (4.85 flock size per household) than found in the present study (Moreda *et al.,* 2013). The variations in flock size seen in different parts of the country might be due to the presence of seasonal outbreak of diseases, predators, feed resource availability, economic aspects of the community, environmental conditions and settlement pattern of the societies.

Reproductive and Productive Performance of Indigenous Chickens
The average age at first egg (6.1) of chickens in the current study was in close agreement with the findings of Deneke *et al.* (2014) from the Southeastern Oromia Zone. High age values at first egg of indigenous chickens was reported from various parts of the country by Tadele *et al.* (2003), Aberra *et al.* (2013), Melkamu *et al.* (2013) and Nebiyu *et al.* (2013). Low age at first egg was also reported from Northwest Ethiopia by Addisu *et al.* (2013) and Solomon *et al.* (2013) with 5.6 and 5.2 months, respectively. Different report on age of chickens at first egg might be due to lack of proper supplementary feeds, availability of scavengable feed resources, disease outbreak and provision of clean water by the households.

The present finding with regard to average egg production per clutch per hen (12.3), number of eggs incubated (10.2) and number of chicks hatched (8.2) differed from the results of Melkamu and Andargie (2013), Nebiyu *et al.* (2013) and Solomon *et al.* (2013). However it was in close agreement with the findings of Addisu *et al.* (2013), Mulgeta and Tebikew (2013) and also was comparable with the reports of CSA (2015). Highest value of eggs/clutch/hen was reported from Eastern Gojam Zone by Melkamu and Andarge (2013) 17 eggs/clutch/hen. The average clutch number per hen per year (3.6) and total egg number per hen per year (44) in the current study was comparable with the findings of Addisu *et al.* (2013) which was 3.62 and 46, respectively. However, high values of clutch number and egg number per hen per year were reported by Melkamu and Andargie (2013) and Solomon *et al.* (2013). The management aspects of the households chicken rearing might be the reason contributing for the observed variations in the production and reproduction traits of indigenous chickens in the country.

The average hatchability (80.5 %) of chickens in the current study was comparable with the results of Aberra *et al.* (2013) and Deneke *et al.* (2014) in which the hatchability percentages were 79.1 and 81.5 percents, respectively. However, observations by several scholars in various parts of the country were higher than the present study (Worku *et al.*, 2012; Nebiyu *et al.*, 2013; Solomon *et al.*, 2013). On the other hand, lower hatchability values were reported from various parts of the country (Melkamu and Andargie, 2013; Getachew *et al.*, 2015). The average survival rate of chickens in the present study (49.2 %) was lower than those reported by Aberra *et al.* (2013), Nebiyu *et al.* (2013), Deneke *et al.* (2014) and Getachew *et al.* (2015) with the respective values of 58.3, 52.3, 62.7 and 66.5 percent. These variations in the hatchability and survivability of chicks might be due to storage condition of the egg, incubation materials, quality of eggs, to some extent the hen factors, seasonal outbreak of disease, predator attacks, poor nutrition and management, availability of scavenging feed resources and feed supplements.

Husbandry Practices of Chickens in the Study Area
In the present study, all the studied districts manage their chickens in scavenging system. This findings is in close agreement with the observations of different scholars in various parts of the country, where scavenging was the dominant type of chicken rearing (Melkamu and Andargie, 2013; Nebiyu *et al.*, 2013; Solomon *et al.*, 2013). This management system might be due to the fact that indigenous chickens can best fits as they receive few inputs such as feed supplementation and health care for their survival, production and productivity.

The majority of chickens in the study area are kept in the kitchen (60.7%) and main houses (30.7%) during night time which is in agreement with the reports of Halima *et al.* (2007), Addisu *et al.* (2013), Moreda *et al.* (2013) and Mulgeta *et al.* (2013). A study conducted in western Kenya indicated, similar scenario where majority of the households (73%) in the rural areas kept their chickens in the kitchen or in main houses (Justus *et al.*, 2013).

In the study districts chickens were provided with supplemental feeds (98.7%), which is in line with those

reported by Addisu *et al*. (2013), Melkamu and Tebikew (2013), Mulgeta *et al*. (2013) and Solomon *et al*. (2013).

Water is provided for chicken from different sources such as river (69.3%), Borehole (22.3%) and well (7.33%) which is also common scenario in various areas (Addisu *et al*., 2013; Nebiyu *et al*., 2013; Solomon *et al*., 2013; Wondu *et al.*, 2013). The present study agrees with the findings of Nebiyu *et al*. (2013) and Solomon *et al*. (2013) who noted river water as the major source for chickens. However, the current study disagrees with the reports of Wondu *et al*. (2013) who found that, tap water as the major source (92 %) for chickens reared in Nothern Gonder Zone of Amhara region. Thus, the current study suggests most of the rural society in the studied districts depends mainly on river, borehole or well water due to lack of tap water.

Production Constraints of Chickens in the Study Area

The major constrains of chickens in the study districts were predators (72.7%) and diseases (27.3%). This result is in agreement with the reports of Melkamu and Wube (2013), Alem (2014), Matiwos and Selamawit (2014) where predators were reported to be the major problems in indigenous chickens reared in various parts of the country. In the current study the types of diseases affecting chicken production were not included as farmers could not identify clearly the types of diseases affecting their chickens. However, the various types of predators which are reported in their scientific names and local languages such as *Milvus migrants* locally known as "Gace", *Helogale hirtula* locally known as "Shiifoo" or "Wociwoco", *Leptailurvs serval* locally known as "Hallaroo" *and Felis silvestris* locally known as "Kubbi Kullaaro" accounting 54.6, 24.4, 15.5, and 4.58 %, respectively, which are also reported in various parts of the country. As reported by Alem (2014), Hawk, Genet, Wild cat, Fox and snake were found to be the most important predators occurred in the low and mid land agro ecological zones of central Tigray. Similarly, as reported by Matiwos and Selamawit (2014), Wild cats, Wild Egyptian vulture, Honey bagger and Snakes were being the most challenging predators in Amaro districts. Hence, the various types of predators observed in the current study and elsewhere might be due to the agro ecological suitability of the country for predators.

Effective population size (Ne) and rate of inbreeding (ΔF)

To obtain some idea on the Ne and rate of inbreeding over generations, Ne was calculated based on the total chicken flocks of farmers who possessed their own breeding male and female chickens. The Ne in the current study ranged from 375 to 685 with the average Ne of 486 implying number of breeding individuals were comparatively low. According to Maiwashe *et al*. (2006) Ne is a measure of genetic variability within a population where large values of Ne indicate more variability and small values of Ne indicate less genetic variability. The low Ne estimated in the current study suggests that the breeding population might be too small. Even if neighboring flocks were scavenging together, which gives an opportunity for breeding cocks to mate with hens, the number of cocks per flock is still considered lower than required.

Effective breeding population size and the corresponding ΔF reported by Nigussie *et al*. (2010) by considering the average mean flock size of chickens for Mandura, Horro and Konso, village chickens, Eskindir *et al*. (2013) from Jarso districts and Hailemichael (2013) for Endamehari, Ofla and Raya- Azebo districts' chicken population were in agreement with the present study. However, the report of Eskindir *et al*. (2013) from Horro districts (3.73) was lower than the current study due to the fact that they considered the average flock size rather than taking the total number of chickens in computing both parameters, *i.e*., Ne and ΔF. However, the result reported by Hagan *et al*. (2013) from Ghana for Coastal, Forest and Guinea Ecological Zones which were 13.3, 11.3 and 12.9 respectively had three fold higher than those reported in Ethiopia. The current study was also in similar scenario with the result reported by Rusfidra *et al*. (2014).

The average rate of inbreeding (0.111%) in the current study was in good agreement with the reports of various scholars in the country. Hailemichael (2013) reported 0.16, 0.15 and 0.14 rate of inbreeding for Endamehari, Ofla and Raya-Azebo districts of chicken population, respectively. The rate of inbreeding reported by Eskindir *et al*. (2013) falls in the range of 0.13 to 0.12 which is in line with the current study. The rate of inbreeding values reported by Hagan *et al*. (2013) was comparable with the observed values in Decha chicken populations. According to Henson (1992), the acceptable level of inbreeding rate per generation is between 1% and 2%. Therefore, the rate of inbreeding obtained from the current study was low which suggests that chicken populations in study area are not exposed to inbreeding.

Conclusion and Recommendations

The current study indicated scavenging as the major chicken production systems practiced across all the study districts. Majority of the respondents in the study area provide supplementary feed and water to their chickens. The results on productive performances of chickens obtained in the present study were comparable with the reports of many scholars and also in line with the national reports of CSA (2015) under scavenging system. The major production constraints were predators and diseases across the studied districts. The result relating to effective population size and rate of inbreeding obtained in the present study indicates the chicken populations are not exposed for inbreeding. Therefore, appropriate intervention strategy should be carried out to effectively utilize

the existing potentials of indigenous chicken populations in combination with conservation of chickens before they have been diluted with exotic chicken breeds.

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