Journal of Agriculture and Environmental Sciences

Research Article

Productivity, economic performances and survivability of exotic chicken breeds under small-scale chicken production system in South Gondar Zone, Ethiopia

Birtukan Matebie[1], Fisseha Moges[2], Asaminew Tassew[2] and Firew Tegegne[2,*]

[1]Office of Agriculture, Addis Zemen District, South Gondar Zone, Ethiopia
2 Department of Animal Sciences, College of Agriculture and Environmental Sciences, Bahir Dar University, P O Box 5501, Bahir Dar, Ethiopia
***Corresponding author:** firewtegegne@yahoo.co.uk

Received: November 10, 2023; Received in revised form: November 20, 2023; Accepted: November 20, 2023

Abstract: *The study was conducted to evaluate the growth, survivability and egg production performance of Bovans Brown and SassoT44 commercial chicken breeds reared in small-scale chicken production enterprises in selected districts of South Gondar Zone in Ethiopia. A multi-stage sampling technique was used to collect data in the year 2019. A total of 21 small-scale chicken farms and 350 chickens were selected for the survey and monitoring-data collection, respectively. The survey data was analyzed using SPSS Version 20 and the GLM procedure of SAS 9.2 was used for the monitoring data. The majority of the producers (71.4%) reared Sasso T44 breed. Most of the farms (90.5%) used commercial feed even though they are challenged by feed shortage and increased feed cost. The interaction effect of breed-district was significant on the body weight and daily weight gain of chickens that the body weights of Sasso T44 chickens at different ages in Addis Zemen district was significantly higher than the other two districts. The overall mortality rate of the chickens up to the 22th weeks of age was 13.2% and 11.5% for Sasso T44, and Bovans Brown, respectively. The average egg production per hen up to the 45th weeks of age was significantly ($P<0.05$) higher for Bovans than Sasso T44. The overall hen day egg production in the first phase (up to the 45th weeks of age) was 65.6% and 57.8% for Bovans Brown and Sasso T44, respectively. There was a significant difference ($P<0.0001$) in age at first egg between the two breeds that Bovans Brown (132 days) was better than Sasso T44 (164 days) breed. In general, chicken in Addis Zemen performed better both in growth and egg production. Sosso T44 breed was better in growth performance while Bovans Brown were better in egg production traits.*

Keywords: Addis Zemen, *Bovans Brown, Chicken breed, Sasso T44*
Citation: Matebie, B., Moges, F., Tassew, A., and Tegegne, F. (2023). Productivity, economic performances and survivability of exotic chicken breeds under small-scale chicken production system in South Gondar zone, Ethiopia. J. Agric. Environ. Sci. 8(2): 91-110. https://dx.doi.org/10.4314/jaes/v8i2.6

1. Introduction

The total chicken population in Ethiopia is estimated to be about 57 million, of which 88.19 %, 6.45 % and 5.36% were reported to be native, cross and exotic chickens, respectively, reared in the backyard, small-scale, and large-scale commercial poultry production systems (CSA, 2021). Despite the huge poultry population, the annual output is only 60,000 metric tons of meat and 40,000 metric tons of egg and the per capita consumption of poultry eggs and meat in

Ethiopia is one of the lowest in the world i.e. 0.4 kg eggs and 0.6 kg of chicken meat per annum (FAO, 2013).

Despite this low consumption, meeting the chicken meat and egg demand for its growing population cannot be achieved using native chickens, due to their lower production performances as compared to exotic ones. Even though the productivity of indigenous chickens can be increased to a certain level through better housing, feeding and management systems, it is difficult to reach an economically acceptable level without genetic selection, upgrading the local breeds and adopting tropically adapted exotic chickens. To enhance the productivity of the poultry sector, introducing highly productive exotic and tropically adapted chickens from different sources and an intensive small-scale performance evaluation should be undertaken. Since the first introduction of exotic chicken in Ethiopia, higher learning institutions, research organizations, the Ministry of Agriculture and certain Non-Governmental Organizations (NGOs) have disseminated many exotic breeds of chicken to rural farmers and urban-based small-scale poultry producers.

Small-scale chicken production is an obvious and well-documented opportunity for poor farmers to start an income-generating activity. Poultry is cheap, easy to rear, and easy to manage. Consequently, there is growing attention and interest in poultry production in villages as well as in peri-urban and urban areas throughout the developing world (FAO, 2009). There are several emerging small-scale poultry farms in Ethiopia in general and South Gonder in particular. These emerging farms have an important contribution in improving the livelihood, food security and poverty reduction as well as provide a good return in peri-urban and urban areas of the country. Among the constraints, the availability and cost of feed ingredients stand at the forefront (Bezabih and Tesfaye, 2013). The feed cost accounts for 65.5% of the total cost of production (Maoba, 2016). In addition to the availability and cost of feed ingredients, breed and environment are factors that affect small-scale production. The growth and production traits of a chicken indicate its genetic constitution and adaptation with respect to a specific environment.

In general, information on management practices and major constraints, growth and egg production performances and survivability of existing exotic chicken under small-scale production systems in Ebinat, Addis Zemen and Debre Tabor districts is lacking. Information on the husbandry practices of the farms is vital to take corrective measures for maximum output with minimum input and assure profitability. Therefore, this study was conducted to investigate the production system, growth, survivability and egg production performance of existing exotic chickens under small-scale production systems in different agro-ecology of South Gondar Zone, Amhara Region, Ethiopia.

2. Materials and Methods

2.1. Description of the study area

The study was conducted in three selected districts (Ebinat, Addis Zemen and Debre Tabor) of South Gondar Zone, Amhara Region, Ethiopia (Figure1). Crop-livestock production system is the main source of livelihood in the South Gondar zone. The main livestock species kept by farmers include dairy cattle, beef cattle, and chicken.

2.2. Study population

For this study, all small-scale layer farms and farm owners who started poultry production on their own initiation and those organized by small and micro enterprises in Ebinat, Addis-Zemen and Debre-Tabor Districts were involved.

2.3. Sampling procedure and sample size

Before undertaking the sampling, background information on small-scale poultry farms through farm visits together with agricultural experts, and Ethio-chicken distributors and a review of available secondary information was done. A list of all small-scale poultry farms was obtained from the District Agricultural Office and Ethio-chicken distributors. The selection of representative districts and small-scale chicken producers were done using a multi-stage (purposive and random) sampling technique. The first stage involves purposive sampling of three districts (out of 11 districts) based on agro-ecology, amount of small-scale chicken-producing farmers and experiences in modern chicken husbandry practices. Accordingly, Ebinat, Addis Zemen and Debre Tabor, representing low land, mid land and high land, respectively, were selected for the study. In the second stage, small-scale layer producers were selected randomly from the registered list of urban poultry farms as a sample frame from each selected district. All small-scale poultry farms (21) in the area were considered for survey data. From 21 small-scale poultry farms 10 poultry farms were selected for monitoring due to the time of the entry of DOC (day-old chicken), the similarity of the management system and the voluntariness of the enterprises to allow us to enter their farm. Thus, three from Ebinat, three from Addis Zemen and four from Debre Tabor registered small-scale chicken poultry producers were randomly selected.

The sample size for each sample farm or the maximum number of chickens was used for monitoring and evaluation in each farm as determined using 10% of its population in each farm. Accordingly, 105, 105 and 140 chickens were used for the districts Ebinat, Addis Zemen and Debre Tabor, respectively.

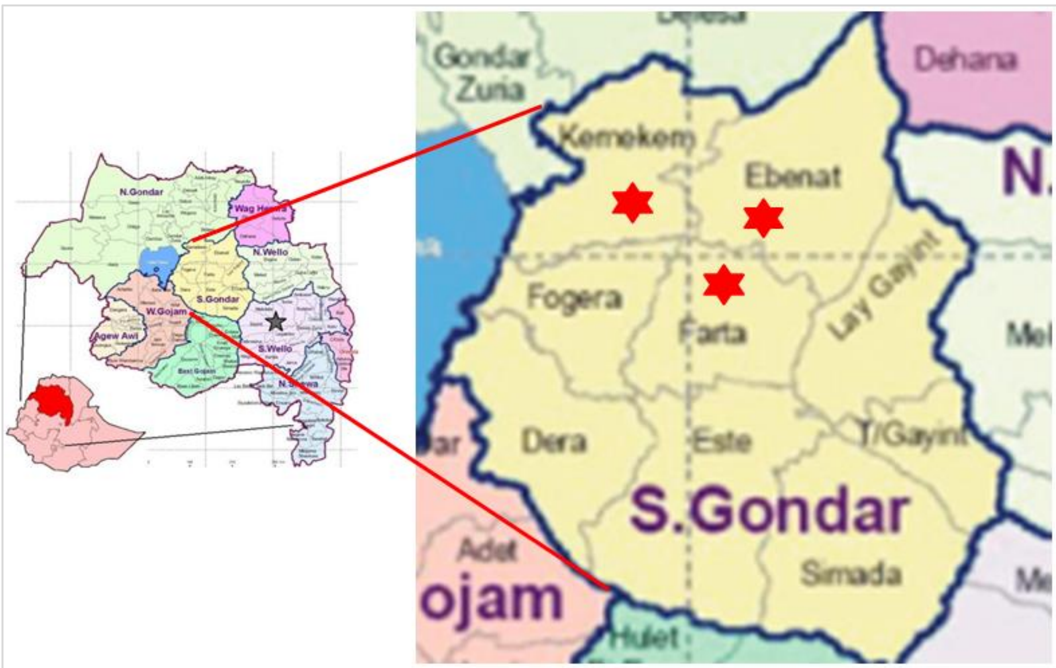

Figure 1: Location map of the study areas (study districts)

Source: Geographic Information System (GIS)

2.4. Methods of data collection

Both primary and secondary data sources were used. Primary sources include questionnaire survey data, and monitoring while secondary data sources include data collected from the Regional and District Agricultural office report, published and un-published documents, books, proceedings, and journals.

2.4.1. Survey

A semi-structured questionnaire was used to generate data on the history of producers, the assessment of the general husbandry practices (housing, feeding, watering, marketing, health) farm profitability, constraints and opportunities of the production for further expansion in the study area were collected from household heads (owners of the farms) and leaders of the farm (organized by small and micro enterprises) through different questionnaires and personal observation.

2.4.2. Data monitoring

Data on growth, mortality (survivability) and egg production performance of existing exotic chicken under small-scale farms were collected using regular measurement and monitoring. Information regarding growth performance data in terms of day-old body weight, final body weight, total body weight gain, and gain per bird per day were recorded at 14-day intervals using a digital sensitive weighting balance.

Mortality was also recorded in both regimens over the rearing bi-weekly interval for 22 weeks. Egg production performance was recorded in seven day intervals up to the 45th week of age. The age of sexual maturity was determined as the age when the first egg was laid. All the chicks were weighed separately to determine day-old chick weight. Final body weight was taken at the 22th week of age. Body weight gain was calculated as a difference between the final body weight of birds and day-old chick weight. Gain per bird per day is determined by dividing the body weight gain by total number of days to attain the final body weight.

Egg production performance was calculated on a Hen-Day Egg Production (HDEP) using the formula below.

$$HDEP = \left(\frac{Total\ eggs\ produced\ in\ a\ day}{Total\ hens\ present\ in\ that\ day}\right) * 100 \qquad [1]$$

2.5. Data analysis

The data collected through the survey were analyzed using Statistical Package for Social Science Version 20 software. The monitoring data were subjected to the analysis of variance (ANOVA) using the general linear model (GLM) procedure of the Statistical Analysis Systems software (SAS, 2008) Version 9.2. When treatment effects were found to be significant ($P<0.05$), mean separation was undertaken using Duncan's Multiple Range Test.

$$Yijk = \mu + Ai + Bj + ABij + eijk \qquad [2]$$

Where,

Y_{ijk} = the observed k variable in the ith breed and jth district

μ = overall mean of the observed variables

A_i = effect due to i^{th} breed (i = Bovans Brown and Sasso T44)

B_j= effect due to jth district (j = Ebinat, Addis Zemen and Debre Tabor)

AB_{ij} = interaction effect of ith breeds and jth districts

e_{ijk} = random residual error

3. Results and Discussion

3.1. Socio-economic characteristics

The overall mean age of the producers in the study districts was 32.05±4.14 years (Table 1). The result is lower than the report of Nusirat *et al*. (2012), and Yemane *et al.* (2016a), who indicated that in urban and peri-urban areas, the small-scale commercial poultry production was run by 31-55 age groups.

Of the total 21 small-scale chicken producers, 71.4% were females and 28.6% of them were males. The small-scale chicken farm operation in the study area was largely run by females than males. The higher involvement of females in small-scale chicken farms in the study districts might be due to the low labor, low energy and low initial capital requirements compared to other investments, limited access to other job opportunities and affection for the job. The current result was in line with Yemane *et al*. (2016a) who reported that females were involved in poultry farming more than males in Addis Ababa, Ethiopia. It was also reported that almost 52% of the farms were owned by women (Muhammad *et al*., 2010).

The analysis of the educational profile of small-scale chicken producers indicated that the majority were above 12 grade (38.1%), followed by those who attended formal high school level (grade 9-12) (23.8%) and 14.3% were 5-8 grade and read and write. The educational profile of small-scale producers results in the majority were above 12 grade this result was in agreement with the result reported by Melkamu (2017) that more than one-third of small-scale farming was run by first-degree graduates.

The survey result revealed that the majority of small-scale producers (57.1%) were married whereas the remaining (33.3% and 9.5%) of the producers were single and divorced, respectively in the study districts. The number of farm producers involved in poultry production in the current study was lower than that reported by Charles *et al*. (2013) and Aromolaran *et al.* (2013), who reported 75% and 63.3% married poultry producers, respectively.

More than half (66.7%) of the producers had experience of less than 2 years while the rest (23.8% and 9.5%) of the producers had 2-5 and 5-10 years of previous experience respectively. The farm experiences in the study districts were lower than the reports of Charles *et al.* (2013), who reported 41.7% of the producers had 1-5 years of experience. Also, Aromolaran *et al.* (2013) reported that 65% of the small-scale producers had less than five years of experience.

About 47.6% of the producers had no off-farm activity while the rest 33.3% and 19% of the producers had private work and governmental work in addition to poultry farms. The result indicates more than half (52.4) of the producers work small-scale poultry farms in addition to other work.

Table 1: Socio-economic characteristics of the respondents

Variables	Districts			Total n (%)
	Ebinat n (%)	Addis Zemen n (%)	Debre Tabor n (7)	
Age (mean ±SD)	31.00±4.39	33.71±4.78	31.00±3.15	32.05±4.14
Respondent sex				
Male	3 (42.9)	3 (42.9)	2 (28.6)	8 (38.1)
Female	4 (57.1)	4 (57.1)	5(71.4)	13 (61.9)
Educational status				
Illiterate	0 (0)	0 (0)	1 (14.3)	1 (4.8)
Read and write	1 (14.3)	1 (14.3)	1 (14.3)	3 (14.3)
< grade 4	0 (0)	0 (0)	1 914.3)	1 (4.8)
5-8 grade	1 (14.3)	2 (28.6)	0 (0)	3 (14.3)
9-12 grade	2 (28.6)	1 (14.3)	2 (28.6)	5 (23.8)
Above 12	3 (42.9)	3 (42.9)	2 (28.6)	8 (38.1)
Marital status				
Single	2 (28.6)	3 (42.9)	2 (28.6)	33.3
Married	5 (71.4)	3 (42.9)	4 (57.1)	12 (57.1)
Divorced	0 (0)	1 (14.3)	1 (14.3)	7 (9.5)
Experience in chicken rearing				
> 2 years	6 (85.7)	5 (71.4)	2 (28.6)	13 (66.7)
2-5 years	1 (14.3)	1 (14.3)	4 (57.1)	6 (23.8)
5-10 years	0 (0)	1 (14.3)	1 (14.3)	2 (9.5)
Off-farm activity				
No off-farm activity	3 (42.9)	3 (42.9)	4 (57.1)	10 (47.6)
Private work	2 (28.6)	3 (42.9)	2 (28.6)	7 (33.3)
Governmental work	2 (28.6)	1 (14.3)	1 (14.3)	4 (19)

Note: n-number of respondents; % - Percentage

3.2. Source of chicken breed and finance

The overall result showed that the majority of the producers used Sasso T44 breed (71.4%) chicken while the rest (28.6 %) used Bovans Brown (Table 2). The major sources of day-old chicks in the study district were private (90.5%) poultry farms. This might be due to the lack of self-replacing and brooding/mothering ability of such exotic hens. Private large-scale commercial poultry farms in the study districts were the major sources of day-old chicks, which was in agreement with the report of Demeke (2007) and Nzietchueng (2008), where large-scale commercial farms and occasionally government-owned breeding and multiplication centers provided for most small-scale commercial poultry farms. Similarly, other scholars reported that more than 90% of the small-scale farms in different parts of the country obtained their birds from commercial hatcheries (Uduak *et al*., 2014; Yemane *et al*., 2016a; Desalew *et al*., 2013).

About 66.7%, 19.0% and 14.3% of producers run their farms using their own finance, cooperatives, and family or friends, respectively in the study district. The source of finance for small-scale poultry farm operations in the current study was in line with reports of Fred *et al*. (2011), who noted that the source of capital was from borrowing, own savings, and gift and inheritance making 22.5, 70, and 7.5% respectively in urban and peri-urban areas. The same result was reported by Akanni (2007) that 61% of the small-scale poultry farm operators sourced their finance internally from personal savings while 20% sourced funds from loans obtained from co-operative societies and 10.28% could secure bank loans. Similarly, Ahmed *et al*. (2011) reported that 79% of respondents obtained capital for their business from family sources, 18% from personal savings and 3% got their capital from bank loans and none from cooperative sources.

Generally the money obtained from different sources was used to purchase day old-chicks, feeds from day-old to the final production period, transportation and medication. A similar result was reported by Fred *et al*. (2011), where about 81% of the total amount of the formal credit accessed was used for purchasing feed, 12% of the total income was used to buy birds and 7% was utilized to purchase vaccines, equipment, land and maintenance costs.

Table 2: Breed type, source of chicks and source of finance in small-scale chicken farms in South Gondar zone

Variable	Districts			Total n(%)
	Ebinat n(%)	Addis Zemen n(%)	Debre Tabor n(%)	
Chicken breed type available				
Sasso T44	5(71.4)	6(85.7)	4(51.7)	15(71.4)
Bovans brown	2(28.6)	1(14.3)	3(42.9)	6(28.6)
Source of Breed				
Private farm	6(85.7)	6(85.7)	7(100)	19(90.5)
Ethio-chicken	6(85.7)	6(85.7)	7(100)	19(90.5)
Local market	1(14.3)	1(14.3)	0 (0)	2(9.5)
Source of finance				
Own income	4(57.1)	5(71.4)	5(71.4)	14(66.7)
Family or friends	1(14.2)	1(14.2)	1(14.2)	3(14.3)
Cooperatives	2(28.5)	1(14.2)	1(14.2)	4(19.0)

Note: n-number of respondents; % - Percentage

3.3. Chicken husbandry practices

3.3.1. Poultry housing system

The overall result showed that more than 57% of the producers reared up the chicks in private (family or own) houses by separating one room, while the rest produced in shades built with the support of the small and micro-enterprise office (28.6%) and in rented houses (14.3%) (Table 3). The housing system in small-scale layer farms is in line with other findings that under an intensive poultry production system, the deep litter management system was the common production system (Akidarju *et al*., 2010; Uduak *et al*., 2014). Similarly, Muhammad *et al*. (2010) noted that small-scale poultry producers used a deep litter management system. The results of the current study were in agreement with that reported by Ahmed *et al.* (2011), where the majority of the women producers practiced deep litter management systems whilst very few kept their birds in battery cages.

The majority (85.7%) of the chicken houses in the study districts had soiled floors, which is in line with the results of Yemane *et al*. (2016b) who reported that about 84.4% of the small-scale intensive poultry houses in Addis Ababa had non-cement floors. Similarly, Bezabih (2017) reported that about 77.6% of the small-scale farms in and around Debre Markos had a soiled floor. However, contradicting results were reported by Ekenma (2015), where the majority (96.6%) of the poultry houses had concrete floors.

Table 3: Housing for small-scale chicken in south Gondar zone

Variable	Districts			Total n(%)
	Ebinat n(%)	Addis Zemen n(%)	DebreTabor n(%)	
Source of house				
Private(family or own)	5(71.4)	4(57.1)	5(71.4)	12(57.1)
Small and micro office	2(28.6)	2(28.6)	2(28.6)	6(28.6)
Rented	1(14.3)	1(14.3)	1(14.3)	3(14.3)
The house consider # of chicken				
Yes	6(85.7)	5(71.4)	5(71.4)	16(76.2)
No	1(14.3)	2(28.60	2(28.6)	5(23.8)
The house consider age of chicken				
Yes	6(85.7)	6(85.7)	6(85.7)	18(85.7)
No	1(14.3)	1(14.3)	1(14.3)	3(14.3)
The house consider ventilation				
Yes	4(57.1)	5(71.4)	5(71.4)	14(66.7)
No	3(42.9)	2(28.6)	2(28.6)	7(33.4)
Floor-type				
Concert	1(14.3)	2(28.6)	0(0)	3(14.3)
Soiled	6(85.7)	5(71.4)	100(100)	18(85.7)

Note: n-number of respondents; % - Percentage

3.3.2. Feed resource and feeding practices

The result showed that about 95.2% of the producers provide commercial feed to chicken of which 90.5% provide commercial feed only and 9.5% provide both commercial and homemade feed (Table 4). The current results agree with the report of Nusirat *et al*. (2012), Uduak *et al*. (2014) and Ekenma (2015), who reported that small-scale commercial poultry producers used commercial feeds. The main source of poultry feed for small-scale chicken production farms in the study Districts was in line with Nzietchueng (2008) where most of small-scale poultry farms obtained their feed from large-scale commercial farms. The results were also in line with that of Yemane *et al.* (2016a), small-scale poultry farms feed source from private feed manufacturers and large-scale commercial farms. About 57.1% of the producers provide feed to their chicken three times a day during morning, afternoon and evening. The other 28.6% of the producers provide feed four times per day during the morning, after noon, evening and at mid night.

The overall feed intake per bird and feed intake per bird per day were significantly ($P<0.05$) different among breeds of chicken. Sasso T44 breed had higher overall feed intake per bird (8.23±3.9 kg) and feed intake per bird per day (53.09±0.00 g) than Bovans Brown (7.81±0.6 kg and 50.7±0.03 g), respectively (Table 5). The feed intake of Bovans brown breed in the present study is lower than the reports of Melkamu *et al.*, (2017) where the overall feed intake per bird and feed intake per bird and per day of Bovans Brown were 9.4±0.2kg and 61.0±3.2g, respectively, under intensive management while 7.9±0.3 kg and 51.3±4.1 g, respectively, under backyard management system in Mekelle, Ethiopia.

Table 4: Feed and feeding practices in small-scale commercial farms in south Gondar zone

Variable	Districts			
	Ebinat n(%)	Addis Zemen n(%)	DebreTabor n(%)	Overall n(%)
Provide commercial feed				
Yes	1(14.3)	7(100)	1(14.3)	19(90.5)
No	6(85.7)	0(0)	6(85.7)	2(9.5)
Type of feed				
Commercial feed only	6(85.7)	7(100)	6(85.7)	19(90.5)
Commercial and home made	1(14.3)	0(0)	1(14.3)	2(9.5)
Source of feed				
Commercial farm	7(100)	7(100)	6(85.7)	20(95.2)
Governmental farm	0(0)	0(0)	1(14.3)	1(4.8)
Frequency of provision				
Twice	1(14.3)	1(14.3)	1(14.3)	3(14.3)
Thrice	4(57.1)	4(57.1)	4(57.1)	12(57.1)
Fourth	2(28.6)	2(28.6)	2(28.6)	6(28.6)
Time of provision				
Morning and afternoon	1(14.3)	1(14.3)	1(14.3)	3(14.3)
Morning, afternoon and evening	4(57.1)	4(57.1)	4(57.1)	12(57.1)
All time	2(28.6)	2(28.6)	2(28.6)	6(28.6)

Note: n-number of respondents; % - Percentage

Table 5: Feed intake of Bovans Brown and Sasso T44 breed in the study area

Variables (up to 22 weeks)	Bovans Brown (Mean±SD)	Sasso T44 (Mean±SD)
Overall feed intake/bird (kg)	7.81 ± 0.6^{b}	8.23 ± 3.9^{a}
Feed intake /bird/day (g)	50.7 ± 0.03^{b}	53.09 ± 0.00^{a}

Note: $^{a, b,}$ = means with different superscripts in a row are significantly different at $p<0.05$

3.3.3. Source of water and watering system

All poultry producers in the study district provided water regularly. About 95.2% water is sourced from well water and the rest is sourced from tap water (Table 6). According to Carroll (2012), offering pipe water was preferred, but if bore or surface water from a dam or river is used then the quality of water must be tested and allowed for use.

The overall result shows that the frequency of water provision about 61.9%, 23.8% and 14.2% of the producers provided water at all times, i.e. morning, and morning and evening in *ad libitum* or freely, twice a day and once a day, respectively.

3.3.4. Chicken health and vaccination systems

All producers vaccinated their chicks against Newcastle disease and Gumboro either four times or more than four times (Table 7). The current finding was higher than Melkamu (2019) who reported that the majority of the producers (46.9%) vaccinated their chicks more than four times under the small-scale production system in and around Debre Markos. According to Dessalew (2012) the majority of the respondents (78.8%) in the Ada'a district did not vaccinate their chicken. Most of the respondents (80%) in the Lume district vaccinated their chicken against Newcastle disease, infectious Bursal disease, fowl typhoid and fowl pox .

The use of anti-ectoparasites was practiced by 81% of the respondents under the small-scale chicken production system in the study districts.

Table 6: Sources of water and watering frequency of small-scale farms in the study areas

Variable	Districts			Total n(%)
	Ebinat n(%)	Addis Zemen n(%)	Debre Tabor n(7)	
Water provision				
Yes	7(100)	7(100)	7(100)	21(100)
Source of water				
Well water	7(100)	7(100)	6(85.7)	20(95.2)
Tap water	0(0)	0(0)	1(14.3)	1(4.8)
Time of provision				
Morning	0(0)	2(28.5)	1(14.3)	3(14.2)
Morning, afternoon	3(42.9)	1(14.3)	1(14.3)	5(23.8)
All times	4(57.1)	4(57.1)	5(71.4)	13(61.9)
Frequency of provision				
Once a day	0(0)	2(28.5)	1(14.3)	3(14.2)
Twice a day	3(42.9)	1(14.3)	1(14.3)	5(23.8)
Ad libitum	4(57.1)	4(57.1)	5(71.4)	13(61.9)

Note: n-number of respondents; % - Percentage

Table 7: Vaccination and anti-ectoparasite application in the study areas

Variables	Districts			Total n(%)
	Ebinat n(%)	Addis Zemen n(%)	DebreTabor n(%)	
Vaccination				
Yes	7(100)	7(100)	7(100)	21(100)
Frequency of vaccination				
Fourth times	2(28.6)	1(14.3)	2(28.6)	5(23.8)
>Forth times	5(71.4)	6(85.7)	5(71.4)	16(76.2)
Anti-ectoparasites				
Yes	5(71.4)	6(85.7)	6(85.7)	17(81)
No	2(28.6)	1(14.3)	1(14.3)	4(19)

Note: n-number of respondents; % - Percentage

3.3.5. Marketing of chicken and eggs

The majority (71.4%) of the producers did not have strategic market linkage to sell egg and chicken. These producers sold the eggs and chicken by searching the market on their own and through promotion (Table 8). Different from this result, Bezabih (2019) reported that nearly 51% of the producers sold their chicks to other farmers through Agriculture Offices in small-scale poultry farms in and around Debre Markos.

Most of the small-scale producers sell their chickens and eggs to middle men (42.9%) and directly to consumers (23.8%) at local market, nearby town and neighboring village.

Plastic containers and cartons were the major materials (42.9%) used to store eggs before selling while only a few (14.3%) of the producers stored the eggs using egg trays.

3.3.6. Biosecurity *measures*

The overall results showed that about 33.3% of the producers used footbaths using formalin and sodium hypochloride solutions in front of their farm entrance (Table 9). The biosecurity of the study area was generally low. This might be due to lack of knowledge/awareness about the use of biosecurity measures and their benefits. The current result showed that the use of footbaths in front of the farm entrance was lower than the results reported by Birhanu *et al. (*2015) and Uduak *et al*. (2014), where 80% and 66% of the farms applied footbath at the entrance door in small-scale poultry farms. In the present study, only 33.3% of the producers were wearing protective clothes. About 90.5% wore shoes during the man`s entry in to the farm. Overall, the biosecurity measures of using protective clothes, shoes, and footbath in the study districts are in line with the report of Nusirat *et al*. (2012) who noted that more than two thirds of the producers used any form of protective clothing on their farms. However, the use of protective clothes was lower than the report of Haftom *et al*. (2015), who noted that 76% of the producers in and around Mekelle in small-scale commercial poultry farms used separate clothes and shoes. Also, the current result contradicted Adedeji *et al.* (2014) who indicated that about 78.95% of the producers practiced biosecurity.

Table 8: Marketing of chicken and egg in small-scale chicken production in the study areas

Variable	Districts			Total n (%)
	Ebinat, n (%)	Adiss-Zemen, n (%)	Debre Tabor, n (%)	
Strategic market linkage				
Yes	2(28.6)	2(28.6)	2(28.6)	6(28.6)
No	5(71.4)	5(71.4)	5(71.4)	15(71.4)
Buyers of hens and eggs				
Consumer	2(28.6)	2(28.6)	1(14.3)	5(23.8)
Middle men	3(42.9)	4(57.1)	2(28.6)	9(42.9)
Shopping center	2(28.6)	-	2(28.6)	4(19)
Hotel and restaurant	-	1(14.3)	2(28.6)	3(14.3)
Selling place of hen and eggs				
Local market	4(57.1)	4(57.1)	1(14.3)	9(42.9)
Neighboring village	3(42.9)	2(28.6)	2(28.6)	4(19)
Nearby town	-	1(14.3)	4(57.1)	8(38.1)
Storage of eggs before selling				
Egg trays	-	2(28.6)	1(14.3)	3(14.3)
Plastic container	2(28.6)	3(42.9)	4(57.1)	9(42.9)
Carton	5(71.4)	2(28.6)	2(28.6)	9(42.9)

Note: n-number of respondents; % - Percentage

Table 9: Biosecurity measures of small-scale chicken production farms in the study areas

Variable	Districts			
	Ebinat n (%)	Adiss Zemen n (%)	Debre-Tabor n (%)	Total n (%)
Foot bath				
Yes	2(28.6)	3(42.9)	2(28.6)	7(33.3)
No	5(71.4)	4(57.1)	5(71.4)	14(66.6)
Wearing close (overall)				
Yes	2(28.6)	3(42.9)	2(28.6)	7(33.3)
No	5(71.4)	4(57.1)	5(71.4)	14(66.6)
Wearing shoes				
Yes	6(85.7)	6(85.7)	5(71.4)	19(90.5)
No	1(14.3)	1(14.3)	2(28.6)	2(9.5)

Note: n-number of respondents; % - Percentage

3.3.7. Sanitation and *hygiene*

About 52.4% and 47.6% of the producers used saw dust and rice straw, respectively, as litter material in the study districts (Table 10). These materials are preferred because of their warming potential and thus protecting the chickens from severe cold. The current results are in line with the findings of Ekenma (2015) who reported that more than 50%of the producers used sawdust as a litter material in poultry farms. Adeyemi and Malomo (2014) noted that wood shaving is the most popularly used litter material followed by sawdust, crushed corn cobs and grasses. Different results were reported by Bezabih (2017) that 98% of small-scale producers used teff straw as litter material up to the depth of 6.2 cm in and around Debre Markos. About 33.3% of the respondents were changing the litter material twice per month while around 23.8% of them cleaned the house weekly and monthly, and 14.3% changed the litter material after three months.

About 77.3% of the producers wash the watering trough daily and the rest wash once and more than once per week. Almost 38% of the producers wash the feeders twice per week while 46.7% of the producers wash the feeders at the end of the production cycle. The overall result indicated that about 66.7% had isolation room for disease-infected chicks while 33.3% of them had no isolation room. Cleaning of the floor and the farm equipment in the study districts was in line with the reports of Nusirat *et al*. (2012), where the floor, feeder and watering trough were cleaned in the farm.

Table 10: Sanitation and hygiene in small-scale chicken farms in the study areas

Variable	Districts			Total n(%)
	Ebinat n(%)	Adiss Zemen n(%)	Debre-Tabor n(%)	
Type of litter material				
Rice straw	4(57.1)	3(42.9)	3(42.9)	10(47.6)
Saw dust	3(42.9)	4(57.1)	4(57.1)	11(52.4)
Frequency of clearing				
Weekly	1(14.3)	2(28.6)	2(28.6)	5(23.8)
Twice per month	4(57.1)	1(14.3)	2(28.6)	7(33.3)
Monthly	1(14.3)	3(42.9)	1(14.3)	5(23.8)
1-3 month	1(14.3)	0(0)	0(0)	1(4.8)
>3 month	0(0)	1(14.3)	2(28.6)	3(14.3)
Washing waterer				
Daily	6(85.7)	6(85.7)	5(71.4)	17(77.3)
Once per week	1(14.3)	0(0)	0(0)	1(4.5)
Twice per week	0(0)	0(0)	1(14.3)	1(4.5)
Thrice per week	0(0)	1(14.3)	1(14.3)	2(9.1)
Washing feederer				
Once per week	0(0)	0(0)	1(14.3)	1(4.5)
Twice per week	1(14.3)	4(57.1)	3(42.9)	8(38.1)
Thrice per week	1(14.3)	0(0)	1(14.3)	2(9.1)
At the end of production	5(71.4)	3(42.9)	2(28.6)	10(47.6)
IRFDI				
Yes	5(71.4)	4(57.1)	5(71.4)	14(66.7)
No	2(28.6)	3(42.9)	2(28.6)	7(33.3)

Note: n-number of respondents; % - Percentage; IRFDI-Isolation Room for Disease Infected chicks

3.4. Chicken growth performance

There were highly significant (P<0.05) effects of breeds, districts and breed-district interaction on the growth performance of chickens at 2, 4, 8, 10, 12, and 22 weeks of age (Table 11). This indicates that the growth potential of the chickens was affected by the genetic potential of the breeds, environment and management differences and interaction between breeds and districts.

The current study revealed that the body weight of the Sasso T44 chicken breed in Addis Zemen district was significantly higher than the other breed-district interactions. The body weight of Bovans Brown in the present study is higher than the body weight reported by Bekele (2018). According to the author, the body weight of Bovan Brown was 1.3612 kg at 22 weeks. Similarly, Getiso *et al*. (2017a) reported that matured (>20 weeks) Sasso cock poultry breed attained a minimum and maximum body weights of 1.5 and 4.5 kg with an average value of 2.98 kg in Southern Ethiopia under village production system, which is consistent with the results of current study for Sasso T44 breed.

The average body weight of Sasso T44 was higher than Bovans Brawn at the age of week 0 (at hatch) up to the 22th week. The higher body weight of Sasso T44 might be due to the fact that it is developed for meat while Bovans are dual type.

The body weight of Bovans Brown in this study is higher than that reported by Essatu *et al.*, (2016) which stated that Bovans Brown commercial egg layers showed 902±10.6gm and 1230.1± 6.1gm of body weight at 12 and 16 weeks of age at Debrezeyit research center.

Selecting an appropriate chicken breed which fits to the small-scale chicken production system is crucial to realize success in adopting improved chicken production. The current finding indicates that Sasso T44 breed matured early in Addis Zemen district (mid-altitude). Thus, the breed could be the best candidate for promotion of small-scale enterprises in Addis Zemen district and similar areas.

The body weight of chicken was significantly different between districts (p<0.05) at the age of week 2 up to 22 weeks. Chicken in Addis Zemen (mid-land) weighted significantly higher as compared to Ebinat (lowland) and Debre Tabor (highland) districts (Table 11). The body weight variation in different districts might be due variations in environment and management. Chicken utilize more feed in the highland to keep the body temperature before utilizing feeds for growth than lowland district. The difference in environmental factors may affect the on-farm growth performance evaluation studies since feeding chicken based on the requirements could not be affordable for the producers. However, the response of different breeds for different environmental conditions could be different.

The total body weight gain and average daily body weight gain of chicken were 1657.9±5.50 g/bird and 10.77±0.04 g/bird/day respectively. There was significant variation in the total body weight gain and daily body weight gain among breeds (p<0.05), districts and breed-district interaction in this study. This indicates that the breeds evaluated didn’t show consistent growth performance across study locations. Differences in growth performance/live weight of chicken could be attributed to differences in genotypes, environment differences between locations and their interaction.

The total body weight gain and average daily body weight gain of Sasso T44 (1691.1±5.33g and 11.0±0.03g) were significantly higher than Bovans Brown (1608.3±9.82 and 10.4±0.01), respectively. The result in this study is higher than the values reported by Kumar *et al*. (2016) the RIR and Bovan White exotic poultry breeds exhibited 8.5 and 7.7g daily body weight gain per bird from day-old to the 22th week of age under intensive private poultry farm in Mekelle Ethiopia.

Table 111: Body weight of Sasso T44 and Bovans Brown breed at starters (week 0-8) in the study areas (Mean ± SE)

Source of variation	Week O (day 1) (g/bird)	Week2 (g/bird)	Week 4 (g/bird)	Week 6 (g/bird)	Week 8 (g/bird)	Week 10 (g/bird)	Week 12 (g/bird)
Over all mean	35.3±0.30	152.4±1.86	277.6±1.50	444.4±4.37	629.0±4.62	846.7±2.34	1115.0±1.08
CV	12.56	15.86	9.37	13.82	6.19	3.97	1.05
Districts	Ns	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EB	35.0±0.45	160.0±2.96^{b}	271.9±2.68^{b}	442.9±5.50^{b}	565.0±8.14^{b}	854.6±3.61^{b}	1114.7±1.73^{b}
AZ	37.2±0.55	175.5±3.46^{a}	289.6±2.36^{a}	513.4±8.97^{a}	708.7±2.57^{a}	874.0±2.83^{a}	1128.3±1.46^{a}
DT	36.1±0.27	129.2±1.73^{c}	272.8±0.25^{b}	393.8±3.74^{c}	617.3±5.99^{c}	820.3±3.61^{c}	1105.3±1.66^{c}
Breeds	<0.0081	<0.0001	< 0.0001	<0.0001	<0.0001	<0.0001	<0.0001
BB	32.6±0.32^{b}	133.0±2.50^{b}	268.5±2.10^{b}	409.0±5.00^{b}	575.2±8.50^{b}	859.6±2.49^{a}	1122.9±0.73^{a}
SS T44	39.9±0.43^{a}	165.3±2.21^{a}	283.7±2.00^{a}	467.9±5.97^{a}	664.9±3.46^{a}	827.3±3.97^{b}	1103.2±2.09^{b}
Districts * Breed	Ns	<0.0001	<0.0087	Ns	<0.0001	<0.0001	<0.0001
EB * BB	35.5±0.65	125.5±1.78^{c}	264.2±4.10^{c}	423.1±4.44	469.6±9.68^{e}	844.7±7.12^{c}	1095.1±1.80^{c}
EB * SST44	37.9±0.59	177.7±2.45^{a}	275.7±3.37^{b}	452.6±7.69	612.7±5.27^{c}	859.5±3.99^{b}	1124.4±1.35^{b}
AZ * BB	35.1±0.46	172.9±5.58^{a}	287.8±3.25^{a}	477.5±10.98	715.2±2.67^{a}	874.5±5.18^{a}	1122.7±1.35^{b}
AZ * SST44	37.1±0.39	176.8±4.40^{a}	290.5±3.14^{a}	531.4±11.75	705.4±3.56^{a}	873.7±3.38^{a}	1139.3±2.61^{a}
DT *BB	36.4±0.34	116.9±0.93^{c}	260.9±2.65^{c}	367.8±2.49	558.1±6.28^{d}	795.1±3.32^{d}	1089.1±1.51^{d}
DT * SST44	37.8±0.92	141.5±2.66^{b}	284.8±3.62^{ab}	419.7±5.52	676.5±1.81^{b}	845.S±4.81^{c}	1121.5±1.11^{b}

Table 11: Continued---

Source of variation	Week 14 (g/bird)	Week 16 (g/bird)	Week 18 (g/bird)	Week 20 (g/bird)	Week 22 (g/bird)	BWG (g/bird)	DBWG (g/bird/day)
Overall mean	1301.8±1.51	1377.2±2.39	1884.0±1.88	1602.0±3.20	1694.9 ± 5.6	1657.9± 5.50	10.77±0.04
CV	2	3.03	1.9	3.56	4.69	4.82	4.82
District (N)	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EB	1302.9±2.61^{b}	1375.8±4.79^{b}	1582.7±1.70^{b}	1600.2±5.00^{b}	1690.7±8.70^{b}	1653.6±8.68^{b}	10.7±0.06^{b}
AZ	1313.9±3.16^{a}	1398.4±3.6^{a}	1608.1±4.55^{a}	1625.0±5.36^{a}	1774.0±8.97^{a}	1733.3±8.91^{a}	11.3±0.06^{a}
DT	1291.8±1.83^{c}	1362.3±3.40^{c}	1561.7±1.80^{c}	1581.6±5.733^{c}	1638.9±7.35^{c}	1604.8±7.20^{c}	10.4±0.05^{a}
Breed	<0.0001	<0.0012	<0.0123	<0.0017	<0.0001	<0.0001	<0.0001
SS T44	1307.9±2.00^{a}	1384.4±2.87^{a}	1590.7±2.68^{a}	1612.9±3.87^{a}	1730.9±5.39^{a}	1691.1±5.33^{a}	11.0±0.03^{a}
BB	1292.7±2.05^{b}	1366.4±3.97^{b}	1574.0±2.18^{b}	1585.95±5.28^{b}	1640.9±9.86^{b}	1608.3±9.82^{b}	10.4±0.01^{b}
Districts*Breeds	0.0162	Ns	Ns	Ns	0.0004	0.0003	0.0003
EB * BB	1289.3±3.11^{c}	1362.3±7.41	1579.1±2.64	1578.5±9.10	1637.6±17.38^{c}	1602.1±17.59^{c}	10.4±0.11^{c}
EB*SST44	1309.7±3.32^{ab}	1382.5±6.02	1597.0±2.18	1600.9±5.57	1717.2±8.10^{b}	1679.3±8.80^{b}	10.9±0.05^{b}
AZ * BB	1313.9±5.52^{a}	1386.4±10.01	1601.3±4.11	1618.2±14.15	1757.4±22.74^{ab}	1723.4±22.67^{a}	11.2±0.15^{a}
AZ*SST44	1313.9±3.87^{a}	1404.4±1.77	1611.4±6.48	1628.4±3.87	1782.2±7.17^{a}	1738.2±7.20^{a}	11.3±0.05^{a}
DT *BB	1283.7±1.60^{c}	1358.3±4.63	1557.8±1.93	1573.5±5.68	1584.3±6.74^{d}	1553.9±6.79^{d}	10.1±0.04^{d}
DT*SST44	1300.0±3.00^{b}	1366.2±4.97	1569.6±2.40	1609.2±9.14	1693.4±9.28^{c}	1655.6±9.38^{c}	10.7±0.06^{c}

Means with different superscripts in a column are significantly different at $p<0.05$; Ns= Non- significant; EB=Ebinat; AZ=Addis Zemen; DT=Debre Tabor; BB=Bovans Brown; SST44= Sasso T44

3.5. Survivability of chicken

The mortality rate of chicks at the age of week 0-8 was 8.7 % and 9.7% for Bovans Brown and Sasso T44, respectively (Figure 2). The mortality rate at the grower phase, at the age of week 9 up to week 22, was 2.8% and 3.6% for Bovans Brown and Sasso T44, respectively. This indicates that, as the age of chicken increases the mortality rate decreases or survivability increases. The overall mortality rate of chicken at the age of week 0 up to week 22 was 11.5% and 13.2% for Bovans Brown and Sasso T44, respectively. Muhammad *et al*. (2010) reported a similar chicken mortality rate of 11.4% in the first two weeks of life. Early chick mortality on a small-scale might be associated with disease, feed, poor management, insufficient brooding temperatures and overcrowded. The mortality rate of the current result is higher than the report of Bezabih (2017) and Isaa *et al*. (2016) who noted that the mortality rate of exotic chicken under small-scale poultry farms was 4.7% at 1-3 week of age in and around Debre Markos. The current results on the overall mortality rate is lower than the reports of Getiso *et al*. (2017b) who reported the overall mortality of Bovans Brown and Sasso T44 was 13.92% and 16.30%, respectively. Anna (2011) also reported mortality percentage can reach 10% or more in the first week of age in poultry farms. The overall mortality rate of Bovans Brown was lower (higher survivability) than the Sasso T44 breed up to 22 week of age.

The mortality rate of chicks at the age of 0 (hatch) up to 8 weeks were 10.1, 6.1 and 11.1% and at the age of 9-22 weeks were 4.1, 2.2 and 3.3% in Ebinat, Adiss Zemen and Debre Tabor District, respectively (Figure 3). The overall mortality rate (0-22 weeks) was 14.2, 8.3 and 14.4% in Ebinat (lowland), Adiss Zemen (midland) and Debre Tabor (highland) districts, respectively. The higher mortality rate of chickens in Ebinat (lowland) and Debre Tabor (high land) areas might be associated with extreme cold and hot temperature, respectively, for newly distributed day-old chicks in these districts.

The current result is higher than that of Tadesse (2014) who reported significantly higher mortality in the lowland (12.96%) than in midland (7.05%) agro-ecological zones of central Tigray. Mortality rate may rise due to disease, feed, overcrowded or high temperature. The result of mortality is lower than the report of Mazengia *et al*. (2012) who noted mortality rate of exotic chickens in low-altitude districts (52.98%) was found higher than high-altitude (48.88%) and mid-altitude (43.25%) districts.

Figure 1: Mortality rate (%) of Bovans Brown and Sasso T44 chicken breeds under small-scale chicken farms in study Districts

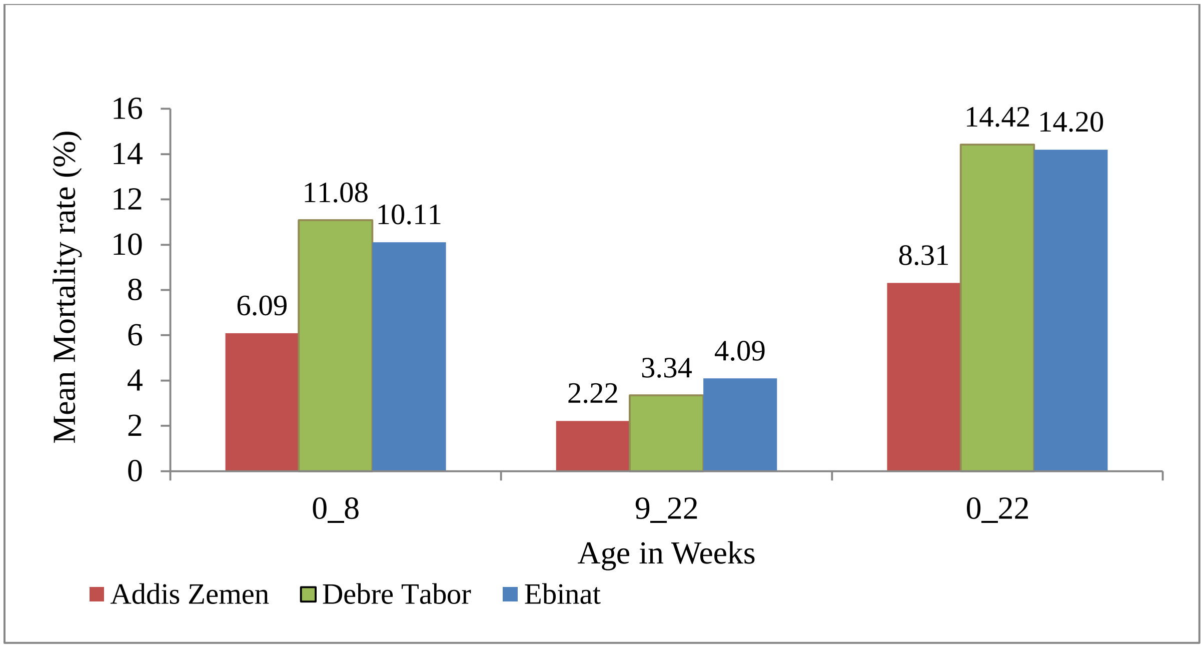

Figure 2: Mortality rate of chicks under Small-scale chicken farms in the study districts

3.6. Reproduction performance

3.6.1. Egg production

The overall egg production of hens up to 6th month (45 weeks of age) was 110.8±49.8 egg/hen/6 month (Table 12). The egg production performance per hen (45 weeks of age) was significantly different ($p<0.05$) between breeds (Table 12). The mean egg performance of the Bovans Brown breed was higher as compared to Sasso T44 which might be due to the fact that Bovans are egg-type breeds. In line with this, the breed has higher egg production performance in the three districts, good adaptation potential of the breed, started egg laying earlier and had lower body weight as compared to Sasso T44 for good egg laying. The current result is higher than the result by Arega (2019) who noted 105 ±1.5, 104 ±1.5, 127±1.5 and 108±1.5 for Kuroiler, Sasso, Sasso RIR and Koekoek, respectively, in Gondar Zuria and Kalu districts of Amhara Region, Ethiopia.

Generally poultry production, particularly egg production is affected by factors such as breed, environmental conditions and management practices including feed and feeding systems. The laying cycle of a chicken flock usually covers a period of about 12 months. Egg production begins when the birds reach about 18-22 weeks of age, depending on the breed and agro-ecology. Flock production rises sharply and reaches a peak, 6-8 weeks later, production then gradually declines to about after 12 months of lay.

The overall hen day egg production (HDEP) in the first phase of production (45 weeks of age) under a small-scale chicken production system was 60.9% (Figure 4). In all age groups Bovans brown (65.6%) breed had the highest HDEP than Sasso T44 (57.8%) in the study districts. Bovans Brown and Sasso T44 breeds reached the highest level of lying at 29th and 30th weeks of age, respectively. Bovans Brown breed also was recorded the highest HDEP as compared to Sasso-T44 breed. This might be due to variations in starting of egg laying where Bovans Brown started early compared to Sasso T44). After the 40th weeks of age the performance of egg lying per day was slightly reduced.

A similar egg production performance which ranged from 57% to 64% was reported by Debrezeit Agricultural Research Center (DZARC) under station conditions during the laying stage (25 to 45 weeks) (DZARC Annual Report, 2012). The result on hen day egg production in the present study is higher than those reported by Biratu and Haile (2016). According to the authors, the egg production performance of Koekoek chicken under farmer’s management conditions was about 52% in the first phase of production (45 weeks of age) but grew to 79.4% in the case of peak production stage in Jimma Zone, Southern, Ethiopia.

The hen day egg production performance among districts is not different (Figure 5). However, the hen day egg production performance shows a sharp increment and reaches a peak at the age of 30th weeks. The hen day egg production however declined after 40th weeks of age.

Table 12: Egg production performance of Bovans Brown and Sasso T44 under small-scale chicken farms

Source of variation	Egg production /hen/6 month
Overall mean (mean± SE)	110.8±49.6
CV	30
Districts	Ns
Ebinat	111.4±50.36
Addis Zemen	109.5±42.50.9
Debre Tabor	111.5±48.6
Breeds	<0.0313
Sasso T44	105.2±52.32^{b}
Bovans Brown	119.3± 44.22^{a}
Districts*Breeds	Ns
Ebinat * Bovans Brown	118.6±8.86
Ebinat * Sasso T44	107.7±7.32
Addis Zemen * Bovans Brown	119.3±8.80
Addis Zemen * Sasso T44	104.5±7.40
Debre Tabor * Bovans Brown	119.6±6.13
Debre Tabor * Sasso T44	103.2±7.16

Means with different superscripts in a column are significantly different at p<0.05; Ns = Non- significant

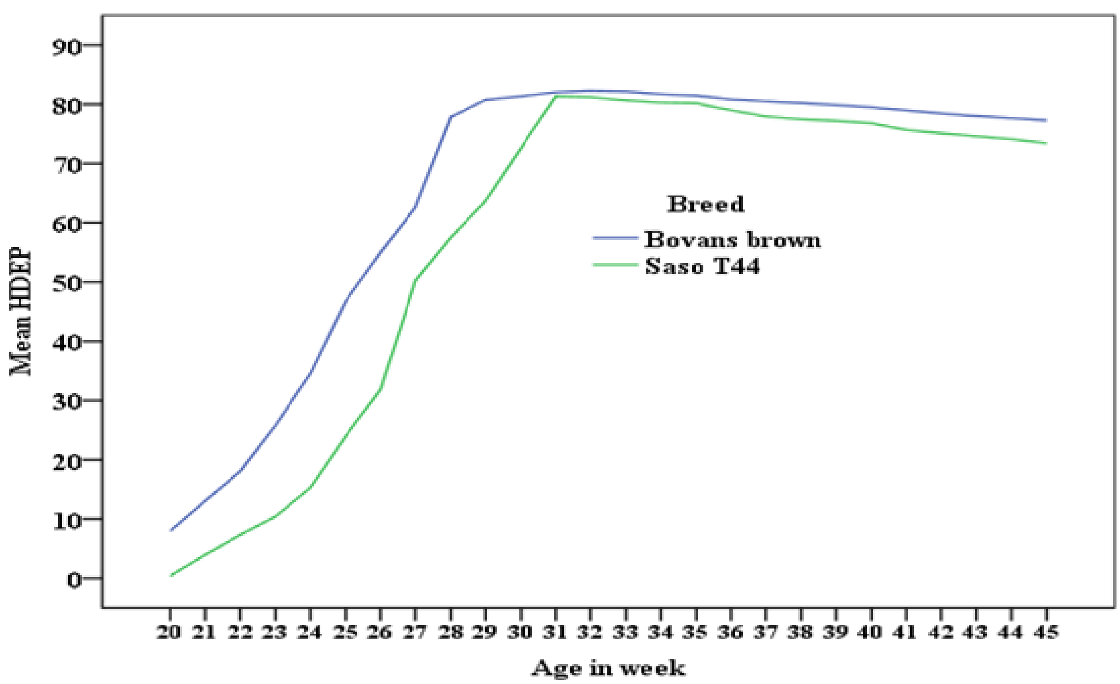

Figure 3: Average Hen Day Egg Percentage (HDEP) of Bovans Brown and Sasso T44 breed in the study districts

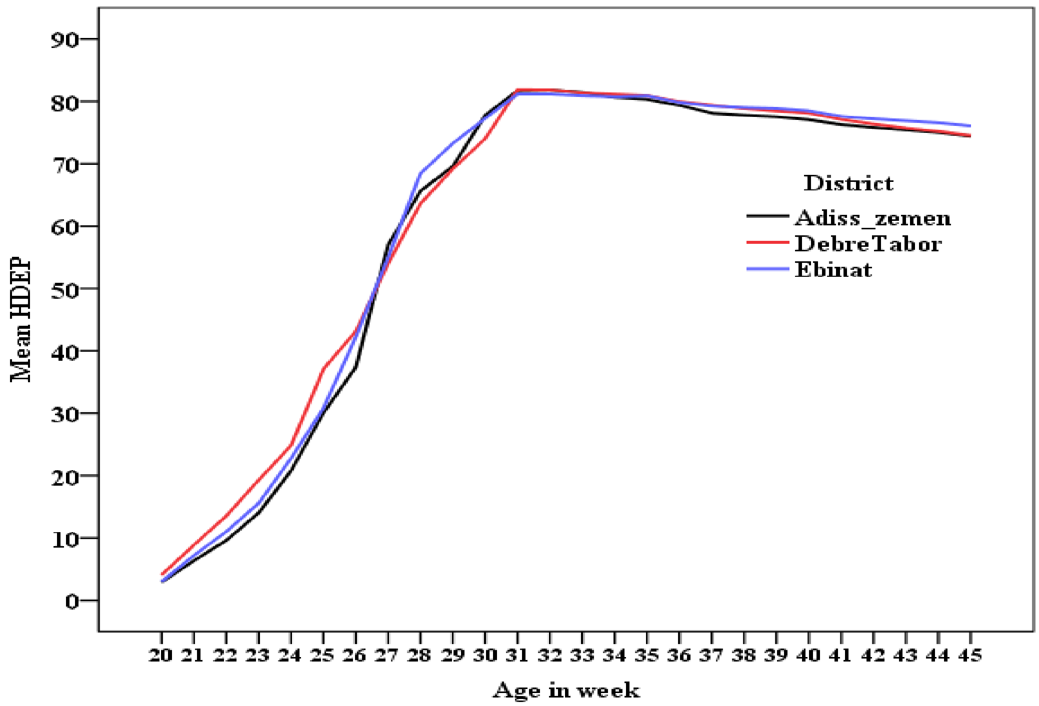

Figure 4: Average hen day percentage in Ebinat, Addis Zemen and Debre-Tabor districts up to 45 week of ages

3.6.2. Age at first laying (AFL) and mature hen body weight

There was a significant difference (P<0.05) among breeds in average age at first laying that the Bovan Brown (132.8±14.4) had shorter AFL than that of Sasso T44 (164.8±11.3) in the study districts (Table 13). These observed differences in age at the first egg of the two breeds in the present study might be due to the genotype differences. As the laying hen body weight increased, egg production decreased and egg weight and feed consumption increased, because heavy birds consume more feed and lay larger eggs with large egg yolk than light hens (Leeson *et al*., 1997).

The AFL of Bovans Brown breed in the current result was lower than those reported by Tadesse *et al*. (2013). According to the authors, the mean AFLs of 165.5±13.2 days were observed for Bovans Brown under village production system in East Shewa, Ethiopia. Similarly, the current AFL of Bovans Brown is higher in intensive (146.0±2.9) and lower in scavenging (163.8±3.4) management systems in Mekelle, Ethiopia (Melkamu *et al*., 2017). Bekele (2018) reported an onset of egg production of Bovans Brown chicken breed at 21.5th week.

There was a significant difference (P<0.05) in mature body weight of hens among breeds. Sasso T44 had higher body weight than Bovans Brown. The current result was higher than the report of Tadesse *et al.* (2013) who reported the adult female body weights of 1.55 kg.

There was significant a difference (p<0.05) in body weight of hen at maturity among the districts. In the Addis Zemen (midland) district, body weight at maturity was higher compared to mature body weight of hens in Ebinat (lowland) and Debre- Tabor (highland) districts. The higher body weight of matured hen might be due to the increase in feed intake in midland than in highland and lowland agro-ecology.

Table 13: Mean age at first egg lay and mature hen body weight in Bovans Brown and Sasso T44 breed in the study districts

Source of variation	Age at first egg laying(day) Mean ± SE	Mature Hen body weight (Kg) Mean ± SE
Overall mean	151.1±4.44	1.6 ±0.003
District	Ns	0.0004
Ebinat	152.6±7.59	1.59±0.005[b]
Addis Zemen	149.4±8.24	1.62±0.005[a]
Debre Tabor	151.2±8.43	1.59±0.06[b]
Breed	<0.0001	<0.0001
Sasso T44	164.8±3.25	1.6±0.004[a]
Bovans Brown	132.8± 4.81	1.5±0.005[b]
Districts *Breed	Ns	Ns
Ebinat * Bovans Brown	141.7±8.94	1.6±0.01
Ebinat * Sasso T44	167.0±11.53	1.6±0.01
Addis Zemen * Bovans Brown	122.2±2.25	1.6±0.01
Addis Zemen * Sasso T44	160.0±4.20	1.6±0.01
Debre Tabor * Bovans Brown	128.0±3.60	1.57±0.05
Debre Tabor * Sasso T44	168.7±2.25	1.6±0.01

Means with different superscripts in a column are significantly different at $p<0.05$; Ns = Non- significant

4. Conclusion and Recommendation

The prevalent breeds kept by small-scale chicken producers in South Gondar Zone are Bovans Brown and Sasso T44 to which the business is started using day-old chickens which are sourced from private poultry farms. Most of the farms followed recommended management practices which are similar to those in other part of the country. However, the production was hampered by different constraints such as feed availability and cost, seasonal disease outbreaks, lack of market linkage, and high cost of day old chicks in the study districts.

In terms of body weight, Sasso T44 out-performed Bovans while Bovans Brown breed was better in egg production in all the districts. The overall mortality rate of Bovans Brown chickens was minimal as compared to Sasso T44. Addid Zemen (midland) district has more favorable environmental conditions than Ebinat (lowland) and Debre Tabor (highland) district in body weight, survivability, profitability and mature hen body weight.

Data availability statement

Data will be made available on request.

Conflicts of interest

The authors declared that there is no conflict of interest.

Acknowledgements

We would like to thank the chicken farm owners in the respective study areas for their willingness and cooperation in participating in this study and for providing valuable information during the interview and follow-up study. Our heartfelt thanks also go to the districts Livestock Development and Agriculture Offices for their assistance throughout the data collection period.

References

Adedeji O.S., Amao S.R., Alabi T.J, and Opebiyi O.B. (2014). Assessment of Poultry Production System in Ilesha West Local Government Area of Osun State Nigeria. *Sch Journal of Agriculture and Veterinary Science. 1*(1):20-27.

Adeyemi O.A and Malomo A. (2014). Survey of Poultry Wastes Management in Abeokuta Ogun State, Nigeria. *Advanced Journal of Environmental Management. 1*(2):014-019

Ahmed A., Mijinyawa M.S., Adamu A.Y. and Suleiman A.D. (2011). Smallholder Poultry Management Practices and Constraint among

Women Poultry Farmers in Kano State Nigeria. *Nigerian Veterinary Journal. 32*:151- 153.

Akanni K. A. (2007). Effect of Micro-finance on Small-scale Poultry Business in South Western Nigeria. Emir. *Journal of Food and Agriculture. 19* (2): 38-47

Akidarju M.S, Onyemaechi E.G. and Dauda M.G. 2010. An Assessment of Some Poultry Management Practices and Disease Recognition by Poultry Farmers in Maiduguri Arid Zone Nigeria. *World's Poultry Science Journal. 66:* 285-296

Arega, H. (2019). *Characterization of chicken production system and on-farm evaluation of introduced exotic chicken breeds in Gonder zuria and Kalu districts of Amhara region, Ethiopia* (Unpublished M.Sc. Thesis), Haramaya University, Ethiopia

Aromolaran, A.K., Ademiluyi, I.O. and Itebu, O.J. (2013). Challenges of Small Poultry Farms in Layer Production in Ibadan Oyo State Nigeria. *Global Journal of Science Frontier Research Agriculture and Veterinary Sciences. 13*(2):1-9

Bekele, B. (2018). Demonstration and Evaluation of Small-Scale Family Poultry (Bovans Brown Layers) at Wondogenet District, Sidama Zone, SNNPR, Ethiopia. *Journal of Fisheries and Livestock Production. 6:*284.

Bezabih 2017.

Bezabih, M and Tesfaye, S. (2013). Production and Marketing of Chicken at Kimbibit District in North Shoa Zone, Oromia Region, Ethiopia. *International Journal of Scientific and Research Publications. 3*(3): 22503153.

Bezabih, M. (2019). *Management practices and constraints of small-scale commercial poultry farms, and performance evaluation of broilers fed diets containing graded levels of dried blood-rumen content mixture.* (PhD Dissertation), Addis Ababa University, 152pp.

Biratu, K., and Haile, S. (2016). Demonstration and Performance Evaluation of Potchefstroom Kokoek Chicken Package at Jimma Zone, South Western Ethiopia. *Journal of Biology, Agriculture and Healthcare. 6*(15):53-58.

Carroll, S. (2012). Best Practice Management for Meat Chicken Production in New South Wales Manual 2 (Meat Chicken Growing Management). ISBN 978 1 74256 250 6.PP 4-20

Charles, O.F., Anthony, A.A.,Stanley, C.N., Abdulfatah, Y. (2013). Extension Strategy Development and Training Needs for Small-scale Commercial Poultry Farmers in Nigeria. *Journal of World's Poultry Research. 3*(4): 99-105.

CSA. (2021). Agricultural Samplesurvey2020/21 [2013 E.C.] Volume Ii. Report On Livestock And Livestock Characteristics.

Demeke, S. (2007). Study on egg production of white leghorn under intensive, semi intensive and rural household conditions in Ethiopia. *Livestock Research for Rural Development.* 8

DZARC (Debreziet Agricultural Research Center). 2012. Annual Research Report 2012/13, Ethiopian Institute Agricultural Research, Debre Zeit, Ethiopia.

Ekenma, Kalu. (2015). Poultry Litter/Manure Management Practices in Intensively Managed Poultry Farms in Portharcourt. *Journal of Agriculture and Veterinary Science. 8*(3):53-58

Ekunwe, P. A., Soniregun, O. O. and Oyedeji, J. O. (2006). Economics of small scale deep litter system of egg production in Oredo Local Government Area of Edo State, Nigeria. *International Journal of Poultry Science. 5*(1): 81-83.

FAO (Food and Agricultural Organization). 2013. Global Poultry Trends- The Poultry Site. PP 1-7

FAO (Food and Agricultural Organization). 2009. Good Practices in Small-Scale Poultry Production. A manual for Trainers and Producers in East Africa. Viale Delle Terme di Caracalla, 00100 Rome, Italy.

Fred, N., Addo, K., Enoch, K., Tham-Agyekum. (2011). Effect of formal credit on the performance of the poultry industry: The case of urban and peri-urban Kumasi in the Ashanti Region, Ghana. *Journal of Development and Agricultural Economics. 3*(6): 236-240

Getiso, a., Bekele, B., Zeleke, B., Gebriel, D., Tadesse, A., Abreham, E., Jemal, H. (2017b). Production performance of Sasso (distributed by ethiochicken private poultry farms) and Bovans brown chickens breed under village production system in three agro-ecologies of Southern Nations Nationalities and Peoples Regional State (SNNPR), Ethiopia. *International Journal of Livestock Production. 8*(9):145-157.

Getiso, A., Jimma, A., Asrat, M., H/Giorgis, K., Zeleke B., Birhanu, T. (2017a). Management Practices and Productive Performances of Sasso Chickens Breed under Village Production System. *Journal of Biology. Agriculture and Healthcare.* 7(7).

Haftom, B., Alemayhu, T., Hagos, Y., Teklu, A. (2015). Assessment of Bio-Security Condition in Small-scale Poultry Production System in and Around Mekelle, Ethiopia. *European Journal of Biological Sciences. 7* (3): 99-102

Jatto, N. A. (2012). Economics and social characteristics of registered poultry egg producers in Ilorin, Kwara State. *Russian Journal of Agricultural and Socio-Economic Sciences, 11* (11):18-23

Kumar, N., Belay, Z.N, Shenkutie, A.M., Taddle, H. (2016). Comparative Performance of Rhode Island Red and Bovan White under Intensive Management in Mekelle, Ethiopia. *International Journal of Livestock Research. 4*(2): 92-98.

Leeson, S., Caston L., Summers J. (1997). Layer performance of four strains of leghorn pullets subjected to various rearing programs. *Poultry Science. 76:*1–5.

Maoba, S. (2016). Production performance and profitability analysis of small scale layer projects supported through casp in Germiston region, Gauteng province. *South African Journal of Agricultural Extension. 44*(1): 42 – 49.

Mazengia, H., Siraw, G., Nega, M. (2012). Challenges and prospects of village-based exotic chicken development strategy in Amhara regional state, Northwest Ethiopia. *Global Journal of Science Frontier Research. 12(10)*.

Melkamu, T., Kumar, N., Gebrekidan, B., Kebede, E and Tkue, T. (2017). Performance of Bovans Brown chickens under intensive and backyard management system in Mekelle, Ethiopia. *Ethiopian Journal of Veterinary Science and Animal Production. 1*(1): 73-80.

Muhammad M., Muhammad L.U., Ambali A.G. and Mani A.U. (2010). A Survey of Early Chick Mortality on Small-Scale Poultry Farms in Jos, Central Nigeria. *International Journal of Poultry Science. 9* (5): 446-449

Nath, B.G., Pathak, P.K. Mohanty A.K. (2012). Constraints Analysis of Poultry Production at Dzongu Area of North Sikkim in India. *Iranian Journal of Applied Animal Science. 2*(4): 397-401

Nusirat, E., Jaji, Z., Badiru, A., Olowoleni, F. and Ambali1, A.G. (2012). Assessment of Management and Health Practices in Some Selected Poultry Establishments in Ilorin, Kwara State, Nigeria. *International Journal of Poultry Science. 11* (8): 524-528

Nzietchueng, S. (2008). Characterization of Poultry Production Systems and Potential Pathways for the Introduction of Highly Pathogenic Avian Influenza in Ethiopia.Draft Report. International Livestock Research Institute.

Rajendran, K. and Samarendu M. (2003). Comparative Economic Analysis and Constraints in Egg Production under Cage vs. Deep Litter Systems of Rearing in India. *International Journal of Poultry Science. 2*(2): 153-158

Tadesse, A. (2014). Production and reproduction performance of rural poultry in lowland and midland agro-ecological zones of central Tigray Northern Ethiopia. *British Journal of Poultry Sciences 3* (1): 06-14.

Tadesse, D., Singh, H., Mengistu, A., Esatu, W., Dessie, T. (2013). Study on productive performances and egg quality traits of exotic chickens under village production system in East Shewa, Ethiopia. *African Journal of Agricultural Research. 8*(13):1123-1128.

Uduak Akpabio, Jacob KP Kwaga, Junaidu Kabir, Veronica J umoh and Otalu Jr Otalu. (2014). Assessment of Some Poultry Management Practices in Kaduna State, Nigeria. *World Journal of Public Health Sciences. 3*(1):1-4

Yemane, N., Tamir, B., Mengistu, A. (2016a). Constraints, Opportunities and Socio-Economic Factors Affecting Flock Size Holding in Small-scale Intensive Urban Poultry Production in Addis Ababa, Ethiopia. *Agriculture and Biology Journal of North America 7*(3): 146-152

Yemane, N., Tamir, B., Mengistu, A. (2016b). Poultry Waste Management Practices under Small-scale Intensive Urban Poultry Production in Addis Ababa, Ethiopia. *Academia Journal of Agricultural Research. 4*(4): 212-217