Growth, survival and egg production of exotic chicken breeds under small scale production system in Bahir Dar City Administration, Amhara Region, Ethiopia

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ABSTRACT

Growth, survival and egg production performance and profitability of exotic chicken breeds were evaluated under small-scale chicken producers in urban and peri-urban areas of Bahir Dar City from 2018 to 2019. Data were collected using semi-structured questionnaires, monitoring and field observation. Thirty-three small-scale chicken enterprises (30 from urban and three from peri-urban areas) were included in this study. All questionnaire data were analyzed using SPSS Version 20. The monitoring data was analyzed with ANOVA using the general linear model (GLM) procedure of SAS version 9.0. The monitoring result revealed that the growth performance of chicken significantly varied with respect to breeds and production systems of producers. Sasso T44 had higher daily body weight gain (10.66 ± 0.03 g) and total body weight gain (1642 ± 5.02 g) within 22 weeks of age in the urban areas. The mean egg production for Bovans Brown at the age of six months was 124.8 ± 4.10 eggs. The annual mean egg production performance of Bovans Brown was 239.63 ± 4.32. The overall mortality rate of all exotic chicken was 6.5%. Despite many constraints, small-scale chicken production was profitable. Seasonal disease outbreaks, shortages of feed and housing problems were the major constraints of small-scale chicken producers. The growth performance and survival rate of exotic chicken was promising, but the egg production was low. Therefore, the management practices of small-scale chicken enterprises in the study area should be improved.

Keywords: Egg production; Exotic chicken; Small-scale chicken production.
DOI: https://dx.doi.org/10.4314/ejst.v14i2.3

INTRODUCTION

Poultry is the largest livestock group in the world and is estimated to be about 23.4 billion consisting mostly of chicken, ducks and turkeys while chicken alone

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reached over one billion (FAO, 2011; CSA, 2013). Chicken production enhances food security and improves community livelihood (Tadelle Dessie *et al*., 2013; Addis Getu *et al.,* 2014; Emebet Moreda, 2015) and contributes 28-30% of all global animal protein consumption (FAO, 2011). The total chicken population of Ethiopia is estimated to be about 56.1 million. About 88.2% are indigenous, 6.5% hybrid and 5.4% exotic. Similarly, the total chicken population of the Amhara Region is estimated to be 17.7 million which accounts for 31.6% of the national chicken population (CSA, 2017/18).

The productivity of Ethiopian indigenous chicken is low. As a result, several attempts have been made to introduce different exotic breeds of chicken to be used on their own or for crossbreeding with the indigenous chickens. But the contribution of exotic chicken breeds to the Ethiopian economy is significantly low compared to that of other African countries (Haftu Kebede, 2016). The chicken production system in Ethiopia is an indigenous and integral part of the farming system that ranges from no input traditional free-ranging to intensive/commercial production system using relatively advanced technology (Solomon Demeke, 2004). The small-scale production system is mostly found in rural, peri-urban and urban areas with a medium level of feed, water, and veterinary service inputs and minimal to low bio-security (Nebiyu Yemane *et al.,* 2013).

Currently, several small-scale chicken farms have emerged and they are contributing to improvement of livelihoods, food security and poverty reduction. They provide good returns to urban and peri-urban areas of the country. However, lack of knowledge on chicken husbandry (feeding, housing, health care), lack of complementary inputs (feed), lack of strong extension follow-up, high disease prevalence, absence of credit services and market remain severe limiting factors in the current chicken production system (Teshome Gemechu and Tesfaye Amene, 2015). Therefore, this study was conducted to evaluate growth, survival, and egg production performance of exotic chicken breeds under small-scale chicken production producers in urban and peri-urban areas of Bahir Dar City, Ethiopia.

MATERIALS AND METHODS

Description of the study area

This study was conducted in Bahir Dar, the capital city of Amhara National Regional State, Ethiopia. Bahir Dar city has 9 sub-cities and 4 peri-urban areas. It's located at about 565 km north of Addis Ababa at 11° 38′ N, 37° 10′ E south of Lake Tana where the Blue Nile River starts. The elevation of the city is about 1801 meter above sea level and receives an average annual rainfall of 850 mm to 1250 mm, a minimum average daily temperature of 10 °C and a maximum of 32 °C (BoARD, 2016). The human population of Bahir Dar city is about 220,344, of which 40,250 people are rural dwellers and 180,094 are urban (BCAO, 2012/13).

Sampling techniques and data collection

Multistage sampling method (purposive and random) was used for this study. All small-scale chicken production enterprises from urban and peri-urban areas were included in the study. All of them were small-scale production systems. Thirty-three small-scale chicken enterprises (30 from urban and three from peri-urban) were included for the assessment of husbandry practices, opportunities and challenges of small-scale chicken producers. Tis-Abay, Meshenti, and Zegie were the peri-urban areas. Data were collected through regular monitoring throughout the 22 weeks on ten randomly selected chicken enterprises (eight from urban and two from peri-urban). A total of 480-day-old chicken from urban and 120-day old chicken from peri-urban areas were taken randomly to evaluate body weight gains and mortality rate of these exotic chicken. All the chicken were weighed separately through sensitive digital balance from day-old to 22nd weeks of age (every 2 weeks) to determine body weight change and growth rate. The mortality rate of chicken was recorded and calculated as the ratio of total dead chicken to the total chicken being started multiplied by 100 and expressed in percentage.

Through physical monitoring, the number of eggs laid was counted and their production potential was evaluated for six months including dry and wet seasons. The annual egg production per bird was also calculated on a hen-day and hen-housed bases. The total cost and revenue of an average of 400 layers per 1½ production years on each farm were computed from farm owners. The existing market price of all variables was considered during the egg production period and all expenses in the production periods were also included. Gross margin analysis was used to determine profitability. The mathematical notation developed by Jatto (2012) for gross margin is shown as follows: GM = TR –TVC (where; GM = Gross Margin, TR = Total Revenue and TVC = Total Variable Cost).

Data management and statistical analysis

The questionnaire and on-farm monitoring data were entered into Microsoft Excel spreadsheet. All the qualitative and quantitative data were subjected to one-way ANOVA using the Generalized Linear Model procedure through Duncan's' Multiple Range Test of Statistical Analysis System (SAS) version 9.0. The separated mean in a significant difference is accepted at $p < .05$. The following model was used during analysis of quantitative data: $Y_{ij} = \mu + \beta_i + kj + mij + e_{ij}$, where: Y_{ij} = Response in terms of sexual maturity (days), number of eggs produced/hen/year, body weights (g) and mortality rates (%) j in i^{th} breed; μ = Overall mean; β_i = Effect of the i^{th} breed types (where $i = 2$, Bovans Brown and SassoT44); kj = Effects of j^{th} chicken production systems/area (where $j = 2$, Urban and Peri-urban); mij = Interaction effect; e_{ij}= Random Error.

RESULTS AND DISCUSSION

Socioeconomic characteristics of small-scale chicken producers

Sex and education status of participants

In general, female owners dominated chicken farms. Similar findings were reported before (Melkamu Bezabih *et al.*, 2016). Egg production was mainly a business of females.

The average family size per farm in urban areas was 3.16 and in peri-urban areas 3.66 and overall average was 3.2. In contrast, Desalew Tadesse *et al.* (2013) and Almaz Abebe (2015) reported 5.4 persons per household in East Shewa Zone and 4.94 in Oromia Region. In case of educational status, 39.4% were grade 9-10 and 30.2% above grade 10, respectively. The educational status of writing and reading was 15.2% which was lower than a previous report of 32.2% in East Gojam zone, Amhara Region (Melese Gashu and Melkamu Bezabih, 2014).

Experiences in chicken production activity

The production experience of most chicken farm owners was very low. About 66.7% of them had less than one year experience and 27.3% 2-5 years' experience. Only 6% had 5-10-year experience in the study areas. In other countries of Africa, experiences are longer, for example, in Nigeria, Adedeji *et al*. (2104) reported that about 16% had an experience of 6-8 years and 42.1% 2-5 years.

Chicken management

Chicken flock size and sources of chicken

The exotic chicken breeds reared in Bahir Dar city were Bovans Brown and Sasso T44. Yet, Bovans Brown dominated egg production because this breed was more accessible and highly preferred for egg production. Similar reports are available from other parts of Ethiopia, such as urban and peri-urban areas of Dessie town (Solomon Tiruneh *et al*., 2018) and the different agro-ecologies of SNNPR, Ethiopia (Aman Getiso *et al.,* 2017b).

The flock size of chicken in urban areas was 900.9 ± 76.5 and peri-urban areas 700 ± 175.6. The overall average flock size was 882.6 ± 71.4 which was higher than previous reports of 844.3 ± 98.3 on small-scale commercial poultry farms in and around Debre Markos (Melkamu Bezabih *et al*., 2016).

The origin of exotic chicken breeds was Ethio-chicken state owned, Kombolcha state owned, and Alema private farms. The source of some 69.7% of chicken was Ethio-chicken state owned farms. In another study, 58.20% originated from Ethio-chicken and local cooperatives (Aman Getiso *et al.*, 2017a).

Feeding and housing

The majority of the producers in the current study (69.7%) used commercial feeds for feeding their chicken and the rest (30.3%) used commercial feed with additional supplements (Table 1). The common supplemented feed in both study areas were purchased vegetables. The current results were similar to some reports such as Bereket Addis *et al*. (2014), Hagazi Fantay *et al*. (2017), but not others (Almaz Abebe, 2015; Aman Getiso *et al.*, 2017a).

Overall, about 30.3% of producers constructed chicken houses based on recommendations. Similar reports are available (Desalew Tadesse *et al*., 2013), but not in others such as under the village production system in SNNPR, Ethiopia (Aman Getiso *et al*., 2017a) whose report was 43.8%.

Most of the chicken houses (sheds) in urban areas (43.3%) were constructed by the government without considering recommended poultry packages. About 67% of chicken enterprises in urban and 33% in peri-urban areas had isolation pen for separation in case of diseases outbreaks and physical defects/injury. But most chicken isolation pens were constructed in the main rearing unit by separating locally available materials and iron sheet walls due to lack of sufficient space. Similar problem has been reported before (Bereket Addis *et al*., 2014; Melkamu Bezabih *et al*., 2016).

Table 1. Chicken houses and feeding practice in small-scale chicken enterprise in the study area.

Variables	Urban area		Peri-urban		Overall	
	(N = 30)	%	(N = 3)	%	(N = 33)	%
Chicken breeds						
Bovans Brown	28	93.3	2	66.7	30	90.9
Sasso T44	2	6.7	1	33.3	3	9.1
Flock size (Mean±SEM)	900.9±76.5		700±175.6		882.64±71.4	
Feeding types practiced						
Commercial feeds	21	70	2	66.7	23	69.7
Commercial feeds with supplement	9	30	1	33.3	10	30.3
Standard chicken house						
Yes	10	33.3	-	-	10	30.3
No	20	66.7	3	100	23	69.7
Have isolation room						
Yes	20	66.7	1	33.3	21	63.6
No	10	33.3	2	66.7	12	36.4

N = number of small-scale chicken enterprises/producers interviewed, % = percent, SEM = standard error of mean

Vaccination and medication

Vaccination and medication are very important activities in chicken production. All small-scale chicken enterprises got their chicken vaccinated for disease prevention despite the fact that the application and safety of live vaccine was very poor. The types of vaccines used were HB1 and LaSota (against New Castle Disease), Infectious Bursal disease and Fowl typhoid. But the frequency of vaccination was different according to the direction given by exotic chicken distributors, degree of access to vaccine and level of understanding. A similar result is reported by Melkamu Bezabih *et al.* (2016) on small-scale commercial poultry farms in and around Debre Markos, Amhara Region. However, Bereket Addis *et al*. (2014) reported that among respondents, 24% vaccinated and 76% didn't vaccinate for the common diseases in small-scale intensive poultry farms in Bahir Dar Zuria District, Ethiopia. In addition to vaccination, about 49% of producers used anti-parasites for disease control measures in the study areas. On the other hand, Almaz Abebe (2015) reported that about 25% of producers used anti-ectoparasites for disease control. Still in other reports, figures were higher such as in and around Mekelle, Ethiopia (Birhanu Haftom *et al*., 2015). This indicated differences in vaccination levels between poultry farms around the country because of differences in knowledge and availability of antibiotics in the country.

Production performance

Growth performance

The overall analysis of the effect of breed and the chicken management practice in the study area had a significant ($p < 0.001$) effect on the growth performance of chicken. However, the day-old body weight of Bovans Brown and SassoT44 was not significantly difference in the study areas (Table 2). This indicated that the growth performance of the chicken was affected by the genetic potential of the breeds and management differences of chicken producers in the study areas. The overall body weight of the chicken breeds at the age of week 16 was 1390.26 ± 4.70 g. The current study indicated that Bovans Brown chicken breed reached 1.58 kg at the age of 5.5 months but Sasso T44 chicken breed reached 1.57 kg at age of 4 months. This result is higher than Birhan Kassa (2018) who reported that Kuloiler chicken reached 1.3 kg at the age of 4 months. This result showed that Sasso T44 chicken breed reached earlier for slaughtering than the report done by Aman Getiso *et al*. (2017b) for Sasso (5.3 ± 1.3 months) and Bovans Brown (6.6 ± 1.3 months) chicken breeds. This indicates that under large-scale chicken production system there would be a possibility of attaining the market weight in 3 months of age.

The overall daily body weight gain and total body weight gain of these breeds within 22 weeks were 10.03 ± 0.02 g and 1546.45 ± 2.91 g, respectively. However, daily body weight gain and total body weight gain for Bovans Brown was 9.1 ± 0.2 g and 1450.4 ± 38.1 g, respectively (Tomas Melkamu *et al*., 2017). Niraj Kumar *et al.* (2014) reported the daily body weight gain and total body weight gain for Rod Island Red was 8.5 ± 0.17 g and 1350 ± 33.8 g, respectively. In contrast, the chicken producers in this study supplied a relatively higher amount of feed to their chicken in order to attain higher body weight within 154 days. The producers fed their chicken well anticipating the advantage in the market because well-fed chicken mature early and command a good market price. All producers in the study area sold their Sasso T44 chicken to the surrounding districts either when they reached the age of slaughtering or when sexually matured for egg production.

Table 2. Mean (M ± SEM) body weight of chicken (0-22 weeks) in Bahir Dar City.

	Urban		Peri- urban			
	Bovans Brown	**Sasso T44**	**Bovans Brown**	**Sasso T44**	**Overall mean**	**CV**
DO	31.9^{b}±0.1	34.3^{a}±0.4	31.2^{b}±0.4	34.5^{a}±0.3	31.3±0.1	9.21
Wk4	264.6^{b}±2.2	386.7^{a}±7.2	217.5^{c}±4.6	223.1^{c}±1.5	267.9±2.5	15.90
Wk8	642.0^{b}±2.0	696.6^{a}±3.4	618.7^{c}±6.4	626.0^{c}±2.8	643.6±1.8	6.18
Wk12	1010.8^{b}±2.1	1068.9^{a}±3.4	988.2^{c}±6.4	997.2^{c}±2.9	1013.0±1.8	3.96
Wk16	1368.2^{b}±5.2	1576.6^{a}±1.6	1386.9^{b}±10.5	1361.8^{b}±4.6	1390.3± 4.7	6.98
Wk22	1563.1^{c}±3.3	1676.3^{a}±5.0	1585.1^{b}±9.3	1572.2^{bc}±6.7	1577.6±2.9	4.05
DBWG	10.0^{b}±0.0	10.7^{a}±0.0	10.1^{b}±0.1	10.0^{b}±0.0	10.0±0.0	4.22
TBWG	1532.6^{b}±3.3	1642^{a}±5.0	1552.9^{b}±9.3	1541.7^{b}±6.7	1546.5±2.9	4.12

^{abc} means significant different within column at ($p < 0.05$), DO = day-old, M = least square mean, Wk = week, DBWG = daily body weight gain, TBWG = total body weight gain, SE = standard error of mean; CV= coefficient of variation

Age at first egg

The mean age at first egg of Bovans Brown and Sasso T44 in the urban area were 149.11 ± 2.46 and 172.5 ± 7.0 days, respectively. Similarly, the mean age at first egg of Bovans Brown and Sasso T44 in the peri-urban area were 152.5 ± 2.50 and 168 days, respectively. This indicated that breed had a significant ($p < 0.001$) effect on the age at sexual maturity of chicken in the study area. The result of age at first lay for Bovans Brown in this study is in line with the reports of Bangu Bekele (2018) under small-scale production systems in Wondogenet Woreda, SNNPR. In comparison, age at first egg for Bovans Brown in the current study was shorter than previous reports of 165.6 ± 13.2 days (Desalew Tadesse *et al*., 2013), 163.8 ± 3.4 days (Tomas Melkamu *et al*., 2017), 171 ± 12.18 days under backyard production systems (Solomon Tiruneh *et al*., 2018) and 174 days on-farm production (Brhane Gebremariam *et al.*, 2017). Moreover, age at sexual maturity of Bovans Brown and Sasso T44 in the current study was shorter than others reported before such as Rhode Island Red (239 ± 5.73) and White Leghorn (245 ± 6.08) days (Abraham Lemlem and Yayneshet Tesfay, 2010).

Annual egg production

The monitoring result revealed that Bovans Brown had egg laying capacity of about 124.8 ± 4.10 eggs on average in six months in the study areas. The total number of eggs laid per hen per year was 239.63 ± 4.32 (Table 3). The current result for this study is lower than 266.32 ± 8.7 eggs (Desalew Tadesse *et al*., 2013) and 292.4 ± 17.9 eggs (Tomas Melkamu *et al*., 2017) on the same breed. However, this result was higher than 189.2 ± 82.6 (Solomon Tiruneh *et al.*, 2018) and 235.86 ± 3.02 eggs/ year (Brhane Gebremariam *et al*., 2017) on the same breed. Due to the good application and husbandry practices of chicken producers, egg production in the urban area was relatively higher than peri-urban areas. This indicates that better improvement on the husbandry practices of chicken producers could improve the performance of the chicken breeds in different parts of the country.

Dry season and wet season

The egg production during the dry season of Bovans Brown was 61.22 ± 1.85 eggs per three months in urban areas, and 60.54 ± 8.02 eggs in the peri-urban areas. In urban areas, Bovans Brown laid slightly lower number of eggs during the dry season than the wet season because of the heat stress.

The egg production of Bovans Brown during the wet season in urban areas was 65.04 ± 1.94 eggs per three months and in peri-urban areas 59.22 ± 0.81. The overall egg production of this breed in the dry season was 61.05 ± 3.86 and in the

wet season 63.59 ± 1.72 eggs. This indicates that egg production performance of Bovans Brown was independent of seasonal variations.

Table 3. Egg production performance **(mean ± SEM)** of Bovans Brown chicken in Bahir Dar City.

Urban	**Peri-urban**			
Egg/hen/six months	**Egg/hen/six months**	**Overall**	***p* - Value**	***F*- Value**
126.3 ± 5.08	119.72 ± 10.21	124.8 ± 4.10	0.53	0.43
Total egg/hen/year	**Total egg/hen/year**			
240.14 ± 4.55	232.25 ± 13.80	239.6 ± 4.32	0.66	0.20

SEM = standard error of mean

Survival of chicken

Cumulative mortality rate

The total mortality rate of Bovans Brown was 7.0% in urban areas and 7.8% in peri-urban and for Sasso T44, it was 3.75% in urban and 3.92% in peri-urban areas. This indicates that Bovans Brown breed had higher mortality rate in both study areas than Sasso T44 breeds due to differences in genetic traits and environment adaptability. The mortality rate of starter chicken for the first 8 weeks of age was relatively higher than growers and pullets due to housing stress, seasonal outbreak of diseases and poor handling practices. The overall mortality rate of all exotic chicken was 6.5%, which was higher than 4.7% observed on existing exotic chicken in and around Debre Markos (Melkamu Bezabih *et al*., 2016), but lower than 20.3 ± 2.3% under backyard production system by smallholder farmers in Mekelle, Tigray region (Tomas Melkamu *et al*., 2017). Differences might have come from differences in genotype, production systems and chicken health management and environmental conditions.

Profitability of small-scale chicken production

The total average operating cost for 400 layers in 1½ year period was 487,751.53 Ethiopian birr in urban and 400,427.92 birr in peri-urban areas. Due to the low-cost, accessibility of supplementary chicken feed and low transportation cost, the peri-urban poultry farms used low feed cost than urban chicken producers.

Feed was cheaper in peri-urban areas because of low feed cost and low transport cost. The total revenue for chicken farming within these production weeks was 534,061.25 birr in urban and 437,623.5 Ethiopian birr peri urban areas. The benefit-cost ratio (1.095) in urban and (1.093) in peri-urban areas showed that the

benefit was 46,309.72 and 37,195.58 Ethiopian birr, respectively (Table 4). Enterprises in urban area benefited more than peri-urban area because of access to market, greater attention for chicken production and improved management practices. The present study indicated that egg production was a profitable business in spite of some constraints facing their production. Maoba (2016) reported similar results on small-scale chicken farms in Germiston Region, Gauteng Province.

Table 4. Profitability of small-scale chicken enterprises in Bahir Dar City.

	Urban		Peri-urban	
Items	**Amount (birr)**	**Production (%)**	**Amount (birr)**	**Production (%)**
Revenue (sale of chicken)	51222.5	9.6	43200.0	9.9
Revenue (sale of eggs)	482350.0	90.3	394000.0	90.0
Others (litter)	488.8	0.1	423.5	0.1
Total revenue	534061.3	100.0	437623.5	100.0
Feed cost	338939.7	69.5	276836.6	69.2
Cost of chicks	16422.5	3.3	15895.0	4.0
Vaccine	1110.0	0.2	1350.0	0.3
Electricity and water bill	4205.6	0.9	3392.5	0.8
Labor / workers	93500.0	19.2	71862.0	17.9
Loan interest (8%)	28165.5	5.8	25856.8	6.5
Tax (10%)	5024.5	1.0	4875.0	1.2
Total variable cost	487367.8		400067.9	
Gross margin	46693.5		37555.6	
Depreciation (equipment)	383.8	0.1	360.0	0.1
Total cost	487751.5	100.0	400427.9	100.0
Net profit/income	46309.7		37195.6	
Gross margin returns	0.096		0.09	
Cost-benefit ratio	1.095		1.093	

Challenges and opportunities of small-scale chicken production

The major opportunities for small-scale chicken enterprises in the study areas include availability of day-old chicken, limited credit service and market. This result corroborates previous reports in Yirgalem and Hawassa towns, Ethiopia (Abdo Mohammed *et al.*, 2016; Yonas Kejela *et al*., 2019).

In order of importance, seasonal disease outbreaks, shortage of feed and lack of standard chicken housing were the major constraints affecting small-scale chicken

enterprises. Similarly, disease and shortage of feed were the major constraints of chicken in the Amhara Region of Ethiopia (Addis Getu *et al.*, 2014). In northern Gondar, Amhara Region, diseases, predators, shortage of supplementary feed, poultry housing problems and lack of veterinary health services were the most important constraints of village chicken production under the urban system (Wondu Mamo *et al*. 2013; Yonas Kejela *et al*., 2019).

CONCLUSION

This study showed that breed and management practices played the major roles in growth, survival and egg production performance of exotic chicken. The husbandry practices of small-scale chicken enterprises were poor due to inadequate training and technical support, lack of standard housing, limited working space and inadequate budget (limited access to credit service). However, the growth performance of both Bovans Brown and Sasso T44 until 22nd week of age was commendable as compared to the standards of small-scale production systems. They had good daily and total body weight gain despite the poor management practices. The mortality rate of starter chicken for the first 8 weeks of age was relatively higher than growers and pullets due to housing stress, seasonal outbreak of diseases and poor handling practices. The egg production performance of Bovans Brown breed was low as compared to the average egg production potential of the exotic chicken (Bovans Brown). Enterprises could enjoy easy access to day-old chicks, some credit service and ample market. However, they were constrained by seasonal disease outbreaks, shortage of feed, lack of quality and standard house in order of importance. Despite all these, egg producing enterprises were profitable.

ACKNOWLEDGEMENTS

We would like to thank the small-scale chicken enterprises who participated in the study, the agricultural development agents and office workers of Bahir Dar city for their cooperation during data collection.

REFERENCES

Abdo Mohammed, Samson Hailemariam, Gebremedhin G. and Kefyalew Gebeyaw (2016). Challenges and opportunities of small-scale poultry production system in

Jigjiga zone, Somalia regional state, Ethiopia. *Poultry, Fish and Wildlife Science* **4**: 2-6.

Abraham Lemlem and Yayneshet Tesfaye (2010). Performance of exotic and indigenous poultry breeds managed by smallholder farmers in northern Ethiopia. *Livestock Research for Rural Development* **22**(7):133.

Addis Getu, Kefyalew Alemayehu and Zewdu Wuletaw (2014). A Phenotypic characterization indigenous chicken ecotype in North Gondar, Ethiopia. M.Sc. Thesis Submitted in Animal Genetics and Breeding Bahir Dar University, 42–60 pp.

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. *Scholars Journal of Agriculture and Veterinary Sciences* **1**(1): 20–27.

Almaz Abebe (2015). Assessment of production performance of improved chicken under rural management practices in Dugda Woreda, East- Shewa Zone, Oromia Region, Ethiopia. MSc. Thesis Submitted to the College of Veterinary Medicine and Agriculture of Addis Ababa University in partial fulfillment of the requirements for the degree of Master of Science in Tropical Animal Production and Health, 22–50 pp.

Aman Getiso, Addisu Jimma, Mebratu Asrat, Kebede H/Giorgis, Bereket Zeleke and Teklayohannes Birhanu (2017a). Management practices and productive performances of Sasso chicken breed under village production system in SNNPR, Ethiopia. *Journal of Biology, Agriculture and Healthcare* **7**(7): 120–130.

Aman Getiso, Bangu Bekele, Bereket Zeleke, Desta Gebriel, Abiti Tadesse, Edget Abreham and Hamid Jemal (2017b). Production performance of Sasso (distributed by Ethio-chicken 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**: 145–157.

Bangu Bekele (2018). Demonstration and evaluation of small-scale family poultry (Bovans Brown Layers) at Wondogenet Woreda, Sidama Zone, SNNPR, Ethiopia. *Journal of Fisheries and Livestock Production* **6**: 284.

BCAO (Bahir Dar City Agricultural Office) (2012/13). Census data report on human, livestock population living in and around Bahir Dar, Bahir (BCAO), Bahir Dar, Ethiopia.

BoARD (Bureau of Agriculture and Rural Development) (2016). Amhara Region, Statistics section. Bahir Dar, Ethiopia.

Bereket Addis, Desalew Tadesse and Shigdaf Mekuriaw (2014). Study on major causes of chicken mortality and associated risk factors in Bahir Dar Zuria District, Ethiopia. *African Journal of Agricultural Research* **9**(48): 3465–3472.

Birhan Kassa (2018). Characterizing chicken production system and on-farm comparative evaluation of growth, reproductive and production performance of different chicken breeds in Western Amhara, Ethiopia. M.Sc. Thesis Submitted to the School of Animal and Range Sciences, Post-graduate Program Directorate Haramaya University, 54-69 pp.

Birhanu Haftom, Tehetna Alemayhu, Yohannes Hagos and Awot Teklu (2015). Assessment of biosecurity condition in small scale poultry production system in and Around Mekelle, Ethiopia. *European Journal of Biology* **7**(3): 99–102.

Brhane Gebremariam, Hailu Mazengia and Tikabo Gebremariam (2017). On-farm productive and reproductive performance of local, exotic and crossbred chickens in Southern Tigray, North Ethiopia. *Journal of Biology, Agriculture and Healthcare* **7**(13): 24–32.

CSA (Central Statistical Authority) (2013). Agricultural sample survey. Report on livestock and livestock characteristics. The Federal Democratic Republic of Ethiopia, Private Peasant Holdings, Statistical Bulletin 570, Addis Ababa, Ethiopia, April 2013, pp:20-28.

CSA (Central Statistical Authority) (2017/18). Agricultural sample survey. Volume II. Report on Livestock and Livestock Characteristics, Private Peasant Holdings. Statistical Bulletin 87. Addis Ababa, Ethiopia, April 2018, pp: 20–35.

Desalew Tadesse, Harpal Singh, Ashenafi Mengistu, Wondimeneh Esatu and Tadelle Dessie (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.

Emebet Moreda (2015). Phenotypic and genetic characterization of indigenous chicken in Southwest Showa and Gurage Zones of Ethiopia. Ph.D. Thesis, Addis Ababa University, 20-35 pp.

FAO (Food and Agricultural organization of the United Nations) (2011). Draft guidelines on phenotypic characterization of animal genetic resources. Rome, Italy. Pp. 66.

Haftu Kebede (2016). Exotic chicken status, production performance and constraints in Ethiopia: A Review. *Asian Journal of Poultry Science* **10**(1): 30–39.

Hagazi Fantay Tadesse, Milsan Getu Banu, Tesfay Awalom, Habtamu Tadelle and Gebrehiwot Tadesse Mawcha (2017). Assessment of chicken feed, feeding management and chicken productivity in intensive poultry farms at selected farms of three Zones in Tigray Region. *Journal of Veterinary Science Technology* **8**: 472.

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.

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.

Melese Gashu and Melkamu Bezabih (2014). Assessment of chicken production under farmers management condition in East Gojam Zone, Amhara Regional State, Ethiopia. *Greener Journal of Animal Breeding and Genetics* **1**(1): 001–010

Melkamu Bezabih Yitbarek, Berhan Tamir Mersso and Ashenafi Mengistu Wosen (2016). Disease management and biosecurity measures of small-scale commercial chicken production enterprises in and around Debre Markos, Amhara region, Ethiopia. *Journal of Veterinary Medicine and Animal Health* **8**: 136–144.

Nebiyu Yemane, Berhan Tamir and Kelay Belihu (2013). Characterization of village chicken production performance under scavenging system in Halaba district of Southern Ethiopia. *Ethiopian Veterinary Journal* **17**(1): 69–80.

Solomon Demeke (2004). Growth performance and survival of local and white leghorn chicken under intensive management system. *Ethiopian Journal of Health Sciences* **27**(2): 161–164.

Solomon Tiruneh, Asress Zegeye., Niguse Belayneh., Alemayehu Amare. and Dawud Ibrahim (2018). Demonstration of commercial layer chicken "Bovans Brown" technology packages for smallholder poultry producers in Eastern Amhara, Ethiopia. www.mwud.gov.et/web/dessie/home.

Tadelle Dessie, Wondmeneh Esatu, Waaij, L.V., Fisseha Zegeye, Solomon Gizaw, Okeyo Mwai and van Arendonk, J. (2013). Village chicken production in the Central and Western Highlands of Ethiopia: Characteristics and Strategies for Improvement. International Livestock Research Institute (ILRI) report, Ethiopia. 27–30.

Teshome Gemechu and Tesfaye Amene (2015. Review on production, husbandry and sustainability of free-ranging poultry production systems in Ethiopia. *International Journal of Science* **4**(04): 28-34.

Tomas Melkamu, Niraj Kumar, Berihu Gebrekidan, Etsay Kebede and Tsegay Tkue (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.

Wondu Mamo, Mehiret Melaku and Berhan Tamir (2013). Characterization of urban poultry production system in Northern Gondar, Amhara Regional State, Ethiopia. *Agriculture and Biology Journal of North America* **4**(3): 192–198.

Yonas Kejela, Sandip Banerjee, Mestawet Taye and Mohammed Beyan (2019). Urban poultry production systems and constraints of local and exotic chickens reared in Yirgalem and Hawassa Towns, Ethiopia. *International Journal of Livestock Production* **10**(2): 62–69.