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Body Weight Performance, Egg Production and Egg Quality Trait of Lohmann Chicken Genotype in Wachemo University Poultry Farm under Intensive Management System

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Authors' contributions

This work was carried out in collaboration among all authors. Author BB did the conceptualization, designing methodology, data collection, formal analysis and writing original draft. Authors BW, SA, DHM, WA and FT did the conceptualization and modifying the manuscript. Authors TL and HA did the conceptualization and provision of fund. All authors read and approved the final manuscript.

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ABSTRACT

Aim: This study was conducted to evaluate body weight performance, egg production and egg quality traits of Lohmann chicken genotype in Wachemo University.
Methodology: For the experiment, the Lohmann layer chicken in the University farm was used and SAS ver 9.4 was used to analyze the data. Body weight and egg production progress were evaluated at different times. A total of 200 eggs (100 at the end of 1st month and 100 at the end of 3rd month of egg lay) were brought to Hawassa University poultry farm laboratory to assess the egg quality traits. For the data analysis, SAS (Ver. 9.4) was used.
Results: The Lohmann chickens weighed 0.93kg at their entry to the university poultry farm and increased in to 1.34kg at end of first month of entry. In the farm, about 34.4%, 42.5% and 58.6% of the hens have laid egg until the end of first, second and third months of egg lay respectively; this indicates that the increasing trend of egg production of Lohmann chickens as age increase. Egg laying age difference has a significant effect ($p<0.05$) on egg weight, egg length, egg width, shell thickness, egg surface area and shell ratio. There was a significant difference in yolk weight, yolk diameter, albumen ratio and yolk index for the eggs collected from the Lohmann chickens at different age. Egg weight has the strong and positive correlation with egg length (78.6%), egg width (84.7%) and egg surface area (99.8%). Albumen weight is more correlated with albumen ration (64.2%) positively and yolk albumen ration (65.6%) negatively.
Conclusion: Poultry production could be influenced by many factors. Among the factors, age was evaluated in the current study; as age increased, the growth performance, egg production and egg quality traits improved.

Keywords: Body weight; egg production; egg quality traits; Lohmann; Wachemo University.

1. INTRODUCTION

Poultry production in Ethiopia plays a crucial role in generating employment opportunities, poverty reduction, improving family nutrition, and in women empowerment. It is a suitable business for resource-poor households due to the small land requirement and low initial investment costs needed [1].

The production performance of exotic chicken under the Ethiopian condition needs to be monitored regularly to provide guidelines for policy makers. Lack of recorded data on the productive performance of chicken makes it difficult to assess the importance and contributions of the past attempts made to improve the sector [2]. It was indicated that the imported breeds of chickens performed well under the intensive management system in Ethiopia (Permin, 2008); [3].

Chicken production is used for efficient transforming feed protein and energy in to consumable human diets. Among the different food sources, poultry products contribute significantly to the Ethiopia's protein demand. The demand of protein food is progressively growing with the improvements of society's income and population growth that affects trends of chicken production. With the increasing population of the country, there is an increasing demand for the supply of food. Thus, the demand for animal products is expected to increase substantially [4].

Egg characteristics greatly influence the process of incubation and are responsible for its success [5]. The eggshell has an important role during embryonic development, isolating the embryo from the external environment while allowing the proper gas exchange through the shell. Barnett et al. [6] reported that eggs with hair-cracks showed increased bacterial exposure and weight loss, with significantly lower hatchability (56.4% vs. 80.9%) compared with intact shells. Moreover, Barnett et al. [6] compared thin and thick shells based on specific gravity measurements and reported a reduction in hatchability of 3 to 9%, which attributed to increased cracks, moisture loss and bacterial contamination of eggs with thin shells.

Chicken meat and eggs have been recommended to bridge the protein gap more than other species of livestock because of short generation interval, high rate of productivity, quick turnover rate, higher feed efficiency, and low labor and land requirements. The role of poultry in Ethiopia became very important over time [3].

To meet the ever increasing demand for meat and eggs, introduction of exotic breeds should be practiced as one of the reasonable options. The testing of exotic chicken genotypes for adaptability and productivity in the study site largely focuses on measuring production volume (growth rate of chicken and number of eggs produced and quality traits). Therefore, the required information was documented based on the objectives; to evaluate growth performance of Lohmann chickens under intensive farming system and to evaluate the egg production and egg quality traits of Lohmann layers.

2. MATERIALS AND METHODS

2.1 Farm Site

Wachemo University (WCU) is one of the public higher educational institutions, which was found in 2009 at Hossana town, Ethiopia. The information for this piece of paper was gathered from Wachemo University poultry farm. Hossana is situated in latitude $7^0 27' 37''$ north and longitude $37^0 41' 22''$ east and has elevation (above sea level) of 2300 mm, average annual rain fall 1331.6mm and average annual temperatures 14.4^0C.

2.2 Establishment of Poultry Farm in Wachemo University

Poultry farm in Wachemo University was established in 2022 to attain the demand towards the chicken and their products. The first batch of the chickens those entered in to the farm was Lohmann breed. One thousand (1000) female pullets at their 81st day of age were interred from Alema poultry farm, Debrezeit, Ethiopia.

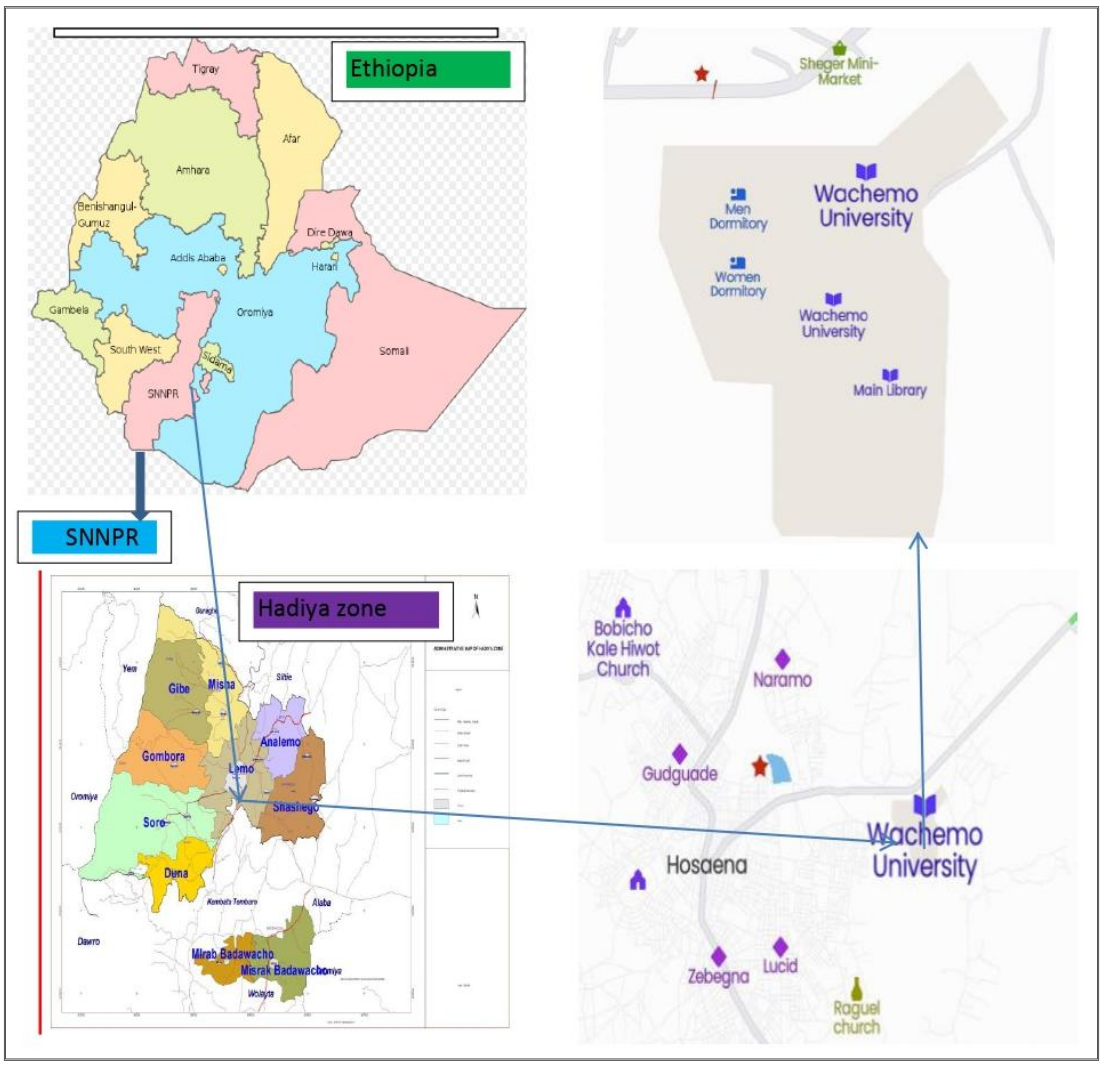

Fig. 1. Map of study site

Table 1. Chemical composition of feeds used for chickens in Wachemo University farm

Nutrient composition	Flock structure	
	Pullets	Layers
Crude protein (%)	15.5	18
Crude fiber (%)	8	6
Crude fat (%)	5	4
Calcium (%)	0.8	1.5
Water moisture	10	10
Energy (kcal/kg)	2750	2950

% = percentage

2.3 Management of Chickens in a Farm

Chicken rearing equipment were cleaned and disinfected prior to one week of the first batch entry. Chickens were kept in a deep litter housing system with concrete floors covered with wood shavings. The chickens fed on the same standard commercial chicken feed following the recommendation of feeding chemical composition by the manufacturers (Table 1).

Body weight was recorded at different ages from the chickens; at their entry in to Wachemo University poultry farm (81st days of age), at the end of first month (111th days of age) and at the end of second month (141th days of age).

For egg quality measurement, the eggs were brought to the Hawassa poultry farm laboratory at two different times of egg-lay. Immediately at the end of the second month of egg lay, 100 eggs were taken and measured and the same number of eggs (100) was broken at the end of 3rd month of egg lay.

2.4 Egg Quality Determination

Each egg was individually weighed using sensitive weighing balance. Egg width and egg length were measured using digital caliper. After external egg parameters measurement, the eggs were broken on a smooth glass platform and the albumen and yolk weights, lengths, and heights (albumen weight (AW), albumen length (AL), albumen height (AH), yolk weight (YW), yolk length (YL) and yolk height (YH) were determined using a digital caliper. Afterward, the shells were cleaned and kept in egg tray for drying at room temperature. Finally, after 24 hours, shell weight (SW) and shell thickness (ST) were measured. Albumen and yolk height (mm) was determined using tripod micrometer. Yolk colour was measured using colour fan of 1–15 leveled colour fans. Egg shape index was computed by dividing egg width with egg length. Haugh unit was calculated according to Haugh (1937) by fitting the average albumen height and egg weight in to the following the equation: 100×log [albumen height+7.57-1.7 (egg weight 0.37)].

Measured egg quality characteristics data were used to calculate some external and internal egg quality characteristics. These calculated characteristics were estimated using equations obtained from Kul and Seker, [7]; Singh, [8]; and Debnath and Ghosh, [9]

External:

$$\text{ESI}\ (\%) = \frac{\text{EG}}{\text{EL}} * 100$$

$$\text{SR}\ (\%) = \frac{\text{SW}}{\text{EW}} * 100$$

$$\text{ESA}\ (\text{cm}^2) = 3.9782 * \text{EW}^{0.75056}$$

$$\text{USSW}\ (\text{mg/cm2}) = \frac{\text{SW}}{\text{ESA}}$$

Internal:

$$\text{AR}\ (\%) = \frac{\text{AW}}{\text{EW}} * 100$$

$$\text{YR}\ (\%) = \frac{\text{YW}}{\text{EW}} * 100$$

$$\text{YI}\ (\%) = \frac{\text{YH}}{\text{YD}} * 100$$

$$\text{YA R}\ (\%) = \frac{\text{YW}}{\text{AW}} * 100$$

$$\text{HU} = 100\log\ (\text{AH} - 1.7\text{EW}^{0.37} + 7.6)$$

Where:

ESI = Egg Shell Index; EG = Egg Width; SR = Shell Ratio; SW = Shell Weight; EW = Egg Weight; ESA = Egg Surface Area; USSW = Unit Surface Shell Weight; AW = Albumen Weight;

AR = Albumen Ratio; YR = Yolk Ratio; YI = Yolk Index; YAR = Yolk Albumen Ratio; HU = Haugh Unit.

2.5 Data Management

Data were analyzed using descriptive statistics. Correlation analysis of egg characteristics was obtained with Pearson product-moment correlation coefficients (PCC) using SAS Ver. 9.4.

The following model was used

$$Yi = \mu + Ai + ei$$

Where: Yi = Observations
μ = Over all mean
Ai = effect of ith age
ei = residual effect

3. RESULTS AND DISCUSION

3.1 Body Weight

The mean body weight of Lohmann at different age is presented in Table 2. The Lohmann chickens weighed 0.93 kg at their entry to the university poultry farm and increased in to 1.34 kg at first month of entry and 1.83kg at their 60 days of their arrival to the Wachemo University poultry farm. Variation (0.94 kg) of the chickens to each other is exhibited more at the age between 111th and 141st days. This is not in agreement with the study conducted by Bekele et al. [10] for the Sasso chickens (1186 g) and even for F1 of Sasso and indigenous (1016 g) in Hawassa University poultry farm in between 15 to 20 weeks of age. The variation of the body weight could be due to the variation in environment, breed and even though the chicken managed on-station in both conditions, the feed they fed on can influence the growth rate. Live body weight is the direct reflection of growth rate, and it influences the production and reproduction traits of chickens and the growth performance of chicken is mostly affected by the environment, which reflects the differences in climatic condition [11].

The rate of mortality and culled chickens are reported in Table 3. The mortality rate of the Lohmann chickens reared in Wachemo University poultry farm was reported as only 1.28%. Unlike to the mortality, the number of chickens culled from the production population is reported higher (4.81%). The culling activity was done for excluding the chickens with disability to be part of the production population, emaciation of the body weight and cannibalism. Following the defeats through the mortality and culling still the compiling of the data for this study, 883 eggs laying Lohmann chickens were certified as the production population in the farm. The mortality of chickens under intensive management system is in agreement with the report of Bekele et al. [10] who revealed that on-station mortality rate of chicken reported as very low; due to the better management towards the chickens in the farms.

Table 2. Mean body weight of the Lohmann chicken genotype in Wachemo University poultry farm

Age (days)	Average body weight (kg)		Minimum	Maximum	Range
	Mean	SD			
81st	0.93	0.13	0.68	1.34	0.66
111th	1.38	0.14	0.98	1.68	0.70
141st	1.83	0.17	1.56	2.50	0.94

SD = Standard deviation

Table 3. Mortality rate and culling of the chickens in the study farm

Age	Mortality			Culling		
	N	Frequency	%	N	Frequency	%
81 – 141 days	1000	15	1.5	985	30	3.05
141 – 201 days	955	10	1.05	945	62	6.56
Average			1.28			4.81

N=number of chickens; %=percentage

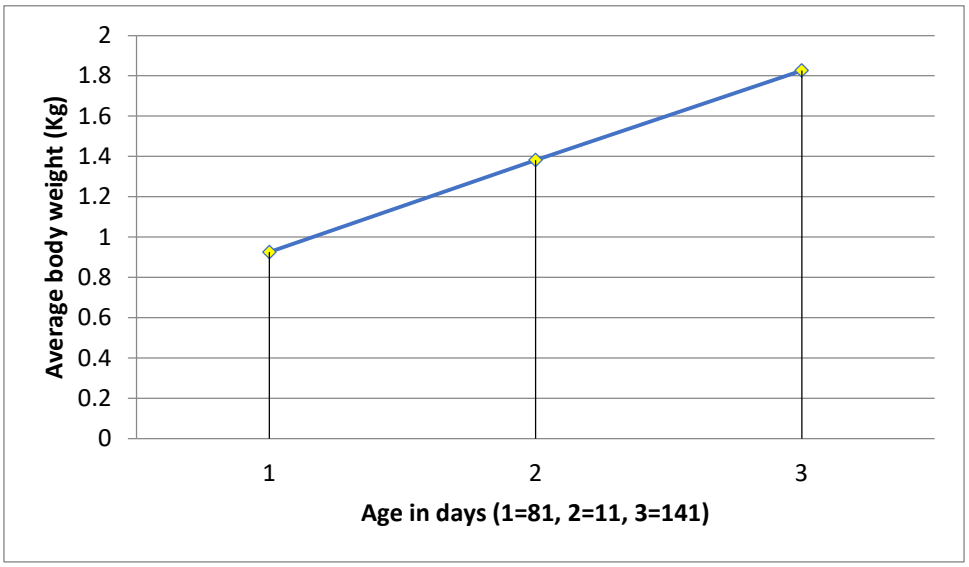

Fig. 2. Body weight trend of Lohmann chicken genotype in poultry farm of Wachemo University at different ages

3.2 Egg Production

Egg production of the Lohmann chicken at the three consecutive months is presented in Table 4. There was a highly significant difference (p<.0001) at egg production of Lohmann chickens in the study farm for the three consecutive months. The egg production evaluation was conducted after the 141st days of their age and this age was their maturity time, because the Lohmann layer chickens had started laying egg but the number of eggs was less than 10%. The egg production is in increasing trend from 310 eggs per month in the first month to 517 eggs per month in the third month.

Proportionally, in the first studied month, 34.4% of the hens have laid egg and was in increasing trend as shown in Table 3. In addition to the information in Table 3, Fig. 3 indicates that the surging trend of egg production of Lohmann chickens in Wachemo University poultry farm month to month which is in increasing manor. Egg production is a dependent variable and is influenced by the breed of chicken, age at point of-lay, and the environment. Different studies reported that there were significant effects of breeds on egg production in different parts of tropical countries [12,13].

3.3 External Egg Quality Traits

Least square mean for external egg parameters is presented in Table 5. Egg laying age difference has a significant influence on egg weight, egg length, egg width, shell thickness, egg surface area and shell ratio.

The Lohmann chickens at the end of third months (221-250 days as indicated Table 4) of egg lay had significantly (p<0.05) higher mean egg weight (60g), egg length (57mm), egg width (43.2mm), shell thickness (0.35mm) and egg surface area (85.9mm^2) than the eggs evaluated from same chicken breed at the end of first month (160-190 days; Table 4) of egg lay. However, shell ratio (9.61%) was measured significantly less thicker for eggs collected from the chickens at the first month of maturity. In congruent with this study Lacin et al. [14] in Lohmann chickens in Egypt reported that as the age of the chickens increase the egg quality parameters revealed the significant increment.

However, there was no significant influence (p>0.05) of egg lay age on shell weight and egg shape index.

Least square mean for internal egg parameters is presented in Table 6. There was a significant difference in yolk weight, yolk diameter, albumen ratio and yolk index for the eggs collected from the Lohmann chickens at different age in Wachemo University poultry farm. Yolk weight and yolk diameter were measured significantly higher for the eggs collected from Lohmann layers at the first egg lay month; however, albumen ratio and yolk index was exhibited higher for the eggs collected at the end of third month of egg production. This report agrees the

report stated by Takele, [3] in different chicken strains in Debrezeit research center. The advancing of yolk weight following age could be for advancement in some ingredients in egg like cholesterol [15,3].

Table 4. Mean egg production and percentage of layer Lohmann chicken breed in poultry farm for the first three months

Age (days)	Egg production (number)		Min.	Max.	No of layers	Rate (%)
	Mean	SD				
160-190 (1st month of egg lay)	310[c]	83.5	130	507	900	34.4
191-220 (2nd month of egg lay)	379[b]	57.9	242	456	892	42.5
221-250 (3rd month of egg lay)	517[a]	63	399	650	883	58.6
P-value	.000					

Max. = maximum, Min. = minimum, SD = Standard deviation, % = percentage

Fig. 3. Egg production rate of Lohmann chicken genotype in poultry farm of Wachemo University

Table 5. Least square mean for external egg parameters of Lohmann chicken breed at different time

Parameters	Age				p-value
	End of 1nd month of egg lay		End of 3rd month of egg lay		
	LSM	SE	LSM	SE	
Egg weight (g)	57.9[b]	0.45	60.0[a]	0.47	0.0017
Egg length (mm)	55.9[b]	0.23	57.0[a]	0.24	0.0013
Egg width (mm)	42.7[b]	0.12	43.2[a]	0.12	0.0069
Shell weight (g)	5.55	0.06	5.52	0.06	0.7503
Shell thickness	0.34[b]	0.003	0.35[a]	0.003	<.0001
Egg shape index (%)	76.5	0.28	75.9	0.29	0.1222
Shell ratio (%)	9.61[a]	0.11	9.26[b]	0.12	0.0392
ESA (mm^2)	83.6[b]	0.49	85.9[a]	0.49	0.0018

ESA = egg surface area, LSM = Least Square mean, SE = Standard error

Table 6. Least square mean for external egg parameters of Lohmann chicken breed at different time

Parameters	Age				P-value
	End of 1nd month of egg lay		End of 3rd month of egg lay		
	LSM	SE	LSM	SE	
Albumen weight	36.6	0.38	37.3	0.37	0.1834
Albumen height	9.30	0.10	9.56	0.11	0.0966
Yolk weight	15.3[b]	0.14	16.2[a]	0.15	0.0003
Yolk height	18.4	0.10	18.5	0.11	0.7843
Yolk diameter	39.0[b]	0.15	40.1[a]	0.18	<.0001
Yolk color	2.41	0.12	2.47	0.13	0.8252
Albumen ratio	63.2[a]	0.33	62.2[b]	0.33	0.0363
Yolk ratio	26.6	0.26	27.0	0.27	0.2840
Yolk index	47.2[a]	0.29	46.1[b]	0.32	0.0119
Yolk Albumen ratio	42.3	0.60	43.6	0.60	0.1277
HU	96.5	0.48	97.2	0.51	0.3292

HU = Hough Unit, LSM = Least Square mean, SE = Standard error

3.4 Correlation of External Egg Quality Traits

Table 7 shows the correlations among external egg characteristics of Lohmann chickens. Egg weight has the strong and positive correlation with egg length (78.6%), egg width (84.7%) and egg surface area (99.8%). Unlike to the many of the evaluated egg parameters, egg surface area and shell ratio have a negative correlation with egg weight. As reported by Yousif and Eltayeb [16]; Yakubu et al. [17]; Kgwatalala et al. [18]; Markos et al. [19]; Bekele et al. [10] the variation in egg weight depends mainly on egg length and egg width because their correlation is strong. Selection for egg length and egg width thus results in simultaneous improvement in egg weight.

Egg length has strong negatively and strong positively correlated with egg shape index (75.5%) and egg surface area (78.6%) respectively. Egg width has strong correlation with egg surface area, but week correlation with shell thickness and shell weight.

3.5 Phenotypic Correlations among Internal Egg Characteristics

Table 8 shows the correlations among internal egg traits of Lohmann chickens in Wachemo University poultry farm. Albumen weight is more correlated with albumen ration (64.2%) positively and yolk albumen ration (65.6%) negatively. Albumen height has a negative correlation with yolk weight, yolk diameter, yolk ration and yolk albumen ratio. The current study revealed the congruent report as Lucin et al. (2008) who stated that Hu and yolk index indicated significantly more as the age of hens increased [20].

Table 7. Phenotypic correlations among external egg quality characteristics of Lohmann chicken breed in Wachemo University poultry farm

Traits	EW	EL	EG	SW	ST	ESI	SR	ESA
EW	1	0.786	0.847	0.222	0.016	-0.247	-0.385	0.998
EL		1	0.494	0.205	0.036	-0.756	-0.291	0.786
EG			1	0.123	0.009	0.194	-0.376	0.847
SW				1	0.238	-0.139	0.736	0.222
ST					1	-0.030	0.240	0.015
ESI						1	0.044	-0.248
SR							1	-0.384
ESA								1

EW=egg weight, EL=egg length, EG=egg width, SW=shell weight, ST=shell thickness, ESI= egg shape index, SR=shell ratio, ESA=egg surface area

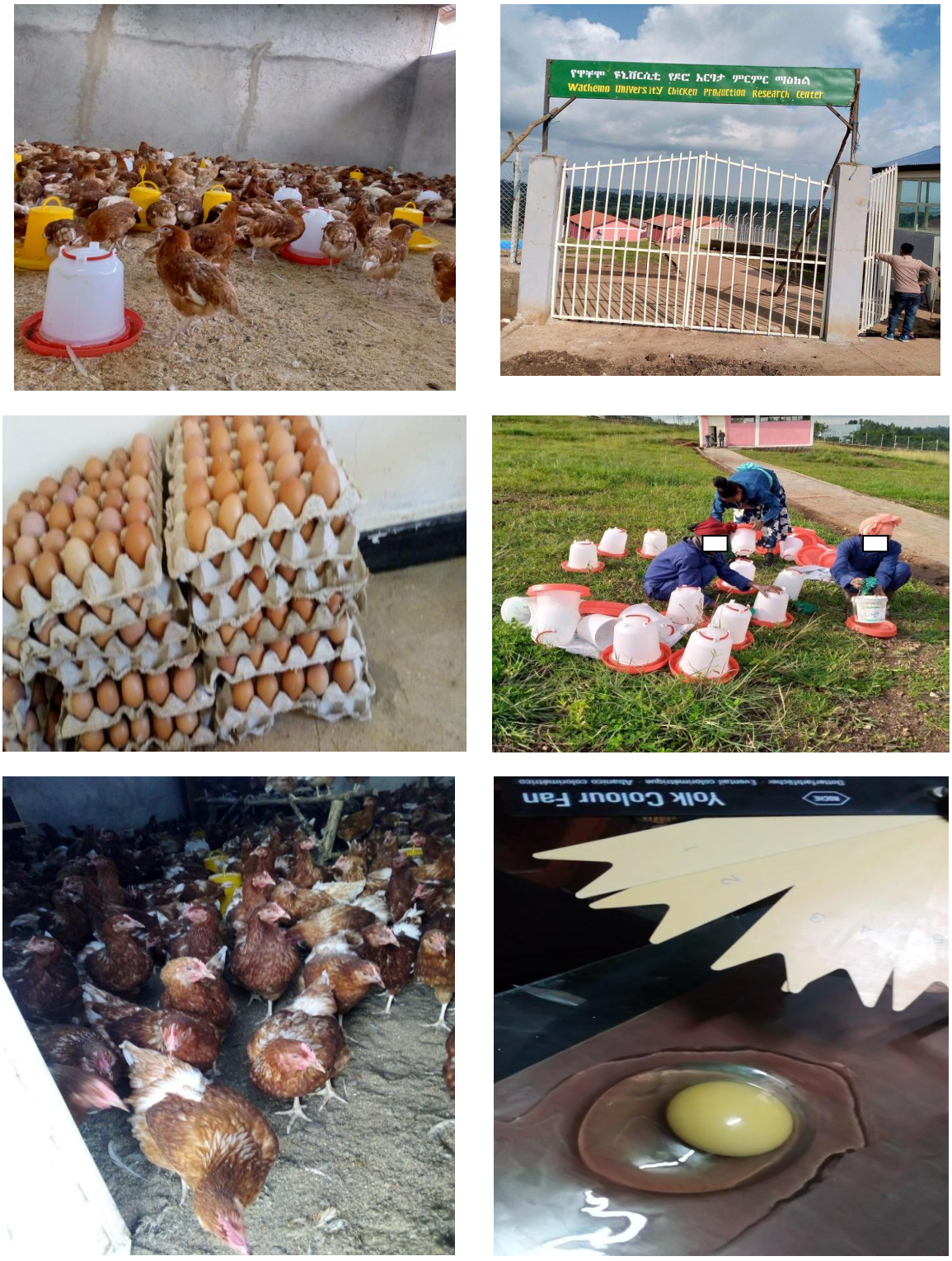

Fig. 4. Pictures taken in and around the farm and during egg quality evaluation

Table 8. Phenotypic correlations among internal egg quality characteristics of Lohmann chicken breed in Wachemo University

Traits	AW	AH	YW	YH	YD	AR	YR	YI	YAR	HU
AW	1	0.227	0.143	0.251	0.194	0.642	-0.550	0.073	-0.656	0.079
AH		1	-0.095	0.433	-0.114	0.205	-0.244	0.406	-0.264	0.789
YW			1	0.181	0.430	-0.348	0.675	-0.151	0.639	-0.178
YH				1	0.056	-0.054	-0.126	0.759	-0.079	0.298
YD					1	-0.281	0.083	-0.599	0.161	-0.192
AR						1	-0.494	0.136	-0.752	0.218
YR							1	-0.171	0.941	-0.159
YI								1	-0.179	0.337
YAR									1	-0.204
HU										1

AW= albumen weight, AH=albumen height, YW=yolk weight, YH=yolk height, YD=yolk diameter, AR=albumen ratio, YR=yolk ratio, YI=yolk index, YAR=yolk albumen ratio, HU=Haugh unit

4. CONCLUSION

Under intensive management system, the growth rate of chickens and egg production is considerably better. Moreover, the mortality rate of the chicks was recorded very low, which again exploits the positive side of managing chickens under intensive management systems. The yolk color is dominantly whitish, that indicates the measure from the diets which fed to chicken.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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