Original Research Article||

Assessment on indigenous chicken incubation, brooding hen and chicks' husbandry practice of farmers at different agroecological zones of Sidama Region, Ethiopia

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Abstract

This study was conducted to assess the indigenous chicken incubation, brooding hen, and chick husbandry practices of farmers in Hulla, Aleta Wondo, and Dale districts, representing highland, midland, and lowland agro-ecologies, respectively. From each agroecology, two kebeles were purposively selected based on potential poultry production and road availability. About 256 households were purposively selected from six kebeles for survey interview. The collected data were analyzed using SPSS version 20 and SAS version 9.0 software packages. The results indicated that all the respondents in the study areas incubate only eggs laid at home. The majority (75.8%) of the respondents in all agroecology did not select eggs for incubation. Majority of the respondents (61.3%) in all agroecological zones stored incubated eggs for two weeks before the incubation. Another majority of respondents (66.8%) in all agroecological zones provided water to brooder hen in the afternoon only. All of the respondents in the study areas incubated eggs and rear their chicks naturally using broody hen. About 62.4, 51.0, and 52.0 % of respondents in highland, midland, and lowland agroecological zones, respectively, responded that the handling problem was the main cause of the failure to hatchability. Almost all of the respondents in the study areas provided free access to water to their chicks. The average number of eggs set per hen was 12.46±1.50 (mean±SD) with no significant difference between agroecological zones. The hatchability of the eggs in the study areas was 83.55% and there was no significant difference between agroecological zones In conclusion, regardless of the agroecological differences, farmers incubated eggs and brooded chicks naturally using broody hens, and they stored incubating eggs for long periods without considering storage conditions. Therefore, promoting incubation and brooding technologies (mini-hatcheries, sandwich incubators, hay box brooders) is necessary to improve the productivity of local chickens.

Key words: Agro-ecology, Brooder hen, Chicks' husbandry, incubation practices, indigenous chicken, Sidama Region

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INTRODUCTION

The total chicken population of Ethiopia is about 49 million, which are kept for egg and meat production, as well as for cash income purposes (CSA, 2020). Even though Ethiopia has a large number of chicken flocks, there are various factors, such as diseases, predators, lack of proper healthcare, feed shortages, and poor marketing information, that hinder the productivity of chickens in most areas of the country (Bayesa, 2021).

Among the above obstacles, poultry diseases are the main constraints incriminated for reduction of total numbers and compromised productivity (Natnael, 2015). The poultry population growth is very low due to the disease and the number is even in a decreasing trend (Fenet and Alemayehu 2019). Local chicken flocks are slow in growth rates and very poor in productivity. Mean body weights at 8 and 16 weeks of age could be as low as 242 and 621 g, respectively (Nigussie, 2011). The mean annual egg production

does not exceed 60 egg/hen with an average egg weight of 40 g (Halima, 2007). Due to this, poultry meat and egg consumption in Ethiopia is extremely low (Matawork 2016). In 2013, the per capita consumption of poultry meat was about 0.66 kg. During the same year, the per capita annual poultry meat consumption of East Africa and Africa were estimated at 1.64 and 6.73 kg, respectively, while the global average stood at 14.99 kg (FAOSTAT, 2018). The per capita consumption of eggs was also low, accounting for around 0.36 kg in 2013 (FAO, 2019).

Despite their lower productivity, local birds are still the major suppliers of poultry products in Ethiopia. They are well adapted to their environments, resistant to diseases, can scavenge for food, and can avoid predators as they are agile and fast, with the color and patterns of their feathers providing natural camouflage (Abdelqader et al., 2007; Mammo, 2012). The incubation period for chicken eggs is 20 to 21 days and increases up to 30 days for other poultry chicks. Proper incubation requires the right combination of temperature, humidity and time (Olsen, 2000). The broody hen chosen for natural incubation should be large (to cover and thus keep more eggs warm), healthy and preferably vaccinated, with a good brooding and mothering record (King'or, 2011). Few researches were conducted on natural incubation practices of local chicken under farmer's management conditions (Shishay et al., 2014). These researches do not provide full information on farmers' practices of incubation and brooding of chicks, management of broody hen and brooding hen selection across different agroecological zones. Agro-ecologically based developmental interventions on improving local chicken need this information. The objective of this study was to assess indigenous chicken incubation practices, as well as brooding hen and chick husbandry practices of farmers in different agroecological areas of Sidama Region, Ethiopia.

MATERIALS AND METHODS

Description of the Study Area

This study was conducted at three districts of Sidama Regional State namely, Hula, Aleta Wondo and Dale representing highland, midland and lowland agroecological zones, respectively. Hula district is located at a distance of 91 km from Hawassa and 366 kms from Addis Ababa. The district is located at longitude and latitude of 6°.41'-6°.61' N and 38°.44'-38°.70' E, respectively and l201 to 3000 masl elevation. Hula is bordered on the south by the Oromia Region, on the west by Dara, on the northwest by Aleta Wondo, on the north by Bursa, and on the east by Bona Zuria districts. It received annual rainfall ranges of 700-1200 mm with annual temperature ranges of 11-18℃. According to the information obtained from the Hula district, the total population of the district is 80,464. The total livestock population of Hula district is 15,456 cattle, 2,215 sheep, 1,056 goats, 769 horses, 456 donkeys, 3,422 poultry. The main agricultural activities of the district are livestock production, enset plantation and cereal crop production.

Aleta Wondo district is one of the 36 districts in Sidama Regional State, located about 64 km from Hawassa and 339 km from the capital city of Ethiopia, Addis Ababa. It is situated in the coordinates of 60 35′ to 60 40′ N latitude and 380 25′ to 380 30′ E longitudes. The annual temperature of the district ranged between 10℃ to 24℃. Elevation ranges from 1700 to 2500 masl. As per the information gotten from the district reports, annual rainfall of the district ranges from 900 mm to 1400 mm. Aleta Wondo district is bordered with Dare in the south, Chuko in the west, Dale and Wonsho on the west and Bursa and Hulla in the east directions. The livestock population was estimated to be 138,251 cattle, 39,211 sheep, 22,421 goat, 3918 horses, 8586 donkeys, 168 mules and 169, 256 poultry The main agricultural practices in the area include coffee plantation, inset plantation, maize and cereal crop production, cattle fattening, apiculture, as well as fruit and vegetable production.

Dale district is one of the 36 districts of Sidama Regional State. The district is located on the highway from Hawassa to Moyale at 45 km from Hawassa and 320 km from the capital, Addis Ababa, and situated with latitude of 6° 39' 20"- 6° 50' 28" N and longitude of 38°18'12" - 39°31'30" E. Dale is bordered on the south by Aleta Wendo and Chuko, in the west by Loka Abaya, in the northwest by Boricha, in the north by Shebedino, and on the east by Wonsho. Its elevation ranges from 1200-3200 masl. The annual rainfall in Dale district ranges from 1,300 to 1,900 mm, and the annual temperature varies from 18°C to 20°C.The main agricultural activity of the district is livestock production, enset plantation, coffee plantation and cereal crops production.

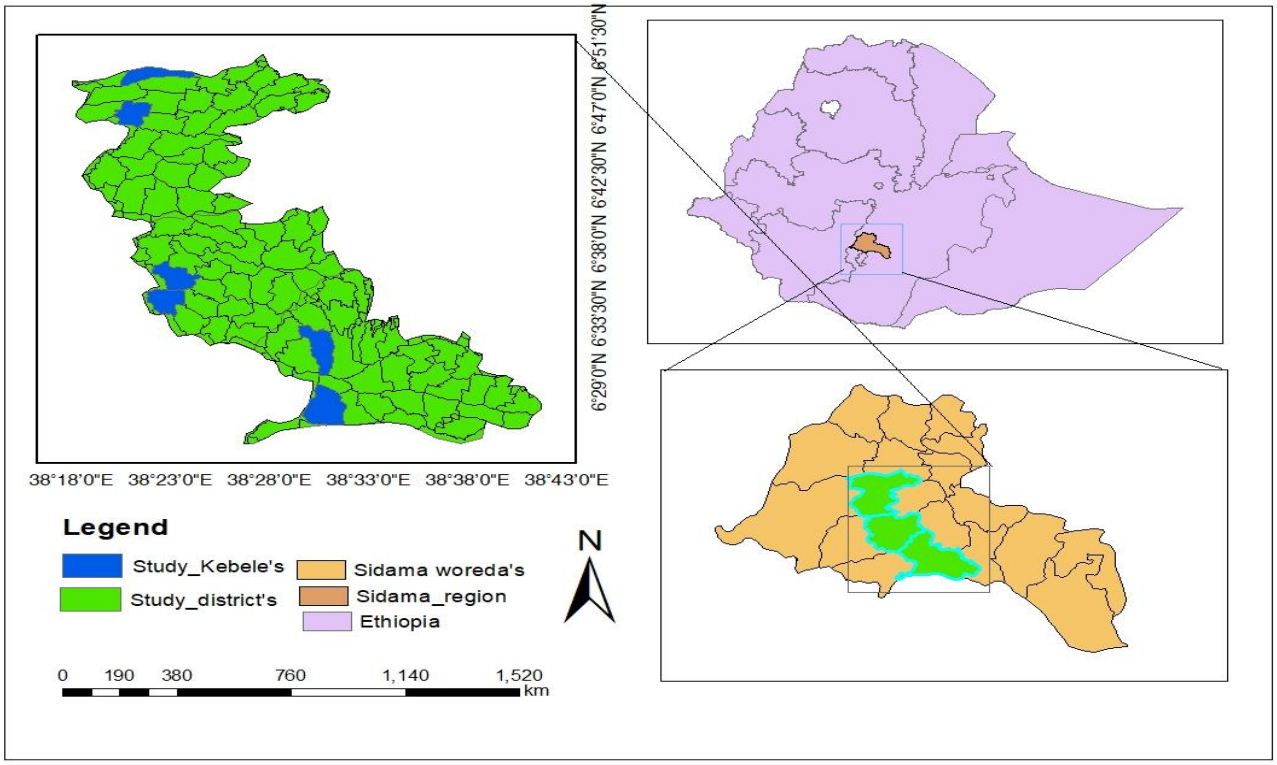

Figure 1. Administrative map of Sidama region and the study areas

Selection of the Study Area and Sampling Technique

A multi-stage sampling technique was used to select both the study area and the study households. The districts were purposively selected primarily based on agro-ecology, their potential for chicken production, and transportation accessibility. Then, two kebeles (the smallest administrative unit) from each district representing one agro-ecology were purposively selected (based on in-depth discussion with districts' office of livestock and fishery), where exotic breeds were less distributed. Households who possessed at least 5 local adult chickens were purposely selected for questionnaire survey. Preliminary data was collected using focus group discussion. One FGD containing six to twenty discussants was established and used in each kebele. Each farmer and key informants were interviewed individually. Proportional samples were taken using the formula by (Yamane, 1967) for kebeles having a different number of households. Accordingly, a total of 256 HHs (85 from highland, 96 from midland and 75 from lowland) were selected for the survey.

$$n = \frac{N}{1+N(e)2}$$

n = where: n is sample size, N= is population size, e = is level of precision

Assumption: - 95% confidence level p = 0.05

Survey Data Collection

Data were collected for demographic characteristics, chicken flock structure, egg selection and handling practices, broody hen selection and management, methods of interrupting broodiness, incubation season of local chicken, methods of chick management, number of chicks hatched per hen, chick hatchability and number of chicks survived to the age of sexual maturity.

Statistical Analysis

Collected qualitative data were analyzed using crosstabs among agroecology in descriptive statistics using statistical package for social science (SPSS) for Windows, version 20.0. Quantitative data was analyzed using general linear model (GLM) procedure of SAS (version 9.0). Mean comparisons were conducted using Duncan's multiple range test. Values were considered as significant at 5% level of significance.

RESULTS AND DISCUSSION

Demographic Characteristics of Respondents

The demographic characteristic of the respondents is shown in Table 1. The results revealed that 55.5% of respondents were male and the rest (44.5%) were female. The number of male respondents was higher at highland agro-ecology than midland and lowland,

which might be due to the presence of market days (Hulla and Aberra markets) during survey work of highland agro-ecological zones. Women are more likely to go to the markets to buy goods for the households' consumption, but men and children remain at homestead and they were available during present survey work. The percentage of female respondents involved in the current study was higher than those reported earlier by Demissu (2020) and Mekonnen (2007) where 87.45% male and 12.55% female and 86.3% male and 13.7% female, respectively participated. Age classification was done according to Meseret (2010). Most of the respondents (73.4%) were categorized under the age group between 31 -45 years and 20.3% of respondents were categorized under the age group between 15 and 30 and only 5.9% were above 45 years of aged. This result was in line with the findings of Meseret (2010), where most of respondents were categorized under the age group between 31-60 years.

The result indicated that 37.5% of the respondents were illiterate and only 6.2% of the responds were categorized under the educational status of college and above. This report showed higher number of illiterate respondents than that reported by Mieraf (2020) where 23.1% and 4.4% of respondents were illiterate and College/University graduate, respectively. Regarding the educational status of surveyed households, there were no clear differences between the different agroecological zones. The average family size of respondents was 5.71±1.69 regardless of the considered agroecological zones. The result from the current study was in agreement witn that reported by Ermias (2015).

Table 1. Demographic characteristic of respondents

Variable	Agro-ecology			Overall	χ^2
	Highland	Midland	Lowland		
Sex (%)					
Male	62(72.9)^a	43(44.8)^b	37(49.3)^b	142(55.5)	16.079
Female	23(27.1)^b	53(55.2)^a	38(50.7)^a	114(44.5)	
Age					
15-30	4(4.7)^b	27(28.1)^a	22(29.3)^a	53(20.7)	136.144
31-45	78(89.4)	62(64.6)	50(66.7)	188(73.4)	
Above 45	5(5.9)	7(7.3)	3(4.0)	15(5.9)	
Educational status					
Illiterate	27(31.8)	40(41.7)	29(38.7)	96(37.5)	
Primary	21(24.7)	22(22.9)	20(26.7)	63(24.6)	10.625
Elementary	26(30.6)	13(13.5)	14(18.7)	53(20.7)	
High school	6(7.1)	14(14.6)	8(10.7)	28(10.9)	
College or above	5(5.9)	7(7.3)	4(5.3)	16(6.2)	
Family size (mean±SD)	5.98±1.41	5.51±1.78	5.67±1.83	5.71±1.69	24.26

Figures outside and inside parenthesis represents frequency and percentiles respectively; SD= standard deviation; values within row with different superscript letters are significantly different at $p<0.05$

Chicken Flock Structure

The flock structure of chicken with the surveyed households is presented in Table 2, which indicates that the overall mean of hen and cocks in the flock were 3.82±0.96 and 1.12±0.35, respectively. The result of current study shows that there is no significant difference on the mean value of hen and cock in the flock composition between all study ago-ecological zones ($p>0.05$). This result was in line with the findings of Welelaw *et al.* (2018), who reported 3.6±1.4 and 1.2±0.9 for hens and cocks, respectively. However, pullets and cockerels were statistically higher at highland areas. However, there is no significant difference between midland and lowland agroecological on the number of pullets and cockerels per household. The overall mean number of pullets and cockerels in the current study were 3.42±1.32 and 1.63±0.78, respectively. Lower value on pullets and higher value of cockerels were reported in the findings of a study by Mekonnen, (2007) who reported 2.35±1.33 and 2.15±1.29 for pullets and cockerels respectively. The total average number of birds was statistically higher at lowland and lower at highland areas ($p<0.05$). The possible reason for this difference might be due to the highest survival rate of chicks in

lowland than in the highland areas. The average flock size of the respondent households at study areas was 9.16±2.70. The average flock size of the current study was in line with findings of Welelaw *et al.* (2018), who reported 9.2±3.5 chicken per household in Sheko district, Bench Maji Zone of Southern Ethiopia. But the results reported by Halima (2007) and Meseret, (2010) were lower with an average flock size of 7.13 and 6.23, respectively at different regions of Ethiopia.

Table 2. Chicken flock structure by sex and age group

Chicken type	Agroecology			Overall	p-value
	Highland	Midland	Lowland		
Hen	3.76±0.83	3.91±0.99	3.78±1.06	3.82±0.96	0.567
Cocks	1.06±0.31	1.12±0.33	1.19±0.39	1.12±0.35	0.201
Pullets	3.09±1.09[a]	3.56±1.43[b]	3.59±1.34[b]	3.42±1.32	0.021
Cockerels	1.41±0.67[a]	1.69±0.79[b]	1.86±0.83[b]	1.63±0.78	0.005
Chicks	-	10±2.65	9.33±3.51	9.67±2.80	0.806
Total	8.47±1.98[a]	9.43±2.77[b]	9.45±3.17[b]	9.16±2.70	0.024

Values are Mean ± SD and those within row with different superscript letters are significantly different at $p<0.05$; SD= standard deviation. Means

Egg Selection Practices of Farmers in the Study Area

The source of eggs to be incubated and egg selection practices of farmers are presented in Table 3. As the result indicate, all respondents in the study incubate only eggs laid at home. During the survey period respondents explained that farmers assume that, eggs purchased from the market or collected from neighbors may not be fertile. All farmers rear cocks with their hens before incubation or they take a hen assumed to hatch eggs to neighbor for mating with cock. This will be done just before the hen start laying incubating eggs. The current study was in line with study by Mekonnen (2007), who reported that 98.13% of the respondents incubate eggs laid at home. Most of the respondents in all studied areas (72.9% from highland, 78.1% from midland and 76.0% from lowland) did not have a practice of selecting eggs for incubation. The study by Demissu (2020) reported that 63.87% of the respondents did not select eggs for incubation, which was lower than the result of the present study. The result in the present study also was in line with the study by Adissu (2013), who reported that 88.24% of respondents did not select eggs for incubation. From respondents, who have practiced egg selection for incubation, 52.2% select eggs with its size, 47.8% for cleanliness at highland, 57.1% for egg size and 42.9% select for cleanliness at midland and 58.1% select for egg size and rest (41.9%) select egg for cleanliness at lowland areas.

Egg Handling before and after Incubation

Egg handling practices of respondents before and during incubation are presented in Table 4. The result indicates that majority (61.3%) of the respondents in all agroecology store eggs for two weeks before incubation. About 25% and 13.7% of the respondents in the study districts store eggs before incubation for one and three weeks, respectively. The difference observed for duration of storing eggs before incubation might be due to differences in the waiting time until the hen shows broody behavior. In general, there is no significant difference between agroecology on the duration of egg storage before incubation. In contradiction with the current study, Demissu, (2020) reported that 72.73% of respondents store eggs till hens show broody behavior and sit on eggs. Similar materials mentioned in a report by Mekonnen (2007), Demissu (2020), Shishay (2014) and Melesse (2012) at different parts of the country, were used for egg setting during incubation.

Table 3. Egg selection practices of farmers

Variables	Agroecology			Overall	χ^2
	Highland (n=85)	Midland (n=96)	Lowland (n=75)		
Source of eggs to be incubated					
Laid at home	100	100	100	100	0.00
Egg selection for incubation					
Yes	27.1	21.9	24.0	24.2	0.663
No	72.9	78.1	76.0	75.8	
Egg selection criteria					
Egg size	52.2	57.1	66.7	58.1	0.882
Cleanliness of the eggs	47.8	42.9	33.3	41.9	
Preferable egg size for incubation					
Medium to large egg size	17.6	12.5	12.0	14.1	1.362
Any size (no considerations)	82.4	87.5	88.0	85.9	

χ^2: Chi-square

Table 4. Egg handling before and during incubation

Parameters	Agroecology			Overall	p-value
	Highland (n=85)	Midland (n=96)	Lowland (n=75)		
Egg storage before incubation					
One week	18(21.1)	22(22.9)	24(32.0)	64(25.0)	0.038
Two weeks	48(56.5)	64(66.7)	45(60.0)	157(61.3)	
Above two weeks	19(22.4)	10(10.4)	6(8.0)	35(13.7)	
Setting materials					
Clay pot	20(23.5)^{ab}	36(37.5)^{b}	13(17.3)^{a}	69(27.0)	<0.001
Bamboo made basket	40(47.1)^{b}	26(27.1)^{a}	12(16.0)^{a}	78(30.5)	
Ground	8(9.4)^{a}	10(10.4)^{a}	32(42.7)^{b}	50(19.5)	
Cartoon	17(20.0)	24(25)	18(24.0)	59(23.0)	
Egg storage materials before incubation					
Clay pot	34(40)	39(40.6)	24(32.0)	97(37.9)	<0.001
Cartoon	9(10.6)	17(17.7)	13(17.3)	39(15.3)	
Bamboo basket	26(30.6)	36(37.5)	24(32.0)	86(33.6)	
Gerry cane	4(4.7)	2(2.1)	2(2.7)	8(3.1)	
Plastic bucket	12(14.1)^{b}	2(2.1)^{a}	3(4.0)^{ab}	17(6.6)	
Ground with soil	0(0.0)^{a}	0(0.0)^{a}	9(12)^{b}	9(3.5)	

Figures outside the parenthesis represent frequency and numbers inside the parenthesis represent percentage values. Values within row with different superscript letters are statistically different at $p<0.05$

Broody Hen Selection and Management

Broody hen selection and management practices are summarized in Table 7. The result of the current study revealed that all (100%) of the respondents at all study agroecologies hatch eggs using natural incubation, which is in agreement with the report of Hailu (2016), where eggs were incubated using broody hen at Sheka Zone of South Western Ethiopia. In the current study all respondents have a habit of selecting the best hen before incubation. It was indicated that, farmers select a hen with a bigger size due to an assumption that the bigger hens are able to incubate and hatch many eggs than smaller ones. This finding was in agreement with the report of FAO (2004) where maximum of 14 to 16 eggs were brooded in one nest, but hatchability often declines with more than ten eggs, depending on the size of the hen. At all agroecology with no significant difference, farmers select breeding hen depending on ample plumage, productivity, mothering ability, hatching history and also combination of two or more criteria mentioned above. This report was consistent with that of Nigussie (2011), who indicated that farmers select breeding hen based on plumage color, body weight, reproductive performances and mothering ability. The majority of respondents (66.8%) provide water to brooder hen in the afternoon only. The rest of the respondents (23.4%) provide water to the broody hen in the morning and afternoon, while 9.8% provide free access to water. The results of the current study differ from those reported by Fisseha et al. (2010), where all respondents provided free access to water for their chickens.

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Table 5. Broody hen selection and management

Variables	Agroecology			Overall	χ^2
	Highland (n=85)	Midland (n=96)	Lowland (n=75)		
Incubation methods used					
Naturally by a broody hen	85(100)	96(100)	75(100)	256(100)	0.00
Do you select broody hen for incubation?					
Yes	85(100)	96(100)	75(100)	256(100)	0.00
Broody hen selection criteria					
Size	20(23.5)	18(18.8)	16(21.3)	54(21.1)	18.704
Ample plumage	15(17.6)	19(19.8)	11(14.7)	45(17.6)	
Productivity	5(5.9)	12(12.5)	6(8.0)	23(9.0)	
Mothering ability	2(2.4)	7(7.3)	4(5.3)	13(5.1)	
Hatching history	1(1.2)	0(0.0)	5(6.7)	6(2.3)	
Size and mothering ability	10(11.8)	8(8.3)	7(9.3)	25(9.8)	
Productivity and mothering ability	28(32.9)	23(24.0)	23(30.7)	74(28.9)	
Size, plumage, productivity and mothering ability	4(4.7)	9(9.4)	3(4.0)	16(6.2)	
Broody hen supplementation					
Yes	85(100)	96(100)	75(100)	256(100)	0.00
Broody hen watering					
Free access	4(4.7)	11(11.5)	10(13.3)	25(9.8)	15.659
Morning and afternoon	14(16.5)^{a}	19(19.8)^{ab}	27(36.0)^{b}	60(23.4)	
Afternoon only	67(78.8)^{a}	66(68.8)^{a}	38(50.7)^{b}	171(66.8)	

Numbers outside brackets are frequency and inside brackets are percentage values. The row with different superscript letters is statistically different at $p<0.05$. χ^2: chi-square.

Incubation Season and Failure to Hatchability

Incubation season and causes of hatchability failure are presented in Table 6. There is no significant difference between the different agroecologies of the study areas in the season of incubation of chickens. Most of the respondents (98.8%) in all agroecology incubate their chickens during dry season. Regarding the hatchability of chicks 90.2% of the respondents said that they achieve best hatchability during dry

season. In this study from all agroecological zones the incubation season preferred by respondents was from September to February due to feed availability and favorable temperature for hatchability and chick survival. Halima (2007) reported that 95.6% respondent look for season to incubate their chicken. The present study was in agreement with the study by Meseret (2010), where respondents chose the time between October and January as the best season to get better hatchability. Ermias (2015) also reported that farmers do not incubate eggs during rainy seasons due to the reason that incubated eggs do not get enough warmth from broody hen and eggs would rot and chicks die due to cold stress. In the study by Ermias (2015) respondents indicated that the sound of thunder storm cause eggs to rot and chicks will die due to the fear of thunder storm. The result indicated that, 55.1% of the respondents believed that the handling problem was main reason for failure of hatchability. Another 28.5% of the respondents said that the problem of brooding hen was main issue for the failure of hatchability. The rest of the respondents (16.4%) did not know the reason for the failure in hatchability. King'or (2011) reported in the review that the size, age, and management of broody hens, as well as the storage conditions of incubating eggs, affect the hatchability of eggs.

Table 6. Incubation season and failure to hatchability

Variables	Agroecology			Overall	p-value
	Highland (n=85)	Midland (n=96)	Lowland (n=75)		
When to incubate chicken					
Dry season	84(98.8)	94(97.9)	75(100)	253(98.8)	0.252
Year-round	1(1.2)	2(2.1)	0(0.00)	3(1.2)	
Season to achieve best hatchability					
Dry season	80(94.1)	84(87.5)	67(89.3)	231(90.2)	0.311
No variation	5(5.9)	12(12.5)	8(10.7)	25(9.8)	
Months of achieving worst hatchability					
Rainy season	80(94.1)	84(87.5)	67(89.3)	231(90.2)	0.311
No variation	5(5.9)	12(12.5)	8(10.7)	25(9.8)	
Causes to failure of hatchability					
Handling problem	53(62.4)	49(51)	39(52.0)	141(55.1)	0.268
Broody hen problem	23(27.1)	26(27.1)	24(32.9)	73(28.5)	
Unknown reason	9(10.6)	21(21.9)	12(16)	42(16.4)	

Numbers outside parenthesis represents number of respondents and inside the parenthesis are percentage values. Row values with different superscript letters are significantly different at $p<0.05$.

Chick Management Practices of Farmers

Chicks rearing and management practices of respondents are summarized above in Table 7. The results indicated that all respondents in the study areas rear chicks naturally using the mother hen ($p=1.00$). Respondents said that they never know chick rearing methods other than natural brooding. The current study was in agreement with that reported by Shishay *et al.*, (2014), where 100% of respondents brooded chicks by broody hen in western part of Tigray Region. The result indicated that 57.4% of the respondents provide chicks with free access to feeding. The rest of the respondents (24.6%) provides feed in the morning, mid-day and afternoon and 18.0% of the respondents provided locally available feed to chicks in the morning and afternoon. Consistent with the present study, poultry owners supplement their baby chicks frequently at different districts of Sheka Zone of Western Ethiopia (Hailu, 2016). The result in the current study indicates that, there is no significant difference between agroecological zones in terms of the frequency of feed provision to baby chicks. Most of the respondents (96.5%) provide free access of water for their chicks. There is no significant difference on watering of chicks between different study agroecological areas ($p>0.05$). The current study revealed higher number of respondents offering water to their chicken than the report (53.8%) of Gamo Gofa Zone by Etalem (2019). About 51.3% of respondents said that highest mortality occurs at first weeks of age and 37.5% and

9.4% answered that highest mortality of chicks occurs at the age of first two weeks and first three weeks, respectively.

Table 7. Methods of chick management

Variables	Agroecology			Overall	p-value
	Highland (n=85)	Midland (n=96)	Lowland (n=75)		
Chick rearing methods					
Broody hen	85(100)	96(100)	75(100)	256(100)	1.00
Chick feeding frequency					
Ad lib	44(51.8)	58(60.4)	45(60.0)	147(57.4)	0.558
Morning, mid-day and afternoon	22(25.9)	21(21.9)	20(26.7)	63(24.6)	
Morning and afternoon	19(22.4)	17(17.7)	10(13.3)	46(18.0)	
Free access water provision to chicks					
Yes	85(100)	90(93.8)	72(96.0)	247(96.5)	0.072
No	0(0.0)	6(6.2)	3(4.0)	9(3.5)	
Age of highest mortality (weeks)					
First week	22(25.9)[a]	64(66.7)[b]	50(66.7)[b]	136(53.1)	<0.001
First two weeks	39(45.9)	32(33.3)	25(33.3)	96(37.5)	
First three weeks	24(28.2)	0(0.0)	0(0.0)	24(9.4)	

[a-b] row values with different superscript letters are significantly different at $p<0.05$. Figures outside parenthesis represent frequency and inside the parenthesis are percentage values.

Hatchability and chicks survived to sexual maturity

The hatchability and the number of chicks survived to the age of sexual maturity at different agroecological zones are shown in Table 8. The result indicated that the number of eggs incubated by a single broody hen was 12.46±1.50. It is statistically higher at highland and midland agroecology than lowland counterpart ($p<0.05$). In agreement with the current result Melesse (2012) reported that the number of eggs incubated per hen to be 12.80±2.30. Similarly, Ermias (2015) reported that an average of 12.2 eggs are incubated by a single broody hen in Central Oromia Region. Similarly, Etalem (2019) reported 12.4±2.4 eggs incubated per broody hen at Gamo Gofa Zone. Hatchability of eggs obtained in this study was 83.55% and there is no significant difference between agroecological areas ($p>0.05$). This result agrees with the reports of Welelaw *et al.* (2018) and Azanaw (2017), where 82.2 and 82.7% hatchability, respectively were reported for indigenous Ethiopian chicken breeds. This research also indicated that the average number of chicks survived to the age of sexual maturity was 4.70±1.13, which was significantly higher for the lowland and the lower for highland areas; the difference likely attributed to the difference of management and environmental conditions. The result of the current research was in line with the report of Welelaw *et al.* (2018), in that 48.8% of chicks survived at different districts of Bench Maji Zone. Higher survival rate (58.25%) was reported by Melesse (2012) in different agro-ecological zones of Ethiopia. Contrarily, lower chick survival rate (2.82 ± 0.92) was reported by Meseret (2010) at Gomma district of Jimma Zone. It is assumed that this variation might be attributed to variation of management system, disease prevalence and veterinary services (Melesse, 2014). The average period on which hen spend on rearing chicks was 2.45±1.99 months, which is not statistically different among the agroecological zones of interest ($p>0.05$). In agreement with current result Meseret (2010) reported weaning age of chicks being around 2.61± 0.4 months in Gomma district of Jimma Zone. Length of brooding period reported by Welelaw *et al.* (2018) (2.90±1.0 for Bench Maji Zone, Southern Ethiopia) was higher than the that indicated in the present study.

Table 8. Chicks' hatchability and number of chicks survived to the age of sexual maturity

Variables	Agroecology			Overall	p-value
	Highland	Midland	Lowland		
	n=85	n=96	n=75	n=256	
Number of eggs set per hen (Mean±SD)	12.71±1.68 [a]	12.61±1.31[a]	11.97±1.37 [b]	12.46±1.50	0.0031
Hatchability (%)	83	83.27	84.63	83.55	0.1176
Number of chicks survived to sexual maturity per hen (Mean±SD)	4.33±0.89[c]	4.71±0.96[b]	5.12±1.42[a]	4.70±1.13	0.000
Period of hen waiting on rearing chicks (months) (Mean±SD)	2.65±0.46[a]	2.46±3.04[a]	2.19±0.30[a]	2.45±1.99	0.2816

Means with in row with different superscript letters are significantly different at $p<0.05$. SD= standard deviation

CONCLUSION

In conclusion, in all agroecological zones, farmers incubated eggs and brood chicks naturally by using a broody hen, and they store incubating eggs for long time (until the hen shows broody behavior) without considering storage conditions. Therefore, promoting incubation and brooding technologies (mini-hatcheries, sandwich incubator, hay box brooder) is necessary to improve the productivity of local chicken.

CONFLICTS OF INTEREST

Author declares that there is no conflict of interest in the publication of this article.

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