INNOVARE JOURNAL OF AGRICULTURAL SCIENCE

Vol 11, Issue 3, 2023

ISSN - 2321-6832

Research Article

BROODING PRACTICES OF LOCAL CHICKEN PRODUCERS AND ON-STATION EVALUATION OF NOVEL BROOD NEST ON HATCHABILITY OF CHICKEN EGG AT GAMO ZONE, SNNPR, ETHIOPIA

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Received: 12 October 2022 Revised and Accepted: 21 January 2023

ABSTRACT

A survey was conducted at Gamo Zone of SNNPR, Ethiopia, to assess the indigenous practices of incubation, brooding, egg selection practices, broody hen selection practices, and causes of hatchability failure. Multistage sampling procedures were employed to select woredas, sample kebeles, and respondents, in which two districts were selected by purposive sampling technique; stratified purposive techniques were employed to select nine sample kebeles, and purposive random sampling techniques were used to select a total of 385 respondents. Pretested structured questionnaire and focused group discussion were employed to generate data. All generated survey data were analyzed using descriptive statistics of SPSS 16. Broody hens were the sole means of egg incubation and chick brooding. Broody hens are selected based on plumage color, egg yield, body weight (size), and mothering ability. Eggs laid at home were the predominant sources of incubation and were selected mainly based on egg type, egg age, and egg size. Clay pots, plastic, bamboo cages, and cartons were used as egg-setting materials, and grasses, straws, cotton seeds, feathers of broody hens, and clothes were used as bedding materials. October–December was the most preferred while July–September was the worst months of the year to incubate eggs and to achieve the best hatchability eggs. Environmental temperature, lack of proper laying nests, and post handling were the critical causes of the failure of egg hatchability in the study area. The total number of eggs incubated using a novel nest was 16 eggs. A comparatively high number of chicks were hatched during the second phase (7–12) from the number of eggs set. There is a strong need for training of chicken producers in increasing hatchability performances through the preparation of proper brooding nest or laying nest, egg selection, feeding, housing, health care, proper post handling, and chick management to increase their economic returns. Community-based holistic improvement programs are also very imperative to design to improve the genetic potential through selective breeding and conservation of the indigenous chicken genetic resources. Further research on hatchability performance evaluation of the indigenous chickens both on-farm and station as well as the effect of the 12 months of the year on incubation and hatchability of eggs.

Keywords: Fertility checking, Breaking broodiness behavior, Bedding, Egg-setting materials.

 DOI: http://dx.doi.org/10.22159/ijags.2023v11i3.46588. Journal homepage: https://innovareacademics.in/journals/index.php/ijags

INTRODUCTION

The livestock industry contributes significantly to physical and economic growth by providing nutritional and food security for productive and healthy living on a worldwide scale (Behnke and Metaferia, 2015). More precisely, livestock is an essential asset for economic diversification and rural livelihoods in a smallholding agricultural system, showing that its economic and nutritional value to the general community is not affected by Ethiopia's current enormous potential (Ahuja, 2013). Feeding a diet that is balanced in all nutrients and at a level that fulfills the production goal while taking the animal's physiological condition into account is critical for attaining high and sustained livestock output (Ahuja, 2013).

Poultry possesses paramount economic importance, especially in low-income and food-deficient countries in the world. In most developing countries, including Ethiopia, animal production is hindered by scarcity and fluctuating quantity and quality of feed ingredients. On the contrary, the world population is estimated to reach 8 billion by 2020 with most of the population growth coming from developing countries (Singh and Makkar, 2001). This expected surge in population will definitely impact the animal industry as more animal protein is demanded. Moreover, the expected economic growth leads to increased demand for high-quality animal protein. The fastest way of meeting the growing demand for protein of animal origin is through increasing the productivity of poultry. Chicken meat is rich in protein, fats, minerals, and vitamins and can be a good source of easily accessible nutrition for resource-poor households, the sick, malnourished, and children under the age of five (Tadelle, 1996).

Village chickens are the easiest livestock species to rear by any household member in every corner of the globe since they are less labor intensive and required low inputs. They have a pivotal role in the improvement of growth, mental development, school performance, and labor productivity and reduction of the likelihood of illness among small-scale farmers 'children through diversification of consumable foods (Martin *et al*., 2011). Village poultry is an available asset to local populations throughout Africa, and they contribute to food security and poverty alleviation, and promote gender equality, especially in the disadvantaged groups (HIV and AIDS infected and affected people, women, and poor farmers) and less-favored areas of rural Africa where the majority of the poor people reside (RSHD, 2011). In addition, they have social, cultural, and religious importance, and are considered "an entry point for poverty reduction and gateway to national food security" because it has the potential in boosting living standards and social needs and improving family nutritional status (Gueye, 2009).

Village chicken fulfills many roles in the livelihood of resources poor households in Ethiopia such as food security, income generation, and others. Consumers usually prefer products of local chicken to exotic ones due to the flavor and taste of the products (egg and meat) (Amsalu, 2003). Despite their significant roles, their low performances masked their potential to uplift the living standards of their owners and contribute to rural developments in Ethiopia. This may be attributed to their low genetic potential, prevalence of diseases and parasites, limited feed resources, constraints related to institutional and socioeconomic, and limited skill management practices (Solomon *et al*., 2013; Nebiyu *et al*., 2013; Nigussie *et al*., 2010).

In Ethiopia, most farmers have always used broody hens to incubate eggs and rear chicks (Meseret, 2010, and Addisu *et al*., 2013). The profitability of a given poultry industry is highly dependent on the hatchability of the breeding hens. Hence, information on indigenous knowledge of egg selection practices, brooding practices, egg storage practices, incubation practices, brooding breaking techniques, fertility testing methods, and factors associated with hatchability failure (constraints) has played a key role in the identification of key points of interventions so as to improve the hatchability of chickens and serve as baseline information or input for the development of agro-ecologically based and holistic improvement programs to ensure sustainable improvement, utilization, and conservation of chicken genetic resources. Little or no research has been done on incubation practices of local chickens under on-station and scavenging production systems in SNNPR, in general, and in Gamo Zone, in particular. Thus, this study was proposed in Gamo Zone with the expectation of its role in narrowing the information gap in this area of interest. Therefore, necessitated the undertaking of this study with the following objectives:

- To investigate traditional brooding practices, brooding breaking practices, fertility testing techniques, egg selection practices, and factors associated with incubation
- To brood and hatch a large number of eggs at a time through a broody hen
- To improve the hatchability of chicken eggs through natural incubation.

METHODS

Description of the study area

The study was conducted in Mirab Abaya, Kamba, and Arbaminch Agricultural Research Center (On-station) districts of Gamo Zone, SNNPR.

Kamba is 115 km far from Arbaminch (the capital of Gamo Gofa Zone) and 563 km from Addis Ababa and lies between 5°57’ and 6°26’N and 36°99’ and 37°32’E latitude and longitude ranges, respectively. The district is characterized by an altitude ranging from 501 up to 3500 m.a.s.l and the minimum and maximum temperatures of 10°C and 27°C, respectively; while the average annual rainfall is 1200 mm/year. The major town in this district is Kamba. The district is bordered on the southwest by the Debub Omo Zone, on the west by Uba Debretsehay, on the northwest by Zala, on the northeast by Deramalo, on the east by Bonke, and on the southeast by the Dirashe special district. The Weito River defines the boundary with Bonke and Dirashe. The district had an estimated total of 68125 head of cattle, 32471 sheep, 27589 goats, 1580 horses, 1254 mules, 4579 donkeys, 70286 poultries of all species, and 2471 beehives (Kamba District Agricultural office, 2018).

Mirab Abaya is one of the districts of Gamo Gofa Zone. It is located 69 km North of A/minch, the capital town of the zone, and 391 km south of Addis Ababa and lies between 6°38’ and 6°64’N and 37°54’ and 37°83’E latitude and longitude ranges, respectively. The district is characterized mostly by flat and undulating land features with an altitude ranging from 1001 up to 3000 m.a.s.l and the minimum and maximum temperatures of 15°C and 25°C, respectively; while the average annual rainfall is 900 mm/year. The major town in this district is Birbir. The districts are bordered on the east by Lake Abaya, on the north by the Wolaita Zone, on the south by the Arbaminch Zuria district, on the northwest by the Kucha district, and on the west by Chencha and Boreda districts. The district had an estimated total of 81435 head of cattle, 25478 sheep, 30587 goats, 82 horses, 186 mules, 4658 donkeys, 82147 poultries of all species, and 2113 beehives (Mirab Abaya District Agricultural office, 2018).

Arba Minch Town: Arba Minch Agricultural Research Center (AMARC) is located 505 km away from Addis Ababa and lies between 5°59’ and 6°40’N and 36°31’ and 37°36’E latitude and longitude ranges, respectively. The district is characterized mostly by flat and undulating land features with an altitude ranging from 1000 up to 1500 m.a.s.l and the minimum and maximum temperatures of 20°C and 25°C, respectively; while the average annual rainfall is 1000–1400 mm/year. The town is totally bordered by the Arba Minch Zuria district. It also shares the portions of two lakes and their islands, Abaya and Chamo, Nechisar National Park is located between these lakes (Arba Minch Town Agricultural Office, 2018).

On-farm research

Sampling techniques

Based on the village poultry population density, chicken production potential, and road accessibility, three kebeles were purposely selected from each district. A total of 385 farmers who reared local chickens were selected from the household package beneficiary’s registration book of each selected kebele using a purposive random sampling technique. The number of respondents per each sample kebeles was determined by proportionate sampling technique based on the households’ size of the sample kebeles.

Sample size determination

Required total respondents were determined using the formula by Cochran (1963) for an infinite population (infinite population ≥ 50,000).

$N_0 = [Z^2pq]/e^2$, Where N_o = required sample size, Z^2 =is the abscissa of the normal curve that cuts off an area at the tails (1-α) (95%=1.96), e = is the margin of error (e.g., ±0.05% margin of error for a confidence level of 95%), p = is the degree of variability in the attributes being measured refers to the distribution of attributes in the population

q= 1-p.

$N_o = [Z^2pq]/e^2 == [(1.96)^2 \times (0.5)\ (0.5)]/(0.05\times0.05) = [3.8416\times0.25]/(0.0025)=0.9604/0.0025=385$ farmers.

The numbers of respondents (farmers) per single selected kebele were determined by proportionate sampling technique as follows:

$W= [A/B] \times N_{0,}$ where A=Total number of households (farmers) living per a single selected kebele, B= Total sum of households living in all selected sample kebeles, and N_0 = the total required calculated sample size.

On-station research to manage experimental birds

Twelve brood boxes of 13 cm circumference punctured floor, 14 cm circumference punctured floor, 15 cm circumference punctured floor, and brood without punctured floor are prepared, and a total of 12 broody hens were purchased from local markets. Fertile eggs were obtained from the Hawassa Ministry of Agriculture Poultry Farm. During candling and after 21 days of natural incubation, data were collected. During the brooding period, hens were fed on commercial ration. Feed and water were provided to hens using plastic cups that had been put near to brooding nest.

Replication	IJAGS_46588			
	T1 13 cm	T2 14 cm	T3 15 cm	Unpunctured brooding floor (control) T4
1	16	16	16	16
2	16	16	16	16
3	16	16	16	16

Data collection

Data on brooding practices, incubation egg sources and selection criteria, egg-setting materials, broody hen selection criteria, incubation practices and causes of hatchability failure, traditional methods of breaking broodiness, and indigenous egg fertility testing techniques of local chicken producers were collected through individual interview using pretested structure questionnaire, and this was augmented with one focused group discussion per each district with 10–12 discussants per each group. For novel brooder; the following data were collected: number of egg sets, egg weight, initial weight of hen, number of eggs culled after candling, chick hatched, chick not hatched, embryonic mortality, chick weight and final weight of hen after hatching, and weight loss of hen.

Statistical analysis
The survey data were analyzed using descriptive statistics of frequency procedures and cross-tabulation of SPSS version 16 (2007). For the novel brood test, the design is CRD with three replications.

RESULTS AND DISCUSSION

Brooding practices, egg sources and selection practices, and egg-setting materials

All respondents (100%) confirmed that they used broody hens for growing chicks. Farmers seem to have good practices of using egg-setting materials, which aimed at providing comfortable incubation environmental conditions for broody hens in the study area. The survey revealed that the proportions of farmers who used different egg-setting materials were significantly different among the districts of the study area ($p<0.05$). Overall, the respondents replied that they used either clay pots with grasses (straw) bedding (27.8%), ground with chopped grasses/straw (4.8%), plastic with grasses (straw) (9.3%), or bamboo cages with straw (45.8%) (Table 1). This result is in agreement with Tadelle *et al*. (2003), who reported that clay pots, bamboo baskets, cartons, or even simply a shallow depression in the ground are common materials and locations used as egg-setting sites, and crop residues of tef and wheat and barley straws were used as bedding materials in five different agro-ecological zones of Ethiopia.

Likewise, the result also showed that 73.6% of the respondents had practices of selection of eggs before incubation, while the remaining 26.4% of them did not practice egg selection at all in the study area (Table 1). The proportions of households who had practiced or had not practiced selection eggs for incubation were nonsignificantly different among the districts. In general, farmers selected eggs based on egg age (78.5%), egg type (13.6%), and egg size (7.8%). In Fogera district, Bogale (2008) reported that 84.7% of the farmers selected large eggs, followed by medium eggs (9.7%) and small-sized eggs (1.4%) for incubation. Addisu *et al.* (2013) also recently reported that 88.24% of the village chicken owners of the North Wollo zone had a practice of egg selection based on egg size and blood content. The season/month of egg laying was used as selection criteria for egg selection. Overall, farmers reported that eggs for hatching were stored until the time when the hen gets broody and ready to incubate, but successful hatchability of eggs can be attained if they use eggs stored for not more than a week. In Nigeria, eggs kept at a high temperature of 40°C deteriorated in quality very fast and were not fit for consumption after 2 weeks of storage, and in a hot climate, where ambient temperature can reach 40–45°C; eggs should not be stored at room temperature for more than 1 week before consumption (Raji *et al*., 2009). Moreover, reducing temperature marginally improved hatchability or egg viability in eggs stored for 9–11 days (Rulz *et al*., 2001).

Farmers practiced storing eggs inside cold containers (100%) with the perception of improving the shelf lives of eggs in the study area (Table 2). Eggs are usually stored inside bins or other containers containing grains. This result is in line with Tadelle *et al.* (2003), who reported that households stored eggs inside grains; especially tef (*Eragrostis tef)* mainly practiced and believed to increase egg shelf lives in five different agro-ecological zones of Ethiopia. All of the households (100%) positioned eggs sideways in the brooder hen in the study area (Table 2).

The placement of eggs in the brooder hen is positioned sideways at all districts. Egg The survey revealed that there were significant variations with respect to the proportions of respondents who practiced or did not practice any special treatment of eggs. Overall, it was indicated that the respondents treated eggs by either washing with cold water (3.9), washing with warm water (26.3%), or cleaning eggs with clothes or other materials (38.1%). It is a good practice of incubating clean eggs but a great emphasis should be taken toward keeping eggs not become wet during cleaning, which ultimately create favorable conditions for microorganisms to enter and multiply inside the eggs and cause spoilage (FAO, 2003).

Moreover, the households responded that their sources of eggs for incubation were either home-laid eggs (88.3%), purchased from neighbors (7.7%), or purchased from the market (4%) in the study area (Table 2). This result is in line with that of Meseret (2010), who reported that home-laid eggs (80.6%), purchased from the market and home-laid eggs (13.9%) and purchased from the market, neighbors and home-laid eggs (5.6) were the major sources of eggs for incubation in Gomma woreda of Jimma zone. Matiwos *et al.* (2013) also reported similar findings, in which lay-at-home (65.1%) and both lay-at-lay and purchase (34.9%) were used as sources of incubated eggs in Nole Kabba woreda of Western Wollega of Ethiopia.

Broody hen selection practices

The respondents replied that they selected broody hens for incubation based on different selection criteria (Table 3). Households selected brooding hens for incubation based on plumage color (27.8%), body weight (large size) (12.2%), broody behavior (27.3%), and mothering ability (24.6%). Farmers gave further emphasis on selecting better broody hens based on good hatching history (60.5%), good protector from predators/aggressive weaning the bird (34.1%), good feeder, hatching history, and protector from predators (5.4%). A study conducted in the

Table 1: Incubation, egg selection criteria, and egg-setting materials

Variable	Agro-ecological zones			X^2–test	p-value
	Mirab Abaya n (%)	Kamba n (%)	Total n (%)		
Incubation of eggs and Brooding chicks				0.00 (ns)	1.00
Broody hen	90 (100)	115 (100)	205 (100)		
Egg-setting materials				47.36 (*)	0.00
Clay pots with grasses (straw) bedding	36 (40)	21 (18.4)	57 (27.8)		
Ground with chopped grasses/straw	8 (8.9)	2 (1.7)	10 (4.8)		
Plastic with grasses (straw)	15 (16.7)	4 (3.4)	19 (9.3)		
Bamboo cages with straw	22 (24.4)	72 (62.6)	94 (45.8)		
Cartoon with grasses and clothes bedding	9 (10)	16 (13.9)	25 (12.3)		
Do you select eggs at the time of/before incubation?				0.00(ns)	1.00
Yes	68 (75.5)	83 (72.2)	151 (73.6)		
No	22 (24.5)	32 (27.8)	54 (26.4)		
Eggs selection criteria				0.00 (ns)	1.00
Egg age	74 (82.2)	87 (75.7)	161 (78.5)		
Egg type	10 (11.1)	18 (15.6)	28 (13.6)		
Egg size	6 (6.7)	10 (8.7)	16 (7.8)		
Egg storage for incubation				0.00 (ns)	1.00
<1 week	68 (75.5)	83 (72.2)	151 (73.6)		
>1 week	22 (24.5)	32 (27.8)	54 (26.4)		

Table 2: Egg selection criteria and special egg treatment practices

Variable	6 pt			X^2-test	p-value
	M/Abaya n (%)	Kamba n (%)	Total n (%)		
Placement of eggs in the brooder hen				1.554 (*)	0.495
Egg positions sideways	90 (100)	115 (100)	205 (99.7)		
Egg positions pointed narrow end down	-	-	-		
How do you store eggs to improve their shelf lives?				7.856 (*)	0.014
Store in a cold room	-	-	-		
Store inside cold containers	90 (100)	115 (100)	505 (98.4)		
Practice special treatment of eggs before incubation				31.25 (*)	0.00
Yes	72 (80)	68 (59.1)	140 (68.3)		
No	18 (20)	47 (40.9)	65 (31.7)		
How do you treat eggs?				19.65 (*)	0.00
Wash with cold water	6 (6.7)	2 (1.8)	8 (3.9)		
Wash with warm water	29 (32.3)	25 (21.7)	54 (26.3)		
Cleaning with clothes or other materials	37 (41.1)	41 (35.6)	78 (38.1)		
No treatment	18 (20)	47 (40.9)	65 (31.7)		
Sources of eggs for incubation				21.25 (*)	0.00
Laid at home	83 (92.2)	98 (85.2)	181 (88.3)		
Purchased from neighbors	5 (5.5)	11 (9.5)	16 (7.7)		
Purchased from market	2 (2.3)	6 (5.3)	8 (4)		

* (p<0.05) and ns (p>0.05) and n=number of respondents interviewed per agro-ecology

Table 3: Broody hen selection criteria and preference of mothering ability characteristic

Variable	Agro-ecological zones			X^2-test	p-value
	M/Abaya n (%)	Kamba n (%)	Total n (%)		
Broody hen selection criteria				8.47 (*)	0.009
Plumage	20 (22.2)	31 (26.9)	51 (27.8)		
Body weight	11 (12.2)	14 (12.3)	25 (12.2)		
Egg yield (production)	2 (2.2)	-	2 (0.9)		
Broody behavior	18 (20)	38 (33)	56 (27.3)		
Mothering ability	39 (43.4)	32 (27.8)	71 (24.6)		
Preference of mothering ability characteristics				7.85 (**)	0.009
Good hatching history	45 (50)	79 (68.7)	124 (60.5)		
Good protector from predators/aggressive weaning	41 (45.5)	29 (25.2)	70 (34.1)		
Good feeder and hatching history	4 (4.5)	7 (6.1)	11 (5.4)		

Fogera district disclosed that 66.7% and 19.4% of local chicken owners selected large- and medium-sized hens for incubation, respectively (Bogale, 2008). This result is also in parallel with the findings of Meseret (2010) which revealed that farmers selected hens for incubation based on either large body size (21.1%), ample plumage/feather cover (3.3%), previous hatching history (6.7%), broodiness (19.4%) or large body size, ample plumage, and previous hatching history (49%) in Gomma woreda of Jimma zone. Besides, the result of a survey conducted in the North Wollo zone disclosed that 88.24% of village chicken owners had a practice of broody hen selection based on body size (26.84%) and broodiness ability history (73.16%) (Addisu *et al*., 2013).

Incubation practices and causes of hatchability failure

The respondents replied that they did not incubate eggs throughout the year and every season in the study area due to the fluctuation of environmental conditions. The result indicated that there were significant variations in line with seasons of egg incubation across the districts (Table 4). Higher proportions of local chicken owners incubated eggs from October to December, but none of the respondents incubated eggs during July-September. Because of the poor survivability of young chicks due to heavy rains, extreme colds on disease outbreak and the prevalence of predators in the Spring.

Furthermore, the survey indicated that all respondents (100%) also replied that there was seasonal variability in the hatchability of eggs (Table 4). It was also found that the seasons (months) of both best and worst hatchability achievements were significantly different across agro-ecological zones of the study area (p<0.05). The optimum incubation temperature of 37.8°C is the thermal homeostasis in the chick embryo and gives the best embryo development and hatchability (Kingori, 2011). The best hatchability of chickens was mainly attained from October to December (84.9%), followed by April–June (8.8%). In a study conducted in the Fogera district, 81.9% and 26.4% of the households replied that the preferred season of incubation was the dry and rainy seasons, respectively (Bogale, 2008).

The result showed that the respondents confirmed that lack of proper laying nests (42.4%), temperature (48.7%), and post handling (8.9%) were the major factors that cause the failure of the hatchability of chickens in the study area (Table 7).

The total number of eggs incubated using a broody hen varied from 8 to 15, with an average number of 9.42 eggs (Table 10). This study was in agreement with previous works of Asefa (2007) at Awassa Zuria, who reported a setting of 9.8 eggs. In another study, Kitalyi (1997) reported 13 eggs for the Gambia and 15 for the Republic of Tanzania. A comparatively high number of chicks were hatched (6–12) from the number of eggs set, and out of the total number of chicks hatched, 4–8 chicks survived to adulthood.

On-station evaluation of novel brood nest on hatchability of chicken egg through a broody hen

The total number of eggs incubated using a novel nest was 16 eggs (Table 10). A comparatively high number of chicks were hatched during the second phase (7–12) from the number of eggs set. This study was in agreement with previous works of Asefa (27007) at Awassa Zuria who reported a setting of 9.8 eggs. In another study, Kitalyi (1997) reported 13 eggs for the Gambia and 15 for the Republic of Tanzania.

Table 4: ???

Variable	Agro-ecological zones			X^2-test	p-value
	Mirab Abaya (%)	Kamba n (%)	Total n (%)		
When do you usually incubate eggs?				21.78(*)	0.01
July–September	-	-	-		
October–December	80 (88.9)	94 (81.7)	174 (84.9)		
January–March	2 (2.2)	11 (9.6)	13 (6.3)		
April–June	8 (8.9)	10 (8.7)	18 (8.8)		
Is there seasonal variability in hatchability?				0.0(ns)	0.000
Yes	90 (100)	115 (100)	205 (100)		
No	-	-	-		
When do you achieve the best hatchability?				12.587(*)	0.001
July–September	-	-	-		
October–December	80 (88.9)	94 (81.7)	174 (84.9)		
January–March	2 (2.2)	11 (9.6)	13 (6.3)		
April–June	8 (8.9)	10 (8.7)	18 (8.8)		
Major causes of failure of hatching				0.00 (ns)	0.00
Lack of proper laying nest	23 (25.5)	64 (55.6)	87 (42.4)		
Temperature	59 (65.6)	41 (35.6)	100 (48.7)		
Post handling	8 (8.9)	10 (8.8)	18 (8.9)		
Average number of eggs/set	$99.53^{ab}\pm0.24$	$9.03^{b}\pm0.14$	$9.70^{a}\pm0.13$	9.42±0.10	
Chicks hatched/set	$7.78^{a}\pm0.19$	$6.97^{b}\pm0.14$	$7.60^{a}\pm0.19$	7.45±0.10	
Surviving chicks	$5.15^{a}\pm0.14$	$5.10^{a}\pm0.14$	$4.92^{a}\pm0.13$	5.06±0.08	

Phase 1 results of the trial

Data collected	T1	T2	TT3	T4
Number of egg set	16	16	16	16
Ave. egg weight during setting (in g)	54	54	53.66	54.66
Initial weight of the hen	1359	1345.66	1369.3	1373.3
Number of eggs broken at incubation	2.66	1.33	2.33	1
Number of eggs culled during candling	1.66	0.66	2	1.66
Embryonic mortality	2.66	1.66	4	3.33
Chick hatched	4.66	9.66	4.66	6
Chick not hatched	4.33	2.66	3	4
Ave. weight of chicks	38	38.3	37	38
Chicks dead after hatched	0.33	0.33	0	0
Ave. weight of hen after hatching	1116	1109	1121.6	1111

Hatchability percentage

Treatment	Number of egg set	Average egg hatched	(%)
1	16	4.66	29.125
2	16	9.66	60.375
3	16	4.66	29.125
4 (control)	16	6	37.5

Phase 2 results of the trial

Data collected	T1	T2	TT3	T4
Number of egg set	16	16	16	16
Ave. egg weight during setting (in g)	53.21	49.8	53	54.1
Initial weight of the hen	1241.54	1287.36	1197.14	1324.7
Number of eggs broken at incubation	3	-	1.66	0.66
Number of eggs culled during candling	2.33	0.96	1.66	1.66
Embryonic mortality	1.66	1.66	4.98	3
Chick hatched	6.66	11.66	5.66	7
Chick not hatched	2.33	1.66	2	3.66
Ave. weight of chicks	38	38.3	37	38
Chicks dead after hatched	0.33	0.33	0	0
Ave. weight of hen after hatching	1116	1109	1121.6	1111

CONCLUSION

Broody hens were the sole means of egg incubation and chick brooding in the study area. Plumage color, egg yield, body weight (size), and mothering ability were selection criteria used for choosing broody hens. Farmers (78.5%) selected eggs for incubation mainly based on egg age. Eggs laid at home were the predominant sources of incubation eggs in the study area. Farmers practiced washing eggs with cold water and warm water and cleaning them with clothes or other materials before incubation to have cleaned eggs for incubation. Local chicken producers tried to create a comfortable incubation environment through the preparation of egg setting and bedding materials. Clay pots, plastic, bamboo cages, and cartons were used as egg-setting materials, and grasses, straws, cotton seeds, feathers of broody hens, and clothes were used as bedding materials. October–December was the most preferred months of the year to incubate eggs and to achieve the best hatchability of eggs by broody hens, while July–September was the worst months of the year for incubation and hatchability of eggs due to high environmental temperatures, prevalence of diseases, and predators and shortage of feeds to scavenge. Environmental temperature, lack of proper laying nests, and post handling were the critical causes of the failure of egg hatchability in the study area. Almost all respondents were capable of checking the fertility of eggs before incubation. The total number of eggs incubated using a novel nest was 16 eggs (Table 10). A comparatively high number of chicks were hatched during the second phase (7–12) from the number of eggs set. There is a strong need for training of chicken producers in increasing hatchability performances through the preparation of proper brooding nest or laying nest, egg selection, feeding, housing, health care, proper post handling storages, egg setting, and bedding materials so as to increase their economic returns. Community-based holistic improvement programs are also very imperative to design to improve the genetic potential through selective breeding and conservation of the indigenous chicken genetic resources. Further research on hatchability performance evaluation of the indigenous chickens in both on-farm and station as well as the effect of the 12 months of the year on incubation and hatchability of eggs.

ACKNOWLEDGMENT

We are grateful to farmers who participated in individual interview and focus group discussion for sharing their knowledge. Our thanks are also extended to the Humera Agricultural Research Center of Tigray Agricultural Research Institute for funding the project, and to researchers of the center who contributed to the implementation of the project.

CONFLICT OF INTEREST

There are no potential conflicts of interest in this research.

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