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Incubation and Brooding Practices of Local Chicken Producers in Ethiopia: The Case of Western Zone of Tigray

Shishay Markos[1*], Berhanu Belay[2] and Tadelle Dessie[3]
1. Humera Agricultural Research Center of Tigray Agricultural Research Institute, P.O.BOX 492, Mekelle, Tigray, Ethiopia
2. Jimma University College of Agriculture and Veterinary Medicine, P.O.Box 307, Jimma, Ethiopia
3. International Livestock Research Institute (ILRI), P.O.BOX, 5689, Addis Ababa, Ethiopia
Corresponding Author * shishaymarkos@gmail.com

Abstract
A survey was conducted in Western Zone of Tigray, Northern Ethiopia to asses indigenous practices of incubation and brooding, egg and broody hen selection practices and causes of hatchability failure. Multi stage sampling produres were employed to select weredas, sample kebeles and respondents in which three rural weredas 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. Kruskal- Wall's test option of Non-parametric tests of SPSS 16 was employed to test proportion difference of each variable among the altitudes. Broody hens were the sole means of egg incubation and chick brooding. Broody hens selected based on plumage color, egg yield, body weight (size) and mothering ability. Eggs Laid at home was the predominant sources of incubation and selected mainly based on egg type, egg age and season/month of laying. Clay pots, ground, plastic, bamboo cages, bin, cartons and dish were used as egg setting materials and grasses, straws, cotton seeds, feather of broody hens, soil, clothes, cow dung, sand were used as bedding materials. June to February were the most preferred while March to May was the worst months of the year to incubate eggs and to achieve best hatchability eggs. Environmental temperature, lack of proper laying nest and post handling were the critical causes of failure of egg hatchability in the study area. Visual examination, floating in water, shaking, cooking sample eggs, breaking sample eggs and weighing were the traditional techniques of egg fertility checking prior to incubation. Farmers attempt to increase egg production by stimulating broody hens to resume laying through hanging upside down, disturbing in the nest, moving to neighbors, tying both wings together, tying outside the original laying nest, tying plastic materials on legs and piercing of noise. However, great emphasis should be given to wards selection of farmers with healthy flock when our option of breaking brooding behavior of hens is moving to neighbors otherwise it may serve as sources of infection for our flocks. There is a strong need for training of chicken producers in increasing hatchability performances through 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 is also very imperative to design in order 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 effect of the twelve months of the year on incubation and hatchability of eggs.
Keywords: Fertility Checking, Breaking Broodiness Behavior, Bedding, Egg Setting Materials

1. Introduction

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 pivotal role in improvement of growth , mental development ,school performances and labor productivity and reduction of the likelihood of illness among the small –scale farmers ' children through diversification of consumable foods (Martin *et al.* 2011).Village poultry are available asset to local populations throughout Africa and they contribute to food security, poverty alleviation and promote gender equality, especially in the disadvantaged groups (HIV and AIDS infected and affected people, women, poor farmers, etc) 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 considered as "an entry point for poverty reduction and gate way to national food security" because it has potential in boosting living standards, social needs and improving family nutritional status (Gueye 2009).

Ethiopia has an estimated of 49.3million with indigenous chicken of non-descriptive breeds accounting 97.3%, hybrid chicken 2.32% and exotic breeds 0.38% (CSA 2011).Moreover, 97.3% of indigenous chickens has been distributed in different agro-ecological zones of Ethiopia (CSA 2011) which indicate their adaptive potential to different environmental conditions, diseases and other stresses (Halima 2007). Village chicken fulfills many roles in the livelihood of resources poor households of Ethiopia such as food security, income generation and others. Consumers usually prefer products of local chicken to exotic ones because of 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 socio-economic 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 to 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) have played key role in identification of key points of interventions so as to improve the hatchability of chickens and serve as baseline information or input for development of agro-ecologically based and holistic improvement programs in order to ensure sustainable improvement, utilization and conservation of chicken genetic resources. Little or no researches have been done incubation and brooding practices of local chickens under scavenging production system in Tigray region in general and in western zone in particular. Thus, this study was proposed to investigate traditional brooding practices, brooding breaking practices, fertility testing techniques, egg selection practices and factors associated with incubation in western Tigray with the expectation of its role in narrowing the information gap on this area of interest

2. Materials and methods

2.1. Description of Study Area

The study was conducted in the three rural weredas (Kafta Humera, Welkait and Tsegede) of Western Zone of Tigray Regional State, North West Ethiopia. It is one of the five administrative zones of Tigray regional state and it has four (4) districts (Setit Humera, Kafta Humera, Welkait and Tsegede) comprising of 81 kebeles with 77 rural kebeles (24, 25 and 28 kebeles from Kafta Humera, Tsegede and Welkait weredas, respectively) and 4 urban kebeles with distance range of 580–750 km from Mekelle, the capital city of Tigray. Setit Humera was not included in the study because Kafta Humera represents it. It covers an area of 1.5 million hectare with Kafta Humera accounts 48.13%, Setit Humera accounts 0.82%, Tsegede accounts 23.43% and Welkait accounts 27.62% (HARC 2013). The total cultivated land of the zone is 573,285 hectares (38.2%) while the uncultivated land accounts 927,000 hectares (62.8%). 341,195.25 hectares (36.8%) of the uncultivated land is covered by different plant species excluding Bowsellia and Acacia Senegal While 185,510 hectares (20%) of the unfarmed land is solely covered by both Bowsellia and Acacia Senegal. The zone consists of three agro-ecological zones (lowland, midland & highland).75%, 15.7% and 9.3% of the land coverage of the zone is Kolla(lowland), weynadegga (midland) and dega (highland), respectively. The geographical location of the zone is 13°42′ to 14°28′ north latitude and 36°23′ to 37°31′ east longitude (Mekonnen *et al*. 2011).The annual rainfall of the zone ranges from 600 mm to 1800 mm while the annual temperature ranges from 27^0c to 45 ^{0}c in the lowland areas (Kolla) and 10^0c to 22 ^{0}c in both midland and highland areas of the zone. The altitude of the zone ranges from 500- 3008 m.a.s.l. The zone shares borders with Tahtay Adibayo, Tselemti and Asgede Tsimbla in the East, Sudan in West, Amhara region in South and Eritrea in the North. The study area represents a remote, tropical climate where extensive agriculture is performed manually by large numbers of migrant laborers.

Throughout the zone, livestock agriculture is the predominant economic activity with about 95% of the total population engaged directly or indirectly in it (Mekonnen *et al*. 2011).Main cattle breeds raised in the Western Zone are the local Arado (in both high land and mid land areas) and Begait cattle (in lowland areas). Semi-intensive production is practiced in Humera district, which is more urban, while extensive production system is dominant in the Welkait and Tsegede districts. The main crops cultivated in the lowland areas of the zone are sesame, cotton and sorghum while teff, wheat, barley, noug, lentils, finger millet, field peas and fababeans are cultivated crops in both midland and high land areas of the zone.

2.2. Sampling Techniques

Three rural (welkait, Tsegede & Kafta Humera) weredas were purposely selected. All kebeles (smallest administrative units in Ethiopia) of three weredas were stratified in to three agro-ecological zones namely lowland, midland and highland (kebeles of both welkait and Tsegede weredas were stratified in to lowland, midland and highland but kebeles of Kafta Humera were stratified in to lowland and midland agro-ecological zones as it only comprises midland and lowland areas). Based on the village poultry population density, chicken production potential and road accessissibilty, four, three and two kebeles were purposely selected from lowland, midland and highland agro-ecological zones, respectively. A total of 385 farmers who reared local chickens were selected from household package beneficiary's registration book of each selected kebele using 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.

2.3. Sample Size Determination

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

$N_o = [Z^2pq] / e^2$, 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 (eg. ±0.05% margin of error for 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.

$N_o = [Z^2pq] / e^2$ == $[(1.96)^2 \times (0.5)(0.5)] / (0.05 \times 0.05)$

= [3.8416 x0.25]/ (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] x N_o, 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_o = the total required calculated sample size

2.4. 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 agro-ecology with 10-12 discussants per each group.

2.5. Statistical Analysis

The survey data were analyzed using descriptive statistics of frequency procedures and cross-tabulation of SPSS version 16 (2007). The Kruskal-Wallis Test option of the non-parametric tests of SPSS was employed to test the effects of the agro-ecology on the proportion of every collected data associated with brooding and incubation practices.

3. Result and Discussion

3.1. Brooding Practices, Egg Sources and Selection Practices and Egg Setting Materials

None of the respondents have used Solomon Hay Box Brooder for rearing chicks in the study area. Moreover, the respondents used broody hens for incubation but not artificial incubator. All respondents (100%) confirmed that they used broody hens for growing chicks (Table 1). However, Solomon Hay Box Brooder was only used when Minister of Agriculture distributed exotic breeds particularly RIR from 1998- 2000 E.C.

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 agro-ecological zones of the study area ($p<0.05$). Overall, the respondents replied that they used either of Clay pots with grasses (straw) bedding (1%), Ground with soil/sand/ash/cow dung/chopped grasses /straw/sand filled sack bedding (15.6%), Bin with grasses/straw/cotton seed/sand & feather of brooding hen/sack & sand /clothes/cow dung &straw/ bedding (68.8%), Plastic with grasses (straw)/soil(sand)/soil or sand/ bedding (7.8%), Bamboo cages with soil and straw/teff straw/ breeding (0.3%),Bin (ducon) with grasses /straw/ bedding during rainy season & with sand bedding during dry season (3.9%), Cartoon with grasses and clothes bedding (0.8%), Dish with soil or clothes bedding (0.5%), Ground / Bin or dish with grasses bedding (0.3%) or Plastic and Bin with grasses /soil/ clothes bedding alternatively (1%) as egg setting materials in the study area(Table 1). In the lowland, farmers mostly used ground or bin or plastic with grasses or straw bedding as egg setting material during incubation in the rainy season with the perception of providing warm for both broody hens and eggs, and in the dry season, they commonly used ground or bin or plastic with sand or soil bedding and /or sack filled with dump soil or sand bedding as egg setting materials with the assumption of reducing temperature and increasing humidity of the incubation environment. In the same context, in both midland and highland agro-ecological zones, farmers mainly used bin or plastic with grasses or straws bedding as egg setting materials during incubation while they rarely used bin or plastic with soil or sand bedding as egg setting materials during the dry season. It seems a good practice but great care should be taken to keep eggs clean and not eggs become wet during setting materials preparation and egg storing in cold storage areas which may be favourable conditions for micro organisms to penetrate the shell and multiply inside the eggs and eventually spoil the egg, causing green, black and red rots (FAO 2003). 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, wheat and barley straws were used as bedding materials in five different agro-ecological zones of Ethiopia.

Likewise, the result also showed that 39.2% of the respondents had practices of selection of eggs before incubation while the remaining 60.8% of them did not practice egg selection at all in the study area (Table 2). The proportions of households who had practiced or had not practiced selection eggs for incubation were significantly different among the agro-ecologies. Generally, farmers selected eggs based on either of egg age (1.3%), egg type (9.9%), egg size (0.3%), egg age and type (19.2%), egg age, egg type and season(month) of egg laying (4.9%), egg age, egg type and size (3.1%) or egg type and size (0.8%). However, none of the households had selected eggs for incubation based on egg color (Table 2). In his study in Fogera district, Bogale (2008) also 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 North Wollo zone had a practice of egg selection based on egg size and blood content. Season /month of egg laying was used as selection criteria for eggs selection only in the lowland but none of the households selected eggs for incubation based on this criteria in both midland and highland agro-ecologies. Because the annual temperature in the lowland areas ranges from 27^0c to 45 ^{0}c while the annual temperature in both midland and highland agro-ecologies ranges from 10^0c to 22 ^{0}c (Mekonnen *et al*. 2011). The optimum temperature for egg storage ranges from 12 ^{o}c to 26^oc (FAO 2003 and Kingori 2011). The annual temperature in the lowland areas is greater than the optimum temperature for egg storage while in both midland and highland is within the range of optimum egg storages temperature. In the lowland, farmers replied that eggs stored for more than three days should not be used for incubation because most of them become spoiled. Farmers argue that successful hatchability of eggs can be achieved in the lowland if eggs are not stored more than two days and this is attained through collection of fresh eggs from all layers and incubate them by selected layer showing brooding behavior. Farmers in the lowland also responded that eggs stored for more than a week are not fitted for consumption because the quality of eggs is completely deteriorated due to extreme environmental temperatures. In both midland and highland agro-ecologies, 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 not more than a week. In Nigeria, eggs kept at high temperature of 40^oc deteriorated in quality very fast and were not fit for consumption after two weeks of storage, and in hot climate, where ambient temperature can reach 40-45^oc; eggs should not be stored at room temperature for more than one week before consumption (Raji *et al*.2009). Moreover, reducing temperature marginally improved hatchability or egg viability in eggs stored for 9 to 11 days (Rulz *et al*. 2001).

Farmers practiced to sore eggs in either cold room (1.6%) or inside cold containers (98.4%) with the perception of improving the shelf lives of eggs in the study area (Table 5). Eggs are usually stored inside bins or other containers containing grains. Storage inside Noug, Cotton seed, Finger Millet and Tef were commonly practiced especially during dry season and is believed to increase humidity so as to increase the shelf lives of eggs and make them suitable for hatching ,sale or consumption. This result is in line with Tadelle *et al* (2003) who reported that household 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. Most of the households (99.7%) positioned eggs sideways in the brooder hen while the remaining 0.3% of them positioned eggs pointed narrow end down in all agro-ecological zones of the study area (Table 5).

Furthermore, 5.5 % of the respondents had good experience of practicing special treatment of eggs before incubation while 94.5% of them did not practice any special treatment of eggs in the study area (Table 2). 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 across agro-ecologies. Overall, it was indicated that the respondents treated eggs with either of wash with cold water (0.8%), wash with warm water (0.3%) or clean eggs with clothes or other materials (4.4%). It is a good practice of incubating clean eggs but great emphasis should be taken towards keeping eggs not become wet during cleaning which ultimately create favorable conditions for microorganisms to enter and multiply inside the eggs and causing spoilage (FAO 2003).

Moreover, the households responded that their sources of eggs for incubation were either home laid eggs (91.2%), purchased from neighbors and home laid eggs (8.6%) or purchased from market and home laid eggs (0.3%) in the study area (Table 5).This result is in line with that of Meseret (2010) who reported that home laid eggs (80.6%), purchased from market and home laid eggs (13.9%) and purchased from market, neighbors and home laid eggs (5.6) were the major sources of eggs for incubation in Gomma wereda 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 wereda of Western Wollega of Ethiopia.

3.2. Broody hen selection practices

In the same way, the respondents replied that they selected broody hens for incubation based on different selection criterias (Table 1). Households selected brooding hens for incubation based on plumage color (97.7%), body weight (large size) (100%), broody behavior (100%) and mothering ability (100%). Farmers gave further emphasis in selecting better broody hens based on good hatching history (62.2%), good protector from predators /aggressive weaning the bird (0.3%), good hatching history and protector from predators /weaning the bird (30.9%), good feeder and hatching history (3.4%), good feeder, hatching history and protector from predators (2.6%) and good ability of setting, feeder, hatching history and protector from predators (0.3%). A study conducted in 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 of 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 wereda of Jimma zone. Besides, the result of a survey conducted in 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).

3.3. 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 because of fluctuation of environmental conditions. The result indicated that there were significant variations in line with seasons of egg incubation across the agro-ecologies (Table 5).Greatest proportions of respondents incubated eggs from June to February and June to march in midland (95.4% and 3.1%,respectively) in contrast with both lowland (85.6% and 0%) and highland (80.9% and 0%). Nevertheless, higher proportions of local chicken owners incubated eggs from June to January and September to June in lowland (13.8% and 0.6%) than midland (0.8% and 0%) but none of the respondents have incubated eggs during these months in highland because of poor survivability of young chicks due to heavy rains and extreme colds in highland. Maximum proportion of farmers incubated eggs from March to June (0.8%) and October to May (3.9%) in highland while none of the respondents incubated eggs in these specific months in both midland and lowland agro-ecologies. In general, the result disclosed that farmers mainly incubated eggs in June to February (87.8%) while September to June (0.3%), October to march (0.3%), June to march (1%), march to June (0.8%) and October to May (3.9%) were the worst months for egg incubation because of poor hatchability, due to high temperature and poor survivability of young chicks in March to May months especially in lowland, due to mud, heavy rains (extreme cold stress) in September to June in highland and disease outbreak and prevalence of predators in Spring.

Furthermore, the survey indicated that all respondents (100%) also replied that there was seasonal variability on the hatchability of eggs (Table 5). It was also found that seasons (months) of both best and worst hatchability achievements were significantly different across agro-ecological zones of the study area ($p<0.05$). In lowland agro-ecology, worst hatchability of chickens mainly attained from March to May (95.6%) followed by February to May (4.4%). This might be due to the environmental temperature in the lowland extremely exceeds the optimum incubation temperature from March to May. The optimum incubation temperature of 37.8^{o}c is the thermal homeostasis in the chick embryo and gives the best embryo development and hatchability (Kingori 2011). However, worst hatchability of chickens mostly achieved from march to may (95.4% and 80.9%) and followed by April to may (3.8%) and June to September(16%), respectively in midland and highland agro-ecologies of the area.

On the contrary, best hatchability of chickens mainly attained from June to February (80.9%) followed by October to May (16%) and June to March (3.2%) in the highland agro-ecology while best hatchability of chicken primarily achieved from June to February especially autumn (95.4%) followed by June to march (0.8%) and June to January (0.8%) in midland. In the lowland agro-ecology, respondents replied that best hatchability mainly attained from eggs incubated from June to February (86.9%) followed by June to January (12.5%) and October to march (0.6%). Generally, the households responded that lowest hatchability were mainly achieved from March to may (91.9%) followed by June to September (3.9%), February to May (2.1%) and April to May (2.1%). However, best hatchability of chickens were mostly attained from June to February especially autumn (88.3%) followed by June to January (5.5%), October to May (3.9%), June to march (1.8%) and October to march (0.5%) in the study area. In a study conducted in Fogera district, 81.9% and 26.4% of the households replied that the preferred season of incubation was dry and rainy season, respectively (Bogale 2008).

The result showed that the respondents confirmed that temperature; lack of proper laying nest and post handling (99%), temperature and lack of proper post handling (0.5%), lack of proper laying nest and post handling (0.3%) and temperature (0.3%) were the major factors that cause failure of hatchability of chickens in the study area (Table 5).

3.4. Traditional Methods of Breaking Broodiness

Furthermore, the result of the study revealed that 97.4% of the total interviewed households used different traditional methods of breaking broodiness to increase egg production by stimulating broody hens to restart egg laying (Table 3). The traditional methods practiced by farmers of the study area and in their order of importance were moving to neighbors (30.1%), moving to neighbors (1st) and hanging upside down (2nd) (8.8%), disturbing in the nest (1st) and Moving to neighbors (2nd) (8.8%), hanging upside down (1st) and moving to neighbors (2nd) (8.6%), hanging upside down (8.3%), disturbing in the nest (5.7%), tying outside the original laying nest (5.5%), moving to neighbors (1st) and tying outside the original laying nest (2nd) (3.9%), tying both wings together (1st) and moving to neighbors (2nd) (3.4%), tying both wings together (3.1%), disturbing in the nest (1st) and tying outside the original laying nest (2nd) (1.6%), tying outside the original laying nest (1st) and Moving to neighbors (2nd) (1.6%), tying outside the original laying nest (1st) and hanging upside down (2nd) (1.3%), moving to neighbors (1st) and disturbing in the nest (2nd) (1%), tying outside the original laying nest (1st) and disturbing in the nest (2nd) (0.8%), hanging upside down (1st) and tying both wings together (2nd) (0.5%), hanging upside down (1st) and tying outside the original laying nest (2nd) (0.5%), tying both wings together (1st), tying outside the original laying nest (2nd) and moving to neighbors (3rd) (0.5%), moving to neighbors (1st) and tying both wings together (2nd) (0.5%), separating broody hen from her chicks (0.5%), hanging upside down (1st), tying both wings together(2nd) and moving to neighbors (3rd) (0.5%), disturbing in the nest (1st) and hanging upside down (2nd) (0.3%), disturbing in the nest (1st) ,tying outside the original laying nest (2nd) and moving to neighbors (3rd) (0.3%), Piercing noise with sharp feather of broody hen for a week (0.3%), moving to neighbors (1st), hanging upside down (2nd) and disturbing in the nest (3rd) (0.3%), tying plastic materials on legs of the broody hen (0.3%), moving to neighbors (1st) and Separating broody hen from her chicks (2nd) (0.3%), disturbing in the nest (1st) and hanging upside down (2nd) and Moving to neighbors (3rd) (0.3%).This result is in parallel with the findings of Matiwos *et al* (2013) who reported that piercing the nostril with a feather to prevent sitting, changing the hen's house/physically moving the hen to nearby house for a couple of days was found the most preferred practice implemented, hanging the hen upside down for a limited period of time each day for about 3-4 days and spraying water on hen's body and its place and also dipping broody hen in water were the brooding breaking techniques practiced in Nole Kabba Woreda of Western Wollega. Similarly, disturbing the broody hen in the nest (48.9%), hanging the hens upside down (18.9%), disturbing the broody hen in the nest, moving to neighbor (15.6%), disturbing the hens in the nest and moving to neighbor (7.8%),depriving the hens from food and water(5%) and, hanging the hens upside down and depriving the hens from food and water (2.2%) were the traditional methods of breaking broodiness practiced by the community of Gomma wereda (Meseret 2010).This r esult also inline with the findings of Nigussie (2011) who reported that hanging upside down (33%) and moving to neighbor houses (33%),submerge in to water up to the breast (1%),change brooding place (9) were the most important methods of breaking broodiness behavior of indigenous chickens in different parts of Ethiopia. Likewise, a report from North Wollo zone revealed that 96.73% of the village chicken owners had an experience of breaking broodiness behavior through either hanging upside down (65.2%), sending to neighbors (27.36%), preventing feed (4.73%) or showing broken egg (2.7%) (Addisu *et al*. 2013).

3.5. Indigenous Egg Fertility Testing Techniques

Farmers in the study area also seem to have good practice of testing eggs before incubation (Table 5). There were no signification variations with regard to the proportions of households who practiced testing of eggs prior to incubation across the agro-ecological zones of the study area. However, the distributions of different egg testing techniques practiced by the farmers were significantly different among the agro-ecological zones of the study area ($P<0.05$). Overall, the result of the survey revealed that 96.1% of the respondents tested eggs before incubation while the remaining 3.9% of them did not practice testing of eggs prior to incubation. The community based egg testing techniques practiced by the farmers of the study area and in their order of relevance were floating eggs in water (53.5%), shaking (14.8%), floating eggs in water (1st) and shaking (2nd) (14.5%), visual examination through sunlight (4.7%), visual examination through sunlight (1st) and floating eggs in water (2nd) (3.9%), visual examination through sunlight (1st) and shaking (2nd) (2.3%),floating eggs in water (1st), visual examination through sunlight (2nd) and shaking (3rd) (0.8%), by coking sample eggs (0.5%), by breaking sample eggs (0.3%), floating eggs in water (1st) and egg color change (change from white to bulla) (2nd) (0.3%), by weighing eggs (0.3%) and floating eggs in water 1st) and by coking sample eggs (2nd) (0.3%). This result is in agreement with the findings of Matiwos *et al* (2013) in which by shaking (47.8%), floating techniques (25%) and visual examination (27.2%) were commonly practiced techniques of normal eggs identification from spoiled ones prior to incubation in Nole Kabba Wereda of Western Wollega of Ethiopia. Similarly, Samson and Endalew (2010) reported that putting in water (28%), sun candling (39%) and shaking were used as methods of normal eggs identification from spoiled ones in Mid Rift Valley of Oromia of Ethiopia.

4. 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 (39.2%) selected eggs for incubation mainly based on egg type, egg age and season/month of laying. Eggs Laid at home was the predominant sources of incubation eggs in the study area. Few farmers (5.5%) practiced to wash eggs with cold water and warm water and cleaning with clothes or other materials prior to incubation in order to have cleaned eggs for incubation. Local chicken producers tried to create comfortable incubation environment through preparation of egg setting and bedding materials. Clay pots, ground, plastic, bamboo cages, bin, cartons and dish were used as egg setting materials and grasses, straws, cotton seeds, feather of broody hens, soil, clothes, cow dung, sand were used as bedding materials. June to February especially autumn were the most preferred months of the year to incubate eggs and to achieve best hatchability of eggs by broody hens while March to May was the worst months of the year for incubation and hatchability of eggs because of high environmental temperatures, prevalence of diseases and predators and shortage of green feeds to scavenge. Environmental temperature, lack of proper laying nest and post handling were the critical causes of failure of egg hatchability in the study area. Almost all respondents (96.1%) were capable of checking fertility of eggs prior to incubation by visual examination ,floating in water, shaking , cooking sample eggs, breaking sample eggs and weighing. All respondents (97.4%) attempt to increase egg production by stimulating broody hens to resume laying. Hanging upside down, disturbing in the nest ,moving to neighbors ,tying both wings together, tying outside the original laying nest, tying plastic materials on legs and piercing of noise were the commonly practiced traditional methods of breaking broodiness in the study area. However, great emphasis should be to wards in selection of farmers with healthy flock when we want to break the brooding behavior of ours by moving to neighbors otherwise it may serve as sources of infection for our flocks. There is a strong need for training of chicken producers in increasing hatchability performances through 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 is also very imperative to design in order 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 effect of the twelve months of the year on incubation and hatchability of eggs.

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Table 7 Incubation, brooding practices, broody hen selection criterias and egg setting materials in three agro-ecological zones of Western Tigray

Variable	Agro- ecological zones				X2 -test	p-value
	Highland n (%)	Midland n (%)	Lowland n (%)	Total n (%)		
Incubation of eggs					0.00(ns)	1.00
Broody hen	94(100)	131(100)	160(100)	385(100)		
Brooding chicks					0.00(ns)	1.00
Broody hen	94(100)	131(100)	160(100)			
Egg setting materials					68.437(*)	0.00
Clay pots with grasses (straw) bedding	1(1.1)	-	3(1.9)	4(1)		
Ground with soil/sand/ash/cow dung/chopped grasses /straw/sand filled sack bedding	2(2.1)	2(1.5)	56(35)	60(15.6)		
Bin(ducon) with grasses/straw/cotton seed/sand & feather of brooding hen/sack & sand /clothes/cow dung &straw/ bedding	86(91.5)	107(81.7)	72(45)	265(68.8)		
Plastic with grasses (straw)/soil(sand)/soil or sand/ bedding	3(3.2)	15(11.5)	12(7.5)	30(7.8)		
Bamboo cages with soil and straw/teff straw/ breeding	-	-	1(0.6)	1(0.3)		
Bin (ducon) with grasses /straw/ bedding during rainy season & with sand bedding during dry season	-	2(1.5)	13(8.1)	15(3.9)		
Cartoon with grasses and clothes bedding	2(2.1)	-	1(0.6)	3(0.8)		
Dish with soil or clothes bedding	-	1(0.8)	1(0.6)	2(0.5)		
Ground / Bin(ducon)or dish with grasses bedding	-	-	1(0.6)	1(0.3)		
Plastic and Bin(ducon) grasses /soil/ clothes bedding alternatively	-	4(3.1)	-	4(1)		
Broody hen selection criterias					9.391(*)	0.009
Plumage	128(97.7)	158(98.8)	380(98.7)	128(97.7)	2.238(ns)	0.327
Body weight	94(100)	131(100)	160(100)	385(100)	0.00(ns)	1.00
Egg yield (production)	94(100)	131(100)	160(100)	385(100)	0.00(ns)	1.00
Broody behavior	94(100)	131(100)	160(100)	385(100)	0.00(ns)	1.00
Mothering ability	94(100)	131(100)	160(100)	385(100)	0.00(ns)	1.00
Preference of mothering ability characteristics					9.391(**)	0.009
Good hatching history	50(53.2)	79(60.3)	112(70)	241(62.2)		
Good protector from predators / aggressive weaning	-	-	1(0.6)	1(0.3)		
Good hatching history & good protector from predators / aggressive weaning the bird	44(46.8)	34(26)	41(25.6)	119(30.9)		
Good feeder & hatching history	-	10(7.6)	3(1.9)	13(3.4)		
Good feeder ,hatching history &protector from predators	-	8(6.1)	2(1.2)	10(2.6)		
Good ability of setting ,feeder ,hatching history & protection from predators	-	-	1(0.6)	1(0.3)		

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

Table 2: Egg selection criteria and special egg treatment practices

Variable	Agro- ecological zones				X2 -test	p-value
	Highland n (%)	Midland n (%)	Lowland n (%)	Total n (%)		
Do you select eggs at time of /before incubation?					14.49(*)	0.001
yes	36(38.3)	36(27.5)	79(49.4)	151(39.2)		
No	58(61.7)	95(72.5)	81(50.6)	234(60.8)		
Eggs selection criteria					21.936(*)	0.00
Egg age	1(1.1)	-	4(2.5)	5(1.3)		
Egg type	22(23.4)	9(6.9)	7(4.4)	38(9.9)		
Egg size	1(1.1)	-	-	1(0.3)		
Egg age & type	10(10.6)	21(16)	43(26.9)	74(19.2)		
Egg age, egg type and season/month of laying	-	-	19(11.9)	19(4.9)		
Egg age, egg type and size	1(1.1)	5(3.8)	6(3.8)	12(3.1)		
Egg type and size	2(2.1)	1(0.8)	-	3(0.8)		
Practice special treatment of eggs before incubation					26.345(*)	0.00
Yes	-	1(0.8)	20(12.5)	21(5.5)		
No	94(100)	130(99.2)	140(87.5)	364(94.5)		
How do you treat eggs?					21.914(*)	0.00
Wash with cold water	-	-	3(1.9)	3(0.8)		
Wash with warm water	-	-	1(0.6)	1(0.3)		
Cleaning with clothes or other materials	1(1.1)	1(0.8)	15(9.4)	17(4.4)		
No treatment	93(98.9)	130(99.2)	141(88.1)	364(94.5)		
Do you select specific egg colors for incubation?					0.00(ns)	1.00
Yes	-	-	-	-		
No	94(100)	131(100)	160(100)	385(100)		

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

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Table 3: Practices to avoid broody behavior of chickens and their ranks according their importance

Practices	Agro- ecological zones				X2 -test	p-value
	Highland n (%)	Midland n (%)	Lowland n (%)	Total n (%)		
Methods of breaking of broody behavior					21.833(*)	0.00
Hanging the bird upside down	4(4.3)	16(12.2)	12(7.5)	32(8.3)		
Disturbing in the nest	2(2.1)	3(2.3)	17(10.6)	22(5.7)		
Moving to neighbors	26(27.7)	64(48.9)	26(16.2)	116(30.1)		
Tying both wings together	4(4.3)	4(3.1)	4(2.5)	12(3.1)		
Tying outside the original laying nest	5(5.3)	1(0.8)	15(9.4)	21(5.5)		
Moving to neighbors (1st)& Disturbing in the nest(2nd)	1(1.1)	1(0.8)	2(1.2)	4 (1)		
Moving to neighbors (1st)& Hanging the bird upside down (2nd)	9(9.6)	13(9.9)	12(7.5)	34(8.8)		
Tying both wings together(1st) & Moving to neighbors(2nd)	4(4.3)	5(3.8)	4(2.5)	13(3.4)		
I do nothing ,they leave their brooding behavior by themselves	-	3(2.3)	7(4.4)	10(2.6)		
Tying outside the original laying nest(1st) & Hanging upside down (2nd)	-	-	5(3.1)	5(1.3)		
Hanging upside down (1st) & Moving to neighbors(2nd)	13(13.8)	9(6.9)	11(6.9)	33(8.6)		
Disturbing in the nest(1st) & Moving to neighbors(2nd)	14(14.9)	1(0.8)	19(11.9)	34(8.8)		
Disturbing in the nest(1st) & Hanging upside down (2nd)	-	-	1(0.6)	1(0.3)		
Disturbing in the nest(1st) &Tying outside the original laying nest(2nd)	1(1.1)	-	5(3.1)	6(1.6)		
Disturbing in the nest(1st) ,Tying outside the original laying nest(2nd) & Moving to neighbors(3rd)	-	-	1(0.6)	1(0.3)		
Hanging upside down (1st) & Tying both wings together(2nd)	-	1(0.8)	1(0.6)	2(0.5)		
Hanging upside down (1st) & Tying outside the original laying nest(2nd)	-	-	2(1.2)	2(0.5)		
Tying outside the original laying nest(1st) & Moving to neighbors(2nd)	1(1.1)	1(0.8)	4(2.5)	6(1.6)		
Moving to neighbors(1st) & Tying outside the original laying nest(2nd)	6(6.4)	3(2.3)	6(3.8)	15(3.9)		
Tying outside the original laying nest(1st) & Disturbing in the nest(2nd)	1(1.1)	-	2(1.2	3(0.8)		
Tying both wings together(1st), Tying outside the original laying nest(2nd) & Moving to neighbors(3rd)	1(1.1)	-	1(0.6)	2(0.5)		
Piercing noise with sharp feather of broody hen for a week	-	-	1(0.6)	1(0.3)		
Moving to neighbors(1st), Hanging upside down (2nd) & Disturbing in the nest(3rd)	-	-	1(0.6)	1(0.3)		
Moving to neighbors(1st) & Tying both wings together(2nd)	1(1.1)	-	1(0.6)	2(0.5)		
Tying plastic materials on legs of the broody hen	1(1.1)	-	-	1(0.3)		
Separating broody hen from her chicks	-	2(1.5)	-	2(0.5)		
Hanging upside down(1st), Tying both wings together(2nd) & Moving to neighbors(3rd)	-	2(1.5)	-	2(0.5)		
Moving to neighbors(1st)& Separating broody hen from her chicks (2nd)	-	1(0.8)	-	1(0.3)		
Disturbing in the nest(1st) ,Hanging upside down(2nd) & Moving to neighbors(3rd)	-	1(0.8)	-	1(0.3)		

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

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Table 4: Traditional fertility testing techniques of eggs before incubation

Variable	Agro-ecological zones				X2 -test	p-value
	Highland n (%)	Midland n (%)	Lowland n (%)	Total n (%)		
Do you test eggs before incubation?					1.939(ns)	0.379
Yes	89(94.7)	125(95.4)	156(97.5)	370(96.1)		
No	5(5.3)	6 (4.6)	4(2.5)	15(3.9)		
What type of technique/s do you use?					28.059(*)	0.000
Visual examination through sunlight	7(7.4)	4(3.1)	7(4.4)	18(4.7)		
Floating eggs in water	21(22.3)	84(64.1)	101(63.1	206(53.5)		
Shaking	26(27.7)	22(16.8)	9(5.6)	57(14.8)		
Floating eggs in water (1st) & shaking (2nd)	32(34)	7(5.3)	17(10.6)	56(14.5)		
Visual examination through sunlight (1st) and shaking (2nd)	2(2.1)	1(0.8)	6(3.8)	9(2.3)		
Floating eggs in water (1st), Visual examination through sunlight (2nd) and shaking (3rd)	-	-	3(1.9)	3(0.8)		
By coking sample eggs	-	1(0.8)	1(0.6)	2(0.5)		
By breaking sample eggs	-	1(0.8)	-	1(0.3)		
Floating eggs in water (1st) and egg color change (2nd)	-	1(0.8)	-	1(0.3)		
By weighing eggs	-	1(0.8)	-	1(0.3)		
Visual examination through sunlight (1st) and floating eggs in water (2nd)	-	3(2.2)	12(7.5)	15(3.9)		
Floating eggs in water (1st) & by coking sample n (2nd)	1(1.1)	-	-	1(0.3)		
I do nothing	5(5.3)	6(4.6)	4(2.5)	15(3.9)		

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

Table 5 Sources of eggs for incubation, major causes of failure of hatching and time of best and worst hatchability

Variable	Agro- ecological zones				X2 -test	p-value
	Highland n (%)	Midland n (%)	Lowland n (%)	Total n (%)		
Sources of eggs for incubation					4.643(ns)	0.098
Laid at home	89(94.7)	114(87)	148(92.5)	351(91.2)		
Purchased from neighbors & laid at home	5(5.3)	16(12.2)	12(7.5)	33(8.6)		
Purchased from market & laid at home	-	1(0.8)	-	1(0.3)		
Do you incubate eggs purchased from market?					1.939(ns)	0.379
Yes	-	1(0.8)	-	1(0.3)		
No	94(100)	130(99.2)	160(100)	384(99.7)		
When do you usually incubate eggs (indicate season of incubation)?					13.41(*)	0.01
June – February	76(80.9)	125(95.4)	137(85.6)	338(87.8)		
June – January	-	1(0.8)	22(13.8)	23(6)		
June -September	-	-	1(0.6)	1(0.3)		
October – march	-	1(0.8)	-	1(0.3)		
June - march	-	4(3.1)	-	4(1)		
March – June	3(3.2)	-	-	3(0.8)		
October –may	15(16)	-	-	15(3.9)		
Is there seasonal variability on hatchability?					0.0(ns)	1.0
Yes	94(100)	131(100)	160(100	385(100)		
No	-	-	-	-		
When do you achieve the worst hatchability?					22.99(*)	0.00
March –may	76(80.9)	125(95.4)	153(95.6)	354(91.9)		
February –may	-	1(0.8)	7(4.4)	8(2.1)		
April –may	3(3.2)	5(3.8)	-	8(2.1)		
June –September	15(16)	-	-	15(3.9)		
When do you achieve the best hatchability?					13.365(*)	0.001
June – February especially autumn	76(80.9)	125(95.4)	139(86.9)	340(88.3)		
June – march	3(3.2)	4(3.1)	-	7(1.8)		
October - march	-	1(0.8)	1(0.6)	2(0.5)		
June – January	-	1(0.8)	20(12.5)	21(5.5)		
October – may	15(16)	-	-	15(3.9)		
Major causes of failure of hatching					1.417(ns)	0.492
Lack of proper laying nest & post handling	-	-	1(0.6)	1(0.3)		
Temperature & Lack of proper laying nest & post handling	94(100)	131(100)	156(97.5)	381(99)		
Temperature	-	-	1(0.6)	1(0.3)		
Temperature & Lack of proper post handling	-	-	2(1.2)	2(0.5)		
variable	Agro-ecological zones				X^2-test	
Placement of eggs in the brooder hen					1.406(*)	0.495
Egg positions side ways	94(100)	131(100)	159(99.4)	384(99.7)		
Egg positions pointed narrow end down	-	-	1(0.6)	1(0.3)		
How do you store eggs to improve their shelf lives?					8.549(*)	0.014
Store in cold room	-	-	6(3.8)	6(1.6)		
Store inside cold containers	94(100)	131(100)	154(96.2)	379(98.4)		

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

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