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Indigenous Chicken Production System and Breeding Practice in North Wollo, Amhara Region, Ethiopia

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Abstract

Production system and breeding practice of indigenous chicken in North Wollo has been conducted from January 2011 to June 2012 with objectives of characterizing the production system and breeding practice, farmer trait preferences. Simultaneously, identification of development intervention for improved utilization of chicken genetic resources was also identified. In the first part of data collection, one focused group discussion per agro-ecological zones was held. Then, administration of well-structured questionnaire on 306 respondents was employed. The questionnaire data was analyzed by using frequency count of SAS 2002. The predominant production system in the study area was Free-range scavenging with seasonal supplementary. The critical constraints of scavenging chicken production were disease (60.13%) predators (20.59%) and feed shortage (19.28%). Cross breeding (80.0%) and line breeding (20.0%) were practice of farmers for improvement of their chicken productivity. Number of egg lay/clutch (37.91%) and plumage colour (37.58%) were the major preferred trait by the farmers in the study area. The overall age at sexual maturity for male and female was 24.25 ± 0.04 and 23.84 ± 0.05 weeks respectively. There was highly significant difference ($p<0.0001$) in egg production/hen/clutch across altitudes. In general in low input and high environmental stressed with poor infrastructure, traditional breeding program would be recommended.

Keywords: Breeding objective; Chicken production; North Wollo; Trait preference

Introduction

Ethiopia is believed to have the largest livestock population in Africa. This livestock sector has been contributing considerable portion to the economy of the country. The livestock sector contributes 20% to the total GDP, supporting the livelihoods of 70 % of the population and generates about 11% of annual export earnings. Livestock sector are still promising to rally round the economic development of the country [1,2].

Indigenous chicken (97.3 %) in Ethiopia is found in huge number distributed across different agro-ecological zones [2] under a traditional family-based scavenging management system [3]. This indicates that they are highly important farm animals kept as a good source of animal protein and income to most of the rural populations by producing 78,000 metric tons egg and 72,300 metric tons meat [4]. From that, more than 90% of the national chicken meat and egg output is from indigenous chickens [5]. Furthermore, their widespread distribution indicates their adaptive potential to the local environmental conditions, diseases and other stresses [6].

Disease, predation, market system, management and production system were major constraints of chicken production in Ethiopia [4,6,7]. Breed improvement and subsequent proper utilization of these local chicken genotypes strongly demands comprehensive characterization, including production system and breeding practice. Therefore, this study was initiated with the following objectives.

General objectives

To identify and characterize production system and breeding practice of the study area

Specific objectives

- To identify trait preference and breeding objective of the farmers in identified indigenous chicken ecotypes.
- To outline priority areas of intervention for genetic improvement of the identified indigenous chicken ecotype population based on farmer trait preferences.
- To identify the main problems hindering proper utilization and conservation of chicken genetic resources in the study area, and forward suggestions on how these constraints should be solved.

Materials and Methods

Description of study area

The study was conducted in North Wollo administration zone, which is located in eastern part of Amhara regional state within 8°95'-12°8'N longitude and 38°5'-40°20'E latitude. The altitude ranges from 700-4100 masl (AbunaYosef Mountain) in Gidan district (in the western parts of the study area). The annual rainfall varies from 650 mm (low altitude) to 1200 mm (high altitude) with the maximum temperature of 25°C in the low altitude and minimum temperature of 16°C in the high altitude. The area also classified mainly in to two seasons, the wet season, from June to September and the dry season from October to May Belay [8].

In general, the zone is divided into three main agro-ecological zones, namely: high altitude (>2500 masl) 31.951%, mid-altitude (1500–2500 masl) 57.493% and low altitude (<1500 masl) 10.556% BoARD [9]. The study area has 1,731,849 human populations with estimated area of 16,400.98 square kilometers [10]. North Wollo administration zone has

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3,652,308 livestock of which 1,132,383 is chicken populations [2]. The characteristic of the zone summarized in Table 1.

Most of this Zone is mountainous and characterized by steep slopes. The land orientation is unsuitable for agriculture and severely limits the cultivated area. A survey conducted in this zone shows that, 24% of the land is arable or cultivable, 4.6% pasture, 0.37% forest, 17.4% shrubland and 47.3% of the land is degraded or unusable. Only 6.3% of the land uses all other purposes.

The average rural household has 0.7 hectare of land (compared to the national average of 1.01 hectare of land and a regional average of 0.75 for the Amhara region). In regarding to major occupation, 13.2% of the population participates in non-farm related jobs, compared to the national average of 25% and a regional average of 21%. The zone is drought prone for many years [11].

Mixed crop-livestock farming is preferred farming system of the study area. Scavenging is predominant production system in case of chicken production. Main crops cultivated in the study area were sorghum, maize, "*teff* "and wheat. Regarding the types of diseases, the most of economically important diseases is Newcastle.

Study methods

Sampling framework and data collection procedures: Rapid field survey was conducted to discover major ecotypes. Accordingly, three major chicken ecotypes were identified from different agro-ecological zones and named based on altitudes: high altitude chicken, mid altitude chicken and low altitude chicken. One focus group discussion per altitude (major ecotype) was held prior to survey data collection. Then multi-stage sampling procedure (purposive: two sample sites per altitude were selected based on chicken population and infrastructure availability). Then, simple random sampling technique was applied to choose 306 chicken owner respondents and interviewed using well-structured questionnaire.

Data collection procedure: Individual or family interview in their house by using well-structured questionnaire was conducted to collect information on husbandry practice, constraints in chicken production, important diseases, feed resource, chicken feeding and housing practices, watering, age at sexual maturity (month), age at first egg laying, average number of eggs per clutch, average number of eggs per set, number of chicks hatched per clutch, number chicks surviving to adulthood, breeding objective, trait preference, egg selection, egg incubation, brooding procedures, broody hen selection, culling practice and mating system.

Data management and statistical technique

Dates from well-structured questionnaire were assessed frequently both on the field and at home for it completeness. Incomplete or vague records were corrected back immediately in the respondent's house or replaced. All data that had been collected from survey were entered, cleaned and managed using Microsoft Excel computer program and regularly up dated and an error checking procedure were run several times until the data entered for analysis.

Production system and socio-economic, breeding objective and trait preference and were imported to [1] for descriptive statistics of frequency count and expressed as percentage.

Result and Discussion

Chicken production system

Feeding and feed resource: All of the chicken owners were found to keep their chicken in free range/scavenging type of production system with occasional supplementary feeds (89.87%) like wheat (36.27%), sorghum (36.27%) and maize (23.53%). Wheat (65%) in high altitude and sorghum in mid altitude (46%) and low altitude (49.06%) were the dominate type of feed supplied to chicken. Most of them provided supplementary feeds two times per day (morning and evening) (42.16%) (Table 2). This result is in line with the report of [12] in which about 97.8 % respondents in Gomma district had a practice of providing supplementary feeding with scavenging production system. Similarly in Kenya, indigenous chicken get their feed by scavenging for insects and wasted grains scattered in the farm, food left-over's and green vegetation with supplementary feed during confinement in the rainy season [13]. The major objective of providing supplementary feed were for healthiness maintaining of their chickens (34.97%), to increase egg production (33.99%) and meat yield (31.70%) (Table 2). Similarly, Bogale [7] reported that the main reason of feed supplementation in Fogera district was to increase egg yield (9.23%) and increase egg and meat yield (90.77%).

Housing and house facility: The abundant house type in all study areas was a room inside the main house (56.86%). Only 15.36% of respondents prepare separate chicken house (Table 3). This result is much higher than from a report of Meseret [12] in which only 3.6% respondents in Gomma district constructed separate chicken house. However, much lower from 50.77 % and 59.7% respondents prepared a separate chicken house in Northwest of Ethiopia and Fogera district [6,7] respectively. In Rattanakiri, only 10.4% of the farmers provided separate house for chicken for night and day [14].

About 37.25% of the respondents cleaned their chicken house two

Sample Sites	Altitude	Indigenous Chicken	human population	land size/hectare	% of land coverage
High altitude					
Kon	3000	40644	132296	81875	31.95
Filaket	2900	137165	234933	191959	
Mid altitude					
Lalibela	2400	9437	77766	115534	57.49
Sanka	1900	61248	144337	93021	
Low altitude					
Mersa	1600	156015	199804	167147	10.56
Robit	1500	10839	230546	173364	

Source: BoARD 2010; RIR= Rhode Island Red; WLH= White leghorn

Table 1: Characteristics of Study Site.

Feeding practice	Agro-ecological zone			
	High altitude n(%)	Mid altitude n(%)	Low altitude n(%)	Total n(%)
Provision of supplementary feeds				
No	8 (8.00)	20 (20.00)	3 (2.83)	31 (10.13)
Yes	92 (92.00)	80 (80.00)	103 (97.17)	275 (89.87)
Reason of supplementary feed				
To increase egg production	62 (62.00)	4 (4.00)	38 (35.85)	104(33.99)
To increase meat yield	2 (2.00)	40 (40.00)	65 (61.32)	107(34.97)
Maintain health	36 (36.00)	58 (58.00)	3 (2.83)	97(31.70)
Frequency of feed supplying/day				
Morning or evening	56 (56.00)	36 (36.00)	15 (14.15)	107 (34.96)
Morning and evening	28 (28.00)	52 (52.00)	36 (33.96)	116 (37.90)
Morning, midday& evening	16 (16.00)	12 (12.00)	55 (51.88)	83 (27.12)
Feed resource				
Sorghum	13 (13.00)	46 (46.00)	52 (49.06)	111(36.27)
Wheat	65 (65.00)	20 (20.00)	26 (24.53)	111 (36.27)
Maize	13(13.00)	31 (31.00)	28 (26.42)	72 (23.53)
Mixture	9 (9.00)	3 (3.00)	-	12 (3.93)
Water supplementation	100 (100.0)	100 (100.0)	106 (100.0)	306 (100.0)

Table 2: Feeding practice, reason of providing supplementary feed, frequency of supplying supplementary feed, feed resource of the study area.

Housing and house facility	Agro-ecological zone			
	High altitude n(%)	Mid altitude n(%)	Low altitude n(%)	Total n(%)
House type				
A room inside the house	45 (45.00)	58 (58.00)	61 (57.55)	174 (56.86)
Bamboo cages	26 (26.00)	13 (13.00)	12 (11.32)	51 (16.67)
Separate house	19 (19.00)	21 (21.00)	9 (8.49)	49 (16.36)
In the kitchen	9 (9.00)	7 (7.00)	24 (22.64)	40 (20.92)
Hand woven basket	1 (1.00)	-	-	1 (0.33)
Unknown	-	1 (1.00)	-	1 (0.33)
Frequency of chicken house cleaning/week				
One time	20 (20.00)	39 (39.00)	22 (20.75)	81 (26.47)
Two times	49 (49.00)	24 (24.00)	41 (38.68)	114(37.25)
Three times	23 (23.00)	27 (27.00)	14 (13.21)	64 (25.82)
Four times	7 (7.00)	10 (10.00)	29 (27.36)	31 (10.13)
Seven times	1 (1.00)	-	-	1 (0.33)
Indigenous knowledge in preventing external parasites				
Smoking	75 (75.00)	77 (77.00)	80 (75.47)	232 (75.82)
Spray chemical	13 (13.00)	11 (11.00)	13 (12.26)	37 (12.09)
Wipe with alcohol	8 (8.00)	8 (8.00)	8 (7.55)	24 (7.84)
No	4 (4.00)	4 (4.00)	5 (4.72)	13 (4.25)
Ash	100(100.0)	100 (100.0)	106(100.0)	306(100.0)

Table 3: Chicken house type, frequency of chicken house cleaning, indigenous knowledge in preventing external parasite in the study area.

times per week. Besides, farmers also have indigenous knowledge in preventing chickens from external parasites by smoking (75.82 %) or spray chemicals (12.09%) the chicken house also by sweep the chicken with locally made alcohol ("*Arekie*") (7.84%). However, the rest 4.25% respondents had not any kind of external parasite control method for their chicken. Farmers in the study area also used ash around chicken house to prevent entrance of ants and other worms (Table 3). Similarly, farmers in different part of Africa used plant products to ward off various ectoparasites such as ticks, lice, mites, fleas and small red ants that can infest village poultry [15]. Furthermore, in Zimbabwe, Anmna senegalensis roots are soaked in water and the fluid is sprinkled in the hen run to repel snakes [16]. In Nigeria, chicken owners grew certain plants (e.g. Eupkoubia sp. and lemon grass) or placed sliced garlic (*Allium sativtm*) around hen houses to repel snakes [17].

Socio-economic and marketing of chicken products

According to result of survey; egg (47.71%) and meat (43.79%) were the major chicken products of home consumption and market supply. In regarding to market of live chicken, every kind of chicken except from chick age group was supplied. The price of live chicken was determined based on body weight (41.83%), combination of comb type and plumage colour (32.35%) and plumage colour (25.82%) in buying and selling marketing system (Table 4). Similarly, Bogale [7] reported that plumage colour and comb type, body weight, plumage colour, comb type, age and sex have respective factors on price of chicken at market. Furthermore, seasonal demand, lack of infrastructure, market site, and health status had great effect on chicken price in Northwest of Ethiopia [6]. In another way, Nigussie [5] reported that plumage colour, live weight and comb type were some factors affecting chicken price at market level.

Some of obstacles in regarding to marketing of chicken like; instable chicken price (40.85%), lack of market place (29.41%) and poor infrastructure (29.74%) were enforced the majority of farmers to sell their chicken and chicken products to small retailers at low price (92.16%) (Table 4). This result is in line with a report of Meseret [12] in which unstable chicken price and seasonal demand of egg and live chicken were some of subjective forces of farmers to sell their chicken and chicken product to small retailer in low price.

Major constraints

According to the survey conducted in the three altitudes; diseases

Marketing system	Agro-ecological zone			
	High altitude n(%)	Mid altitude n(%)	Low altitude n(%)	Total n(%)
Major chicken products				
Egg	55 (55.00)	36 (36.00)	55 (51.89)	146 (47.71)
Meat	33 (33.00)	56 (56.00)	45 (42.45)	134 (43.79)
Other	12 (12.00)	8 (8.00)	6 (5.66)	26 (8.50)
Price difference at live chicken				
Plumage colour	28 (28.00)	24 (24.00)	27 (25.47)	79 (25.82)
Body weight	41 (41.00)	44 (44.00)	43 (40.57)	128 (41.83)
Comb type & plumage colour	31 (31.00)	32 (32.00)	36 (33.96)	99 (32.35)
Constraints at market level				
Instable chicken price	40 (40.00)	41 (41.00)	44 (41.51)	125 (40.85)
demand seasonality	-	31 (31.00)	28 (26.42)	90 (29.41)
Lack of market place	31 (31.00)	28 (28.00)	34 (32.08)	91 (29.74)
Market flow of live chicken from producer to consumer				
Indirect	88 (88.00)	93 (93.00)	101 (95.28)	282 (92.16)
Direct	12 (12.00)	7 (7.00)	5 (4.72)	24 (7.84)

Table 4: Major chicken product, price difference, constraints at market level and market chain of the study area.

Local name of disease	Symptom	Agro-ecological zone			
		High altitude n(%)	Mid altitude n(%)	Low altitude n(%)	Total n(%)
fengile	Dullness, weight loss, discharge from mouth and nose	95(95.00)	95 (95.00)	66 (62.86) -	256 (83.93)
Melalat	Loss of feather	-	3 (3.00)	18 (17.14)	21 (6.89)
Unknown	Loss of appetite and weight loss	5 (5.00)	2 (2.00)	21 (20.00)	28 (9.18)

Table 5: Local name and symptom of major type of diseases in the study area.

Diseases	Agro-ecological zone			
	High altitude n(%)	Mild altitude n(%)	Low altitude n(%)	Total n(%)
Source of infection				
Brought chicken	11 (11.00)	11 (11.00)	13 (12.26)	35 (11.44)
Neighboring household	51 (51.00)	50 (50.00)	52 (49.05)	154 (50.00)
Unknown	38 (38.00)	39 (39.00)	41 (38.68)	118 (38.56)
Severity of diseases				
Destroyed more than half of the flock	50 (50.00) 50 (50.00)	47 (47.00)	50 (53.00)	150 (49.02)
Destroyed less than half the flock		53(5.00 3)	50 (53.00)	156 (50.98)
Susceptible age				
Chicks	84 (84.00)	83 (83.00)	88 (83.02)	255 (83.33)
Chicks and elder	14 (14.00)	3 (3.00)	5 (4.72)	10 (3.27)
All	2 (2.00)	14 (14.00)	13 (12.26)	41 (13.40)
Favorable season				
After rainy	1 (1.00)	-	-	1 (0.33)
Before rainy	24 (24.00)	22 (22.00)	20 (18.87)	57 (18.63)
Dry	-	9 (9.00)	11 (10.38)	29 (9.48)
During rainy	75 (75.00)	69.00 (69)	70.75 (75)	71.57 (219)
Ethno veterinary				
"Damakasie"	2 (2.00)	6 (6.00)	7 (6.60)	15 (4.90)
Lemon	33 (33.00)	32 (32.00)	35 (33.02)	100 (32.68)
White onion	5 (5.00)	3 (3.00)	7 (6.60)	14 (4.58)
Alcohol ("*Arekie*")	51 (51.00)	51 (51.00)	47 (44.34)	149 (48.69)
Conversion treatment				
Chemical		1 (1.00)	4 (3.77)	10 (3.27)
No		7 (7.00)	6 (5.66)	18 (5.88)

Table 6: Source of infection, severity of disease, favourable season and treatment of sick chicken across the three altitudes.

(60.13%), feed shortage (20.59%) and predator or theft (19.28%) were major constraints of chicken production. This finding is in line with the report of Bogale [7] in which shortage of supplementary feed (19.4%) was constraint in Fogera district. In other study, Halima [6] reported that diseases and predator were the first and the second major factor that causes loss of chicken in Northwest Ethiopia.

Diseases and mortality: Newcastle Disease (NCD) (locally called as "*fengile*") was the most prevalent and economically important disease affecting village chicken production (85.91%). In addition of NCD, cannibalism (locally called "*melalat*") was observed as a constraint in mid altitude (3.0%) and low altitude (17.14%) areas at dry and sun-drenched season (Table 5). This result shows an agreement with the reports that major causes of indigenous chicken death is seasonal outbreak NCD in Northwest Ethiopia [6], in Bure district [4], in Fogera district [7] and in Gomma district [12]. Similarly, Yongolo [18] also supported the argument of NCD was the most devastating disease and considered as a major constraint to the development of both village and commercial chicken industry in Africa.

According to respondents in the study area, neighbouring chicken (50%) was the major source chicken infection. Most frequently, diseases occurrence had observed in rainy season (71.57%). All indigenous chicken ecotypes were equally susceptible for diseases. However, there was susceptibility difference in different age groups; chicks (83.33%) were highly sensitive for disease than younger and elder (Table 6). This result shows an agreement with the report of Halima [6] in which neighbours flocks were the major source of chicken infection and the highest chicken death rate were observed during the rainy season (90.86 %) in North West Ethiopia. Furthermore, Fisseha [4] reported that NCD affects every chicken ecotypes and age group equally but hens in lying and incubating periods are the most affected and sensitive age groups.

Rural communities of the study area use different local treatment to cure the sick chicken. Ethno veterinary services using alcohol ("*Arekie*") (48.69%), "*damakasie*" (4.90%), lemon (32.68%), white onion (4.58%) were some of indigenous knowledge in treating the sick chicken. In addition, the farmers in the study area also use conventionally method of treating the sick chicken by using different industrial chemicals (3.27%).However, 5.88% of respondents hadn't any treatment; they simply let the chicken to die (Table 6). This result is in line with the findings Fisseha (2009) in which farmers in Bure district treated the sick chickens against NCD by using locally made alcohol ('*Arekie*'), lemon and onion (42.9%), plant materials (like "*semiza*" & "*endod*") (33.2%), tetracycline capsule (11.8%) and by cutting around the wing of infected chicken to remove 'infected' blood (7.1%).

Breeding objectives and practice

Farmers breeding practice: Survey on breeding practice of respondent revealed that only 17.3% of respondents have breeding practice in improving their chicken productivity either by cross breeding (80.0%) or by line breeding (20.0%) (Table 7). This result is not in line with report of Meseret [12] in which traditional chicken production system was characterized by lack of systematic breeding practice in Gomma district. Furthermore, a study conducted in different part of Ethiopia revealed that village chicken breeding is completely uncontrolled and replacement stock produced through natural incubation using broody hens [5]. In another study, Fisseha [4] reported that about 92.2% of chicken owner farmers in Bure district had the tradition of selecting cocks for breeding stock. Okeno et al. [19] in Kenya reported that farmers who are confining their flocks do selection of chicken for breeding.

Combination of comb type and plumage colour (28.30%) and egg production and broodiness performance (32.07%) were the major selection criteria of farmers in genetic improvement for male and female chickens respectively (Table 7). This result shows an agreement with the report of Fisseha [4] in which plumage color (45.4%) and comb type (8.6%) were some of selection criteria for breeding stock in Bure district. Another study conducted in mid Rift valley of Oromia revealed that 68% of the farmers select productive hen by its body size, 12% by finger accommodation between the pelvic bones and 20% by pedigree performance for replacement [20].

Mating system and culling practice

According to survey, about 10.79% of respondents control mating of their flock for at least two or three egg per clutch while 89.21% of respondent had uncontrolled natural mating system. Retaining the best indigenous or high yielding exotic cock (52.79%) with hens during conception period was the major way of mate control of their flock (Table 8). This result is not in line with the report of Nigussie [5] in which there was no systematic mating in any regions of Ethiopia. Another study in the three districts of SNNPRS disclosed that the free-range feeding practice attributed to indiscriminate mating of cocks and hens [21].

Slaughtering (53.27%), selling (41.18%) and devour or sell eggs of unwanted hens (5.56%) were a major means of culling less productive chicken from the flock (Table 8). This result agrees with the finding of Bogale [7] who reported that the home consumption and selling were the main culling mean of poor productivity (46.5%), old age and poor productivity (25%) and sickness (5.65%) chicken from their flock. Another study in Northwest Ethiopia by Halima [6] also revealed that farmers cull poor productivity and old age chickens via selling.

Trait preference of farmers: Number of egg production/clutch (37.91%) and plumage colour (37.58%) were the major preferred trait of farmers. Higher percent of farmers found in high altitude select egg (46.00%) as primary trait whereas plumage colour was primary selected trait in low altitude (44.34%) (Table 8). This result is not in line with the report Nigussie [5] in which farmers in different part of Ethiopia mainly select adaptive traits, meat and egg test as their preferred traits. The most important traits of farmers in Jordan were growth rate, disease tolerance, egg yield, body size and fertility [22]. Majority of the farmers in Kenya considered egg yield as the most important trait followed by mothering ability and body size [19]. Identification of traits of economic importance is vital in the development of breeding objectives. Therefore,

Breeding practice	Agro-ecological zone			
	High altitude n(%)	Mid altitude n(%)	Low altitude n(%)	Total n(%)
Breeding practice				
No	94 (94.00)	75 (75.00)	84 (79.24)	253 (82.7)
Yes	6 (6.00)	25 (25.00)	22 (20.75)	53 (17.3)
Methods of breeding				
Importing exotic	7(77.78)	0	4(33.33)	13(24.53)
Improving Indigenous	2 (22.22)	30 (100)	8 (66.67)	40 (75.47)
Ways of improving indigenous				
Cross breeding	8 (88.89)	12 (100.0)	12 (63.16)	32 (80.0)
Line breeding	1 (11.12)	0 (0)	7 (36.84)	8 (20.0)
Selection criteria chicken for improvements of indigenous				
Male PC &CT	7 (29.17)	2 (20.0)	6(31.58)	15 (28.30)
comb type	1 (4.17)	5(50.0)	1 (5.26)	7 (13.21)
Female Plumage colour	6 (25.00)	1 (10.0)	7(36.84)	14(26.41)
EPP & BP	10 (41.67)	2 (20.0)	5 (26.32)	17 (32.07)

Table 7: Breeding practice, breeding method and selection criteria of chicken in the study area.

Breeding practice	Agro-ecological zone				
	High altitude n(%)	Mid altitude n(%)	Low altitude n(%)	Total n(%)	Rank
Mating system control					
No Yes	98 (98.0) 2 (2.0)	88 (88.0) 12 (12.0)	87 (82.07) 19 (17.92)	273 (89.21) 33 (10.78)	-
Ways of mate controlling					
Culling underproductive Cull at early age Retaining Preventing mate	2 (3.17) 9 (14.29) 35 (55.56) 17 (26.98)	5 (7.81) 13 (20.31) 35 (54.69) 11 (17.19)	- 16 (22.86) 34 (48.57) 20 (28.57)	7 (3.55) 38 (19.29) 104 (52.79) 48 (24.37)	-
Culling practice of less productive chicken					
Slaughter Sell Sell or consume eggs	56 (56.0) 40 (40.0) 4 (4.0)	51 (51.0) 44 (44.0) 5 (5.0)	56 (52.83) 42 (39.62) 8 (7.55)	163 (53.27) 126 (41.18) 17 (5.56)	-
Inbreeding concept					
No Yes	37 (37.0) 63 (63.0)	45 (45.0) 55 (55.0)	53 (50.0) 53 (50.0)	135 (44.12) 171 (55.88)	
Trait preference					
Egg no Meat Plumage colour Mothering ability Diseases resistance	46(46.0)[a] 14(14.0)[a] 37(37.0)[a] 3(3.0)[a] -	33(33.0)[b] 19(19.0)[a] 31(31.0)[a] 4(4.0)[a] 2(2.0)[a]	37(34.91)[b] 22(20.75)[a] 47(44.34)[b] 7(6.60)[a] 4(3.77)[a]	116 (37.91) 55 (17.97) 115 (37.58) 14 (4.58) 52 (15.96)	1 3 2 5 4

Table 8: Mating system, mating control, culling practice of less productive chickens and trait preference of farmers in the study area.

Incubation practice	Agro-ecological zone			
	High altitude n(%)	Mid altitude n(%)	low altitude n(%)	Total n(%)
Egg selection				
No Yes	88 (88.00) 12 (12.00)	87 (87.00) 13 (13.00)	95 (89.62) 11 (10.38)	270 (88.24) 36 (11.76)
Size of selected egg				
Large	12 (100.00)	13 (100.00)	11(100.00)	36 (100.00)
Broody hen selection				
No Yes	14 (14.00) 86 (86.00)	12 (12.00) 88 (88.00)	10 (9.43) 96 (90.57)	36 (11.76) 270 (88.24)
Bases of broody hen selection				
Body size Broodiness ability history	28 (32.18) 59 (67.82)	20 (22.73) 68 (77.27)	25 (25.77) 72 (74.23)	73 (26.84) 199 (73.16)
Impending broodiness				
No Yes	3 (3.00) 97 (97.00)	3 (3.00) 97 (97.00)	4 (3.77) 102 (96.23)	10 (3.27) 296 (96.73)
Ways of impending broodiness				
hanging down the hen sending to neighbors preventing feed showing broken egg	62 (63.92) 29 (29.90) 6 (6.19) -	69 (69.07) 22 (22.68) 4 (4.12) 4 (4.12)	64 (62.75) 30 (29.41) 4 (3.92) 4 (3.92)	193 (65.20) 81 (27.36) 14 (4.73) 8 (2.7)

Table 9: Incubation practice in the study area.

breeding programs for improving the productivity of indigenous chicken should target these traits and consider the current and future production circumstances.

Incubation practice

According to survey, about 88.23% of respondents had a practice of egg and broody hen selection. Egg selection was performed based on size (larger sized) and blood content (if the egg expected to have exotic blood content, it was collected separately and gets priority area for incubation). Furthermore, broody hen selection was conducted based on body size (26.83%) and broodiness ability history (73.16%) (Table 9). This result shows an agreement with report of Meseret [12] in which farmers in Gomma district had good practice of selecting hens for incubation based on size; large size hens (66.7%) were selected. Similarly, a report from Bure district revealed that 86.4% of village chicken owners had a practice of selecting broody hens based on looking hen's past egg incubation performance (73.9%), body size (7.9%), thick feather (2.1%), size of eggs laid (2.5%) [4].

Respondents in the study area also have an experience of impending broodiness behavior (96.73%) when they lost full egg of a particular hen in different way. Hanging down the hen (65.20%) and sending the hen to neighbors (27.36%) were the major way of breaking broodiness (Table 9). This result shows an agreement with the findings of Nigussie [5] who reported that hanging upside-down (33),moving to neighbour houses (33), submerge into water up to the breast (1), change brooding place (9) were some form of impending broodiness behavior of indigenous chicken in different part of Ethiopia.

Traits	Agro-ecological zone			
	High altitude Mean±Se/n	Mid altitude Mean±Se	Low altitude Mean±Se	Total Mean±Se
Male				
Age at sexual maturity	24.31^{ba}±0.07	24.35^{a}±0.07	24.11^{b}±0.07	24.25±0.04
Female (n) 161				
Age at sexual maturity	23.26^{b}±0.14	24.04^{a}±0.08	24.20^{a}±0.07	23.84±.06
Age at first egg laying	25.77^{b}±0.07	26.03^{a}±0.05	26.11^{a}±0.05	25.97±0.03
Clutch number	3.71^{a}±0.03	3.59^{b}±0.03	3.55^{b}±0.03	3.62±0.02
Egg number/hen/clutch	13.18^{a}±0.18	12.56^{b}±0.16	12.20^{c}±0.17	12.64±0.10
Incubated/hen/clutch	11.48^{a}±0.15	11.42^{a}±0.14	11.17^{a}±0.17	11.36±0.09
Hatched/hen/clutch	9.31^{b}±0.18	9.86^{a}±015	9.60^{ba}±0.19	9.60±0.10
Weaned/hen/clutch	4.47^{b}±0.13	4.96^{a}±0.10	4.29^{b}±0.10	4.59±0.06
Egg number/hen/yr	52.30^{a}±0.64	48.32^{b}±0.64	47.99^{b}±0.64	49.51±0.38
Egg at Clutch number				
One	10.31^{a}±0.25	10.40^{a}±0.24	9.64^{a}±0.28	10.11±0.15
Two	14.05^{a}±0.27	12.60^{b}±0.23	11.78^{c}±0.22	12.85±0.17
Three	15.00^{a}±0.10	14.20^{b}±0.14	14.20^{b}±0.10	14.41±0.08
Four	14.41^{a}±0.30	13.70^{ba}±0.25	13.05^{b}±0.33	13.76±0.17
Five	11.50^{a}±0.33	10.70^{a}±0.32	11.12^{a}±0.43	11.12±0.20
Annual egg no at Clutch				
One	-	-	-	-
Two	53.58^{a}±1.05	46.63^{b}±1.20	42.25^{c}±1.08	47.65±0.80
Three	57.19^{a}±0.37	52.31^{b}±0.63	53.10^{b}±0.45	53.91±0.34
Four	54.26^{a}±1.07	50.60^{b}±1.20	50.19^{b}±1.42	51.62±0.74
Five	44.12^{a}±1.16	43.83^{a}±1.44	40.84^{a}±1.43	42.90±0.78

Table 10: Mean comparison of reproductive and productive traits in North Wollo.

Reproductive and productive performance

The participants of focus group discussion in each agro-ecological zones stated that there was no special reproductive as well as productive performance their surrounding chicken than other part indigenous chicken of Ethiopia. They also revealed that indigenous chicken reach sexual maturity within half of a year.

Reproductive performance

Age at sexual maturity: According to respondents, the overall mean age of sexual maturity was 24.25 ± 0.04 and 23.84 ± 0.05 weeks for male and female respectively. There was highly significant difference ($p<0.0001$) and significant difference ($p<0.0441$) in age at sexual maturity of female and male chicken ecotypes among the three altitudes respectively. Subsequent mean comparison of age at sexual maturity across altitudes is presented in Table 10. This result is in line with the report of Bogale [7] in which mean age of sexual maturity of indigenous chicken in Fogera district was 23.48 ± 0.1 and 23.6 ± 0.11 weeks for male and female respectively.

Age at first egg laying: The overall mean of age at first egg laying for female chicken ecotypes in the study area was 25.97 ± 0.04 weeks. There was highly significant difference ($p<0.0001$) in means of age at first egg laying. Subsequent mean comparison was presented in (Table 10). This result comparable with the findings of Tadelle, et al. [3] who reported that the mean age at first egg laying of indigenous hens in different part of Ethiopia was 27.2 weeks. However, this result is lower than from mean age at first egg laying of chicken found in central highland of Ethiopia and in three districts of SNNPRs which were 24.4 to 32.64 and 28.28 weeks reported by Tadelle [23] and Mekonnen [21] respectively. On the other hand, the result is longer than the average age of first egg laying (20 weeks) in Northwest Ethiopia [6].

Clutch number: The overall average clutch number of chicken in the study area was 3.62/year. There was significant difference ($p<0.0008$) in clutch number among the three altitudes. Subsequent mean comparison of clutch interval was presented in (Table 10). This result shows an agreement with the report of Meseret [12]; Mekonnen [21] in which the mean clutch number of indigenous chicken in Gomma district and three districts of SNNPRs was 3.43/yr and 3.8/yr respectively.

Production traits

Egg production: The average number of egg production/hen/clutch and mean annual egg production/hen in this study area were 12.64 ± 0.1 and 49.51 ± 0.38 respectively. There was highly significant difference ($p<0.0001$) in average number of egg/hen/clutch and average egg number/hen/year among the three altitudes. Subsequent mean comparison of egg production/hen/clutch and egg production/hen/yr was presented in Table 10. This result is in line with the report of Meseret [12] and CSA [10] in which mean egg number/hen/clutch was 12.92 and 12 (national average of egg production/hen/clutch) respectively. In average about 9.6 ± 0.1 was hatched from that only 4.59 ± 0.06 chicks weaned. This result is lower than report of Bogale [7] in which the average number of chicks weaned was 7.63 in Fogera districts.

Clutch number also had highly significant effect ($p<0.0001$) on average egg production/hen/clutch and mean annual egg production/hen. Average egg production/clutch and mean annual egg production/hen shows an increment at clutch number three and four than at first and second clutch periods. However, it decreased at clutch number more than five (Table 10). This result is in line with the findings of Tadelle, et al. [3] in which the overall mean egg laying performance of hens for the first, second and third (higher) clutches were 17.0, 20.9 and 24.8 eggs respectively (indigenous hens laid 8 eggs more by the third clutch compared to the first clutch).

Breeding program

Description of breeding program components: Development of

any genetic improvement strategy requires description of production environment, identifying the availability of infrastructure, setting appropriate breeding objective, selecting traits to be improved based on their influence on returns and costs to the producer and consideration of stockholders [24]. Thus, designing a breeding program needs decision on a series of such interacting components [25]. Some of the most important components of this breeding program are discussed as follows:

Production system, stakeholders, and infrastructures of the study area: The production system of the study area as explained earlier is characterized by low input and high environmental stress and no essential infrastructure. It is a subsistence based production system, and not market-oriented. As reported by the farmers, diseases, predators and feed shortage were the most important limiting factors. Lack of marketing facilities was also mentioned as constraints. The typical flock sizes were small; there were no farmers associations specifically equipped for chicken genetic improvement. The involvement of other stakeholders (non-governmental organizations and government bodies) in genetic improvement of indigenous chicken genotype was none.

Selected traits for genetic improvement in the study area: The goal traits, which are used in designing of the forthcoming breeding program, should logically be based on preferred traits identified by farmers. Traits that represent breeding goal should be measured easily and also it heritability value have be considered. Traits those are not easy to be measured must have a high genetic correlation with indicator trait, and desirable economic value, either as a marketable commodity or as a means of reducing production costs [24]. Egg production/hen, meat yield and diseases resistance were the farmer's preferred trait to be improved in the study area. Accordingly egg production/hen [26], meat yield have moderate heritability value [27]. However, diseases resistance has low heritable value.

By considering the production system, the availability of infrastructure, flock size of respondents and trait preference of farmers and their heritable value; the following breeding program would be proposed for sustainable breed improvement.

Proposed breeding program: Traditional breeding methods with full participation of farmer's are the best approach at farm level for small flock size. Rolling mating, grading mating, clan mating and breeding out-and-out mating are methods of traditional breeding program [28].

More or less the characteristics of all study area were the same. The only difference in on settlement of farmers (i.e. High altitude and mid altitude farmers were found in scattered village; concomitantly, most of farmers in low altitude found settled by condensed in one area. Rather, all farmers' had small flock size, poor infrastructure and similar trait interest. Base on this and heritable value of traits traditional breeding methods were recommended.

Conclusion and Recommendation

In predominant scavenging type of production system only small number of respondents (15.36%) prepare separate chicken house. Egg (54.25%) and meat (42.45%) was the first and second major chicken product. The average age at sexual maturity of indigenous chicken was 24.25 ± 0.04 and 23.84 ± 0.05 weeks for male and female respectively. The overall average age at first egg laying was 25.97 ± 0.04, and mean egg production of hen/clutch was 12.64 ± 0.1. The average body weight of the indigenous cocks and hens were 1500.97gm and 1256.36gm respectively.

Newcastle disease, feed shortage and predators were economically important constraints. All indigenous chicken were equally susceptible for diseases. However, there was susceptibility difference in different age groups. Ethno-veterinary service using alcohol ("*Arekie*") (48.69%), "*damakasie*" (4.90%), lemon (32.68%), white onion (4.58%) was some of indigenous knowledge in treating the sick chicken.

Egg production and plumage colour was major traits preferred by the farmers. Mating of chicken is usually natural, but both controlled and uncontrolled mating was practiced. Uncontrolled mating is practiced mainly due to free scavenging production system. In cases of control mating, both cross breeding and line breeding performed to improve egg production and plumage colour in market preference respectively. About 11.76% and 88.24% of respondent in the study area had practice of egg and hen selection respectively based on size; (100% large sized egg and 26.84% large body sized hen) for incubation. Egg production/hen, meat yield and diseases resistance were farmer's preferred traits to be improved. By understanding production system, economic cost, feature market demand, trait preference, flock size, infrastructure, in general breeding components, traditional breeding program should be implemented.

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