Chicken Reproductive Performance in Ethiopia: Review

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ABSTRACT

To improve the reproductive performance; several scholars conducted research in different parts of Ethiopia on indigenous, crosses and exotic chickens. However, there were inconsistencies among the various studies. This review was, therefore, conducted to assess the reproductive characteristics of indigenous, exotic and their crosses. Under scavenging system, the indigenous chickens are characterized by less clutch size (2.7-4.2 per year), good hatchability rate (59.6-93.2%), higher mortality rates (25.3-61.15), and reach sexual maturity at advanced age (19.6-26.8 weeks for male; 19.7-34.05 weeks for female). The age at first mating and laying recorded for exotic and their crosses were nearly similar to those of indigenous chickens. The hatchability rate of crossbreed chickens are varying from 54.7-78.7% and it is by far lower for exotic breeds. The exotic (18.83-53%) and crossbreed (9-40%) chickens are relatively better in survival rate than local chickens. Overall, the local chickens are better for their hatchability and have reproduction performance than exotic and crossbreed chickens. From this review, it is concluded that there is variation in chicken reproductive performance of the same breed in different parts of the country.

Introduction

Reproduction is one of the most important aspects of poultry breeding (Abou-Elewa and Abdou, 2017) and it is characterized by parameters, such as, age at sexual maturity, fertility, hatchability, clutch size and clutch length (Addisu, 2013). Among reproduction traits, sexual maturity is paramount in terms of progress in poultry breeding (Chiemela et al., 2018). Age at sexual maturity refers to age at which the reproductive system achieves its complete development and it has long been considered as an important factor that determines fecundity trait and affects subsequent performance (Forment et al., 2009). In females, age at sexual maturity can be easily determined externally as age at which hens lay their first egg (Tandondjou et al., 2014). Early matured pullets laid their first egg before 136 days, while late pullets matured when they were 152 days of age or more (Amira, 2008). To some extent, late sexual development is demonstrated among the local chicken populations in comparison to different exotic pure breeds and hybrids (Chiemela et al., 2018) and one of the expressions of low productivity of local chicken ecotypes was also late maturity (Abera, 2000). As a consequence, many researchers have conducted crossbreeding for improvement of age at sexual maturity for native chickens in Africa (Chiemela et al., 2018).

In an attempt to increase poultry production; hatchability and high level of survivability cannot be over looked (Ajayi and Agaviezor, 2016). Hatchability is the percentage of fertile eggs that hatch (King’ori, 2011; Ndofor-Foleng et al., 2015). Hatchability determines levels of reproduction from the quantity of breeding stock within a phase of time (Obike et al., 2014; Ajayi and Agaviezor, 2016). As such, they vary across different breeds and diversified within same breed depending on genetic and environmental influence (Ajayi and Agaviezor, 2016). High hatchability of eggs of breeder stock and survivability of the chicks is necessary to produce large numbers of chickens (Ndofor-Foleng et al., 2015). Hatchability of 80% (of eggs set) from natural incubation is normal or a range of 75 to 80% is considered satisfactory (Sonaiya and Swan 2004). However, high hatchability can improve poultry production when there is good chick survival and good supply chain of day-old chicks (King’ori, 2011).

In addition, poultry breeders must consider total egg production rate as key traits in egg stocks (Schmidt and Figueiredo, 2005). Conversely, total egg production of a flock of hens is determined by the individual patterns of sequential laying, number of clutches and size of the clutches (Johnston and Gous, 2003). Laying sequence or
clutch is defined as the number of eggs that are laid on consecutive days and separated from another by one or more pause days (Tumova et al., 2017). Egg production is characterized by the number of eggs in a clutch and the period between clutches, where oviposition fails to occur because of pause, which results in missing egg between clutches (Sakunthaladevi et al., 2011). Several scholars conducted research in different parts of Ethiopia on indigenous, crosses and exotic chicken characterization but there are inconsistencies among the various studies. This review was, therefore, carried out to assess the reproduction performance for indigenous, exotic and crossbreed chickens and need to publish in an organized form.

Reproduction Performances

Age at Sexual Maturity

In spite of genetic variation, the average age at sexual maturity reported in different parts of the country was different and it ranges from 19.6 to 26.8 weeks for male chickens (Table 1) and 19.7 to 34.05 weeks for female chickens (Table 2). This variation in age at sexual maturity may be due to the variation in environmental factors (temperature and nutrition) in different parts of the country. This supported by Guni et al. (2013), who observed variation both between and within districts with respect to age at first egg which is attributable to the genetic ecotype and non-genetic factors.

Table 1. Review of sexual maturity of male chickens in different parts of Ethiopia

| Age at maturity(weeks) | Breed/s | Study site | Author/s |
|------------------------|---------|------------|----------|
| 26.0                   | Indigenous | Central Tigray | Alem (2014) |
| 24.9                   | Cross | Central Tigray | Alem (2014) |
| 25.2                   | Exotic | Central Tigray | Alem (2014) |
| 24.6                   | Indigenous | Bure District | Fisseha et al. (2010) |
| 22.0                   | Indigenous | North west Ethiopia | Halima et al. (2007) |
| 24.3                   | Indigenous | North Wollo | Addisu et al. (2013) |
| 22.4                   | Indigenous | Sheka zone | Assefa et al. (2019) |
| 19.6                   | Koekoek | North Western Amhara | Sisay et al. (2017) |
| 24.0                   | BW | North Western Amhara | Sisay et al. (2017) |
| 26.8                   | Indigenous | Nole Kabba District (Wollega) | Matiwos et al. (2013) |
| 23.3                   | Indigenous | Metekel | Solomon et al. (2013) |
| 22.5                   | Indigenous | Gena Bossa District of Dawro Zone | Matawork et al. (2019) |
| 23.5                   | Indigenous | Fogera District | Bogale (2008) |
| 20.0                   | Indigenous | Mezhenger | Yadessa et al. (2017) |
| 19.6                   | Indigenous | Sheka | Yadessa et al. (2017) |
| 21.2                   | Indigenous | Benchi-Maji | Yadessa et al. (2017) |

BW= Bovance Brown

Table 2. Review of sexual maturity of female chickens in different parts of Ethiopia

| Age at maturity(weeks) | Breed/s | Study site | Author/s |
|------------------------|---------|------------|----------|
| 27.5                   | Indigenous | Bure District | Fisseha et al. (2010) |
| 22.3                   | Indigenous | North west Ethiopia | Halima et al. (2007) |
| 24.1                   | Indigenous | Gena Bossa District (Dawro Zone) | Matawork et al. (2019) |
| 27.2                   | Indigenous | Central Tigray | Alem (2014) |
| 25.7                   | Cross | Central Tigray | Alem (2014) |
| 25.4                   | Exotic | Central Tigray | Alem (2014) |
| 30.3                   | Indigenous | Dale district | Mekonen (2007) |
| 30.1                   | Indigenous | Nole kabba district | Matiwos et al. (2013) |
| 24.3                   | Cross | Nole kabba district | Matiwos et al. (2013) |
| 23.8                   | Indigenous | North Wollo | Addisu et al. (2013) |
| 26.0                   | BB | North Western Amhara | Sisay et al. (2017) |
| 21.6                   | Koekoek | North Western Amhara | Sisay et al. (2017) |
| 25.2                   | BW | North Western Amhara | Sisay et al. (2017) |
| 25.2                   | Indigenous | Sheka zone | Assefa et al. (2019) |
| 22.3                   | Indigenous | Metekel | Solomon et al. (2013) |
| 23.6                   | Indigenous | Fogera District | Bogale (2008) |
| 19.7                   | Indigenous | Mezhenger | Yadessa et al. (2017) |
| 20.8                   | Indigenous | Sheka | Yadessa et al. (2017) |
| 20.6                   | Indigenous | Benchi-Maji | Yadessa et al. (2017) |
| 34.05                  | Indigenous | Boricha district, Sidama zone | Serkalem et al.(2019) |
| 22.18                  | Sasso | Boricha district, Sidama zone | Serkalem et al.(2019) |
| 24.9                   | Koekoek | Boricha district, Sidama zone | Serkalem et al.(2019) |
| 22.46                  | BB | Boricha district, Sidama zone | Serkalem et al.(2019) |

BB=Bovance Brown, BW= Bovance White
A slightly faster age of sexual maturity recorded for indigenous cockerel than pullet. Moreover, the age at first mating and laying recorded in Ethiopia for exotic and their crossbreed were nearly similar to those of indigenous. This contradicts the findings of Akhtar (2005), who reported that crossbred chickens attain sexual maturity earlier than their pure breeds. Almost similar age at first egg was reported for female indigenous chickens in Kenya (21.4 weeks, Wambui et al., 2018) whereas the latter maturity age reported in Ghana (28-30 weeks, Dankwa et al., 2000), in Rwanda (30.2 weeks, Mahoro et al., 2017), in Tanzania (32.06 weeks, Guni et al., 2013), and in Botswana (27.3 weeks, Moreki, 2010). Besides, Mwalusanya et al. (2002) reported that the age at first egg ranges between 6 and 8 months (25.71-34.3 weeks) for local chickens under village management conditions. The late age at first mating (7.02 month or 30.1 weeks) for indigenous male chickens in Tanzania was reported by Guni et al. (2013). The early maturity of indigenous chickens as compared to other some African countries indicated that the Ethiopian indigenous ecotypes are better in productivity. The known reasons for differences in the age at which chickens attain sexual maturity are in part, due to differences among breeds or ecotypes, strains within a breed and management system. This review showed the existence of variation in attainment of age at first mate and egg lay for indigenous, exotic and cross breeds chickens in different locations of the country. This agreed to the findings of Akhtar (2005) who argued that location had significant effect on sexual maturity.

### Hatchability Percentage

As indicated in Table 3, many scientific scholars reported different hatchability performance for different chickens breeds in different parts of the country and it ranges between 59.6 and 93.2% for indigenous chickens whereas for the crossbreed it varies from 54.7 to 78.7%. However, the hatchability percentages of eggs for exotic breeds are by far lower than the indigenous and crossbreed chickens. The hatchability rate for indigenous chickens in Ethiopia is within the range reported for family poultry in low income food-deficit countries of Africa, which is 60-95% (Gueye, 2003). However, the hatchability noted in Ethiopia for indigenous chickens is similar to results described in some other African countries, 50-100% in Tanzania (Minga et al., 1989), 62-76% in Kenya (Ndegwa et al., 2014), 60-90% in Burkina Faso (Bourzat and Saunders, 1990), 60-95% in Senegal (Gueye, 2003), 70.8-85.7% in Uganda (Illango et al., 1999) and 70.1-78.3% in Nigeria (Sola-Oja, 2011). Besides, mean hatchability (80.9%) for eggs of indigenous chickens observed in Ethiopia (Tadelle and Ogle, 1996) is higher than 69.7% (Eugene, 2004) in Philippines, 78% (Khalafalla, 2000) in Sudan and 74% (Maphosa et al., 2004) in Zimbabwe despite the fact that it was lower than 90% in Sudan (Wilson, 1979), 82% in Zimbabwe (Kusina et al., 2010) and 84% in Uganda (Kirunda et al., 2010). While the normal hatchability (80%) or a satisfactory hatchability (75 to 80%) had also been reported among village chickens in other studies in other countries for natural incubation (Sonaiya and Swan, 2004).

### Table 3. Review of hatchability in different parts of Ethiopia

| Eggs set no. | Hatchability (%) | Breed               | Study site                  | Author/s          |
|--------------|------------------|---------------------|------------------------------|------------------|
| 10.2         | 85.7             | Indigenous          | Central Tigray               | Alem (2014)      |
| 8.3          | 78.7             | Cross               | Central Tigray               | Alem (2014)      |
| 13.0         | 59.6             | Indigenous          | Nebise sar midir district    | Melkamu and Andarge (2014) |
| 11.3         | 82.7             | Indigenous          | Nole kabba district          | Matiwos et al. (2013) |
| 9.5          | 44.4             | Exotic              | Nole kabba district          | Matiwos et al. (2013) |
| 11.6         | 83.6             | Indigenous          | Assosa zone                  | Alemayehu et al. (2015) |
| 11.6         | 80.2             | Indigenous          | Kamashi zone                 | Alemayehu et al. (2015) |
| 11.8         | 83.9             | Indigenous          | Mao-komo district            | Alemayehu et al. (2015) |
| 13.0         | 92.3             | Indigenous          | South Gonder zone            | Halima et al. (2007) |
| 13.0         | 87.2             | Indigenous          | West Gojam zone              | Halima et al. (2007) |
| 13.0         | 88.5             | Indigenous          | Awi zone                     | Halima et al. (2007) |
| 13.0         | 93.2             | Indigenous          | East Gojam zone              | Halima et al. (2007) |
| 14.7         | 84.7             | Indigenous          | Metekel zone                 | Solomon et al. (2013) |
| DNF          | 77.5             | Indigenous          | North western Amhara         | Sisay et al. (2017) |
| DNF          | 12.7             | BB                  | North western Amhara         | Sisay et al. (2017) |
| DNF          | 54.7             | Koekoek             | North western Amhara         | Sisay et al. (2017) |
| DNF          | 34.0             | BW                  | North western Amhara         | Sisay et al. (2017) |
| 13.0         | 82.6             | Indigenous          | Bure district                | Moges et al. (2010) |
| 9.8          | 89.0             | Indigenous          | Dale district                | Moges et al. (2010) |
| 13.0         | 78.9             | Indigenous          | Fogera district              | Moges et al. (2010) |
| 12.7         | 81.7             | Indigenous          | Dawro zone                   | Matawork et al. (2019) |

DNF=data is not found, BB=Bovance Brown, BW= Bovance White

The hatchability of exotic and their crosses were relatively lower than the pure line indigenous chickens (Table 3). The natural hatchability percent in Ethiopia under backyard management system is better than the hatchability revealed (63.1-84.1%) under backyard conditions (Faroq et al., 2000). This variability in hatchability might be raised from the genotype and husbandry practices given to chickens in different regions of the country. Moreover, several factors have been examined to affect hatchability and, among others, they include season of lay, disease, nutrition, age, egg quality, genetic factors, hygiene and incubation conditions (Kirunda et al., 2010; Nebiyu et al., 2013). This difference might be also due to disparity of feed and water given to the broody hen at incubation time.
**Clutch Size and Length**

Despite their breed, the overall number of clutch size observed in different parts of the country under Smallholders’ is various and it ranges between 2.7 and 4.3 per year (Table 4). This was almost similar to values reported in Ghana (3.4; Aboe et al., 2006), in Kenya (3.4; Olwande et al., 2009), in Uganda (2.5-3.0; Kyarisima et al., 2004), in Burkina Faso (2.7-3.0; Bourzat and Saunders, 1990) and in other developing countries (2-3 clutches; Moges et al., 2010). Moreover, different average numbers of clutch sizes were observed per hen per year in some other African countries such as 3.7 in Ghana (Awuni, 2005), 3.1 in Uganda (Ssewanyana et al., 2004), 2.6 in Rwanda (Mahoro et al., 2017), 3.2 in Gambia (Kitalyi and Mayer, 1998), 3.78 in Guinea (Mourad et al., 1997), 3.3 in Tanzania (Guni et al., 2013) and 4 in Nigeria (Wambui et al., 2018). However, higher mean number of clutches per year was reported in Sudan (4.5; Wi et al., 2018). However, higher mean number of clutches per year, eggs per clutch and clutch length in different parts of Ethiopia (Table 4). This was almost similar to values reported in Ghana (3.4; Aboe et al., 2006), in Kenya (3.4; Olwande et al., 2009), in Uganda (2.5-3.0; Kyarisima et al., 2004), in Burkina Faso (12-18; Bourzat and Saunders, 1990), Tanzania (6-20; Minga et al., 1989) and in other developing countries (9-19 eggs; Kingori et al., 2010; Moges et al., 2010). The observed egg production per hen per clutch was fallen within 6-26 which noted in the country by central statistical agency (CSA, 2013). However, this value was higher than 10-14 average egg production per clutch per hen reported in Uganda (Ssewanyana et al., 2004) and in Sudan (Khalafalla, 2000) for the village chickens.

**Table 4. Review of clutch size and clutch length in different parts of Ethiopia**

| Clutch size | Clutch Length (days) | Eggs/clutch | Breed | Author/s |
|------------|---------------------|-------------|-------|----------|
| 3.0        | 16.0                | 12-13       | Indigenous | Bogale (2008) |
| 3.0        | 25.3                | 12.78       | Indigenous | Matatwork et al. (2019) |
| 3.2        | 21.6                | 13.60       | Indigenous | Alem (2014) |
| 3.1        | 31.6                | 27.40       | Cross | Alem (2014) |
| 3.2        | 44.4                | 41.80       | Exotic (RIR) | Alem (2014) |
| 2.7        | 27.9                | 10.10       | Indigenous | Alemayehu et al. (2015) |
| 3.8        | 26.2                | 14.60       | Indigenous | Moges et al. (2010) |
| 3.9        | 27.7                | 14.40       | Indigenous | Yadessa et al. (2017) |
| 3.8        | 26.0                | 13.30       | Indigenous | Nebiyu et al. (2013) |
| 3.7        | 24.7                | 14.20       | Indigenous | Letebrhan et al. (2015) |
| 3.6        | 20.0                | 12.30       | Indigenous | Tadele et al. (2018) |
| 4.2        | 25.9                | 14.80       | Indigenous | Zereu and Lijalem (2016) |
| 4.3        | 31.9                | 31.24       | BB | Sisay et al. (2017) |
| 3.9        | 34.7                | 34.50       | Koekoek | Sisay et al. (2017) |
| 3.9        | 42.5                | 40.10       | BW | Sisay et al. (2017) |
| 4.0        | 12.0                | 21.00       | Indigenous | CSA (2017/18) |
| 4.0        | 38.0                | 45.00       | Cross | CSA (2017/18) |
| DNF        | 133.0               | 169.00      | Exotic | CSA (2017/18) |
| DNF        | DNF                 | 13.30       | Indigenous | Serkalem et al.(2019) |
| DNF        | DNF                 | 25.10       | Sasso | Serkalem et al.(2019) |
| DNF        | DNF                 | 25.00       | BB | Serkalem et al.(2019) |
| DNF        | DNF                 | 26.20       | Koekoek | Serkalem et al.(2019) |

DNF=data is not found, BB=Bovance Brown, BW=Bovance White

Besides, average of 12.5 eggs per clutch was reported in Nigeria (Wambui et al., 2018). The mean value of clutch length for indigenous chicken was varying from 12 to 27.7 days (Table 4). In various parts of the country, many scholars reported different clutch length for indigenous chicken, 22.54 (Brhane et al., 2017), 26.2 (Mekonnen, 2007), 26 (Nebiyu et al., 2013) and 15 to 28 days (Alem, 2014). On average, 26 days of clutch length was reported in southern parts of the country, which is higher than the values (17.8 days) reported in Tanzania (Guni et al., 2013). The observed differences between countries with respect to number of clutches per year, eggs per clutch and clutch length might be due to both genetic and environmental differences. Moreover, this difference might be due to differences in management (health care, feed type and feeding frequency) and weather conditions in various agroecologies of the country.

**Mortality Rate**

Indigenous chickens are known by their desirable characters such as resistance to diseases and adapted to their environment (Abdelqader et al., 2007; Nebiyu et al., 2013). However, the figures in Table 5 demonstrated higher mortality rates (25.3-61.15) for the Ethiopian indigenous chicken kept under backyard management conditions than crossbred and exotic managed under similar conditions. Figures in Table 5 illustrated as the crossbreed (9-40%) chickens are relatively better in survival rate than indigenous (25.3-61.15) and exotic breed (18.83-53%). This might be due to resistance development in crossbreed chickens than the pure breed. Likewise, the higher average mortality for indigenous chickens were reported in some African countries (50.25 % in Nigeria), (56.5% in Senegal), (62.5% in Ghana), (61.5 in Ethiopia), (53.75 % in Cote d’Ivoire), (74% in Uganda), (40-60% in Kenya), (30.2% in Tanzania)
(Mourad et al., 1997; Sonaiya et al., 1999; Kingori et al., 2010; Guni et al., 2013). Besides, Solomon (2004) reported higher mortality percentage (24%) for indigenous chickens kept under an intensive management system. Chicken mortalities in Ethiopia due to diseases are estimated to range from 20 to 50%, but it may rise as high as 80% during epidemics (Tadelle and Ogle, 2001). Similarly, Sonaiya and Swan (2004) reported 50 to 100% mortality in Africa due to Newcastle disease whereas Moreki (2010) reported higher mortality rate from hatching to maturity age under backyard management system. Chicken mortality due to mismanagement, predator and diseases in the continent. This variation in mortality rate and diseases in other African countries could be due to the variation in breed type or ecotype, agro-ecological differences, chickens health management, prevalence of predators, density of chickens kept, and season of the year. Thus, improvement in managerial practices is necessary to reduce mortality since it is an important indicator for poor welfare (LayWel, 2006).

Table 5. Review of mortality rate from hatching to maturity age under backyard management system

| Mortality (%) | Breed/s | Author/s |
|---------------|---------|----------|
| 59.9          | Local breed (Jarso ecotype) | Tadelle and Ogle (2001); Reta (2009) |
| 26.6          | Local breed (Konso ecotype) | Reta (2009) |
| 37.2          | Local breed (Tepi ecotype) | Reta (2009) |
| 25.3          | Local breed (Horro ecotype) | Reta (2009) |
| 27.4          | Local breed (Tilili ecotype) | Reta (2009) |
| 60.0          | Local breed | Tadelle and Ogle (2001); Reta (2009) |
| 34.2          | Local breed | Alem (2014) |
| 36.3          | Local breed | Abrahim and Yayneshet (2010) |
| 19.0          | Crossbreed (Local and Fayoumi) | Fassill et al. (2010) |
| 18.0          | Crossbreed (Local and RIR) | Fassill et al. (2010) |
| 9.0           | Crossbreed (Local and Fayoumi) | Fassill et al. (2010) |
| 40.0          | Crossbreed (Local and RIR) | Fassill et al. (2010) |
| 38.12         | Exotic breed | Alem (2014) |
| 48.8          | White Leghorn | Addis and Malede (2014) |
| 53.0          | Yarkon | Addis and Malede (2014) |
| 44.5          | Fayoumi | Ewonetu (2017) |
| 18.83         | White Leghorn | Ewonetu (2017) |
| 17.50         | Bovans White | Kumar et al.(2014) |
| 33.3          | Rhode Island Red | Addis and Malede (2014) |
| 18.6-25.4     | Rhode Island Red | Reta et al. (2012) |
| 18.9          | Rhode Island Red | Kumar et al.(2014) |

**Conclusion**

This review indicated as variations exist in chickens reproductive performances in different areas of Ethiopia. This variation explained by many scholars in relation to chickens breed, available feed, agro-ecology, disease and other environmental factors. The mortality rate reported in Ethiopia is higher (25.3-61.15%) than the observed mortality in other African countries. There is some evidence that there is a large amount of genetic discrepancy in chicken reproduction performances in Ethiopia and this indicates the existence of divergent subpopulations within the chicken population that gives room for genetic improvement between and within subpopulations. Finally, this review draws the following recommendations:

- The reproductive performances of chickens in Ethiopia is almost similar to other African countries.
- Attention should be given to improve the chicken survival rate or decrease mortality.
- There was few known report of on-farm research experiment on the reproductive performances of the indigenous chickens. Thus, indigenous chickens should be evaluated under intensive and good management conditions in order to have fairly accurate figures on their reproductive performances.

**Acknowledgements**

The authors are grateful for the other publishers who freely accessed their material to review and compile this manuscript.

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