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Research Article

Production and Reproductive Performance of Dual-purpose Koekoek Breeds Under Different Production Systems in Ethiopia

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Abstract

The objective of this paper review was depending on production and reproductive performance of dual purpose koekoek chicken under different management system in Ethiopia. According to Recent estimates the poultry population in Ethiopia is around 57 million out of which native chickens (none descriptive breeds) represent 78.85%, hybrid chickens 12.02%, and exotic breeds of chicken 9.11%. The total national annual poultry meat and eggs production in Ethiopia is estimated at 72, 300 and 78, 000 metric tons, respectively, and indigenous poultry contributes almost 99% of the national egg and poultry meat production. Dual purpose koekoek chicken is a South African breed of chicken developed in the 1960s at the Potchefstroom Agricultural College in the city of Potchefstroom by Chris Marais. The breed was intended as a dual purpose, free ranging chicken with laying capabilities as well as a large structure for meat production. According different result of study report the reproduction and production performance of this breed under different management system shows significance difference. The production and reproduction performance of koekoek chickens declined compared to intensive management system and farmers` management condition due to poor managements (lack of adequate supplementary feed and poor hygienic conditions). The production performance of koekoek chickens under back yard management condition also hindered due to inadequate veterinary service and lack of multiplying agent (source of stock replacement) and disease outbreak that caused high mortality rate. Average mortality rate during (0-8 weeks) is high and become decrease when they are age of (9-20) weeks. Their survival rate at different management system is high at the age of maturity. (9-20 weeks) Koekoek chickens are well adapted to semi-arid agroecology of mid rift valley area of Ethiopia.

Keywords

Koekoek Chicken, Production, Reproduction

1. Introduction

Poultry includes all domestic birds such as chickens, turkeys, ducks, geese, ostrich, guinea fowl, doves, and pigeons kept for food production (meat and eggs). In Ethiopia, however, the term poultry is almost synonymous with chicken, as the use of other poultry species is generally uncommon. Poultry production in Ethiopia plays a crucial role in generating employment opportunities, poverty reduction, improving family nutrition, and women empowerment [1, 2]. Livestock production

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covers 40% of agricultural output in Ethiopia, playing an important role in the national economy as it contributes 18% of the total GDP [3]. It is a suitable business for resource-poor households due to the small land requirement and low initial investment costs needed. Recent estimates put the poultry population in Ethiopia at around 57 million out of which native chickens (none descriptive breeds) represent 78.85%, hybrid chickens 12.02%, and exotic breeds of chicken 9.11% [4].

The total national annual poultry meat and eggs production is estimated at 72, 300 and 78, 000 metric tons, respectively, and indigenous poultry contributes almost 99% of the national egg and poultry meat production [5]. To increase the production potential of the current poultry system the need transforming from the traditional scavenging family poultry system to the improved semi-scavenging family poultry system and then increase the scale of specialized layer and broiler production so as to cover the domestic red meat consumption is indicated in the National Livestock Road Map [6].

The dual-purpose Koekoek chicken breed is important in medium input production systems or semi-scavenging production systems. It is also a popular breed in South Africa and neighboring countries due to egg and meat production as well as their ability to hatch their own offspring [7]. which has similar characteristics with Ethiopian indigenous chickens' ecotypes and easily manageable at the farmer's level. Poultry meat and egg consumption in Ethiopia is low. For instance, the per capita consumption of eggs is around 4.1 eggs [1]. which is far lower than the global and African average.

To alter this scenario and to boost the production and consumption of poultry products, the Government of Ethiopia through the Livestock Master Plan of Ethiopia [8]. has set ambitious targets. The poultry sector in Ethiopia can be characterized into three major production systems based on some selected parameters such as breed, flock size, housing, feed, health, technology, and bio-security. These are large commercial, small scale commercial and village or backyard poultry production system. These production systems have their own specific chicken breeds, inputs and production properties. Each can sustainably coexist and contribute to solve the socio-economic problems of different target societies [9]. Therefore, the objective of this paper is to discuss the production and reproductive performance of dual-purpose chicken under different management system in Ethiopia.

2. Literature Review

2.1. Overview of Poultry Production in Ethiopia

Poultry production is an important and diverse component of global agriculture. Poultry is the largest livestock species which accounts for 20.35 billion worldwide [10]. Poultry is kept in most areas of the world and provides an acceptable form of animal protein (meat and egg) to most people throughout the world. They provide a source of high-quality protein and a source of income. The poultry sector supports the livelihoods and food security of millions of people. Currently, the demand for poultry meat and eggs has increased, due to population growth, increased income, and urbanization [11].

The world poultry meat production in 2012 was 103.5 million tonnes, which contributes 34.3% of global meat production (excluding fish) of which Africa's share is only 4.9 million tonnes [12]. Global egg production was estimated at around 65 million tons in 2012, from which Africa shares 3.0 million tonnes [12].

Poultry production is an important economic activity in Ethiopia. It plays a significant role in family nutrition besides its social and cultural benefits. In Ethiopia chickens are the most widespread and almost every rural family owns chickens, which provide a valuable source of family protein and income [13]. The country has diverse agro-climatic conditions favoring the production of many different kinds of crops, providing a wide range of ingredients and alternative feedstuffs suitable for poultry feeding. Making use of these resources to complement the scavenging resource base promises the considerable potential for success [14].

The total national annual poultry meat and eggs production is estimated at 72300 and 78000 metric tons, respectively and indigenous poultry contributes almost 99% of the national egg and poultry meat production [5]. To increase the production potential of the current poultry system the need totransform from the traditional scavenging family poultry system to the improved semi-scavenging family poultry system and then increase the scale of specialized layer and broiler production to cover the domestic red meat consumption is indicated in the National Livestock Road Map [6].

2.2. Poultry Production System in Ethiopia

Poultry production in Ethiopia is an indigenous and integral part of the farming system that ranges from low-input traditional free ranges to modern production systems using relatively advanced technology [15]. The poultry sector in Ethiopia can be characterized into three major production systems based on some selected parameters such as breed, flock size, housing, feeding, health, technology, and bio-security. These systems are the traditional poultry production system, small-scale market-oriented poultry production system and commercial poultry production system [16].

2.2.1. Large-scale Commercial Production System

The large-scale commercial production system is a highly intensive production system involving an average of greater or equal to 10,000 birds kept under indoor conditions with a medium to high bio-security level. According to [17]. reports the large-scale commercial production systemis a highly intensive production system that involves from 2,500 to 50,000 birds kept under indoor conditions with moderate to high bio-security levels.

This system heavily depends on imported exotic breeds that require intensive inputs such as feed, housing, health, and

modern management systems. It is estimated that this sector accounts for nearly 2% of the national poultry population [18]. This system is characterized by higher level of productivity where poultry production is entirely market oriented to meet the large poultry demand in major cities. The existence of somehow better biosecurity practices has reduced chick mortality rates to merely 5% [19]. In commercial system, the profit from poultry production can be increased by minimizing feed cost which accounts for more than half of the total cost of production. Large scale poultry producers mostly make their own feed [20].

2.2.2. Small-scale Production System

The small-scale intensive production system is characterized by a medium level of feed, water and veterinary service inputs and minimal to low bio-security. Most small-scale poultry farms obtain their feed and foundation stock from large-scale commercial farms [21]. There are few studies about diseases affecting poultry in this production system [22] mentioned coccidiosis as a cause of mortality, reduced weight gain, and egg production and market value of affected birds.

In small-scale poultry farms, modest flock sizes usually ranging from 50 to 500 exotic breeds are kept for operating on a more commercial basis [23]. However, [24] reported under this system of production, a small number of exotic breeds of chickens (50-1,000) are produced along commercial lines using relatively modern management methods. This activity is being undertaken as a source of income in and around major cities and towns with relatively improved feeding, housing and health care [23, 25]. Most small-scale poultry farms are located around Debre-Zeit town in Oromia region and Addis Ababa [24].

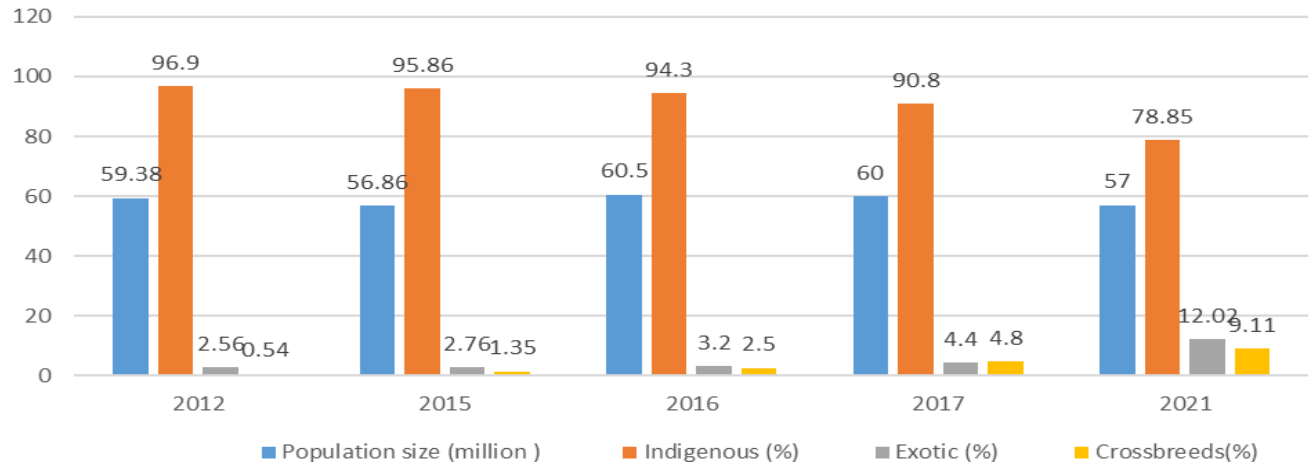
2.2.3. Traditional Production System

Traditional poultry is the predominant system in Ethiopia and accounts for nearly 98% of the poultry population [26]. The breeds are mostly indigenous chickens and although some hybrids and exotic breeds (< 50 birds) may be kept under this system and managed by individual farm household management with minimum labor inputs [18]. When birds are kept under a scavenging system; little or no inputs for housing, feeding or health care are provided. The system is not business oriented and is rather intended to satisfy the various needs of farm households. This is similar to the report done by [18], which shows the Village/indigenous production system is characterized by little or no inputs for housing, feeding (scavenging is the only source of diet), and health care with a minimal level of bio-security, high off-take rates and high level of mortality.

As such, it does not involve investment beyond the cost of the foundation stock, a few handfuls of local grains and possibly simple night shades, mostly night time in the family dwellings. Mostly, indigenous chickens are kept although some hybrids and exotic breeds may be kept under this system. The traditional system of poultry production, which has come to be known as "balanced farming" is characterized by its low input and a corresponding low output [5].

2.3. Poultry Population and Breeds in Ethiopia

The total poultry population estimation reported by CSA, [27-30, 4]. was shown in Figure 1 below. It is also expected that this number will increase because it tends to follow the rapid population growth and urbanization of human, shortage of cultivating and grazing land, unemployed and high and unbalanced protein demand. Poultry is relatively become with the most preferred animal [31].



Source: CSA, [27-30, 4].

Figure 1. *Poultry population and breed.*

3. Production and Reproduction Performance of Dual-purpose KoeKoek Chicken

3.1. Adaptation

Koekoek chicken breed is suitable for the semi scavenging production system, tropically adapted and farmers preferred breed. It was also good scavenger and it could survive and give good production (meat and egg) under farmers' management practice and their survival rate of the breed up to eight weeks of age under a small holder farmer's condition was 88.3% [32]. As a study report of [31]. done in eastern and south eastern part of Tigray Ethiopia Potchefstroom Koe koek chicken breed is adaptable to the mid altitude areas of eastern and south eastern zones of the country.

They are ideal breed for a free-range environment, especially for the rural communities because they are highly scavengers so that there is no need of confining them to a house. It can cause death due to suffocation, cannibalism due to mineral deficiency and they can also compete with human food. This chicken breed has an observable broody behavior which has similar characteristics with the Ethiopian indigenous chicken breeds. This broody behavior helps farmers to reproduce the breed sustainably under traditional management system. Both the Koekoek and indigenous chicken have broody behavior but comparatively Koekoek has low broody behavior than the indigenous one as most hens do not show any sign of broody behavior or not easily observed by the producers. Though broadness behavior is preferred by the rural farmers, it has negative impact on egg production and this is the main reason for the low egg productivity of the indigenous chicken ecotypes of Ethiopia [31].

3.2. Mortality and Survival Rate

The mortality and survival rates of chicks raised under various management systems were displayed in Table 1 Below. The mortality and survival rates are higher than at backyard management systems, according to several reports. The differences between them could be the result of different management styles. The chicks' survival rate was comparable to [32]. at Sidama Zone, who reported an 8-week survival rate of 88.30%. Predator was the leading cause of mortality, followed by sickness. Inadequate housing, watering, and feeding conditions at the pastorals are other causes of mortality.

Table 1. *Mortality and survival of chicks.*

Age Of Chicken	Mortality Rate	Survival Rate	Management System	Authors
1st 4 weeks	21.67%	73.11%	Backyard	[33].
2nd 4 weeks	5.22%	94.78%		
20 weeks	4%	96%	Intensive	[34].
8 weeks	33.9%	64.1%	Backyard	[35].
0-8 weeks	3.26%	96.74%	Intensive	[36].
12-20 weeks	1.505	98.495%		
6-8 weeks	5%	95%	Back Yard	[37].
8-12 weeks	8.75%	83.75		
72 weeks	9.75%	90.25%	Back Yard	[38].
22 weeks	31%	69%	Back Yard	[39].
74 weeks	4.8%	95.19%	Village	[40].
8 weeks	11.7%	88.3%	Village	[32].

3.3. Growth Performance and Voluntaries Feed Intake of Koekoek Chicken

Growth involves the simultaneous deposition of bones, muscle, and fat; each exhibiting an individual pattern of development. When based on the percentage increase in weight at the end of the pre-laying phase, the most rapid growth or weight gains are made when the chick is young. As the chick grows older, the weekly increments of weight increase be-

come materially less. The heavier the day-old chick, the heavier the pullet at 12 to 18 weeks, but the correlation is less at older ages [41].

At 20 to 21 weeks of age, factors other than initial chick weight show their effect on body weight and variations in body weight cannot be associated with day-old weight. It is generally recognized that the growth of animals from conception to maturity occurs in a sigmoidal response of size over time, usually by plotting live weight against age. This sigmoidal response indicates that growth is self-accelerating during the early growth phase until the inflection when it becomes self-inhibiting for the final phase approaching maturity [42].

Feed consumption is a variable phenomenon and is influenced by several factors such as strain of the bird, ambient temperature, and density of birds in the shed, hygienic conditions, rearing environment, feed restriction, and feed characteristics. Poultry eat a daily amount of feed approximately 5% of their bodyweight [43]. Feed intake of layers can be increased through providing feed at the proper time of the day mostly in the cool hours of the day – early morning and late evening in tropics [44]. Feed intake is increased as the energy value of the diet decreased and the fiber content of the diet increased [45].

Feed intake is influenced by the amount of energy present in the diet [46]. When feed quality and house temperature are maintained constant, an increase density of birds increased feed intake/dozens of eggs by 68 g/bird [47]. For optimum production, water is important for feed metabolism in the body. In moderate environmental temperatures, high-producing white leghorn hens require 300-320 Kcal of Metabolizable energy per hen per day [48]. have reported that daily consumption of 17 or 18 g of protein supported optimum egg production and egg size. Layers can adjust their feed consumption in order to obtain adequate energy when receiving diets ranging in energy from approximately 2500 to 3300 kcal ME per kg of diet. Rapid growth and early maturity are not desired in layer chicken [49].

According to the table below, the mean average feed intake was 33.04 during the starter stage and 78.24 and 75.68 average mean for the grower stage of females and males respectively. There were significant differences between the intensive management system and the backyard management system [34] report that the feed intake of the starter is 56.4 and for the grower 84.3 and 124 for layers respectively in the backyard management system.

Ahead of exhaustive utilization of this commercial balanced ration, the farmers were advised to prepare feeds from locally available materials/crops which include maize, sorghum, wheat, soybean, salt and lime stone based on different stages of development (grower and layer stages). The overall average amount of supplemental feed used in this study were recorded 60 gm/day/chicken irrespective of the two stages (grower and layer stages) which is below their requirements both in quantity and quality. Scavenging was the major means of satisfying their nutrient requirements.

Table 2. *Feed Intake of Koee Koek Chicken and Thier Growth.*

Weeks (0-8)	Feed intake g/b/day	Feed intake g/b/week	Body weight g/b/week	Mortality	Weeks (12-20)	Feed intake g/b/day		Feed intake g/b/week		Body weight g/b/week		Mortality	
						Female	Male	Female	Male	Female	Male	Female	Male
1	8.65	60.55	52.08	9.84	12	65.3	69.54	457.2	486.7	592.32	612.9	2.33	0.47
2	14.42	100.94	89.89	3.9	13	69.9	74.8	489.6	523.6	657.01	698.8	0.95	0.94
3	22.76	159.32	97.29	0.50	14	71.5	77.22	500.8	540.5	722.24	764.34	1.44	0.95
4	27.24	190.68	115.75	0.00	15	75.8	69.01	531.0	483.0	616.10	925.89	0.44	0.000
5	37.61	263.27	135.68	0.20	16	83.1	76.67	581.6	536.6	794.59	1068.22	0.99	1.91
6	40.52	283.64	189.61	0.00	17	84.2	77.34	589.7	541.3	862.23	1159.18	1.99	1.95
7	54.82	383.74	217.22	1.00	18	83.7	76.66	585.6	536.6	896.68	1292.54	1.52	2.99
8	58.04	406.28	309.85	9.80	19	73.9	77.98	517.1	545.9	1120.2	1568.78	2.58	2.05
					20	96.64	82.86	676.5	580.0	12980.57	1680.81	0.000	0.00
Mean	33.04		150.92			78.24	75.68	529.6	530.5	840.03	1085.7	1.60	1.41

Source: [36]. (g= gram, b=bird)

3.4. Production Performance

According to [50]. Potchefstroom Koekoek was bred at the Potchefstroom Agricultural College in South Africa during the 1950s. This breed is a composite of the White Leghorn, Black Australorp and Bared Plymouth Rock. This breed can therefore be considered as a locally developed breed. The Potchefstroom Koekoek cocks and aged hens are used for meat production. The Koekoe's colour pattern is a sex-linked gene that is very useful for color sexing in cross-breeding for egg producing types of hens used in medium input production systems. This breed is very popular among rural farmers in South Africa, and neighboring countries for egg and meat production as well as their ability to hatch their own offspring.

3.4.1. Average Egg Production and Egg Quality

The average egg production potential hens /year of dual-purpose chickens under different management systems was listed in Table 3 below. Based on different study reports there is a difference in egg production potential between management systems. Under the commercial management system egg production potential of this chicken is high and it is lowest under back yard management system. This is because factors that contribute to a reduction in egg production of the chicken might be input supply and access, husbandry practice, and quantity and quality of supplementary feeds. The quality of an egg from a chicken is determined by both internal and external factors. External features of eggs include egg weight and eggshell thickness, while internal qualities include yolk height, albumin height, yolk weight, yolk color, albumin %, etc. Table 3 below displays the typical percentage of both egg quality under intensive and village management techniques. According to the following reports, there are considerable variations between village and intensive management systems with regard to some attributes and no such differences exist with regard to other traits.

Table 3. *Egg Production Potential and Egg Quality Traits.*

Av. egg production	Management system	Author	
178.07 eggs	Back yard	[51].	
109 eggs	Back yard	[32].	
213 eggs	Intensive	[34].	
176 eggs	Back yard	[52].	
221	Intensive	[40].	
187	Intensive	[53].	
149	Intensive	[54].	
164	Back yard	[55].	
154.17	Back yard	[33].	
180-200	Small scale	[31].	
Egg quality traits (Internal and external)	Management system	Percentage	Source: [56].
Yolk height (mm)	Back yard	32.5	
	Intensive	32.9	
Albumin height (mm)	Village	10.24	
	Intensive	10.25	
Yolk weight (g)	Village	26.9	
	Intensive	29.5	
Yolk color (ranges 1-15)	Village	19.07	
	Intensive	19.8	
Albumen weight (gm)	Village	48.2	
	Intensive	46.5	
Haugh unit	Village	145.14	
	Intensive	143.07	

Av. egg production	Management system	Author
Yolk percent	Village	56.57
	Intensive	61.5
Albumin percent	Village	101.2
	Intensive	98.27
Yolk albumen	Village	1.03
	Village	1.18
Egg weight	Intensive	88.5
	Village	87.03
Shell thickness	Intensive	0.54
	Village	0.54

3.4.2. Average Age at First Laying Eggs and Average Body Weight

According to the [37]. report Under pastoral conditions, the first egg was laid at 167.2 and 167.6 years of age. In [31] 's report, the age at first conception was 6 months in the Tigray region and 187 days in the Shebedino woreda of the Sidama region. His report was lower [32]. But higher than the age of initial egg laying of the same breed reported by [39].) in the East Showa zone, which is 22 weeks; [57]. in the southern part of Ethiopia (142 days); [31]; and [58] (153 days). In South Africa, this chicken has reached the age of 130 days [59]. At different management system average age at first laying eggs and average body weight of dual-purpose chicken were listed by Table 4 Below.

Table 4. Average Age at First Laying Eggs and Body Weight.

Average age at first laying of chickens under different management system				
Average Age at First Laying	**Management System**	**Authors**		
167.4 days	Back yard	[37]		
186.9 days	Back yard	[32]		
154 days	Intensive farm	[39]		
186.28 days	Back yard	[33]		
140 days	Intensive	[34]		
154 days	Intensive	[36]		
202 days	Intensive	[38]		
220 days	Back yard	[35]		
153 days	Back yard	[60]		
177.1 days	Small scale farm	[61]		
180 days	Villega production s	[31]		
Average body weight of chicken under different management system				
Sex of chicken	Weeks /Month	Av. body weight	Management system	Authors
Male	20 weeks	1.49	Back yard	[32]
Female	20 weeks	1.23		

Average age at first laying of chickens under different management system

Average Age at First Laying	Management System	Authors		
Male	22 weeks	2.4	Intensive	[39]
Female	22 weeks	1.6		
Male	20 weeks	1.404	Back yard	[33]
Female	20 weeks	1.213		
Male	48 weeks	2.5425	Intensive	[36]
Female	48 weeks	1.793		
Male	48 weeks	2.65	Back yard	[52]
Female	48 weeks	1.82		
Male	20 weeks	1.33	Back yard	[31]
Female	20 weeks	1.2		
Male	32 weeks	1.87	Back yard	[31]
Female	32 weeks	1.64		
Male	48 weeks	2.47	Back yard	[31]
Female	48 weeks	1.59		
Male	48 weeks	2.6	Back yard	[60]
Female	48 weeks	1.9		

3.5. Reproductive Performance

Fertility and Hatchability

The sustainability of poultry production at all operational scales depends on a steady supply of day-old chicks, with egg fertility and hatchability serving as primary determinants of supply because they are important reproductive parameters [1]. Fertility is an important parameter in chickens and reflects the total actual reproductive capacity of females and males expressed by their ability when mated together to produce offspring. An egg is said to be infertile when it fails to show any evidence of developing embryo and it depends on various factors such as breed, season, pre-incubation holding period, lighting, level of nutrition, mating and time of mating [61].

Hatchability is a trait of economic importance in the chicken industry because it has a strong effect on chick output. It is influenced by several factors such as egg weight, turning of eggs, storage, humidity, shell strength, egg size and genetic factors within the chickens kept. The ability of the embryo to successfully escape from the shell is called hatchability. Good hatchability of eggs is to some extent heritable but is determined by a complicated genetic constitution and the environment [61]. According to different reports under different management system the percentage of fertility and hatchability of Koekoek chickens were showed by Figure 2 below.

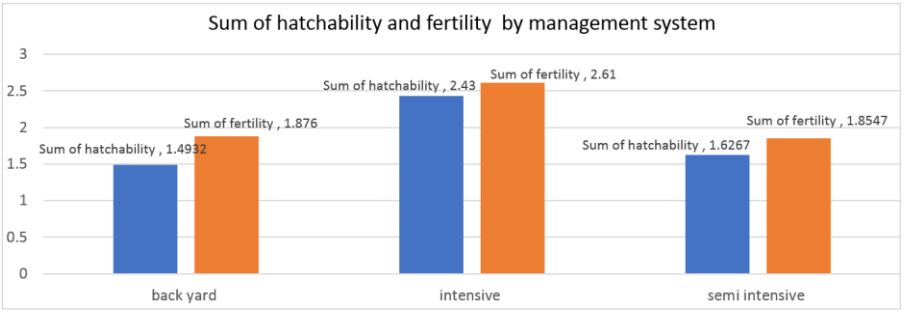


Figure 2. *Fertility and Hatchability of Chicken (Source: [56]).*

4. Conclusion

Dual purpose koekoek chicken is a South African breed of chicken developed in the 1960s at the Potchefstroom Agricultural College in the city of Potchefstroom by Chris Marais. The breed was intended as a dual purpose, free ranging chicken with laying capabilities as well as a large structure for meat production. According different result of study report the reproduction and production performance of this breed under different management system shows significance difference.

The production and reproduction performance of koekoek chickens declined compared to intensive management system and farmers` management condition due to poor managements (lack of adequate supplementary feed and poor hygienic conditions). The production performance of koekoek chickens under back yard management condition also hindered due to inadequate veterinary service and lack of multiplying agent (source of stock replacement) and disease outbreak that caused high mortality rate.

Average mortality rate during (0-8 weeks) is high and become decrease when they are age of (9-20) weeks. Their survival rate at different management system is high at the age of maturity (9-20 weeks). Koekoek chickens are well adapted to semi-arid agroecology of mid rift valley area of Ethiopia. The mortality rate is high during (0-8) weeks and become low when they are 9-20 weeks age. Survival rate is also high when they are 9-20 weeks age and low when they are 0-8 weeks of age.

Abbreviations

CSA Central Statistics Agency
FAO Food and Agricultural Organization

Conflicts of Interest

The authors declare no conflicts of interest.

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