Growth, Reproduction and Survival of Quail in Savannah Ecological Zone of Ghana

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Abstract

This research was undertaken to ascertain the growth performance, reproduction, and survival of quails given optimal feeding and management conditions in the savannah ecological zone of Ghana. The research was designed to cover both wet and dry seasons experienced in the region. In both seasons, 50 day-old chicks were used for the experiment and growth, survival and reproductive parameters were recorded. The results showed that there was no significant difference in weekly body weights (average body weight for weeks 1, 2, 3 and 4 respectively were 6.38g, 16.00g, 39g, and 70.00g). It was observed that feed intake in both seasons increased as birds advanced in age. Overall mean age at first egg was 58.00 days and 55.50 days in wet and dry seasons, respectively. In the wet and dry seasons, hen-day egg production was 88.33 and 87.63% respectively, in the 2nd month of lay. The mean for egg number per bird for the first three months of lay was 24.46 and 24.13 in wet and dry seasons, respectively. All external egg traits studied showed no significant difference in wet and dry seasons. It was also observed that mortality rate (between hatch day and 1 week was 26% and 32%; in wet and dry seasons respectively: between week 1-2 was 2.90% and 5.88% in wet and dry seasons respectively) obtained in this present study between day one (hatch) and 1 week of age) decreased with age. In conclusion, the climate and natural conditions of the Northern Region of Ghana (guinea savanna ecological zone) are very suitable for quail rearing. It is therefore recommended that local poultry farmers should go into quail farming in this part of the country as the climatic factors support their growth.

Keywords: Egg quality traits, Feed conversion, Japanese quail, Reproductive performance, Wet and dry seasons.

Croissance, Reproduction et Survie de la Caille Dans la Zone Écologique de Savannah au Ghana

Résumé

Cette recherche a été entreprise pour déterminer le rendement de croissance, la reproduction et la survie des cailles étant donné les conditions optimales d'alimentation et de gestion dans la zone écologique de la savane du Ghana. La recherche a été conçue pour couvrir les saisons humides et sèches vécues dans la région. Au cours des deux saisons, des poussins de 50 jours ont été utilisés pour l'expérience et des paramètres de croissance, de survie et de reproduction ont été enregistrés. Les résultats n'ont révélé aucune différence significative dans le poids corporel hebdomadaire (le poids corporel moyen des semaines 1, 2, 3 et 4 était de 6,38g, 16,00g, 39g et 70,00g respectivement). Il a été observé que l'apport alimentaire au cours des deux saisons augmentait à mesure que les oiseaux vieillissaient. L'âge moyen global au premier œuf était de 58,00 jours et

55,50 jours en saison humide et sèche, respectivement. Pendant les saisons humides et sèches, la production d'œufs de poule était de 88,33 % et de 87,63 % respectivement, au deuxième mois de ponte. La moyenne du nombre d'œufs par oiseau pendant les trois premiers mois de ponte était de 24,46 et de 24,13 en saison humide et sèche, respectivement. Tous les caractères externes des œufs étudiés n'ont montré aucune différence significative entre les saisons humides et sèches. On a également observé que le taux de mortalité (entre le jour de l'éclosion et la semaine était de 26 % et 32 %; en saison humide et sèche respectivement : entre la semaine 1 et 2 était de 2,90 % et 5,88 % en saison humide et sèche respectivement) a été obtenu dans cette étude entre le premier jour (éclosion) et 1 semaine) a diminué avec l'âge. En conclusion, le climat et les conditions naturelles de la Région Nord du Ghana (zone écologique de la savane de Guinée) sont très propices à l'élevage de la caille. Il est donc recommandé que les aviculteurs locaux se lancent dans l'élevage de cailles dans cette partie du pays car les facteurs climatiques soutiennent leur croissance.

Mots clés: Caractéristiques de la qualité des œufs, Conversion alimentaire, Caille du Japon, Parformance de reproduction, Saison humides et sèches.

Introduction

A quail is a small avian species that belongs to the Pheasant group (Mishra and Shukla, 2014). Quails are a small, short-tailed game bird resembling partridges but are smaller and stockier. Quail can be bred personally for meat or used for commercial production as well as research purposes (NRC, 1994). Japanese quails (*coturnix japonica)* have the advantage of fast growth and reproduction (Roshdy *et al.,* 2010). The Japanese quail is listed as near threatened because it is suspected to be undergoing a moderately rapid population decline as a result of hunting and habitat destruction (Birdlife International, 2016). In the Northern Region of Ghana, the adoption of quail farming remains low in comparison with the high numbers of farmers keeping chicken or guinea fowl. Quail farming is unpopular due to lack of adequate information on quail husbandry. Although few works have been carried out on the general growth and survival of quails in other regions of the world, virtually no information exists on the growth and survival of quails in Ghana particularly the arid conditions of the northern savannah ecological zone of Ghana. The northern savannah ecological zone of Ghana is characterized by harsh weather conditions of high and low temperatures with the dry season lasting up to 5 to 7 continuous months (Agbolosu *et al*, 2012). Carrying out this study about the growth performance of the Japanese quails under this arid condition of the savannah ecological zone of Ghana will be beneficial in making an informed decision on the adoption of quail farming in northern Ghana and Ghana at large. This study was designed to ascertain the growth, reproduction, and survival of quails in the savannah ecological zone of Ghana.

Materials and Methods

Study Site

The research was conducted at the University for Development Studies, Nyankpala campus. The project site is located in the Tolon District and about 20 km south-west of Tamale; the capital of Northern Region of Ghana. The location lies on latitude 9°24′N and longitude 0°59′W in the Guinea Savannah Zone. It has an average rainfall and temperature of 1024 mm and 28.30°C, respectively (SARI, 2004). The study area is characterized by a very long period of dry season ranging from November to April.

Design of experiment

The experiment was conducted over a period

Image 1: Experimental cage before the start of the project

of eight months; 1st September 2017 to 23rd January 2018, representing the wet season (being actually a transitional season from wet to dry). The experiment was repeated in the dry season to compare the growth and reproduction between the seasons. This took place from 30th November 2017 to 24th April 2018. Image 1 shows the experimental cage before the procurement of the chicks in the wet season.

Experimental birds and their management

Fifty day-old chicks were obtained from a local hatchery in Tamale, the Northern Regional capital of Ghana. The chicks were brooded in the experimental pen for a period of 14 days using kerosene lanterns as light and heat sources. The light and heat were provided for 24 hours to prevent piling and death. The litter material used for the brooding and rearing was rice hulls. Water and feeding troughs were positioned at vantage points in the brooding pen to facilitate easy access. A brooding temperature range of 30°C to 35°C was maintained in the brooding house for the first two weeks. The temperature was gradually decreased at the rate of 3.5°C on a weekly basis as the chicks develop more feathers. Experimental birds used for the experiment in the dry season were hatched from the eggs laid by the base population (wet season cohort). From nine weeks of age, the eggs laid were collected and hatched. To ensure similarity between the two seasons of the experiment, 50-day old chicks were used as the start population for the dry season. The brooding procedure was repeated in the dry season as it was in the wet season. In the wet season, the birds were housed in a deep litter floored cage measuring 120 cm x 60 cm x 25cm length, width, and height respectively. Since Japanese quail chicks do not express sexual dimorphism; sex differentiation was done at week 4, when sexual dimorphism was evident in birds. Image 2 shows a 3-week old quail – difficult to determine the sex using sexual dimorphism, while Image 3 shows the adult male and female birds during sex differentiation. As at week 4, 21 quail hens were differentiated from 15 males in the wet season. The male's breast is narrow and covered with the equally distributed feather of brown and white in colour; whiles the female's breast is broad and covered with brown and black-dotted feathers. In managing the aggression between males, when signs of violence were observed, the birds were put in the ratio of one male to three females in the pen. In the dry season, a stock of 50 birds was raised and mortalities were recorded as in the wet season. Sex differentiation was also done at week 4 and out of a total of 33 surviving birds; there were 18 females and 15 males. To minimize the violence and male-to-female overstocking, the ratio of one male to three females was done. Apart from the seasonal differences, the other treatments were equal throughout the experimental period. The first four weeks of the study represented the chick phase, where chicks were fed an already formulated chick mash of 22% crude protein (CP) and 13.188 MJ/kg metabolizable energy. The experimental birds were then given Layer mash of 19.2% Crude Protein and 11.262 MJ/kg metabolizable energy during the grower's phase which lasted for another 16 and 17 weeks in the wet and dry season, respectively. The ingredients were thoroughly

Image 2: A three-week old quail

Image 2: A three-week old quail

mixed and the quantities given to birds were measured daily. Japanese quails are known to be hardy and show resistance to most diseases of poultry, so no medication was administered to the birds. Also, throughout the period of the experiment, good sanitation and hygiene were ensured. Water was provided ad libitum. Due to some challenges in feed procurement throughout weeks 4, 5 and 6, there were some deficiencies in feeding the birds. Growth performance in terms of body weight was evaluated by recording the initial body weight (day old) of the chicks.

Measurement of Traits

The body weight gain, feed conversion ability, mortality rate, and egg number were determined using the following formulae according to Dauda *et al*. (2014).

Body weight:

The birds were weighed weekly early in the morning before feeding. 20 birds were picked randomly without performing any selection (to minimize biases) and weighed individually to keep all the records of individual body weight. A container and a weighing scale were the main instruments used. The container during weighing is first put on the weighing scale and adjusted to zero. All the 20 birds then put individually into container and weight taken. The individual body weight was recorded weekly for six weeks. The same procedure was repeated for both the wet and dry seasons. The live weights were used to calculate growth rates of the quail.

Average daily gains (ADG) were calculated as:

$$\text{Average Daily Weight Gain} = \frac{W2 - W1}{N}$$

Where:

W1 is the initial weight,
W2 is the final weight,
N is the number of days taken from initial weight to the present weight

Feed conversion efficiency:

Feed conversion is the ratio of feed consumption per unit increase in weight or quantity of eggs produced. Feed conversion efficiency was obtained from the measure of the body weight gained and the feed intake. This was estimated on a weekly basis for the first six weeks.

$$\text{Feed conversion ration} = \frac{\text{Feed intake}}{\text{Weight gain}}$$

Mortality Rate

'In-pen' temperature was recorded three times daily in the morning, at noon and in the evening for the first six weeks of the experiment. Mortality was also recorded when sighted, for the first six weeks of the experiment. The mortality rate was estimated for the first six weeks on a weekly basis and calculated as:

$$\text{Weekly mortality rate} = \frac{\text{No of dead quail over the week}}{\text{No of quail at the beginning of the week}} \times \frac{100}{1}$$

Egg Number:

Eggs from the birds were collected three times daily thus in the morning, afternoon and evening. The number of eggs collected from the cage per day was recorded accordingly. Eggs were individually weighed on a 0.01 g nearest-accuracy digital balance to obtain the egg weights. The total number of eggs laid was recorded monthly for a period of 3 months. The measures of egg production below were determined;

(a) Hen Housed Production (% HHP):
This was expressed as:

$$\%HHP = \frac{\text{Total eggs laid}}{\text{No. of hens housed x no. of days since housed}} \times \frac{100}{1}$$

(b) Hen Day Production (% HDP)

$$\text{Egg number per hen} = \frac{\text{Total eggs laid}}{\text{No. of hens housed}}$$

(c) Egg number per hen housed:
The average number of eggs per hen housed was determined as:

$$\%HHP = \frac{\text{Total eggs laid}}{\text{No. of hens housed x no. of days since hen laid}} \times \frac{100}{1}$$

Statistical Analysis

The statistical analysis of all obtained data was performed using GENSTAT Discovery, 2013 Edition. After the data obtained had been tested for normality and proven normal, parametric statistical procedures were carried out to test differences among means at 5% level of significance. T-tests and Analysis of Variance (ANOVA) were performed to test the significant differences among means in terms of seasonal variations and monthly variations, respectively. Fisher's Protected Least Significant Difference (LSD) test was used to separate means which were proven to be significantly different following the ANOVA.

Results

Growth Performance

Table 1 shows the mean weekly body weight of quails in both seasons from hatch to 6 weeks old. By comparison, the overall mean (up to six weeks old) in the wet and dry seasons showed no statistically significant difference ($t = 1.63$; $p = 0.105$). Apart from hatch day (day old), there were no significant differences between weeks one, two and three ($p>0.05$). However, there was a significant difference observed in weeks four, five and six due to deficiencies in feeding the birds (in the dry season) during the study.

Feed Consumption Rate

Table 2 presents the means and standard error of means of Average Daily Gain (ADG), Feed Intake (FI) and Feed Conversion Ratio (FCR) for both wet and dry seasons. The ADG for the wet and dry seasons (for week 0 - week 1) was 1.85 g and 1.78 g, respectively. Pertaining to ADG, there was no chronological increase with respect to age in both seasons, but FI increased (in both seasons) as birds advanced in age. FCR estimates were 2.33 g (wet) and 2.15 g (dry) at week 2 and 6.10 g (wet) and 9.93 g (dry) at week 6. It was observed that there was a gradual increase in the FCR in the

Table 1: Weekly body weight (g) of Japanese quail varieties in the wet and dry season

Weeks	Wet		Dry		Significance
	Mean ±SD	Range	Mean ±SD	Range	P value
1	6.38[a] ±0.39	5.99-7.02	6.79[a*]±0.36	6.13-7.56	0.001
2	16.00[b] ±5.03	10-20	17.50[b]±4.44	10-20	0.324
3	39.00[c] ±11.19	10-50	40.00[c] ±6.49	30-50	0.732
4	70.00[d] ±14.87	40-90	76.00[d] ±6.81	70-90	0.113
5	103.00[e*] ±13.02	80-120	89.50[e]±7.59	80-100	< 0.001
6	125.50[f*] ±12.09	100-140	103.00[f]±10.31	90-120	< 0.001
7	144.00[g*] ±12.31	120-160	106.5[f] ±10.89	90-130	< 0.001

SD: Standard Deviation. Means with similar superscripts within the column do not differ significantly, α = .05

Table 2: Means of Average Daily Gain, ADG (g), Feed Intake, FI (g) and Feed Conversion Ratio, FCR (g) of Japanesequails raised in the guine savannah ecological zone of Ghana

Weeks	ADG (g)		FI (g)		FCR (g)	
	Wet	Dry	Wet	Dry	Wet	Dry
0 - 1	1.85	1.78	7.60	7.37	4.10	4.15
1 - 2	4.29	4.29	110.01	9.21	2.33	2.15
2 - 3	5.71	5.71	12.07	10.30	2.11	1.80
3 - 4	4.29	1.43	13.78	11.12	3.21	7.79
4 - 5	2.86	2.86	15.53	13.24	5.44	4.63
5 - 6	2.86	1.43	17.43	14.18	6.10	9.93
Overall Mean	**3.64**	**2.92**	**12.74**	**10.90**	**3.88**	**5.07**
SEM	**0.56**	**0.72**	**1.48**	**1.03**	**0.67**	**1.31**

ADG - Average Daily Gain, FCR – Feed Conversion Ratio and FI - Feed Intake

initial stage of the birds but as quails attained maturity, the FCR largely increased.

Reproductive Performance

The means of age at first egg of the experimental birds are presented in Table 3. The ages at which the quails laid their first eggs were in the range of 44 to 72 days in the wet season and 48-67 days in the dry season. Mean values of 58.0±1.58 and 55.5±1.19 days were recorded in the wet and dry seasons, respectively. Table 4 shows hen-day and hen-housed egg productions. In both seasons, as the month of lay advanced, values for hen housed and hen-day egg production increased from first to the second month accordingly and started decreasing from the third month. Table 5 presents the means of the total egg count and egg number per quail for the first three months of lay during the experiment. As the months of production progressed, there was also a simultaneous increase in the egg numbers and egg weight from first to second month accordingly and started decreasing from the third month; as presented in Table 5. Per 21 hens, the total egg counts recorded

Table 3: Means of "Age at first egg" of Japanese quails raised in the guinea savannah ecological zone of Ghana

Parameter / Season	Wet Season	Dry Season
Age at first egg (days)	44	48
Overall mean (days)	**58.00**	**55.50**
SEM	**1.58**	**1.19**

SEM – Standard Error Mean

Table 4: Values of the first three months of Hen housed and Hen-day egg production of Quails raised in the guinea savannah ecological zone of Ghana

Month of Lay	Hen-Housed (%)		Hen-Day (%)	
	Wet Season	Dry Season	Wet	Dry
1	29.78	25.85	72.04	62.54
2	36.51	36.22	88.33	87.63
3	31.56	34.44	76.34	83.33

Table 5: Total egg count and egg number per quail hen in the first three months of lay

Month of Lay	Total Egg Count		Egg No. Per Hen	
	Wet (21 hens)	Dry (18 hens)	Wet	Dry
1	469	349	22.33	19.39
2	575	489	27.38	27.17
3	497	465	23.67	25.83
Overall Mean	513.67	434.33	24.46	24.13
SEM	0.333	0.396	1.510	2.401

SEM – Standard Error Mean

were 469, 575 and 497 for the first, second and third months, respectively in the wet season. Also per 18 hens, total egg counts obtained in the dry season were 349, 489 and 465 for the first, second and third months, respectively.

Survival and Mortality Rate

The number of deaths in the wet season is shown in Figure 1, dry season in Figure 2. In the wet season, per temperature and mortality, the minimum tempera-ture recorded with cases of mortalities were in the range of 21°C to 28°C; whiles the maximum temperature figures were in the range of 29°C to 36°C, represented in Figure 3. In the dry season, as shown in Figure 4, per temperature and mortality, the minimum temperature recorded with cases of mortalities were in the range of 20°C to 29°C; whiles the maximum temperature figures were in the range of 32°C to 41°C. The mortality rates in both seasons recorded are represented in Figure 5. It can be observed that the mortality rate decreased with age. It can be observed that low temperatures (below 30°C) contributed to the mortalities of quails in their early days (In the wet season- days 1 to 11; whiles days 1 to 7 in the dry season)

Discussion

Growth Performance

As the birds advanced in age, their body weight increased simultaneously. The day-old body weight of quail in this present study ranged between 6.13 g and 7.56 g. The values obtained in this study are similar to those of Bagh *et al.* (2016), Daikwo *et al.* (2011), Dauda *et al.* (2014) and Vali (2009) but lower than the range of values reported by Abdel-

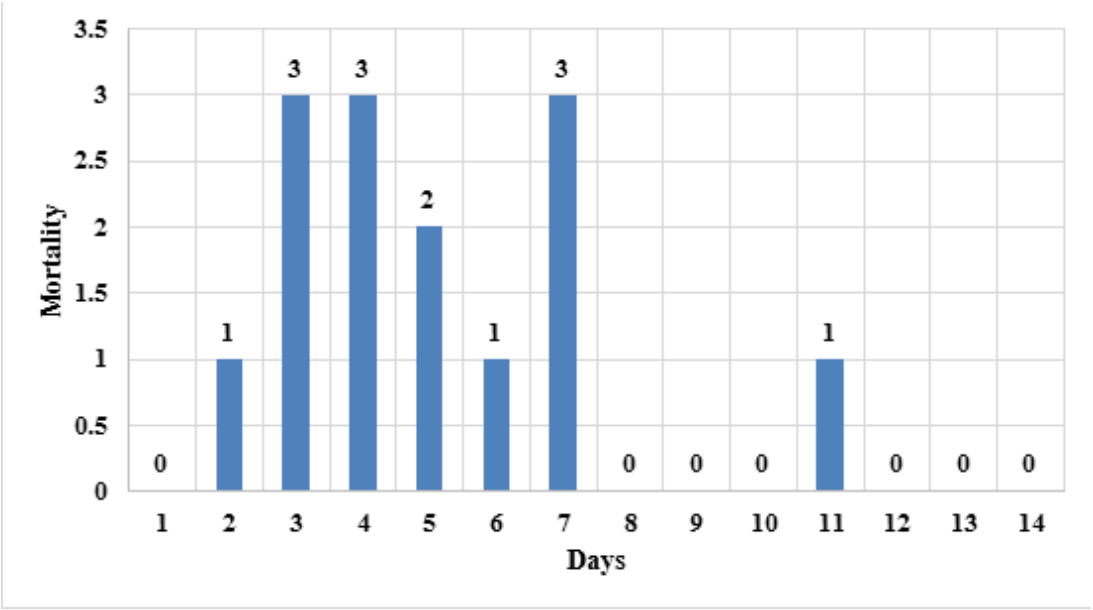

Figure 1: Number of deaths in the Wet Season

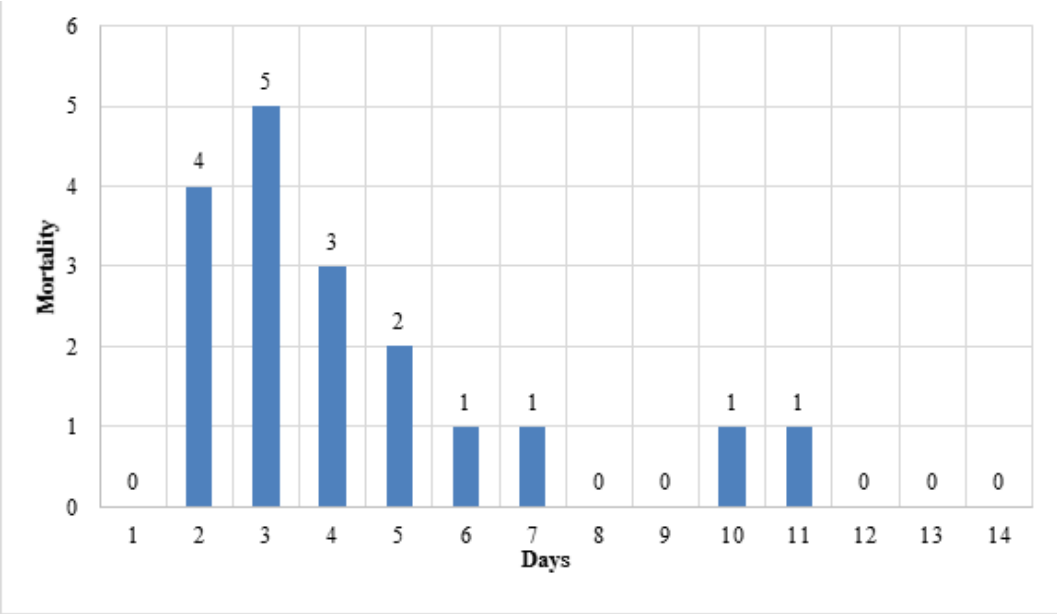

Figure 2: Number of deaths in the Dry Season

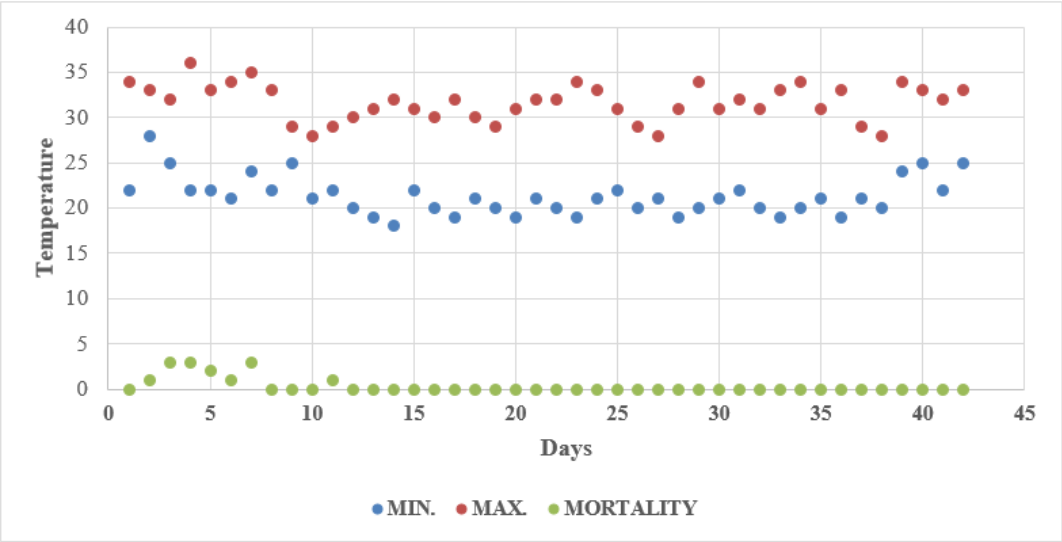

Figure 3: Temperature and Mortality in the Wet season

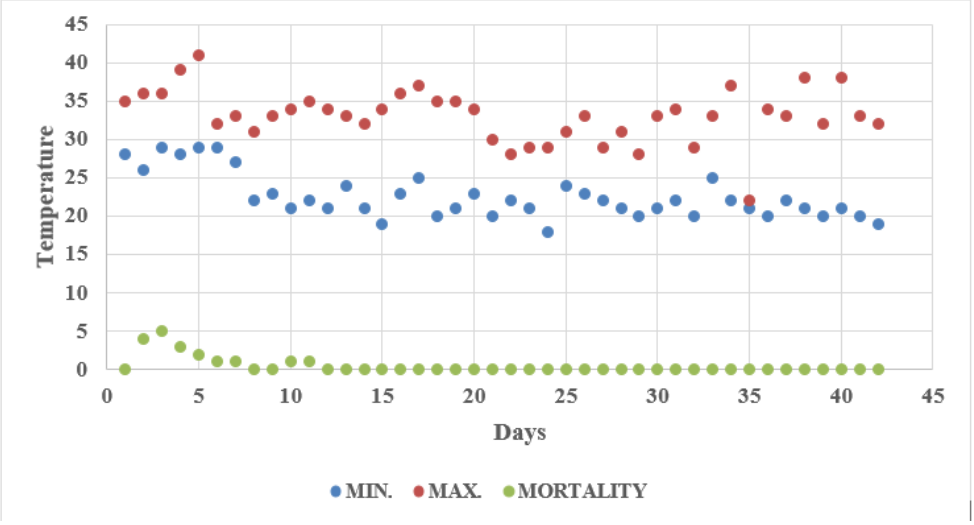

Figure 4: Temperature and Mortality in the Dry season

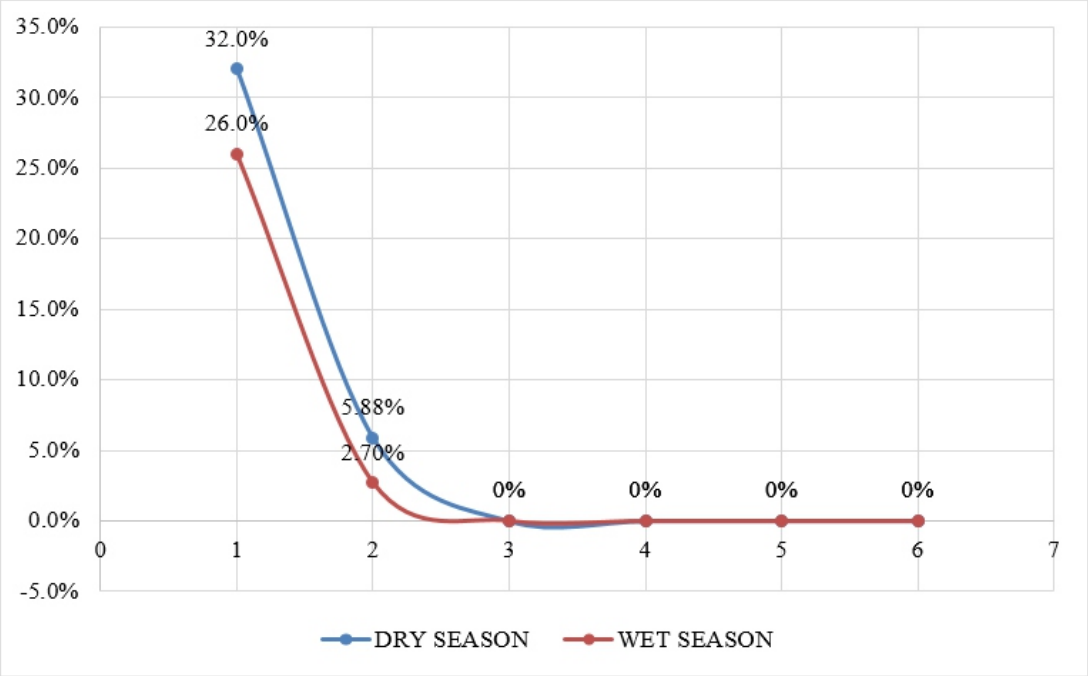

Figure 5: Mortality rate in both wet and dry seasons

Hakim, *et al.* (2009). The difference in the mean body weight at hatch (in wet and dry seasons) recorded in this experiment agrees with the observation of Hussain *et al.* (2013) who reported that second generation (eggs produced during the second batch of laying) shows maximum weekly body weights at the age of day one. In both the wet and dry seasons, there was increasing significant differences in body weight among the weeks as the birds aged which agrees with Hussain *et al.* (2013). The body weight of quails in this study at 1, 2, 3, 4, 5 and 6 weeks of age were in line with Vali (2009) and Bagh *et al.* (2016) but higher than those reported by Almeida *et al.* (2002) and Dauda *et al.* (2014). Comparatively, the differences observed could be attributed to differences in genetic makeup, managerial and environmental conditions under which the experimental flocks were raised. Growth rate, in terms of ADG of the birds, became faster as they increased in age but was initially quite slow (in 0-1 week). Dauda *et al.* (2014) reported a similar pattern of growth. The highest growth rate (5.71 g/day) was observed in the 2-3 week period in both wet and dry seasons. This differed from what Dauda *et al.* (2014) reported, which was (the 4-5-week period in that study). Differences in genetic make-up, environmental factors, as well as management of birds could be responsible for differences in the studies.

Feed Consumption Rate:

From the results, it was observed that, as birds advanced in age and body weight, their corresponding feed intake increased. Dauda

et al. (2014) reported a similar pattern. Feed intake values obtained in this study for 0-1, 1-2 and 2-3 weeks in both seasons were higher than those reported by Dauda *et al.* (2014) and Vali (2009), but values for 3-4, 4-5 and 5-6 weeks were similar to the values reported by Dauda *et al.* (2014) and Vali (2009). The values of feed conversion ratio (wet and dry seasons) obtained in this experiment throughout the six-week period were higher than the values reported by Vali (2009) but similar to the findings of Dauda *et al.* (2014). However, the values of FCR (5.44 and 4.63 in wet and dry seasons respectively) at week 4-5 are similar to the 4.65±0.17 by Dauda *et al.* (2014) and 4.07 reported by Vali (2009). As chicks learn to feed when they are growing, they tend to waste feed a lot. This could account for the high feed to gain ratio observed in the first week (0-1 week), compared to the weeks 1-2 of this study. Also, the high ratio observed in weeks 4-6 in the wet season and weeks 3-6 in the dry season could be attributed to the fact that as the birds aged, their feed conversion efficiency reduced.

Reproductive Performance

The mean age at first egg obtained in this study (58.0 days and 55.5 days for wet and dry seasons, respectively) agrees with the observation of Mark (1979), who reported the range of 45.3-58.9 days. These present findings also agree with the range of 50.94-61.22 days reported by El-Deen *et al.* (2015) and El-Full (2001). Dauda *et al.* (2014) also recorded a value of 54.49±0.20 days. A range of 48.9-49.6 days was reported by Thomas and Ahuja (1988) as age at which Japanese quail attained sexual maturity. Sezer *et al.* (2006) documented the age at first egg as 45.82±0.22 days which is in concordance with the findings of this study. The reason for the differences in age at first egg can be attributed to the difference in feeding and management practices. Dauda *et al.* (2014) stated that, when quails lay their first egg at an early age, the advantage is that, it could lead to reduced generation interval but on large-scale egg production, the ready market may not be found for many small eggs which the birds produce at an early age. But if early age at first egg is met with a simultaneous body weight increase, then the egg size could also increase. The 3- month egg production (73.38 and 72.39 eggs per quail hen in wet and dry seasons, respectively) obtained in this experiment is higher than the value of 62.43±0.23 reported by Dauda *et al.* (2014), but in line with 72.19±0.22 eggs reported by Daikwo (2011). Dauda *et al.* (2014) had 17.31±0.05, 21.93±0.08 and 23.19±0.11 as the average number of eggs per bird in the first, second and third months, respectively. The findings in this study were fairly higher. Dauda *et al.* (2014) stated that in Japanese quail, egg production is likely to vary. The variations could be attributed to the differences in breeds or strains, environmental conditions, management of birds and feeding. With respect to the %HHP and %HDP recorded in this study (in both the wet and dry seasons) values were higher than the values reported by Dauda *et al.* (2014). Factors such as feeding, management, and climatic conditions could contribute to variation in values. With high %HHP and %HDP, there is an assurance of increased supply of quail eggs to consumers. The effectiveness of the quail production marked high hen-day while good management of birds, hen-house production.

Survival and Mortality of Quails

Values of mortality rates 26.00% and 32.00% (in wet and dry seasons respectively) obtained in this present study between day one (hatch) and 1 week of age is slightly higher than 16.67% reported by Roshdy *et al.* (2010) and 18.34% reported by Dauda *et al.* (2014). Roshdy *et al.* (2010) reported a range of 2.20% and 10.00 % as the average mortality rates of quails housed in pens and cages

respectively. The mortality rates of 2.90% and 5.88% (in wet and dry seasons respectively) for week 1-2 falls within that range. In this study, it was observed that, mortalities were recorded when the temperatures of brooding (from 35°C to 40°C) of quail chicks were not met, from hatch to one week of age; as recommended by Manaa *et al.*(2015), Maurice and Gerry(2008), and Mondry (2016). Generally, as birds increased in age, their mortality rate reduced, as similarly reported by Seker *et al.* (2009). The differences in incubator used for hatching, environmental conditions, stocking density, a system of housing and management of birds are among the causes of variations in mortality rates.

Conclusion

From the results obtained in this study, it can be concluded that the climate and natural conditions of the Guinea savannah ecological zone are suitable for quail rearing. The high hen-day and hen-house egg production values obtained in this study show the possibility of an adequate supply of quail eggs to consumers.

Acknowledgments

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