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On Farm Performance Evaluation of Exotic Chickens in Central Tigray, Northern Ethiopia

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Abstract

The study was carried out on two purposively selected districts of central zone of Tigray, viz., Mereb Leke and Tahtay Michew. The aim of the study was to evaluate the on-farm performance of three exotic chicken strains under the farmer condition. A total of 96 households (48 household per district) were participated and then the selected strains (Sasso Rhode Island Red, Kuroiler and Koekoek) were distributed. GLM procedure was used for the on-farm data analysis. Data collected during the entire study were, growth data, fertility and hatchability, egg production, weight and age at point of lay. Better overall average daily body weight gains were achieved from 12-16 and 16-20 weeks by kuroiler chicken strains with value of 10.29, 13.68 gram respectively. Egg at first lay of SRIR and Kuroiler strains were 23.69 and 25.25 weeks respectively. The overall average egg production in the study area was 63.36% which was scored by SRIR strain. According to this study, based on their fast-growing kuroiler strain and based on their egg production potential SRIR strain were recommended to the study area and like agro ecologies.

Keywords: body weight, chicken strain, on-farm, performance

1. Introduction

In the developing world poultry production is based mainly on scavenging production systems, which makes substantial contributions to household food security (Muchadeyi *et al*. 2007). Livestock production covers 40% of agricultural output in Ethiopia, playing an important role in the national economy and it contributes 18% of the total GDP (FAO, 2010). Ethiopia has the largest livestock population in Africa and estimated to be 59.5 million cattle, 30.70 million sheep, 30.20 million goats 2.16 million horses, 8.44 million donkeys, 0.41 million mules, 1.21 million camels, 5.89 million beehives, 56.53 million chickens with regard to blood level of chicken, 94.31 percent, 3.21 percent and 2.49 percent of the total poultry were reported to be indigenous, hybrid and exotic (CSA, 2017), respectively.

In Ethiopia, chickens are widespread and almost every rural family owns chicken, which provide a valuable sources of family protein and income (Tadelle *et al*. 2003). Chicken production and product consumption are progressively growing in the world. Chicken accounts for about 33% of the global meat consumption and is expected to grow at 2-3% per year in the world (Mengesha *et al*. 2013). Rural poultry production in Ethiopia represents a significant part of the national economy in general and for the rural economy in particular.

Several studies (Fisseha, 2009; Aberra and Tegegne, 2011; Goraga *et al*. 2012; and Halima *et al*. 2009) indicated that Ethiopian indigenous chicken is highly populated, diversified as compared to other livestock species, but their performance is characterized by small flock size, small body size, low egg yield in terms of number and size, slow maturity and limited sources of income as compared to exotic chicken (Solomon, 2008). The demand of the people on sustaining the nutritional security is highly increasing. Most of the previous studies were focusing on in intensive farming system which cannot represent the figure of on farm performance. Hence, in order to improve the productivity of chicken and to satisfy the demand of the beneficiaries evaluating the performance of exotic chicken at farmer level is highly important. The general objective of the study was to evaluate the performance of exotic chickens in central Tigray and the specific objectives were, to evaluate production performance and reproductive performance.

2. Materials and Methods

2.1 Description of the Study Area

The study was conducted in central Zone of Tigray in Tahtay Michew (mid land) and Mereb Leke (lowland) districts, which was selected purposively agro ecologically.

Tahtay Maichew is located at an altitude ranged from1500-2260 m.a.s.l. and at a latitude of 1406'N and longitude of 38046'E in semi-arid tropical belt of Ethiopia with a 'Weina-dega' agro climatic zones. Mean annual rain fall of the area is 700-1000 mm with a temperature ranged 18 to 26oc. The dominant crops grown in the district were Teff (*Eragrostis tef*), chickpea (*Cicer arietinum*), Wheat (*Triticum*), Barley (*Hordeum vulgare*), maize (*Zea mays*), sorghum (Sorghum bicolor), bean (*Phaseolus vulgaris*). The district possesses 39269 Cattle, 8686 Sheep, 34459 Goats, 6892 Asses, 166 mule, 469 Camel, 238458 chicken, and 3345 bee hive.

Mereb Leke is one of the districts in Central administrative Zone of Tigray, which is located at14˚22'25" N latitude and 38º47'32" E longitude at an elevation of 1390 -1950 meters above sea level. The mean annual rainfall in the area ranges from 400 to 600 mm and the rainfall distribution is mono modal with an erratic distribution beginning in late June and ending in the last week of August. The mean maximum and minimum temperature of the district ranges 33.9ºC and18.7ºC, respectively and the average temperature of the study area was 26.3ºC. The major crops grown in this district includes; ground nut (*Arachis hypogaea*), finger millet (*Eleusine coracana*), sorghum (Sorghum bicolor), maize (*Zea mays*) and Teff (*Eragrostis tef*). Livestock production has a special emphasis in the study district and people in the area possess large number of livestock. The district possesses 53039 Cattle, 21839 Sheep, 52981 Goats, 9921 Asses, 171 Mule, 1087 Camel, 293529 chicken and 2849 Bee hives.

2.2 Methods of Sampling and Types of Data Collection

Both purposive and random sampling methods were used for the on-farm performance evaluation. A total of 96 (48 households from each district) were selected purposely based on some criteria and three types of chicken strain (koekoek, kuroiler and SRIR) were introduced to each district. Some of the criteria for households participating in the on-farm study were; keeping chicken for at least two years, willingness to accept 25-30 birds of a randomly selected strain, commitment at least to provide night shelter at a minimum, supplemental feeding and willingness to take part in chicken performance related discussion. For exotic chicken production performance evaluation data were collected for the traits body weight (using sensitive balance) at 12, 16 and 20 weeks, body weight gain (between 12^{th} and 16^{th} weeks, 16^{th} and 20^{th} weeks) age at point of lay, egg production, fertility and hatch ability performance of the introduced chicken were evaluated at the farmer level.

2.3 Experimental Design

The type of design used to determine the on-farm performance of the exotic chicken strain was used randomized complete block design.

The field is divided into blocks (district) each block is then divided into a number of units (kebele) equal to the number of treatments/breeds (i.e., all treatments or breeds are observed within each block) within each block, the treatments are assigned at random so that a different treatment is applied.

Mathematical model for RCBD

$Yijk = \mu+Ti+Bj+eijk$

Yij = is the average body weight measured of the i^{th} group of bird

μ = overall mean

Ti = the Ti^{th} breed effect (1-3, Koekoek, SRIR, and Kuroiler)

Bj= the Bj^{th} district effect (1-2, Tahtay Michew and Mereb Leke)

eijk = random error term

2.4 Analysis of Variance (ANOVA)

All quantitative on farm performance data like sexual maturity, age at point of first egg, body weight, egg weight, fertility and hatchability were analyzed using SAS 9.1.3 by using PROC GLM procedure and mean difference was assessed by Tukey.

3. Results and Discussion

3.1 Production Performances of Exotic Chickens

3.1.1 Body Weight of Female Exotic Chickens

The mean body weight at 12, 16 and 20 weeks had significant difference between the strains. There was significant statistical difference for Kuroiler breed between the districts. At the level of 12 weeks age the effect of breed and district had a significant (P<0.001) difference on body weight. At this age the breeds had different growth performance, and district effect has also been significant (P<0.001). The district effect can happen due to transport stress, less adaptability, low feed accessibility and lack of concern regarding housing. The body weight of Kuroiler achieved in the current study was less due to stress during transport and low provision of feed supplementation as compared to Natukunda *et al. (*2011) who reported the body weight of Kuroiler at 12 weeks of age was 998 and 1162 gram for female and male chickens, respectively. Comparatively the effect of breed at 16 and 20 weeks of age have a significant difference (P<0.05).

The effect of breed on body weight has a significant difference across the 12, 16- and 20-weeks weight of males. The mean body weight of the male chicken at the age of 12 weeks was higher for kuroiler breed followed by SRIR in Tahtay Michew district. As the growth stage increased the variation of body weight has also increased. Generally, the result showed that the breeds in the study district performed well in Tahtay Michew as compared to that of Mereb Leke. The result of this study on body weight of Kuroiler breed at week 20 was lower than the result from a study by Kugonza *et al*. (2008) who indicated that Kuroiler weigh 3.6 kg at 4 months of age in restricted range condition in Uganda. Similarly, Kugonza *et al. (*2008) at the 12,16 and 20 weeks the weight of female kuroiler chicken was 998.58, 1366.61 and 1781.76 gram which was higher as compared in the study conducted area. This implies the chicken was affected due to stress and low feed provision during supplementation which is not proportional to their body weight. However, the female body weight of the current study was similar with the fact sheet of African Chicken Genetic gain, as reported by Tadelle and Fasil (2016) that female kuroiler chicken reach a weight of at least 1kg at around three months and a comparable result was also reported by Dirsha, (2009) for SRIR that body weight of female S-RIR chicken at sexual maturity was 1.78 ± 0.21 kg at the age of 20 weeks. Aberra *et al*. (2011) reported 1204 g of body weight female local Kei chickens, respectively, which is higher than that obtained from the current study at 20 weeks for local strains. The result of this study was less body weight achievement as compared to Natukunda *et al*. (2011) as reported the body weight of kuroiler at 12 weeks age achieve 998.38 and 1161.92 gram for female and male kuroiler chickens respectively.

Table1. Mean Body Weight of Chicken Strains at 12, 16 and 20 Weeks Age (Mean ±Se)

Sex	Week	Strain	Study district		District effect	Strain effect
			Mereb Leke	Tahtay Michew		
Female	12	Koekoek	585.00±7.07	608.50±34.02	***	***
		Kuroiler	776.71±93.77	815.71±57.11		
		SRIR	635.17±21.19	705.37±109.05		
	16	Koekoek	886.06±162.99	850.87±206.5	NS	**
		Kuroiler	990.18±157.96	988.71±+150.49		
		SRIR	789.88±132.77	904.25±72.36		
	20	Koekoek	1053.89±24.85	1306.67±222.05	NS	**
		Kuroiler	1475±127.37	1534.70±92.55		
		SRIR	1327.50±134.62	1438.7±84.55		
Male	12	Koekoek	515.003±5.36	634.25±64.79	***	*
		Kuroiler	595.36±127.	774.28±76.34		
		SRIR	541.11±48.66	741.00±169.49		
	16	Koekoek	950.00±211.42	781.15±92.68	NS	*
		Kuroiler	1068.96±189.44	1204.67±126.13		
		SRIR	875.19±127.08	936.00±68.89		
	20	Koekoek	1261.54±257.89	1266.7±202.07	NS	**
		Kuroiler	1747.39±410.85	1508.49±223.1		
		SRIR	1399.11±210.16	1311.71±90.50		

NS= Non-Significant; *(0.05) = Significant; ** (0.01) = Significant; *** (0.001) = Highly Significant;

3.1.2 Daily Body Weight Gain of the Exotic Chickens

The female and male daily body weight gain of the exotic chicken across 12 to 16 and 16 to 20 weeks were indicated in the table2. The mean female body weight gains from 12 to 16 and from 16 to 20 weeks were differed significantly ($p<0.05$) among breeds in the study area. The highest body weight gains were attained by kuroiler breeds in both the study districts. Comparatively from 12 to 16 weeks age, the strains attained better body weight gain in Mereb Leke than Tahtay Michew. The weight gains from 16 to 20 was better as compared with that of 12 to 16 weeks age and this implies that age has a significant effect on both body weight and body weight gains.

In both the study area from 16 to 20 weeks on average daily body weight gains per strain was higher due to better adaptability and genetic difference of the chicken as compared with the study of (Niraj *et al.* 2016) who reported that the RIR and Bovan chicken breeds achieved 8.5 ±0.17 and 7.7 ±0.23-gram daily body weight gains per bird from day old to 22 weeks age under intensive private poultry farm in Mekelle, north Ethiopia. Under intensive management condition, (Tadelle *et al.* 2003) reported an average daily weight gain of 7.2 g for local chickens between 6 and 12 weeks of age, which was higher than the result of current study for local chickens of age 12 to 16 weeks. In comparison to the local chicken, the introduced chicken breeds were achieved higher daily body weight gains at farmer level beyond the local strains under the intensive management.

The mean body weight gain of the introduced male chicken strains has no significantly difference at strain level from 12-16 weeks, but it has high significant level ($p<0.001$) between the district level. The better body weight gain in Mereb Leke implies that the strain was favored more at that age level to that environment condition. At the age of 16-20 weeks the body weight gain per bird of the male chicken has a significant difference in both the district and strain level. This difference was due to management practice given by household to their chicken and genetic adaptability of the strain at that age class. The maximum body weight gain was achieved by kuroiler strains due to its genetic make and wider adaptability of the strain. The result of the body weight gain conducted in this study were much lower as compared with Sasso chicken which was conducted in Egypt at the age of 4-5 weeks achieved a daily body weight gain per bird was 36.14 ± 0.48 gram (El Said *et al*. 2011).

Table 2. Mean daily body weight gains of exotic chickens

Sex	week	Strain	Study district		District effect	Strain effect
			Mereb Leke	Tahtay Michew		
Female	12-16	Koekoek	5.86±1.33	6.18±1.33	NS	**
		Kuroiler	12.60±1.33	8.99±1.33		
		SRIR	9.09±1.33	7.08±1.33		
	16-20	Koekoek	9.12±1.25	13.59±1.25	NS	**
		Kuroiler	14.53±1.25	14.81±1.25		
		SRIR	12.20±1.25	7.72±1.25		
Male	12-16	Koekoek	12.71^{c}±1.50	9.378d±2.83	**	*
		Kuroiler	16.24^{a}±5.87	11.13c±2.62		
		SRIR	15.20^{ab}±4.60	7.242e±1.15		
	16-20	Koekoek	13.57^{c}±3.40	15.19^{de}±2.56	**	*
		Kuroiler	15.60^{a}±2.62	19.24^{c}±1.24		
		SRIR	14.66^{ab}±4.47	16.01^{d}±2.06		

NS= non-significant; *(0.05) = Significant; ** (0.01) = Significant;

3.2 Egg Production of the Exotic Chickens

As indicated in Table3. The result revealed that, hen-housed egg production percentage in the specified age class of strains was higher in SRIR strain. There was no significant difference between districts on hen-housed egg production percentage, but highly significant difference among strains ($P<0.001$). The result implies that, SRIR strain were express their genetic potential in terms of age at point of lay and egg production earlier than their half-life production potential. The study was similar with the results with peak hen egg production percentage of Fayoumi chicken at 31-36 weeks of age with hen day egg production 60.22% in northern Ethiopia (Abraham and Yayneshet, 2010).

Table 3. Mean comparison of hen-housed egg production percentage up to 44 weeks

Strain	Tahtay Michew	Mereb Leke	District effect	Strain effect
SRIR	70.12±9.81	56.61±8.89	0.169^{ns}	0.06^{ns}
Kuroiler	58.13±7.38	50.60±7.22		
Koekoek	40.15±4.08	33.07±10.06		

NS= non-significant

3.3 Reproductive Performance of the Introduced Exotic Chickens

3.3.1 Fertility and Hatch Ability of Chicken Eggs

The fertility percentage among the breeds show significant different (P<0.001). The fertility percentage differences were due to their genetic difference. The study was slightly in line with (Udeh and Omeje, 2014) reported that light body weight breed has higher fertility than the heavy weight breeds.

The result obtained in this study area shows, hatch ability percentage based on the fertile basis was 80, 75, 81.48 and 68.96 for local, koekoek, kuroiler and SRIR respectively with show significant difference (P<0.001). The result obtained in this study was higher as compared to the report of (Wondmeneh et al. 2015; Shumuye et al. 2018) on fertile egg basis 67.9±4.11, 76.5% respectively. Similarly, hatchability on the total egg basis has shown significance difference (P<0.001) between breeds. The average hatchability findings in this study were lower than 78% as reported by (Tadelle and Fasil, 2016) at Debrezeit agricultural research center on total egg basis. Islam and Nishibori (2010) also found that scavenging indigenous chickens had better fertility and hatch ability than exotic chickens in hot humid.

3.3.2 Age and Body Weight at First Lay

At the strain level there was a significant difference (p<0.05) in age in weeks at sexual maturity or age at point of lay. The stain also shows a significant difference (p<0.05) at the district level for age at point of lay. On average SRIR chicken breeds attain point of lay at earlier age, followed by kuroiler and koekoek breeds. The result obtained in this study on the average age at point of lay was better as compared to (Aman *et al*. 2017) on the breed of Sasso, Bovans Brown and local chicken were 5.7 ±1.6 and 6.0±1.4, 5.6±0.8 and 6.0±1.5, 6.4± 0.7 and 8.1±1.3 months in midland and low land agro ecologies respectively in the southern Ethiopia. The age at point of lay in this study was in line with (Lwelamira *et al.* 2008) who reported those 173.2±0.8 days in Tanzani. The age at point of lay in this result was better as compared to the results reported by (Yayneshet and Abraham, 2010) as 231±5.53 days for Fayoumi, 239±5.73 days for Rhode Island's Red and 245±6.08 for White Leghorn in northern Ethiopia. In contrast, the age at point of lay in this study was slightly late as compared to the study conducted by (Desalew, 2012) was 153 days in Ada'a and Lume districts east Shewa. The result conducted (Matiwos *et al*., 2013) in western Wollega reported that the overall age at sexual maturity of exotic chicken was 5.66±0.116 months which was late as compared to this study.

Table 4. Age and body weight at point of lay of chicken breeds

District	Strain	Age at first lay(weeks)/mean± se/	Weight at first lay/mean±se/
Mereb Leke	Koekoek	25.56±0.363	1448.12±60.74
	Kuroiler	25.15±0.363	1922.50±60.74
	SRIR	24.52±0.363	1588.06±60.74
Tahtay Michew	Koekoek	25.50±0.363	1548.00±60.74
	Kuroiler	24.52±0.363	2082.18±60.74
	SRIR	23.69±0.363	1793.37±60.74
CV (%)		5.86	13.99
Strain effect		0.05	0.001
District effect		0.43	0.006

4. Conclusion and Recommendation

4.1 Conclusion

According to this study, the result of the on-farm exotic chicken performance indicated that mean body weight at the age of 12, 16 and 20 weeks were significantly different among strains. This was due to their genetic adaptability of the strain to different environmental conditions. Generally, kuroiler strains were observed to have attained significantly heavier body weight as compared to other strains under the semi scavenging management conditions. Age at point of lay was significant at strain level and SRIR strain was come to point of lay earlier than the other exotic chicken strains in the study area, but the weight at point of lay was significant in both stain and district level. This may indicate that weight is more affected by strain genetics and environmental condition.

4.2 Recommendations

In the current study, the result reveal that from the introduced exotic chicken strains, Kuroiler chicken strain was better performed in short period of time in terms of growth performance in both the study districts. Due to this reason, it is advisable to produce in wider range and disseminate this strain to fulfill the meat production gap than egg production to similar agro ecologies of the study area.

Findings of this research indicated that SRIR strain is best for egg production and younger age at first egg. So, this strain was recommended for egg production and to fulfill protein demand from egg in similar agro ecologies of the study districts. Explore the potential of the breed for integrating this research with ongoing extension efforts in the region. Investigating the possibility of collaborating with local stakeholders like farmer cooperatives or poultry breeding companies for further research and implementation.

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References

Belay, S. R., Mehari, Haftom, Y., & Haileslassie, A. (2018). Production performance evaluation of koekoek chicken under farmer management practice in Tigray region, northern Ethiopia. *International Journal of Livestock Production*, *9*(9), 232-237. https://doi.org/10.5897/IJLP2017.0436

CSA (Central Statistical Agency). (2016). Federal Democratic Republic of Ethiopia Central Statistical Agency Agricultural Sample Survey 2016/17 [2009 E.C] Volume II. Report on Livestock and Livestock Characteristics. 573 Statistical Bulletin. Addis Ababa, Ethiopia.

Demam, D. (2009). Assessment of village rhode island red chicken management practices in cheha woreda and evaluation of different levels of brewers dried grain on growth performance of the chicks. A thesis submitted to the school of Graduate Studies of Haramaya University, Haramaya, Ethiopia.

Demeke, S. (2008). The structure, marketing and importance of the commercial and village poultry industry an analysis of poultry sector in Ethiopia. *A consultancy report to FAO*, Addis Ababa, Ethiopia.

Dessie, T., & Fasil, G. (2016). African chickens' genetic gains, more productive chickens for Africa's smallholder.

Dessie, T. T., Mengesha, Y. A., & Peters, K. J. (2003). Village chicken production systems in Ethiopia: 2. Use patterns and performance valuation and chicken products and socio-economic functions of chicken; *Livestock Research for Rural Development, 15*(1).

Elsaid, A., Gmilat, Fatman, I., El Hofy, Saleh, K., Mohamoud, & Bdurahman (2016). Characterization of Virulence-Associated Genes, Antimicrobial Resistance Genes, and Class 1 Integrons in *Salmonella enterica* serovar Typhimurium Isolates from Chicken Meat and Humans in Egypt

Esatu, W., Fasil, G., & Tadelle, D. (2015). Initial performance data on some chicken breeds identified for ACGG in Ethiopia.

FAO. (2010). Poultry meat and Eggs. Agribusiness handbook. Director of Investment.

Getiso, A., Addisu, J., Asrat, M., Kebede, H., Bereket, Z., & Teklayohannes, B. (2017). Management Practices and Productive Performances of Sasso Chickens Breed under Village Production System in SNNPR, Ethiopia. *Journal of Biology, Agriculture and Healthcare*7.

Goraga, Z., Weigend, S., & Brockmann, G. (2012). Genetic diversity and population structure of five Ethiopian

chicken ecotypes. *Animal genetics*, *43*(4), 454-457. https://doi.org/10.1111/j.1365-2052.2011.02270.x

Habtie, M., A., Negasi & D., Solomon. (2013). Evaluation of Socio-economic Role and Challenges of Rural Poultry Keeping in Nole Kabba District, Western Wollega, Ethiopia. *Direct Research Journal Agriculture and Food Science, 1*(3), 33-39. https://doi.org/10.5455/ijlr.20130213080235

Harth, R. (2011). A new breed, highly productive chicken helps raise Ugandans from poverty. *Thebiodesign institute.*

Hassen, H., Neser, F. W. C., De Kock, A., & van Marle-Köster, E. (2009). Study on the genetic diversity of native chickens innorthwest Ethiopia using microsatellite markers. *African Journal of Biotechnology*, *8*(7).

Islam, M., A., & Nishibori, M. (2010). Crossbred chicken for poultry production in the tropics. *The journal of poultry science*, *47*(4), 271-279. https://doi.org/10.2141/jpsa.010033

Kugonza, D. R., Kyarisiima, C. C., &Iisa, A. (2008).Indigenous chicken flocks of Eastern Uganda: I. Productivity, management and strategies for better performance. *Livestock Research for Rural Development*, 20(9).

Lemlem, A., & Yaynshet, T. (2010). Performance of exotic and indigenous poultry breeds managed by smallholder farmers in northern Ethiopia. *Livestock Research Rural Developmet, 2.*

Lwelamira, J., Kifaro, G. C., & Gwakisa, P. (2008). Breeding strategies for improving performance of Kuchi chicken ecotype of Tanzania for production under village conditions. *Livestock Research for Rural Development*, *20*(11).

Melesse, A., Tegegne, N., & Workineh, T. (2011). Effects of feeding Moringa stenopetala leaf meal on nutrient intake and growth performance of Rhode Island Red chicks under tropical climate. *Tropical and Subtropical Agro ecosystems, Journal. 14.*

Mengesha, M., Birhanu, T., & Tadelle, D. (2011)**.** Village chicken characteristics and their seasonal production situation in Jamma District, South Wollo, Ethiopia. *Livestock Research for Rural Development, 20*(7).

Moges, F. (2009). Studies on production and marketing systems of local chicken ecotypes in Burie Wereda, north west Amhara (Doctoral dissertation, Hawassa University).

Natukunda, K., Kugonza, D. R., & Kyarisiima, C. C. (2011). Indigenous chickens of the Kamuli Plains in Uganda: I. Production system and flock dynamics. *Livestock Research for Rural Development*, *23*(10), 1-13.

Niraj, K., Tomas, M., Berihu, G., Etsay, K., & Tsegay, T. (2016). Performance of Bovans Brown chickens under intensive and backyard management system in Mekelle, Ethiopia.

Tadesse, D., Harpal, S., Mengistu, A., Wondmeneh, E., & Tadelle, D. (2013). Study on productive performances and egg quality traits of exotic chickens under village production system in East Shewa, Ethiopia. *African Journal of Agricultural Research, 8*(13), 1123-1128. https://doi.org/10.5897/AJAR2013.6987

Udeh, I., & Omeje, S. I. (2014). Hatching characteristics of local and exotic (egg type) chickens using a locally fabricated incubator. *strain*, *1*, p.3.