Journal of Biology, Agriculture and Healthcare
ISSN 2224-3208 (Paper) ISSN 2225-093X (Online)
Vol.4, No.20, 2014

Comparative Analysis of Broilers' Rearing in Different Housings Systems in Wet Humid Climate, South West Nigeria

Wasiu Agunbiade LAMIDI*^
*Dept. of Agricultural Education, Osun State College of Education (OSSCE), PMB 208, Ila-Orangun, Osun State, Nigeria.
^Dept. of Agronomy, College of Agriculture, Ejigbo campus, Osun State University, Osogbo, Osun State, Nigeria.
Correspondence E-mail address: lwasiuagunbiade@yahoo.com; +2348062085175

Abstract
The experiment was 2 × 4 factorial design of 2 levels: deep litter and cage and 4 replicates for each. The replicates were labelled PA, PB, PC and PD for the deep litter while the cages were labelled C1- C10, A1- A10, G1-G10 and E1- E10. The birds were fed *ad libitum* of broiler growers for the first four weeks and broiler finisher for the last four weeks with equal water supply. Measurement of experimental parameters started from third week, initial weights and subsequent weekly weights were taken till eighth week. Total birds' weights per pen and cage were recorded weekly to find out the economic usage of both systems and cost implication of rearing. The experiment was performed twice with two set of birds -same age and weight bracket in April – June (AJ) and July – September (JS) in the same year and house. One-way ANOVA and paired t-test were used for statistical analysis for the weights and weight gains/losses, chickcop economic analysis was also used. Significant ($p = 0.029$; $p<0.05$) different was observed between the weights of broilers and different housing systems in AJ and JS experiments. The battery cage gave highest body weight gains/week, 28.00±1.21 g and 28.00±0.90 g respectively for pen and cage. Final weight of the broilers at 8th week was 1.696 ± 0.71 kg in cage E. There were stronger relationships between different housing systems and body weights of the broilers with R^2 ranges between 0.999 and 1. JS had 1.63% increase of weight gains over the AJ. Proximate analysis revealed that both housing systems did not affect the meat quality of the broilers. The Total Production Costs in Naira, (TPC), were higher in battery cage, but had high values for figure of merit, thus with higher economic benefits at long term.
Keywords: battery cage, broilers, deep litter, economic analysis, southwest Nigeria

1.0 Introduction

Majority of the broilers' farmers in Nigeria, if not all, engage deep litter housing for rearing, using battery cage for layers simply because of initial cost of the cage or its sophistication (Lamidi, 2005). Deep litter housing is durable, permits higher evaporation of moisture, litter are easily changed periodically for birds' comfort, there is space economy, clean eggs and litter can be used as manure in the field. Battery cage has cleaner eggs than deep litter, every time labour usage is reduced, durable with adequate care provided the cages were made up of good steel of high structural strength to reduce cage fatigue, disease spread is less, space economy is better, birds are confined therefore wasteful energy in moving round is converted to carcass, litters are easily collected under the cages and litters permit higher evaporation of moisture and litters are used on the farms or use to feed fish [Bessei, (2006); Lamidi, (2005); Sainsbury and Sainsbury (1988)]. When asked or encouraged to try the use of battery cage for broiler's rearing, farmers in this part of the world snub not only your message but you as well. This necessitates the experiment to know the merits battery cage may have over the deep litter to further educate them more.

Poultry farming is one of the many different jobs undertaken by people of all categories all over the world irrespective of their background jobs' training. It is a way of providing jobs for the jobless (Anyakoha, 2006), thereby becoming an entrepreneur. The continuing growth of poultry industry in the world is due to poultry efficiency in converting vegetable proteins into animal proteins; acceptability and accessibility of its meat to most people unlike pork that is unacceptable to some religions; its attractiveness and competitive costs; its healthfulness as perceived in human diets; the ease of its technology transfer between countries and the less initial capital needed for small scale rearing etc. (Lamidi, 2005).

In Nigeria, land tenure system hinders farming even for people who have huge amount of money to start arable or plantation agriculture, the type of entrepreneurship most then resulted to is poultry production enterprise to meet such demand or market opportunity (Anyakoha, 2006). Many people in Nigeria have interests in poultry farming despite some problems like poor enterprising culture; lack of entrepreneurship's teachers, materials and equipment in schools; unavailability of fund; non-inclusion of entrepreneurship programme in the school curricula; poor societal attitudes to Technical and Vocational Education development and insensitivity of government to creation and expansion strategies for enterprise (Oviawe, 2010).

Some studies showed large benefits in reducing stocking density on the performance of broilers [Škrbić et al., (2009); Mtileni et al., (2007); Chmelničná et al., (2007); Dozier et al., (2006); Dozier et al., (2005); Biligili and Hess, (1995], while other documented that reducing stocking density had no influence (Thomas et al., 2004) or even had negative impacts on broilers performance (Feddes et al., 2002). The discrepancies between these studies clearly indicate for more oriented studies, to clarify our understanding of how broilers' performance might be affected in different stocking density rates [Alaeldein et al., (2013); Turkyilmaz (2006)] and even in different housing systems. However, there are scanty studies on the rearing of broilers in cages partly due to the societal needs and financial implications to the farmers.

It was hypothesized, therefore, that floor space/bird in deep litter housing would impose an impact on the performance and welfare of broilers, where broilers in high density rate will express more pronounced responses compared to broilers in low density rate as in case of 2 birds per cage in battery cage. Accordingly, the objective of the present study was to investigate the influence of different floor areas/bird as a result of different housing systems (expressed as final body weight/m^2) on the performance (Body Weight Gain-BWG and Cost of Rearing-COR) parameters of Anak broiler chickens.

2.0 Materials and Methods

A deep litter of dimension 360 cm × 160 cm was built using wooden wall up to 3ft up the floor, other wall part was made up of wire mesh. The house was divided into four equal parts each of dimension 160 cm × 87.5 cm with demarcating walls each of 3.3cm thickness. The ceiling was made up of asbestoes overlaid with woven mat to reduce rate of evaporation and to keep inner house at normal relative humidity of 70% in the tropical climate. The floor was made of concrete of good strength with water absorbent litter of about 2.5 cm depth. The experiment was carried out in the tropical humid climate of Ila-Orangun in south-western Nigeria, at longitude 14^0 33'E and latitude 7^0 N. Each pen was loaded with 20 birds of nearly equal weights and three weeks old of Anak breeds, each bird had 700cm^2 floor space to itself. This floor space was selected for rearing due to earlier experiment by [Lamidi, (2005); Feddes et al., (2002) and Feddes et al., (1999)]. The battery cage housing had 40 equal cages in a stand with 2 birds/cage, a cage dimension was 70 cm × 20 cm for a bird to have 700cm^2 cage floor space to itself. A total of 160 birds were raised together from day-old, brood under the same conditions and at three weeks old were randomly distributed into their pens (Bessei, 2006) or cages (40) in a randomized complete block design. At this point, the birds had nearly equal body weights of close range 0.850-0.860 kg.

There were four replicates for each of the experiment with deep litter pens labelled PA, PB, PC and PD while battery cages were labelled C1- C10, A1- A10, G1-G10 and E1- E10 for four replicates making the experiment 2 × 4 factorial design of 2 levels: deep litter and battery cage and 4 replicates. The birds, each number-tagged with reference to their respective houses were reared on equal water and feed *ad libitum* of broiler growers for the first four weeks and broiler finisher for the last four weeks to reach market value. Feeds fed to the broilers were from Guinea Feeds Nigeria Limited specially formulated for the broilers. The birds had same temperature, humidity and other climatic conditions throughout. The initial costs of the broilers were all common to both systems and were therefore treated so and therefore not included in the final results. Weights of the birds in grammes were taken in every other day with the weight gains/losses recorded accordingly per bird. However, the cost of each house construction and cost of waste management as done by the labourers were not the same and were included in the economic analysis.

The experiment was performed twice with 2 set of birds, Anak breeds in both cases using same age and weight bracket birds between mid-April – mid-June (tagged AJ in the experiment) and between mid-July – mid-September (tagged JS in the experiment) in the same year in the same house. Proximate analysis was done on the meat of four broilers killed in each of the pens PA, PB, PC and PD and 16 birds out of the 40 birds in the cage experiment for each of AJ and JS periods. This was to know if the meat qualities were affected by their housing types.

One-way ANOVA was used to analyse week-to-week body weights and body weight gains/losses (BWG) among the replicates. Duncan Multiple Range Test, (DMRT) was used for means' separation. Paired t-test and Chickcop Economic analysis (Feddes et al., 2002; 1999) were respectively used for statistical analysis and for the costs of rearing for the two factors of cage and deep litter.

3.0 Results and Discussions

Tables 1 and 2 show the average weights' gain (± standard deviation) per broiler for different pens/cage at week-to-week measurements of body weights and analysis for both experimental periods. There were no weights losses in week-to-week observations but body weight gains in different replicates. The reasons are not only due to the fact that the birds fed well but also may be due to their breed, managerial ability in term of housing systems and probably the methods of their handling.

The significant effect of different weights and week-to-week weights' gains in broilers at different pens and cages were observed with different housing systems, the results show that significant ($p = 0.028$)

different was observed between the weights of broilers and different housing systems in the first and second experiments. The mean values were statistically different from each other in their respective experiment, Table 3a. All values were expressed as statistical means ± standard error of the mean (SEM). There were significant differences between these mean values in the 5 – 6, 6 – 7 and 7 – 8 weeks; at their market prices (8th week), the mean values were different for the battery cage, showing and signifying higher weight gains (28.00±1.21 g and 28.00±0.90 g respectively for pen and cage. This implies that farmers will expect more money from their sales. The highest final weight of the broilers at 8th week was 1.696 ± 0.71 kg in cage E, this may be due to the effect of the cage which restricted their movements, that did not provide the birds spaces to roam about and instead use their gained energy that could have been expended on wasteful and unnecessary exercises to build up carcass that the farmer needs. The whole area (14,000cm^2) in the deep litter was opened to each of the bird therein, while a bird had only 1,400cm^2 floor area in battery cage. This is 10 times the latter's floor space, though with the same stocking densities of a bird/700cm^2.

Proximate analysis revealed the quality of the broilers' meat. The protein, ether extract, crude fibre, ash content and the moisture content of the broilers' meat were not all within the same range for each of the parameter showing that they were slightly affected within their limit in the meat quality. In Table 3b, the mean values of the crude protein and moisture content results were not statistically different from each other in their respective experiment, however, mean values of ether extract and crude fibre of their meat statistically different in pens and cage while ash content was only statistically different in pens and not in cage. It may be surmised that the housing systems, deep litter or battery cage, did affect the meat quality of the broilers. The reason for this may be due to the level of the hygienic conditions around the birds of which the deep litter may lagged behind the battery cage or may be due to the fact that battery cage permits higher evaporation of moisture from the litter than the deep litter housing.

Weights' gains for the JS experiment were greater than their corresponding values in the AJ experiment in all the replicates (Tables 1, 2 and 3a). Although nearly the same weight-bracket birds of the same age were used at both periods with the same conditions of rearing, it can be surmised that the effects of period in the year may have been responsible for significant discrepancies of weight gains of the JS and in AJ. Rainfall is usually at its peak in the tropics between August and September (JS experiment), thus with the same conditions of rearing and same breeds and same housing, weight gains may likely have increased more in JS (890.8 g highest in deep litter) because of high rain intensity and the resulting high relative humidity and low temperature. Table 3a revealed statistical differences among values in AJ experiment as well as among JS experiment in pens PC, PD and cages C, A, G and E from third week to eighth week.

Moreover, significant ($p = 0.029$) different was observed between the body weight gains (BWG) of broilers and different housing systems in the AJ and JS experiments. The mean values were not statistically different from each other in their respective experiments, Table 3b. The R^2 value for the correlation coefficients for the BWG were 0.675 for the AJ and 0.168 for JS, these were respectively high stronger correlation and low, weak correlation at both periods. In both, there were evidence of inter-relationship between the BWG and the housing systems. This account for differences in the body weight gains (BWG) of broiler per pen/cage and these are due to the period of the year and housing factor. This result agrees with [Feddes et al., (2002), (1999)] that housing types strictly affect BWG of broilers.

Figure 1 shows the weight gains at the 8th week of rearing, when their rearing ceased according to the experimental procedures and the birds were ready for the market. The graph revealed that highest values for the weight gains were got for the cage (28.0 g at both A and E portions in the cage) while pen PB had 27.5 g highest. Further analysis showed that JS had 1.63% increase of weight gains over the AJ. This showed that different rearing periods leads to different carcass yield, thus may be surmised that effect of high relative humidity with low temperature coupled with housing types rather than stocking density during the peak of the rain (August to September) in the tropics might have to do with this increment. Probably the level of ammonia odour emanating from the litter seemingly compacted by broilers' leg in the deep litter that may not permit higher evaporation of moisture from it may also be responsible for this increment. These results agree with Dawkins et al., (2004) which found out that chicken welfare is influenced more by housing conditions than by their stocking density.

For Figure 2 and 3, the results of the regression analysis show that there were stronger correlations between the different housing systems and the body weights of the broiler per pen/cage with R^2 values 0.999 (pen) and 1 (cage) for Figure 2 and R^2 values 0.999 (pen) and 1 (cage) for Figure 3. The regression equations as shown in equations 1- 4 revealed stronger relationships between the independent variable Y (different housing systems) and body weights X of the broilers. It may be surmised that the higher R^2 values got for both systems of housing revealed that broilers do well in both provided good managerial hands are used with good breed and favourable climatic conditions.

For Figure 2

$$Y_{pen} = 14.50X^3 - 114.5X^2 + 272.0X + 1208 \quad R^2 = 0.999 \quad (1)$$

$$Y_{cage} = -5.33X^3 + 61.0X^2 - 1296.0X + 1554 \quad R^2 = 1 \quad (2)$$

For Figure 3

$$Y_{pen} = 15.5X^3 + 126.0X^2 - 290.5X + 1591 \quad R^2 = 0.999 \quad (3)$$

$$Y_{cage} = -73.83X^3 + 613.5X^2 - 1441X + 2372 \quad R^2 = 1 \quad (4)$$

3.1 Cost Implications

Figure 3 shows that the greatest liveweight at 56 days at JS was at battery cage treatment with carcass yield of 1.696 kg or 1696 g. The costs of different buildings, pens/cage; labour, waste collection and others common to both methods like feeding were estimated and shown in Table 4a. However, discrepancies in the cost of labour and waste management were as a result of differences in the volume of their wastes and litter removal/replacement. Since the price of birds, inoculation/drug administering, their transportations and feedings were common to both methods, their costs' estimates were the same and not included. The price quoted were the local prices of products or labour and others in the area as at the time.

Furtherance to the economic analysis in the research, the figure of merit which is defined as the yield in grammes (BW) per unit total production cost evaluated for the pen and cage were calculated and recorded in Table 4b. The Total Production Costs in Naira, (TPC), were higher in battery cage, but due to the durability of the cage, labour cost reduction and other reduced costs for battery cage, this may soon be over-ridden, especially as cage had high values for the figure of merit and overall economic benefits, Tables 4a and 5. The ranking shows that cages in battery cage housing had highest ranking than the pens in deep litter housing.

Using Chickcop [Feddes et al., (2002), (1999)], a detail economic analysis was conducted. The area for each bird in the pen/cage was estimated based on the fact that the whole space in each of the pen/cage was available to roam about for a bird. For the deep litter, each bird had a space of 14,000cm^2, created for twenty birds, on the other hand, for the cage, they were confined to the small area of 1,400cm^2, Table 5. The amount of product per unit area (kg/m^2), here expressed as (g/cm^2) decreases with decreasing stocking density, highest (1.125 and 1.2114 g/cm^2) for cage with only two birds/cage and lower (0.0984 g/cm^2) for pens at a pen/20 birds. The ranking shows that cage had highest ranking than the pens in the deep litter housing.

4.0 Conclusions and Applications

The following conclusions were arrived at:

1. Significant ($p<0.05$) different was observed between the weights of broilers and different housing systems in the first and second experiments. Mean values were different for the battery cage, showing and signifying higher weight gains (28.00±1.21 g and 28.00±0.90 g respectively for pen and cage.
2. Significant ($p<0.05$) different was observed between the body weight gains (BWG) of broilers and different housing systems in the AJ and JS experiments. The highest values for the weight gains were got for the cage (28.0 g) while pen had 27.5 g highest in it. JS had 1.63% increase of weight gains over the AJ.
3. The highest final body weight of the broilers at 8th week was 1.696 ± 0.71 kg in battery cage.
4. The protein, ether extract, crude fibre, ash content and the moisture content of the broilers' meat were not all within the same range for each of the parameter showing that they were affected by the housing methods used in the broilers' rearing.
5. There were stronger correlations between the different housing systems and the body weights of the broiler per pen/cage with higher R^2 values.
6. Total Production Costs in Naira, (TPC), were higher in battery cage, but had high values for figure of merit, thus with higher economic benefits at long term.

Farmers are currently using deep litter housing for broilers, battery cage will lead to more final/market weight per floor area/bird because of high body weight gains (BWG), high values for figure of merit, though with initial higher installation cost but with overall higher economic benefit later and therefore farmers are encouraged to use battery cage for broilers' rearing.

5.0 References

Alaeldein M. A, Emad M. S, Elsayeid O.S. H, Mu'ath Q. Al-G, Raed M. A. (2013). Impacts of stocking density on the performance and welfare of broiler chickens. Italian Journal of Animal Science, Volume 12, e11. www. Accessed 03/04/2013

Anyakoha, E.U. (2006). Practical tips for economic empowerment and survival. Nsukka: AP Express.

Bessei, W. (2006). Welfare of broilers: A review. World Poultry Science Journal 62:455-466.

Biligili, S.F., Hess, J.B. (1995). Placement density influences broiler carcass grade and meat yields. J. Appl. Poultry Res. 4:384-389.

Chmelničná, L., Solčianska, L. (2007). Relationship between cage area and yield of the main elements of chicken carcasses. Pol. J. Food Nutr. Sci. 57:81-83.

Dawkins, M.S., Donnelly, C.A., Jones, T.A., (2004). Chicken welfare is influenced more by housing conditions than by stocking density. Nature 427:342-344.

Dozier, W.A., Thaxton, J.P., Purswell, J.L., Olanrewaju, H.A., Branton, S.L., Roush, W.B. (2006). Stocking density effects on male broilers grown to 1.8 kilograms of BW. Poultry Science 85:344-351.

Dozier, W.A., Thaxton, J.P., Branton, S.L., Morgan, G.W., Miles, D.M., Roush, W.B., Lott, B.D., Vizzier-Thaxton, Y. (2005). Stocking density on growth performance and processing yields of heavy broilers. Poultry Science 84:1332-1338.

Feddes, J.J., Emmanuel, E.J., Zuidhof, M.J. (2002). Broiler performance, body weight variance, feed and water intake, and carcass quality at different stocking densities. Poultry Science 81:774-779.

Feddes J.J.R. Emmanuael R.H, Macgovern R.H and Zuidoff M.J. (1999). Broiler Performance, weight variance, feed and water intake and carcass quality at different stocking densities. Poultry Research Centre News- (2): 13 and 23 Broiler Breeder on line http//www.agric.gov.ab.ca/aprc/

Lamidi, W. A. (2005). Effects of Floor Space and Stocking Density on Broiler Production in Nigeria. M.Sc. Dissertation, Department of Agricultural Engineering, Faculty of Technology, Obafemi Awolowo University, Ile-Ife, Nigeria.

Mtileni, B.J., Nephawe, K.A., Nesamvuni, A.E., Benyi, K. (2007). The influence of stocking density on body weight, egg weight, and feed intake of adult broiler breeder hens. Poultry Science 86:1615-1619.

Oviawe, J. I. (2010). Repositioning Nigerian Youths for Economic Empowerment through Entrepreneurship Education. European Journal of Education Studies, 2(2): 113-118

Sainsbury D and Sainsbury P. 1988. Livestock Health and Housing 3rd edition ELBS London, page 4

Škrbić, Z., Pavlovski, Z., Lukić, M., Perić, L., Milošević, N. (2009). The effect of stocking density on certain broiler welfare parameter. Biotechnol. Anim. Husband. 25:11-21.

Thomas, D.G., Ravindran, V. Thomas, D.V., Camden, B.J., Cottam, Y.H., Morel, P.C.H.,Cook, C.J. (2004). Influence of stocking density on the performance, carcass characteristics and selected welfare indicators of broiler chickens. New Zeal. Vet. J. 52:76-81.

Turkyilmaz M. K. (2006). The Effect of Stocking Density on Stress Reaction in Broiler Chicken during Summer. Turk Journal of Veterinary Animal Science 32(1):31-36.

Table 1: Average body weights gains by broilers per pen/cage from third week to eighth week, g –April-June (AJ)

Wk	Birds' weights' gains in pens/g				Birds' weights' gains in cages/g			
	PA	PB	PC	PD	C	A	G	E
3 – 4	70.8±0.59	70.90±0.47	70.90±0.56	80.00±0.49	80.30±0.54	80.10±0.49	80.20±0.61	80.00±0.49
4 – 5	110.6±0.57	120.3±0.63	110.7±0.55	120.5±0.75	120.3±0.83	120.5±0.44	120.7±1.03	120.5±0.75
5 – 6	140.6±1.47	140.7±0.77	150.1±2.58	140.6±0.79	170.4±2.08	150.4±1.40	150.7±1.61	150.8±1.79
6 – 7	190.3±1.03	190.2±0.66	190.4±0.93	190.3±0.83	230.9±0.87	240.5±0.85	210.2±2.43	200.3±2.02
7 – 8	240.8±0.61	250.1±0.76	250.0±0.70	250.0±0.63	260.4±1.66	270.4±1.46	260.6±1.52	280.0±0.90
TBWG, g	780.10	790.20	790.10	790.40	880.30	870.90	840.4	840.6

Wk –week; TBWG- total body weight gain

Table 2: Average body weights gains by broilers per pen/cage from third week to eighth week, g – -July-September (JS)

Wk	Birds' weights' gains in pens/g				Birds' weights' gains in cages/g			
	PA	PB	PC	PD	C	A	G	E
3 – 4	80.30±0.43	80.30±0.38	80.10±0.56	80.10±0.36	80.30±0.38	80.00±0.45	80.20±0.40	80.20±0.34
4 – 5	120.4±0.87	120.7±0.59	120.9±0.84	120.9±0.64	120.2±1.03	120.9±0.77	110.7±0.55	120.5±0.75
5 – 6	180.1±0.80	160.8±1.57	160.3±0.84	170.2±1.45	140.6±1.47	140.7±0.77	140.0±1.27	140.7±0.77
6 – 7	240.6±1.30	240.5±0.85	220.1±2.37	220.1±2.50	190.8±1.14	190.4±0.95	210.8±1.18	190.7±1.19
7 – 8	260.4±1.66	270.5±1.30	260.6±1.52	280.0±1.21	250.7±1.45	250.4±1.13	260.1±1.41	260.0±1.46
TBWG,g	890.8	890.80	860.00	880.30	800.60	800.40	810.80	810.10

Wk- week; TBWG- total body weight gain

Table 3a: Mean values of body weights' gains (BWG) of broiler at different periods of the experiment, AJ and JS

Week	AJ				JS			
	PA	PB	PC	PD	C	A	G	E
3 – 4	70.90[a]	70.95[a]	80.20[b]	80.10[a]	80.30[b]	80.10[a]	80.15[b]	80.20[b]
4 – 5	120.00[a]	120.10[a]	120.40[b]	120.60[b]	120.55[b]	120.90[b]	120.55[b]	120.10[a]
5 – 6	140.65[a]	140.90[a]	160.40[b]	150.75[ab]	170.45[c]	160.75[c]	140.65[a]	140.35[a]
6 – 7	190.15[a]	190.35[a]	240.20[ab]	200.75[b]	240.55[ab]	220.10[ab]	190.60[a]	200.75[b]
7 – 8	240.95[a]	250.00[a]	260.90[ab]	270.30[b]	260.75[ab]	270.30[b]	250.55[bc]	260.05[abc]

[a,b,c]Means with the same letters along the same row are not significantly different ($P < 0.05$)

Table 3b: Mean values of proximate analysis of the broiler meat at different housing systems in the experiment.

Parameters	Means of proximate values in pens, %				Means of proximate values in cages, %			
	PA	PB	PC	PD	C	A	G	E
Crude Protein	20.17[a]	20.32[a]	19.76[a]	19.53[a]	20.14[a]	20.21[a]	20.14[a]	19.75[a]
Ether extract	0.54[a]	0.68[a]	0.52[a]	1.41[b]	1.18[b]	0.47[a]	1.18[b]	0.34[a]
Fibre	0.30[a]	0.12[a]	0.20[a]	1.98[b]	0.75[a]	0.14[a]	0.25[a]	1.04[b]
Ash content	0.79[a]	0.76[a]	1.12[b]	0.67[a]	0.73[a]	0.68[a]	0.73[a]	0.87[a]
Moisture	78.20[a]	78.12[a]	78.40[a]	76.41[a]	77.20[a]	78.50[a]	77.70[a]	78.00[a]

[a,b]Means with the same letters along the same row are not significantly different ($P < 0.05$)

Table 4a: Cost estimate (naira, ₦*) of some operations

Pens/ Cage	Cost of labour	Cost of buildings and pen/cage, ₦		Costs of waste management /pen/cage, ₦	Other costs-common to both methods	Total Production Cost, ₦
		Building/ cage	Accessories			
AJ						
PENS	12,000	60,000	3,600	6,000	90,000	171,600
CAGE	8,000	70,000	1,000	3,000	90,000	172,000
JS						
PENS	12,000	-	-	6,000	90,000	108,000
CAGE	8,000	-	-	2,500	90,000	100,500

*Presently, $1 US dollar = 163 Nigerian Naira, ₦ and £1 British Pound = 250 Nigerian Naira, ₦

Table 4b: Cost estimate (naira, ₦*) of birds

Periods of experiment	Pens/ cage	TPC, ₦	Body Weight, (BW) kg	Figure of merit kg/₦	Ranking of figure of merit
1st - **AJ**	PENS	171,600	1.417	8.26×10^{-6}	2nd
	CAGE	172,000	1.575	9.16×10^{-6}	1st
2nd - **JS**	PENS	108,000	1.429	1.32×10^{-5}	2nd
	CAGE	100,500	1.696	1.69×10^{-5}	1st

*Presently, $1 US dollar = 163 Nigerian Naira, ₦ and £1 British Pound = 250 Nigerian Naira, ₦

Table 5: Chickcop economic estimate, (Naira, ₦) of Birds

Pens/cage	Areas, cm^2	Mean Final Weight, g	Chickcop Economic analysis, g/cm^2	Ranking
PA	14,000	1405	0.1004	7th
PB	14,000	1378	0.09843	8th
PC	14,000	1417	0.1012	6th
PD	14,000	1429	0.1021	5th
C	1,400	1470	1.0500	3rd
A	1,400	1352	0.9657	4th
G	1,400	1575	1.1250	1st
E	1,400	1696	1.2114	2nd

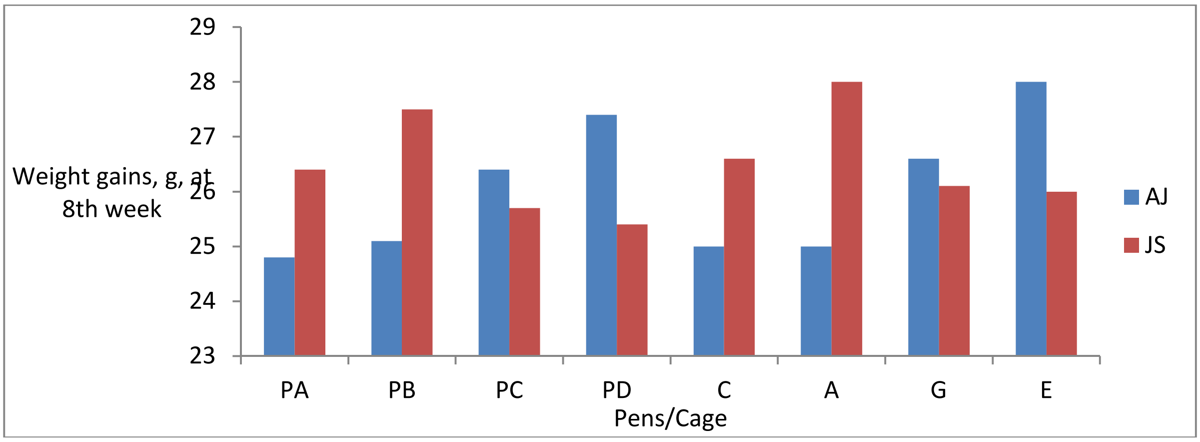

Figure 1: Average weight gains for different housings at AJ and JS at 8th week.

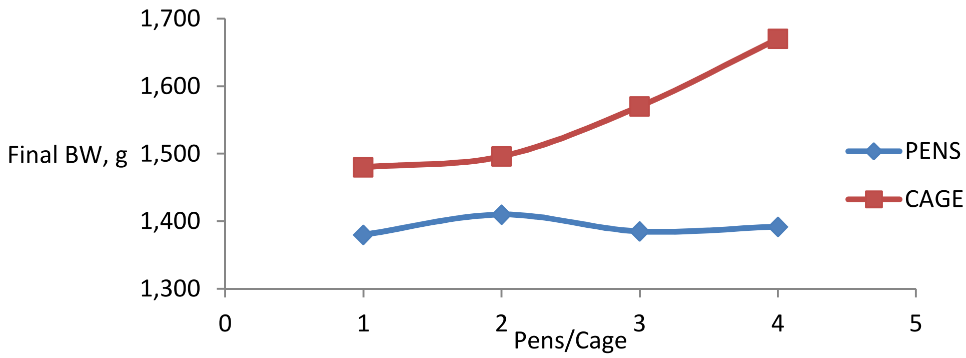

Figure 2: Final Body Weights (BW) for different housings April-June (AJ) experiment.

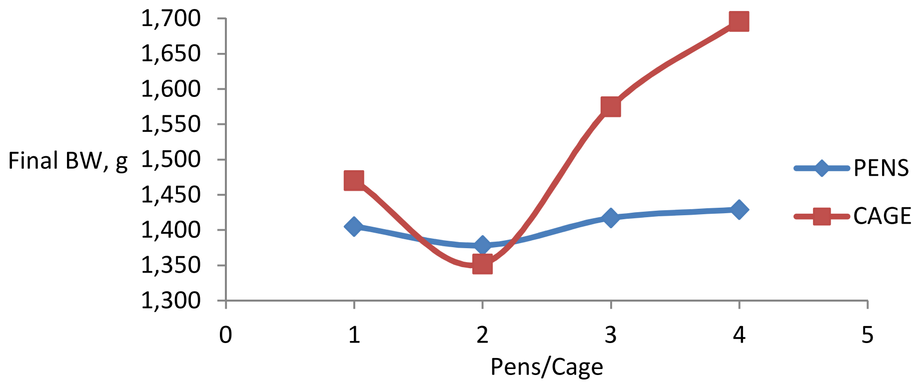

Figure 3: Final Body Weights (BW) for different housings July-September (JS) experiment.