Farmers’ choice of genotypes and trait preferences in tropically adapted chickens in five agro-ecological zones in Nigeria

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Abstract
This study aimed at determining chicken genotypes of choice and traits preference in chicken by smallholder farmers in Nigeria. Data were obtained from a total of 2063 farmers using structured questionnaires in five agro-ecological zones in Nigeria. Chi square ($\chi^2$) statistics was used to explore relationships between categorical variables. The mean ranks of the six genotypes and twelve traits of preference were compared using the non-parametric Kruskal–Wallis $H$ (with Mann–Whitney $U$ test for post hoc separation of mean ranks), Friedman, and Wilcoxon signed-rank (with Bonferroni’s adjustments) tests. Categorical principal component analysis (CATPCA) was used to assign farmers into groups. Gender distribution of farmers was found to be statistically significant ($\chi^2 = 16.599; P \leq 0.002$) across the zones. With the exception of Shika Brown, preferences for chicken genotypes were significantly ($P \leq 0.01$) influenced by agro-ecological zone. However, gender differentiated response was only significant ($P \leq 0.01$) in Sasso chicken with more preference by male farmers. Overall, FUNAAB Alpha, Sasso, and Noiler chicken were ranked 1st, followed by Kuroiler (4th), Shika Brown (5th), and Fulani birds (6th), respectively. Within genotypes, within and across zones and gender, preferences for traits varied significantly ($P \leq 0.005$ and $P \leq 0.01$). Traits of preference for selection of chicken breeding stock tended towards body size, egg number, egg size, and meat taste. Spearman’s rank order correlation coefficients of traits of preference were significant ($P \leq 0.01$) and ranged from 0.22 to 0.90. The two PCs extracted, which explained 65.3% of the variability in the dataset, were able to assign the farmers into two groups based on preference for body size of cock and hen and the other ten traits combined. The present findings may guide the choice of appropriate chicken genotypes while the traits of economic importance may be incorporated into future genetic improvement and conservation programs in Nigeria.

Keywords Chicken · Traits · Non-parametric · Multivariate analysis · Tropics

Introduction
Indigenous chicken are widely distributed in the rural areas of tropical and sub-tropical countries (Ajayi 2010). The birds play a key role for the poor farmers and the underprivileged within the rural setting as regards subsidiary income, provision of chicken meat and eggs (Padhi 2016) and food security (Melesse 2014). In spite of this, smallholder poultry sub-sector in sub-Saharan Africa is beset with myriad of problems among which are poor nutrition, limited technical know-how,
vagaries of climatic factors, slow-growing, low meat yield, small size/number of eggs, low input, and high mortality (Yakubu, 2010; Ayanwale et al. 2015; Dessie, 2017).

In order to address the factors militating against high chicken production and productivity at the smallholder level, research efforts in the area of genetics and breeding “among others” have been made in the past three decades (Adebokun and Sonaiya 2002; Sonaiya 2016). One of such is the development of chicken genotypes that are adapted to the prevailing tropical conditions (Adebambo et al. 2018). However, it has been reported that the proper identification of appropriate chicken breeds that will be suitable to a particular environment or agro-ecological zone in Nigeria is required for the growth and development of the poultry industry (Hassan et al. 2018). Such decision on the chicken genotypes of preference is expected to be based on farmers’ choice especially at the smallholder level using the bottom-up approach. This coupled with farmers’ traits of preference may be valuable inputs for appropriate design and implementation of agro-ecologically friendly and sustainable genetic improvement programs of the indigenous stock. Knowledge of trait preferences for breeding decisions is central to the formulation of livestock policies aimed at improving the livelihoods of smallholder chicken farmers. Evaluation of trait preferences of local poultry producers is required for the design of appropriate breeding programs (Brown et al. 2017). This may be particularly indispensable under the free scavenging production system (Markos et al. 2016), where the economic weights of traits could be difficult to calculate and also permit the inclusion of non-market traits in the economic valuation of the chicken (Bett et al. 2011). This assertion is believed to be workable only when due emphasis has been laid on the phenotypic and genetic correlations as well as the heritability of the traits. This is in consonance with the recommendations of Woldu et al. (2016), Traoré et al. (2017), and Peruch et al. (2019). The attendant effect may be holistic improvement, sustainable utilization, as well as rational conservation of the indigenous chicken to improve the living standard of the smallholder farmers (Markos et al. 2016). However, future breeding studies on preference traits should also put into consideration the interests of marketers and consumers. This is because of the probable rejection of chicken/chicken products that do not include the traits of preference of some critical stakeholders along the poultry value chain. Similar findings were reported by Okeno et al. (2011) where breeding programs designed without inputs from all the relevant stakeholders stood a high risk of being rejected by the end users.

Under the African Chicken Genetic Gains (ACGG) project, Kuroiler and Sasso birds (foreign, but tropically adapted genotypes) alongside the newly developed Nigerian indigenous FUNAAB alpha, as well as the Shika Brown, Fulani, and Noiler chicken were tested in five agroecological zones of Nigeria. This study, therefore, aimed at evaluating choice of chicken genotypes and trait preferences by smallholder chicken farmers in Nigeria. This may assist in future research efforts on genotypes and traits of economic importance by private and public intervention programs geared towards boosting smallholder chicken production.

Materials and methods

Description of study area

The post on-farm data collection study was conducted in five agro-ecological zones under the African Chicken Genetic Gains (ACGG) project in Nigeria. The ACGG is a platform for testing, delivering, and continuously improving tropically adapted chickens for productivity growth in 3 selected African countries: Ethiopia, Tanzania, and Nigeria (www.africaggg.net). In Nigeria, the on-farm test was conducted from 2016 to 2018. It was a randomized complete block design (RCBD) of 420 farmers per agro-ecology. The breeds were randomly allocated to the farmers, and each farmer received one breed of 30 birds at 6 weeks old. The birds were managed under the traditional poultry scavenging system in all the five zones. Each zone was represented by a State [Kwara (Humid Kishin-Ilorin-Kabba Plain), Rivers (Very Humid/Per Humid Niger-Delta), Imo (Very Humid Onitsha-Enugu-Abakaliki-Calabar Lowland and Scarpland), Nasarawa (Sub-Humid Central Niger-Benue Trough) and Kebbi (Dry Sub-Humid Illela-Sokoto-Yelwa Plain)] as delineated by NSPFS (2005) (Table 1).

Management of birds

The feeding of birds was supplemented with readily available commercial feeds, agricultural by-products and kitchen wastes. Health management practice was also carried out based on the capacity of the farmers. The study was conducted between December 2017 and August 2018.

Sampling procedure

A total of 2100 (420 per zone) rural chicken keepers from five zones (Kwara, Rivers, Imo, Nasarawa, and Kebbi) were randomly sampled. In each zone, twelve villages, two per local government area (LGA) in each of the three senatorial districts were randomly selected. However, data for final analysis were only available for 2063 farmers. The distribution of the participating farmers that were earlier given a certain number of Sasso, Kuroiler, Fulani, Shika Brown, Noiler, and FUNAAB alpha birds for the on-farm testing (for periodic performance data collection such as body weight and egg parameters of birds) is shown in Table 2. The ethical guidelines of International Livestock Research Institute (ILRI), Ethiopia,
were strictly adhered to. The present study was approved by the ILRI Institutional Research Ethics Committee (ILRI IREC) with reference no.: ILRI-IREC2015-08/1. Each farmer also gave written informed consent to participate in the study in line with best global practices.

Data collection procedure

Structured questionnaires were used to elicit information on the gender of farmers, the choice of chicken genotypes and traits of preference in a post-on-farm data collection survey. During the on-farm test, the farmers met every quarter in each project village, at the community innovation platform, to among other things compare the performance of the breeds allocated to them. Based on individual experience over time, each farmer was asked to assess subjectively the performance of the genotype given to him/her and indicate Yes/No his or her preference for the genotype. Where the response was not in the affirmative, the farmer was asked to indicate a ready alternative chicken genotype to the one he/she was given. Information on the farmers’ preferences for traits of economic importance that influenced their choice of a particular genotype was also obtained. The traits (body size – cock; body size – hen; supplementary feed consumption – cock; supplementary feed consumption – hen; egg number – hen; egg size – hen; scavenging ability – cock; scavenging ability – hen; meat taste – cock; meat taste – hen; ease of sales – cock and ease of sales – hen) as perceived by the respondents were ranked on a scale of one (Like very much), two (Like), three (Not Important), four (Dislike), five (Dislike very much), six (Not Applicable).

Statistical analysis

Chi-square ($\chi^2$) statistics was used to explore relationships between the gender of farmers and zones, chicken genotype of choice by the farmers as well as the alternative genotype across zones and according to gender. Within each genotype, zone and gender, comparisons of means were performed using the Friedman test. For post hoc separation we used the non-parametric Kruskal-Wallis $H$ test followed by the Mann-Whitney $U$ test for post hoc separation of mean ranks. The non-parametric Wilcoxon signed-rank test with Bonferroni’s adjustment (Dossa et al. 2015; Yakubu et al. 2019) was used for between-genotype, between-zone and within-genotype, within- and between-zone comparisons of the traits of economic importance. Within each zone and gender, comparisons of means were performed using the post hoc analysis of variance test followed by the non-parametric Wilcoxon signed-rank test with Bonferroni’s adjustment (Dossa et al. 2015; Yakubu et al. 2019).

Table 1

| Features | Zone          |
|----------|--------------|
|          | Kwara        | Rivers       | Imo          | Nasarawa     | Kebbi        |
|          | GPS coordinates |             |             |             |             |
|          | Between latitudes 8° 30’ N and 8° 50’ N and 4° E 20’ and 4° 35’ E | Between latitudes 4° 45’ N and longitude 6° 50’ E | Between latitudes 4° 45’ N and longitude 7° 15’ N and 6° 50’ E | Between latitudes 7° 52’ N and 8° 56’ N and longitude 7° 25’ E and 9° 37’ E | Between latitudes 4° 45’ N and longitude 6° 50’ E |
| Temperature (°C) | 26.8          | 26.7         | 26.4         | 28.4         | 28.4         |
| Relative humidity (%) | 74.4          | 83.4         | 80.0         | 74.0         | 47.4         |
| Rainfall (mm, per annum) | 1217          | 2708         | 2219         | 1169         | 807          |
| Land mass (km²) | 35,705        | 10,575       | 5,288        | 28,735       | 36,985       |
| Human population | 2,365,353     | 5,198,716    | 3,927,563    | 1,869,377    | 3,256,541    |
| Major ethnic group | Yoruba        | Ogoni        | Igbo         | Egon          | Hausa-Fulani |
| Major economic activities | Agriculture | Oil, agriculture, and fishing | Agriculture and oil | Agriculture and solid minerals | Agriculture and fishing |

Sources: NPC (2006); NBS (2011); Eludoyin et al. (2013); Esiohu and Onubuogu (2014)
ranks of the traits of economic importance was also used for the comparison between zones and gender.

In order to explore hidden patterns of trait preferences for appropriate grouping of the respondents, categorical principal component analysis (CATPCA) procedure was used as described by Martin-Collado et al. (2015). The varimax criterion with Kaiser normalization was used to rotate the PC matrix to facilitate easy interpretation of the analysis. Chronbach’s alpha was used to test the reliability of the PCA. The PCA was preceded by Spearman’s rank order correlation analysis of farmers’ traits of preference to indicate the directional effects and plausible trade-offs between traits. IBM (2015) statistical package was employed in the analysis.

Results

Gender distribution was found to be statistically significant ($\chi^2 = 16.599; P \leq 0.002$) across the zones. More male households were found in Kwara (163, 38.9%), Kebbi (134, 32.0%), and Nasarawa (131, 31.2%) while the female respondents were more in Imo (310, 73.8%), Nasarawa (289, 68.8%), and Kebbi (285, 68.0%), respectively (Fig. 1).

The preference for a chicken genotype was significantly ($P \leq 0.01$) influenced by agro-ecological zone with the exception of Shika Brown (percentage likeness for this genotype ranged from 52.6 to 72.3%) (Table 3). There was high preference for FUNAAB Alpha in Rivers (90.9%), Nasarawa (89.6%), and Kebbi (87.5%), respectively. The preference for Kuroiler was also high in Imo (88.1%), Rivers (83.1%), and Kwara (81.0%). Similarly, 91.7 (Imo), 88.0 (Rivers), 79.8 (Nasarawa), and 73.8% (Kwara) of the farmers given Sasso chicken expressed their likeness for the birds. On the other hand, 88.1 (Nasarawa), 86.9 (Imo), and 79.8 (both Kwara and Kebbi) showed high preference for Noiler birds. However, the Fulani birds were least preferred by farmers across zones (5.6–48.5%).

The likeness of Shika Brown, FUNAAB Alpha, Fulani, Kuroiler, and Noiler birds was not significantly ($P > 0.05$) influenced by gender (Table 4). However, there was significant ($P \leq 0.05$) gender effect as regards preference for Sasso chicken in the direction of male farmers.

Out of a total of 599 farmers who did not like the particular genotypes given to them; when they were asked to indicate the alternative genotypes they preferred, their interest varied significantly ($\chi^2 = 230.006; P \leq 0.01$) across zones (Table 5). From this, there was high preference for Sasso, Noiler, FUNAAB Alpha, and Kuroiler.

Gender had no significant effect ($\chi^2 = 10.134; P \leq 0.07$) across alternative genotypes, although the number of female farmers was higher (Fig. 2): males [Shika Brown (11, 6.4%), FUNAAB Alpha (29, 16.8%), Fulani (3, 1.7%), Kuroiler (37, 21.4%), Sasso (57, 32.9%), and Noiler (36, 20.8%)] and females [Shika Brown (37, 8.7%), FUNAAB Alpha (81, 19.0%), Fulani (17, 4.0%), Kuroiler (57, 13.4%), Sasso (123, 28.9%), and Noiler (111, 26.1%)].

In order to appropriately rank the five chicken genotypes, data on actual chicken genotype preferences across zones (Table 3 above) and those of the alternative genotypes (Table 5 above) were combined (Table 6). Equal ranking (1st position) was observed in the case of FUNAAB Alpha, Sasso, and Noiler birds. Kuroiler, Shika Brown, and Fulani chickens were ranked 4th, 5th, and 6th, respectively.

Within-genotype ranking of the chickens is shown in Table 7. Farmers appeared to attach importance ($P \leq 0.01$) to BSC, BSH, ENH, EZH, MTC, and MTH in the choice of

### Table 2 The distribution of respondents based on zone and chicken genotype

| Zone     | Fulani | FUNAAB Alpha | Shika Brown | Noiler | Kuroiler | Sasso | Total |
|----------|--------|--------------|-------------|--------|----------|-------|-------|
| Kwara    | 36     | 48           | 83          | 84     | 84       | 84    | 419   |
| Rivers   | 33     | 44           | 77          | 77     | 77       | 77    | 385   |
| Imo      | 36     | 48           | 84          | 84     | 84       | 84    | 420   |
| Nasarawa | 36     | 48           | 84          | 84     | 84       | 84    | 420   |
| Kebbi    | 36     | 48           | 84          | 84     | 84       | 83    | 419   |
| Grand total |        |              |             |        |          |       | 2063  |

![Fig. 1 Gender distribution of households](image-url)
Shika Brown, FUNAAB Alpha, Fulani, Kuroiler, Sasso, and Noiler chickens (Table 5). Additionally, SAH, SAC, SFH, and SFC were highly ($P \leq 0.01$) ranked in Fulani birds while Noiler farmers also rated higher SFH and SFC.

Across genotypes, higher ratings of BSC and BSH were more ($P \leq 0.001$) evident in FUNAAB Alpha, Sasso, Noiler, and Kuroiler (Table 8). However, ENH and EZH were more prioritized ($P \leq 0.001$) in Shika Brown, SFC (Noiler and Fulani) and SFH (Noiler, Fulani and FUNAAB Alpha) were also highly rated. Preferences for SAC and SAH were higher ($P \leq 0.001$) in Fulani, FUNAAB Alpha, and Shika Brown (also have higher rating for MTC and MTH). There was almost equal preference for ease of sales of cocks and hens.

Across all genotypes within a specific zone, traits preference varied significantly ($P \leq 0.01$) (Table 9). In Kwara, farmers tended to favour BSC, BSH, ENH, SFH, EZH, SAH, and MTH. Farmers in Rivers ranked SAC and ESC lowest. In Imo, farmers were more favorably disposed to BSC, BSH, MTC, MTH, and EZH with less emphasis on SFC and SFH. In Nasarawa, SAH and SAC were ranked lowest while ESC, BSC, BSH, MTC, MTH, EZH, and ESH were highly ranked. BSC, BSH, and SAH were the traits prioritized in Kebbi.

Trait preferences irrespective of chicken genotypes varied across the five zones ($P \leq 0.01$) (Table 10). BSC, BSH, SAC, and SAH were ranked highest in Kebbi compared to others. However, farmers in Nasarawa attached more importance to EZH, MTC, MTH, ESC, and ESH in comparison with their counterparts from other zones. Farmers in Kwara had the least ranking for most of the traits. However, there was similarity in the ranking of the traits between farmers in Rivers and Imo.

Within each gender, trait preference varied significantly ($P \leq 0.01$) with the exception of BSC, BSH, MTC, and MTH that were highly ranked by both male and female farmers (Table 11). ENH, EZH, ESC, ESH, SAC, and SAH were more rated by the male farmers.

SFC (ranked higher by males) was the only trait significantly ($P \leq 0.05$) influenced by gender (Table 12). However, the significance values of SFH (females; $P \leq 0.055$) and BSH (males; $P \leq 0.082$) were closer to ($P \leq 0.05$) compared with those of ENH, ESC, BSC, SAC, EZH, MTC, ESH, and MTH, respectively.

Supplementary feed consumption (0.90), scavenging ability (0.87), meat quality trait (0.86), ease of sales (0.85), body size (0.83), and egg trait (0.80) measurements were strongly and significantly ($P \leq 0.01$) related (Table 13). The correlation coefficients between MTC and ESC (0.65) and MTH and ESH (0.68) were also high ($P \leq 0.01$). The relationship between MTC and ESC (0.60) as well as that of MTH and ESC (0.62) was equally strong ($P \leq 0.01$).

Table 3  Chicken genotype preference by farmers across zones in Nigeria

| Factor         | Zone          | Kwara No. (%) | Rivers No. (%) | Imo No. (%) | Nasarawa No. (%) | Kebbi No. (%) | Chi-square | $P$ value |
|----------------|---------------|---------------|---------------|-------------|------------------|---------------|------------|-----------|
| Genotype       |               |               |               |             |                  |               |            |           |
| Shika Brown    | Liked         | 49 (59.0)     | 40 (52.6)     | 60 (72.3)   | 48 (57.1)        | 52 (61.9)     | 7.342      | 0.119**   |
|                | Not liked     | 34 (41.0)     | 36 (47.4)     | 23 (27.7)   | 36 (42.9)        | 32 (38.1)     |            |           |
| FUNAAB Alpha   | Liked         | 38 (79.2)     | 40 (90.9)     | 30 (62.5)   | 43 (89.6)        | 42 (87.5)     |            |           |
|                | Not liked     | 10 (20.8)     | 4 (9.1)       | 18 (37.5)   | 5 (10.4)         | 6 (12.5)      | 17.671     | 0.01**    |
| Fulani         | Liked         | 17 (47.2)     | 16 (48.5)     | 3 (8.3)     | 2 (5.6)          | 14 (38.9)     |            |           |
|                | Not liked     | 19 (52.8)     | 17 (51.5)     | 33 (91.7)   | 34 (94.4)        | 22 (61.1)     | 30.433     | 0.01**    |
| Kuroiler       | Liked         | 68 (81.0)     | 64 (83.1)     | 74 (88.1)   | 58 (69.0)        | 52 (64.2)     |            |           |
|                | Not liked     | 16 (19.0)     | 13 (16.9)     | 10 (11.9)   | 26 (31.0)        | 29 (35.8)     | 18.743     | 0.01**    |
| Sasso          | Liked         | 62 (73.8)     | 66 (88.0)     | 77 (91.7)   | 67 (79.8)        | 50 (60.2)     |            |           |
|                | Not liked     | 22 (26.2)     | 9 (12.0)      | 7 (8.3)     | 17 (20.2)        | 33 (39.8)     | 30.246     | 0.01**    |
| Noiler         | Liked         | 67 (79.8)     | 47 (61.0)     | 73 (86.9)   | 74 (88.1)        | 67 (79.8)     |            |           |
|                | Not liked     | 17 (20.2)     | 30 (39.0)     | 11 (13.1)   | 10 (11.9)        | 17 (20.2)     | 22.675     | 0.01**    |

*ns* Significant at $P \leq 0.01$; not significant
Two PCs were extracted which explained 65.3% (Table 14) of the variability in the dataset. The first PC with Eigen value 5.421 contributed 45.2% to the total variance. It was characterized by supplementary feed consumption–cock; supplementary feed consumption–hen; egg number–hen; egg size–hen; scavenging ability–cock; scavenging ability–hen; meat taste–cock; meat taste–hen; ease of sales–cock and ease of sales–hen. However, body size in both cock and hen had high and positive loadings on the second PC with eigenvalue 2.416 and 20.1% contribution to the variance total. The total Cronbach’s alpha value of 0.952 was very high, which is an indication of the reliability of the PCA. Irrespective of gender and agro-ecological zone, the farmers can be grouped into two: Those that emphasize body size in both cock and hen and those that attach more importance to supplementary feed consumption–cock; supplementary feed consumption–hen; egg number–hen; egg size–hen; scavenging ability–cock; scavenging ability–hen; meat taste–cock; meat taste–hen; ease of sales–cock and ease of sales–hen.

Table 4  Chicken genotype preference according to gender of farmers in Nigeria

| Genotype      | Gender | Male No. (%) | Female No. (%) | Chi-square | P value |
|---------------|--------|--------------|----------------|------------|---------|
| Shika Brown   | Liked  | 71 (58.2)    | 178 (61.8)     | 0.468      | 0.494***|
|               | Not liked | 51 (41.8)   | 110 (38.2)     |            |         |
| FUNAAB Alpha  | Liked  | 62 (81.6)    | 131 (81.9)     |            |         |
|               | Not liked | 14 (18.4)  | 29 (18.1)      | 0.003      | 0.956***|
| Fulani        | Liked  | 20 (33.3)    | 32 (27.4)      | 0.684      | 0.408***|
|               | Not liked | 40 (66.7)   | 85 (72.6)      |            |         |
| Kuroiler      | Liked  | 93 (79.5)    | 223 (76.1)     | 0.540      | 0.462***|
|               | Not liked | 24 (20.5)  | 70 (23.9)      |            |         |
| Sasso         | Liked  | 109 (85.8)   | 213 (75.3)     |            |         |
|               | Not liked | 18 (14.2)  | 70 (24.7)      | 0.119      | 0.016*  |
| Noiler        | Liked  | 121 (81.8)   | 207 (78.1)     | 0.771      | 0.380***|
|               | Not liked | 27 (18.2)  | 58 (21.9)      |            |         |

*Significant at $P \leq 0.05$; **not significant

Table 5  Alternative chicken genotype preference by farmers across zones in Nigeria

| Zone          | Kwara No. (%) | Rivers No. (%) | Imo No. (%) | Nasarawa No. (%) | Kebbi No. (%) | Chi-square | P value |
|---------------|---------------|----------------|-------------|------------------|--------------|------------|---------|
| Genotype      | Shika Brown   | 5 (4.3)        | 9 (8.3)     | 17 (16.2)        | 3 (2.3)      | 14 (10.0)  |         |
|               | FUNAAB α      | 20 (17.1)      | 17 (15.6)   | 5 (4.8)          | 12 (9.4)     | 56 (40.0)  |         |
|               | Fulani        | 11 (9.4)       | 2 (1.8)     | 1 (1.0)          | 0 (0.0)      | 6 (4.3)    |         |
|               | Kuroiler      | 32 (27.4)      | 19 (17.4)   | 19 (18.1)        | 13 (10.2)    | 11 (7.9)   |         |
|               | Sasso         | 21 (17.9)      | 56 (51.4)   | 54 (51.4)        | 43 (33.6)    | 6 (4.3)    |         |
|               | Noiler        | 28 (23.9)      | 6 (5.5)     | 9 (8.6)          | 57 (38.8)    | 47 (33.6)  | 230.006  | 0.01*** |

α alpha

**Significant at $P \leq 0.01$

Discussion

The preponderance of females over males could be attributed to the fact that the primary targets of ACGG project are women and youth. This could have influenced the deliberate selection of more female households than their male counterparts. However, it is generally believed that more women are involved in poultry activities compared to men. This was
corroborated by earlier studies (Bagnol 2009; Paudel et al. 2009; Fida et al. 2018).

The high preference for FUNAAB Alpha, Sasso, and Noiler birds in the present study could be due to their desirable performance in the field. This could have been influenced mainly by their body size and egg number. Although Kuroiler was ranked fourth, it was able to compete well with Sasso and Noiler chicken. This implies that in the case of non-availability of the latter, Kuroiler could be a good substitute. The low ranking of Shika Brown might be attributed to the fact that the breed was developed mainly for egg production unlike others that are dual-purpose. The least preference for Fulani chicken could be as a result of its low productivity compared to other genotypes [6-week body weight of 416.82 g (Sasso), 450.86 g (Kuroiler), and 228.66 g (Fulani) (Yakubu and Ari 2018); 20-week body weight (cocks) of 1.3 g (Fulani), 2.1 g (Fhana Alpha), 1.7 g (Shika Brown), 2.9 g (Kuroiler), 3.0 g (Sasso), and 2.6 g (Noiler) (Adebambo et al. 2018)]. However, this genotype is renowned for its high adaptability to the prevailing hot-dry tropical environment of Nigeria (Yakubu and Ari 2018) and good scavenging ability. Some of the merits indicated by farmers for the choice of a

| Genotype       | Liked No. (%) | Not liked No. (%) | Mean rank | Kruskall–Wallis test | Position |
|---------------|---------------|------------------|-----------|----------------------|----------|
| Shika Brown   | 297 (64.8)    | 161 (35.2)       | 1496.65c  |                      | 5th      |
| FUNAAB Alpha  | 303 (87.6)    | 43 (12.4)        | 1194.98a  |                      | 1st      |
| Fulani        | 72 (36.5)     | 125 (63.5)       | 1872.32d  |                      | 6th      |
| Kuroiler      | 410 (81.3)    | 94 (18.7)        | 1277.59b  |                      | 4th      |
| Sasso         | 502 (85.1)    | 88 (14.9)        | 1228.00ab |                      | 1st      |
| Noiler        | 475 (84.8)    | 85 (15.2)        | 1311.50ab | 292.970**            | 1st      |

Means in columns followed by different letters are different significantly ($P \leq 0.05$)

**Significant at $P \leq 0.01$

* The lower the mean, the more important the genotype

Table 6: Ranking of preferred chicken genotypes by farmers in Nigeria

| Traits | Shika Brown Mean | FUNAAB Alpha Mean | Fulani Mean | Kuroiler Mean | Sasso Mean | Noiler Mean |
|--------|------------------|------------------|-------------|---------------|------------|-------------|
| BSC    | 1.45 ± 0.68a     | 1.32 ± 0.68a     | 1.85 ± 0.99a | 1.46 ± 0.89a  | 1.54 ± 1.05a | 1.39 ± 0.69a |
| BSH    | 1.58 ± 0.83b     | 1.37 ± 0.67a     | 1.74 ± 0.92a | 1.52 ± 0.89a  | 1.61 ± 1.07a | 1.44 ± 0.74a |
| SFC    | 2.09 ± 1.28d     | 2.05 ± 1.31c     | 2.02 ± 1.09ab | 2.08 ± 1.23c  | 2.30 ± 1.31d | 1.86 ± 1.15b |
| SFH    | 2.04 ± 1.18d     | 1.97 ± 1.17c     | 1.97 ± 1.07a | 2.07 ± 1.21c  | 2.27 ± 1.19d | 1.80 ± 0.95b |
| ENH    | 1.66 ± 1.08b     | 1.72 ± 0.96b     | 2.03 ± 1.04ab | 2.02 ± 1.24c  | 2.13 ± 1.23c | 1.73 ± 0.84b |
| EZH    | 1.70 ± 1.14b     | 1.81 ± 1.03bc    | 2.44 ± 1.28b | 1.90 ± 1.19b  | 2.05 ± 1.23c | 1.75 ± 0.81b |
| SAC    | 1.98 ± 1.15cd    | 2.05 ± 1.37c     | 1.81 ± 0.90a | 2.16 ± 1.32c  | 2.26 ± 1.32d | 2.09 ± 1.19d |
| SAH    | 1.92 ± 1.00c     | 1.86 ± 1.10bc    | 1.77 ± 0.88a | 2.02 ± 1.11c  | 2.16 ± 1.14d | 1.97 ± 0.96cd |
| MTC    | 1.71 ± 1.24b     | 1.88 ± 1.32bc    | 1.85 ± 1.16a | 1.89 ± 1.37b  | 2.02 ± 1.51c | 1.89 ± 1.24b |
| MTH    | 1.65 ± 1.00b     | 1.77 ± 1.06bc    | 1.84 ± 1.09a | 1.88 ± 1.13b  | 1.88 ± 1.11b | 1.85 ± 0.91b |
| ESC    | 1.92 ± 1.47c     | 2.01 ± 1.60c     | 2.27 ± 1.37b | 2.14 ± 1.59c  | 2.24 ± 1.71d | 1.90 ± 1.44bc |
| ESH    | 1.94 ± 1.26cd    | 1.90 ± 1.23bc    | 2.23 ± 1.35b | 2.03 ± 1.30c  | 2.17 ± 1.35d | 1.83 ± 1.08b |
| Friedman test | 176.808 | 246.979         | 40.095 | 275.042 | 383.830 | 441.899 |
| Asymptotic Sig. | $P < 0.05$ | $P < 0.05$ | $P < 0.05$ | $P < 0.05$ | $P < 0.05$ | $P < 0.05$ |

Means in columns followed by different letters are different at the Bonferroni-adjusted significance level $P \leq 0.004$ (Friedman test followed by Wilcoxon signed-rank post hoc tests with Bonferroni’s correction for multiple comparisons)

BSC body size–cock, BSH body size–hen, SFC supplementary feed consumption–cock, SFH supplementary feed consumption–hen, ENH egg number–hen, EZH egg size–hen, SAC scavenging ability–cock, SAH scavenging ability–hen, MTC meat taste–cock, MTH meat taste–hen, ESC ease of sales–cock, ESH ease of sales–hen, SD standard deviation

* The lower the mean, the more important the trait
### Table 8  
Mean ranks of traits preference across six chicken genotypes and their significance level according to Kruskall–Wallis test

| Genotype | Shika Brown | FUNAAB Alpha | Fulani | Kuroiler | Sasso | Noiler |
|----------|-------------|--------------|--------|----------|-------|--------|
| **BSC**  | 1082.90b    | 971.94a      | 1351.16c | 1018.16ab| 1010.99ab| 1012.96ab | 40.292** |
| **BSH**  | 1088.59b    | 974.47a      | 1230.45c | 1023.56ab| 1010.54a | 1002.51a | 21.008** |
| **SFC**  | 1013.94b    | 991.78b      | 975.38ab | 1014.69b | 1096.48c| 911.83a  | 28.286** |
| **SFH**  | 1005.98b    | 971.39a      | 939.06ab | 1001.40b | 1102.78c| 910.31a  | 32.361** |
| **ENH**  | 801.83a     | 878.48b      | 1059.23c| 982.83bc | 1042.54c| 925.90b  | 49.808** |
| **EZH**  | 821.92a     | 924.11b      | 1197.42d| 936.70bc | 1007.94c| 951.92bc | 39.894** |
| **SAC**  | 965.69ab    | 946.06a      | 1059.87b| 1000.97b | 1018.89b| 956.98b  | 21.744** |
| **SAH**  | 982.42ab    | 912.29a      | 939.06ab | 1001.40b | 1102.78c| 910.31a  | 22.065** |
| **MTC**  | 911.95a     | 1029.04b     | 1059.87b| 1000.97b | 1018.89b| 956.98b  | 14.402*  |
| **MTH**  | 877.24a     | 970.45b      | 1012.48bc| 1010.54bc| 999.60bc| 1056.98c | 21.744** |
| **ESC**  | 933.71a     | 977.94a      | 1094.91b| 926.91ab | 928.25a | 1028.14b | 16.222** |
| **ESH**  | 933.71a     | 977.94a      | 1094.91b| 926.91ab | 928.25a | 1028.14b | 16.222** |

The lower the mean rank, the more important the trait. Means followed by different letters in rows are different [Kruskall–Wallis test followed by Mann–Whitney U tests (P ≤ 0.05)].

*BSC* body size–cock, *BSH* body size–hen, *SFC* supplementary feed consumption–cock, *SFH* supplementary feed consumption–hen, *ENH* egg number–hen, *EZH* egg size–hen, *SAC* scavenging ability–cock, *SAH* scavenging ability–hen, *MTC* meat taste–cock, *MTH* meat taste–hen, *ESC* ease of sales–cock, *ESH* ease of sales–hen

*, **Asymptotic significance at P ≤ 0.005 and P ≤ 0.001, respectively

### Table 9  
Mean (± SD) of traits preference in chicken and their significance level according to Friedman test within each zone

| Zone       | Kwara Mean* | Rivers Mean* | Imo Mean* | Nasarawa Mean* | Kebbi Mean* |
|------------|-------------|--------------|-----------|----------------|-------------|
| **BSC**    | 1.60 ± 0.81a| 1.68 ± 1.12a | 1.54 ± 0.83a| 1.34 ± 0.73ab  | 1.16 ± 0.53a |
| **BSH**    | 1.65 ± 0.83a| 1.75 ± 1.12b | 1.64 ± 0.93b| 1.37 ± 0.72ab  | 1.22 ± 0.56b |
| **SFC**    | 2.52 ± 1.50b| 2.20 ± 1.10c | 2.31 ± 1.23e| 1.69 ± 1.10ef  | 1.82 ± 1.23c |
| **SFH**    | 2.34 ± 1.24b| 2.18 ± 1.06cd| 2.27 ± 1.15e| 1.72 ± 1.07f   | 1.75 ± 1.07de|
| **ENH**    | 2.32 ± 1.46b| 2.06 ± 0.99c | 2.03 ± 1.13d| 1.52 ± 0.78de  | 1.65 ± 0.98cd|
| **EZH**    | 2.36 ± 1.48b| 2.07 ± 1.06c | 1.88 ± 1.02c| 1.49 ± 0.76cd  | 1.78 ± 1.07de|
| **SAC**    | 2.79 ± 1.77d| 2.34 ± 1.23d | 2.11 ± 1.07d| 1.89 ± 1.02g   | 1.66 ± 1.05cd|
| **SAH**    | 2.56 ± 1.44bc| 2.17 ± 1.00c | 1.98 ± 0.89cd| 1.88 ± 1.03g   | 1.56 ± 0.75c |
| **MTC**    | 2.97 ± 2.01e| 2.14 ± 1.52c | 1.69 ± 1.01b| 1.41 ± 0.61bc  | 1.66 ± 0.99cd|
| **MTH**    | 2.72 ± 1.54cd| 1.91 ± 1.02bc| 1.73 ± 0.93b| 1.44 ± 0.62bcd | 1.62 ± 0.70cd|
| **ESC**    | 3.29 ± 2.04f| 2.36 ± 1.69d | 1.90 ± 1.25cd| 1.32 ± 0.68a   | 1.91 ± 1.52c |
| **ESH**    | 2.99 ± 1.64e| 2.09 ± 1.13c | 1.99 ± 1.20cd| 1.49 ± 0.84cd  | 1.75 ± 1.06de|
| Friedman test (chi-square) | 388.533 | 232.91 | 378.733 | 484.311 | 375.744 |

Means in columns followed by different letters are different at the Bonferroni-adjusted significance level P ≤ 0.004 (Friedman test followed by Wilcoxon signed-rank post hoc tests with Bonferroni’s correction for multiple comparisons)

*BSC* body size–cock, *BSH* body size–hen, *SFC* supplementary feed consumption–cock, *SFH* supplementary feed consumption–hen, *ENH* egg number–hen, *EZH* egg size–hen, *SAC* scavenging ability–cock, *SAH* scavenging ability–hen, *MTC* meat taste–cock, *MTH* meat taste–hen, *ESC* ease of sales–cock, *ESH* ease of sales–hen

*a* The lower the mean, the more important the trait

SD standard deviation
particular genotype in the current study are similar to the egg productivity, body size and fast growth traits reported by Sisay et al. (2018) and Mahoro et al. (2018). Gender differences in the present study as regards the choice of Sasso chicken breed

| Traits | Kwara Mean rank | Rivers Mean rank | Imo Mean rank | Nasarawa Mean rank | Kebbi Mean rank | Kruskall–Wallis test | Asymptotic significance |
|--------|----------------|-----------------|--------------|-------------------|----------------|---------------------|-------------------------|
| BSC    | 1189.20d       | 1101.00c        | 1148.59cd    | 934.50b           | 815.54a        | 160.429             | ≤ 0.01                 |
| BSH    | 1162.02c       | 1108.26c        | 1135.43c     | 919.35b           | 826.32a        | 137.414             | ≤ 0.01                 |
| SFC    | 1206.66c       | 1133.27b        | 1110.27b     | 777.76a           | 814.81a        | 217.365             | ≤ 0.01                 |
| SFH    | 1181.58b       | 1126.19b        | 1097.60b     | 801.50a           | 793.50a        | 199.583             | ≤ 0.01                 |
| ENH    | 1083.77b       | 1057.04b        | 998.20b      | 776.76a           | 817.72a        | 128.954             | ≤ 0.01                 |
| EZH    | 1101.44d       | 1024.71c        | 1036.81cd    | 877.62b           | 108.628        | 161.247             | ≤ 0.01                 |
| SAC    | 1167.70c       | 1108.28c        | 1135.43c     | 916.90b           | 760.55a        | 154.146             | ≤ 0.01                 |
| SAH    | 1175.48d       | 1096.71c        | 1058.74c     | 754.13a           | 154.146        | 123.535             | ≤ 0.01                 |
| MTC    | 1236.80d       | 1032.73c        | 1006.82bc    | 939.67b           | 126.289        | 126.289             | ≤ 0.01                 |
| MTH    | 1220.33d       | 1015.01c        | 1018.57bc    | 933.24b           | 126.289        | 126.289             | ≤ 0.01                 |
| ESC    | 1327.31d       | 1040.45c        | 965.41bc     | 902.63b           | 281.623        | 214.355             | ≤ 0.01                 |
| ESH    | 1277.50d       | 1020.14c        | 975.56c      | 865.73b           | 214.355        | 214.355             | ≤ 0.01                 |

BSC body size–cock, BSH body size–hen, SFC supplementary feed consumption–cock, SFH supplementary feed consumption–hen, ENH egg number–hen, EZH egg size–hen, SAC scavenging ability–cock, SAH scavenging ability–hen, MTC meat taste–cock, MTH meat taste–hen, ESC ease of sales–cock, ESH ease of sales–hen

The lower the mean rank, the more important the trait. Means followed by different letters in rows are different [Kruskall-Wallis test followed by Mann–Whitney U tests (P ≤ 0.05)]

Table 11 Mean (± SD) of traits preferred by male and female chicken farmers according to Friedman test

| Traits | Female Mean a | Male Mean a |
|--------|---------------|-------------|
| BSC    | 1.46 ± 0.86a  | 1.44 ± 0.82a|
| BSH    | 1.54 ± 0.90b  | 1.47 ± 0.82a|
| SFC    | 2.03 ± 1.21ef | 2.18 ± 1.33d|
| SFH    | 2.00 ± 1.13e  | 2.11 ± 1.18d|
| ENH    | 1.92 ± 1.15de | 1.80 ± 0.97b|
| EZH    | 1.90 ± 1.13cd | 1.83 ± 1.04b|
| SAC    | 2.12 ± 1.27f  | 2.09 ± 1.25d|
| SAH    | 2.00 ± 1.08e  | 1.99 ± 1.03c|
| MTC    | 1.91 ± 1.38d  | 1.86 ± 1.28b|
| MTH    | 1.83 ± 1.06c  | 1.81 ± 1.01b|
| ESC    | 2.07 ± 1.57ef | 2.05 ± 1.58c|
| ESH    | 1.99 ± 1.26de | 2.00 ± 1.25c|
| Friedman test (chi-square) | 821.347 | 504.187 |
| Asymptotic significance | P < 0.05 | P < 0.05 |

Means in columns followed by different letters are different at the Bonferroni-adjusted significance level P ≤ 0.004 (Friedman test followed by Wilcoxon signed-rank post hoc tests with Bonferroni’s correction for multiple comparisons)

BSC body size–cock, BSH body size–hen, SFC supplementary feed consumption–cock, SFH supplementary feed consumption–hen, ENH egg number–hen, EZH egg size–hen, SAC scavenging ability–cock, SAH scavenging ability–hen, MTC meat taste–cock, MTH meat taste–hen, ESC ease of sales–cock, ESH ease of sales–hen

a The lower the mean, the more important the trait
may be attributed to poultry keeping objectives and varied importance attached to the chicken genotype by both male and female farmers.

Within each zone, traits of preference for selection of breeding stock in the present study tended towards body size, egg number, egg size, and meat taste. The observation on body size is in consonance with the findings of Muchadeyi et al. (2009) where the trait was ranked first among the criteria for choosing chicken breeding stock. Similarly, Mahoro et al. (2018) included body size and egg yield among the important economic traits to select the indigenous chickens. In a related study, Markos et al. (2016) ranked egg number and body weight as first and second, respectively, while Asmelash et al. (2018) reported that egg size was highly rated compared to other traits in village chicken. It has been recommended that breeding strategies should aim not only at the growth and performance of chicken, but also put into consideration the qualitative aspects of meat (Paiva et al. 2018). The varying ranking of the traits of preference across zones in the present study could be attributed to heterogeneity in production environments. This was quite more evident between the sub-humid agro-ecological zones (Nasarawa and Kebbi) and their humid counterparts (Kwara, Rivers and Imo). However, the current findings are at variance with the submission of Markos et al. (2016) where there was no variability across agro-ecological zones in the ranking indices of chicken producers’ trait preferences.

The preference for body size within gender and the high ranking of egg number, egg size, meat taste, and ease of sales by male farmers in the current study might not be unconnected with their direct monetary values as consumers may be willing to pay premium with a unit increase in the traits. The easier the sales of the birds, the more the income also generated. However, across gender preference for supplementary feed consumption by female farmers might be due to the extra nutrients the birds will derive which may increase their production level. This present information may inform breeding management decisions along gender mainstreaming in the study localities. In a related study in other species, Marshall et al. (2016) reported that gender differences may result from production objectives and the specific roles and responsibilities of males and females in traditional livestock rearing. This is linked to the constant state of change, evolution and development of traditional gender roles (Paudel et al. 2009; Karmebäck et al., 2015). However, the best way gender-differentiated trait preferences could make sense is to understand how such preferences reflect underlying gender differences in “assets, markets, information, and risk, and the ways institutions and policies condition these” (Ashby, 2018).

The strong positive relationship between supplementary feed consumption and scavenging ability is not quite unexpected since feed intake will increase correspondingly with increase in the ability to search for feed resources within the environment. In the same vein, an improvement in the taste of

Table 12  Mean ranks of traits preferred by male and female farmers in the choice of chicken breeding stock according to Kruskall–Wallis test

| Traits                      | Gender |       |       |       |       |
|-----------------------------|--------|-------|-------|-------|-------|
|                             | Female | Male  | Mean  | Mean  | Kruskall–Wallis test | Asymptotic significance |
| BSC body size–cock          | 1034.74| 1018.15| 0.511 | 0.475<sup>ns</sup> |
| BSH body size–hen           | 1038.15| 1034.74| 3.020 | 0.082<sup>ns</sup> |
| SFC supplementary feed consumption–cock | 987.27 | 1047.05| 5.197 | 0.023<sup>*</sup> |
| SFH supplementary feed consumption–hen | 983.35 | 1033.43| 3.680 | 0.055<sup>ns</sup> |
| ENH egg number–hen          | 954.16 | 926.38 | 1.227 | 0.268<sup>ns</sup> |
| EZH egg size–hen            | 951.77 | 941.27 | 0.176 | 0.675<sup>ns</sup> |
| SAC scavenging ability–cock | 1016.57| 1002.10| 0.306 | 0.580<sup>ns</sup> |
| SAH scavenging ability–hen | 1005.76| 1006.51| 0.001 | 0.977<sup>ns</sup> |
| MTC meat taste–cock         | 1013.95| 1007.77| 0.059 | 0.808<sup>ns</sup> |
| MTH meat taste–hen          | 994.15 | 993.68 | 0.000 | 0.985<sup>ns</sup> |
| ESC ease of sales–cock      | 997.63 | 975.15 | 0.784 | 0.376<sup>ns</sup> |
| ESH ease of sales–hen       | 970.47 | 968.99 | 0.003 | 0.954<sup>ns</sup> |

The lower the mean rank, the more important the trait

*BSC body size–cock, BSH body size–hen, SFC supplementary feed consumption–cock, SFH supplementary feed consumption–hen, ENH egg number–hen, EZH egg size–hen, SAC scavenging ability–cock, SAH scavenging ability–hen, MTC meat taste–cock, MTH meat taste–hen, ESC ease of sales–cock, ESH ease of sales–hen

<sup>*</sup>Significant at <i>P</i> ≤ 0.05; <sup>ns</sup> not significant
chicken meat may facilitate sales of the live chicken/chicken products. According to Northcutt (2009), a quality attribute determining poultry meat acceptability is flavor which might affect its subsequent sales (Kyarisiima et al. 2011). The relationships among the traits of preference in the present study permitted the possible grouping of the farmers along the line of preferred traits using PCA.

Two distinct groups of households keeping chickens in the sample population emerge, each displaying differing preferences for the chicken traits. This indicates the importance of considering heterogeneity within population segments as it provides a useful framework for adapting breeding policy interventions to specific producer segments. The present clustering could be attributed to individual differences in perceptions of trait of importance, the production objectives, social-cultural beliefs and livelihood strategies. Where resources are scarce, it is possible that genetic improvement of body size may meet the production objective of a particular group of farmers. On the other hand, there is another group which breeding objective emphasizes parameters such as supplementary feed consumption, egg number and size, scavenging ability, meat quality, and ease of sales. Such group may also be targeted during future poultry breeding and marketing interventions. PCA can be used for ranking and grouping (Ajayi et al. 2012; Lopes et al., 2013) and to explore the relationship between traits in a dataset (Pinto et al. 2006).

### Conclusion

The present study revealed equal ranking of FUNAAB Alpha, Sasso, and Noiler, followed by Kuroiler, Shika Brown, and Fulani chickens across five agro-ecological zones in Nigeria. More male farmers indicated preference for Sasso birds only across zones which could mainly be due to varying production objective. Traits of economic importance that appeared consistent in selecting breeding stock were body size, egg number, egg size, and meat taste. However, gender-differentiated trait preference was evident in supplementary feed consumption (female farmers) only. The chicken farmers were distinctly assigned into two groups (body size and non-body size traits) using categorical principal component analysis. These findings when combined with quantitative on-farm data have implications for future breeding programs geared towards increased chicken production and productivity in the tropics using bottom-top approach.
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Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

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