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Genetics solutions for improved chicken production in Ghana

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Abstract: The Tropical Poultry Genetics Solutions project intervention in Ghana, a collaboration between the International Livestock Research Institute and the University of Ghana, with support from Ghana's Ministry of Food and Agriculture, seeks to test the adaptability, productivity and farmer preferences of tropically adapted improved dual-purpose chicken genotypes under different production systems. Poultry farmers from two agroecological zones in five of the 16 regions of Ghana were selected to participate in the project. These farmers were provided with selected tropically adapted chicken genotypes, namely Kuroiler and Hubbard, to manage under their production system, and data was collected on bird performance in terms of body weight, egg production, quality and overall acceptability by the farmers. The findings indicate a high farmer preference for, and significantly better ($p \leq 0.05$) growth performance of the introduced chicken genotypes compared to local chickens. For instance, the introduced birds reached an average weight of 2kg within 18 weeks, compared to local chickens which required 30 weeks on average to reach 1.6kg under semi-intensive production management conditions. Additionally, the egg production and carcass attributes of these selected genotypes were found to be comparable to those of the local chickens. Based on these positive results, we recommend the multiplication and widespread adoption of Kuroiler and Hubbard chicken strains among smallholder farmers in Ghana. By doing so, we anticipate improved chicken production, increased income generation, enhanced livelihoods and protein food security in the country.

Keywords: Chicken breeds, Dual-purpose, Hubbard, Kuroiler, Sustainable Development Goals

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Introduction

Poultry production in Africa is mainly based on free-range indigenous chickens (Dessie *et al*, 2011), which are well-valued in terms of their contribution to nutritious diets, household income and sociocultural attributes (Aboe *et al*, 2006; Dessie *et al*, 2011). Indigenous chickens in Africa are adaptive to the environment, survive on low-energy feeds, are often resistant to endemic diseases, and have been characterized to have good potential to be selected for meat and eggs (Ajayi, 2010; Dessie *et al*, 2011). Thus, African chicken resources constitute a reservoir of useful genes important for adaptation and meeting local breeding goals (Osei-Amponsah *et al*, 2013). Such indigenous chickens are mostly maintained under traditional village production systems, typically characterized by low input and low egg and meat production (Dessie *et al*, 2011; Birhanu *et al*, 2023). In Ghana, smallholder chicken production systems are predominantly based on unimproved genotypes maintained mostly in low-input extensive systems. Despite their unique adaptive attributes, contribution to protein food security, low capital requirements and minimal production risks, their overall productivity remains relatively low. There is a need to select

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and improve indigenous chickens to take full advantage of their adaptive potential and genetic variability (Osei-Amponsah *et al*, 2013). Genetic selection within the indigenous breed ideally relies on accurate data recording, including pedigree, and for the birds to be raised in a similar environment where the selection programmes have occurred. Additionally, a large population with a substantial number of active and reserve sire and dam lines is needed to allow exhaustive exploitation of genetic variations for the meat yield trait (Alemu *et al*, 2021). To overcome these challenges, the introduction of productive, yet tropically adapted chicken strains provides an opportunity to increase meat yield and egg number in developing countries (Alemu *et al*, 2021).

The African Chicken Genetic Gains (ACGG; https://africacgg.net/) project led by the International Livestock Research Institute (ILRI) was started in 2014 and implemented over five years in Ethiopia, Tanzania and Nigeria. The programme's vision was to increase smallholder chicken production and productivity growth as a pathway out of poverty in sub-Saharan Africa. To increase meat yield and egg number in a sustainable manner, selected chicken strains were made available to rural farmers in Ethiopia, Nigeria and Tanzania, through the ACGG project (Alemu *et al*, 2021). Sasso and Kuroiler chickens were among the improved strains that had been tested in Tanzania and were distributed on a large scale by the ACGG project. These strains are suitable for backyard systems and can be used for meat and egg production, with minimal provision of commercial feed (Dessie and Getachew, 2016). Following the success of the ACGG project, dual-purpose tropically adapted chicken breeds such as Hubbard, Kuroiler, Noiler and Sasso are being promoted by ILRI under the Tropical Poultry Genetic Solutions (TPGS) project (https://www.ilri.org/research/projects/tpgs). The Ghana component of TPGS is collaborating with local stakeholders to test the performance of the newly selected strains in terms of body weight, egg production and survivability in two different agroecological zones compared to the indigenous chicken in Ghana. The superior performance of introduced strains such as Kuroiler and Hubbard over indigenous chickens will give smallholder farmers a good alternative for backyard poultry production. This should help improve income generation and livelihood of smallholder farmers in Africa and contribute to the attainment of the UN Sustainable Development Goals (SDGs), particularly SDG 1 (No poverty), SDG 2 (Zero hunger) and SDG 3 (Good health and well-being). Therefore, the objective of this research was to evaluate the performance of the TPGS-introduced chicken genotypes in terms of survivability, growth and egg production as well as their acceptance by stakeholders, particularly farmers. The findings of this study will serve as valuable input for chicken breeders, policymakers and other stakeholders in the development of selected more resilient chicken genotypes in Africa.

Materials and methods

Project scope and farmer selection

The Ghana component of the TPGS project, managed by the Animal Science Department of the University of Ghana with support from the Ministry of Food and Agriculture (MoFA), supplied Kuroiler and Hubbard chickens to selected poultry farmers across two management systems – intensive and semi-intensive – in the forest and coastal savannah agroecological zones of Ghana. The Kuroiler is a tropically adapted dual-purpose chicken developed in India by Kegg Farms Private Limited. It is widely reported that this cross-bred chicken originated from crossing Rhode Island Red, White Leghorn, Barred Plymouth Rock, and two Indian local chicken breeds with some broiler blood infusion to obtain specific broiler characteristics (Dessie and Getachew, 2016). Hens attain 2.5kg within 12 months, begin laying eggs at five to six months, and then lay 150–200 eggs during their 12–16-month egg-laying period, initially more than 20 eggs per month (Dessie and Getachew, 2016). Males reach 4kg in 12 months and weigh at least 1kg at around three months. The breed thrives well on household waste, scraps and vegetation and, thus, does not compete with human food for grain or require any special feeding (Dessie and Getachew, 2016). Hubbard has been a worldwide reference for broiler breeding stock, with the company supplying day-old grandparent and parent stock chicks all over the world. Hubbard chickens are characterized by good growth, feed conversion ratio, excellent viability and good meat yield. The Hubbard JA57 reach between 2.3 and 2.4kg on average at 20 weeks (https://www.hubbardbreeders.com/).

The present project was undertaken in the Greater Accra, Central, Eastern, Bono and Ashanti Regions of Ghana (Figure 1), the main areas of chicken production in the country. Stakeholder engagement, particularly with the Poultry Farmers Association, Regional and District Livestock Officers of the MoFA and the Women in Poultry Value Chain, enabled us to identify and agree with the targeted beneficiaries their needs and challenges in adopting improved technologies to enhance their production efficiency. Two service providers located in the Eastern and Ashanti Regions of Ghana were contracted to hatch fertilized eggs and brood the chickens for a period of five weeks before they were distributed to the participating poultry farmers. The study sampled poultry farmers from five regions across two agroecological zones in Ghana. These farmers were provided with Kuroiler and Hubbard chicken genotypes, which had been selected for improved growth and egg production performance, to raise under semi-intensive or intensive systems. In these systems, housing, feeding and veterinary care were provided for the chickens, with birds allowed to freely roam around the farm during the day in the semi-intensive system. Six communities (villages/towns) were sampled from each of the selected regions. Within each community, nine households (smallholder farmers) were selected as project beneficiaries. Thus, 54 households per region and 270 farmers nationwide participated in the programme. Three enumerators with minimum qualifications that met the standard selection criteria by ILRI were chosen in each region to support the project in terms of data collection. The Regional Livestock Officers of MoFA in the participating regions were assigned as supervisors to oversee the activities of the enumerators. Enumerators and their supervisors were trained on the data collection protocols, which were captured in real time using tablets installed with ODK software (ICTD, 2010). Throughout the project, regular communication was established between enumerators and the project team to ensure speedy resolution of any challenges encountered in the field.

Egg incubation and mothering of chickens

In total, 10,080 fertile Kuroiler eggs were imported from Uganda on 6 December 2021 and hatched by Akro Farms, Akropong, Eastern Region, one of the selected private hatcheries whilst a second batch of 5,040 fertile eggs each of the Hubbard JA57-I and JA57-II strains were received from Morocco on 9 April 2022 and hatched by Topman Farms, Kumasi, Ashanti Region. The day-old chicks were raised intensively in mother units for up to five weeks. The feed provided was a commercially prepared chick mash with 3,080kcal/kg of energy and 21% crude protein. All prescribed prophylactic vaccines, including the 1^{st} and 2^{nd} Newcastle and Gumboro vaccinations, were provided. Two hundred and seventy (270) beneficiary farmers received 40 birds of each of the three chicken strains at random, with no special preference for sex and size.

Data collection and analysis

Data on body weight, age at first egg (AFE), egg number and weight were collected from participating farmers using ODK tools. The first phase of TPGS Ghana took place between December 2021 and March 2023. During this period, on average, poultry farms were visited monthly for sensitization and body weight measurements, starting when the birds were five weeks of age for approximately 8 visits in total. Data entries were double-checked by supervisors before the final authorization to upload onto the server at ILRI. A total of 180 eggs made up of 60 eggs each from Kuroiler, local forest and local coastal savannah chicken ecotypes aged 34–36 weeks, were randomly sampled from farmers and kept at room temperature for three days before measuring egg quality parameters including egg weight, Haugh unit, albumin height and yolk colour using an electronic egg analyzer (ORKA Food Technology LLC, 2006) at the Molecular Genetics Laboratory, Department of Animal Science, University of Ghana, Legon. Shell thickness was measured with an electronic Vernier calliper by taking the average thicknesses of the large, central and narrow ends of individual eggs (Melesse *et al*, 2010).

The one-way analysis of variance (ANOVA) procedure of GenStat 12th Edition (2009) was used for the data analysis. The effect of age and genotype of chicken were estimated based on the following model:

$$y_{ijk} = \mu + a_i + g_j + ag_{(ij)} + e_{ijk}$$

Where y_{ijk} = body weight of chicken; μ = the population mean; a_i = effect of age of chicken; g_j = effect of genotype; $ag_{(ij)}$ = age and genotype interaction; e_{ijk} = residual or the random error term.

The effect of management system and sex on growth performance of Kuroiler chickens at week 17 was analyzed based on the following model:

$$y_{ijk} = \mu + m_i + s_j + ms_{(ij)} + e_{ijk}$$

Where y_{ijk} = body weight of chicken; μ = the population mean; m_i = effect of management system; s_j = effect of sex; $ms_{(ij)}$ = management and sex interaction; e_{ijk} = residual or the random error term.

The effect of genotype on egg quality traits of sampled eggs of Kuroiler and two local chicken ecotypes from the forest and coastal savannah zones of Ghana was analyzed using the following model:

$$y_{ij} = \mu + g_i + e_{ij}$$

Where y_{ij} = egg quality parameter; μ = the population mean; g_i = effect of chicken genotype; e_{ij} = residual or the random error term.

Where the ANOVA indicated a significant genotype effect, the means were separated using Tukey's test at the 5% margin of error. Tukey's test was chosen for mean separation on account of its robustness, requiring a single value judging the significance of all mean differences and is thus quick and easy to use (Steel and Torrie, 1981). We also surveyed farmer trait preferences in the introduced chicken genotypes. Farmers were asked to rank ten traits (fast growth, good survivability, good disease resistance, low feed intake, laying more eggs, laying big eggs, good mothering, plumage colour, tough meat and soft meat) indicating their preference for the introduced chicken genotypes compared to local chickens. In terms of hatchability, we used the two-proportion Z-Test to calculate the true difference in the hatching performance percentages between Kuroiler and Hubbard chicken eggs.

Results and discussion

Body weight and growth performance

The growth rates of both the Kuroiler and Hubbard chicken genotypes are shown in Figure 2. The growth rates of both the Kuroiler and Hubbard chickens were superior to those of the local chickens of Ghana kept under semi-intensive management reported in an earlier study (Osei-Amponsah *et al*, 2012). This finding of superior growth performance and productivity of the introduced chicken genotypes compared to the local chickens aligns with previous studies that have reported on the benefits of using adopted breeds selected for improved production in smallholder systems (Bamidele

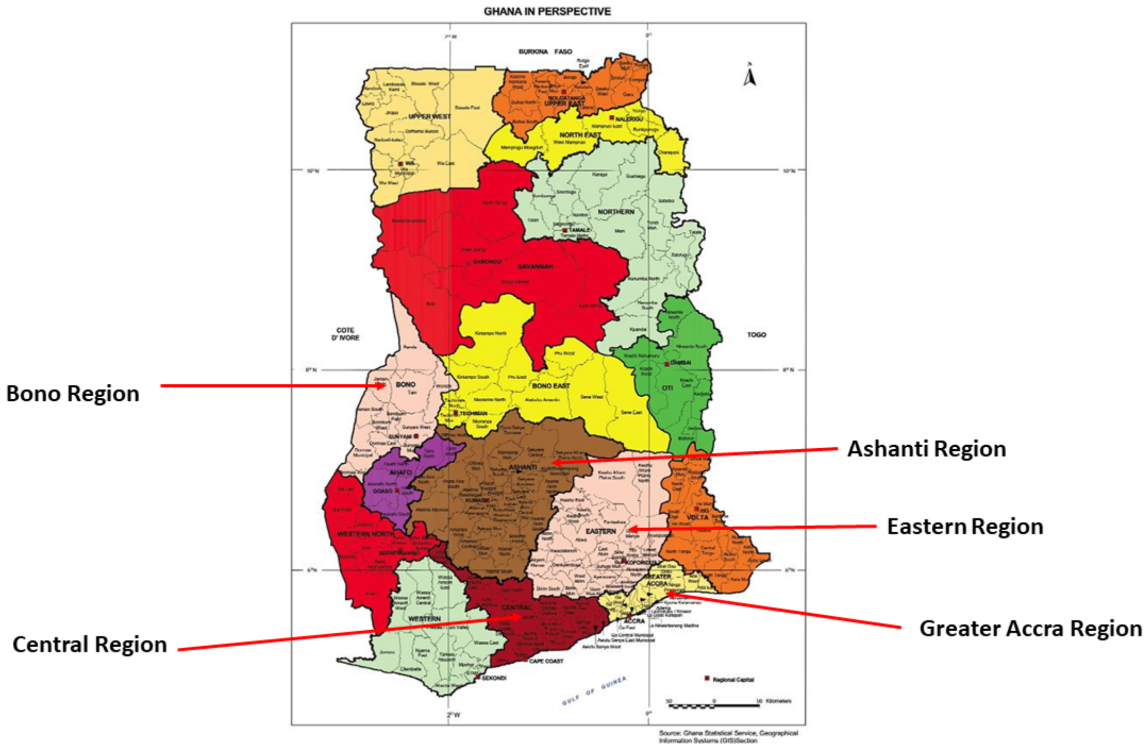

Figure 1. Map of Ghana showing sampled regions. Source: Ghana Statistical Service, Geographical Information Service (GIS) Section.

et al, 2023). The significant reduction in the number of sampled chickens over time was largely due to the disposal (sale) of particularly male birds after 17 weeks to reduce the feeding costs of the farmer.

The production system was found to influence the growth of chickens. On average, Kuroiler chickens raised intensively weighed significantly ($p < 0.05$) more (2.0kg) than those kept under semi-intensive (1.8kg) management (Table 1). The significant ($p < 0.05$) effect of the production management system on growth was expected because birds in confinement spend less energy moving around than those in the open. Furthermore, husbandry practices, such as feeding, biosecurity and veterinary care, are expected to be better and easier in confinement. In a previous study on growth performance of chickens, Osei-Amponsah *et al* (2012) reported the average body weight (g) of female and male local Ghanaian chickens at hatch, 20 and 28 weeks to be 25.8, 1,033.5 and 1,273.5g, respectively. In the male population, the average body weights at these ages were 26.6, 1,358.5 and 1,593.5g respectively indicating a clear sexual dimorphism. This growth performance in local chickens was however significantly ($p \leq 0.05$) lower than the exotic Sasso T44 raised under the same management condition which gave average body weights in females at the same ages as 38.2, 2355.0 and 2,635.0g with corresponding values of 37.6, 2,777.0 and 3,192.0g in males (Osei-Amponsah *et al*, 2012).

The body weights recorded for Kuroiler chickens in the current study were lower than those reported for the same breed and age on station in Ethiopia (Alemu *et al*, 2021; Bedru, 2021). This emphasizes the importance of improved management practices for the growth and development of chickens. Local chicken improvement programmes should incorporate supplementary feeding, veterinary care and housing to enhance productivity (Osei-Amponsah *et al*, 2012). Under improved management, local Ghanaian Savannah and Forest chicken ecotypes weighed between 1.2–1.7kg at seven months of age (Osei-Amponsah *et al*, 2012). This was lower than that recorded at four months for both Kuroiler and Hubbard chickens in the present study. The superior growth performance of Kuroiler over local chickens is due to the genetic potential of the breed as a commercial strain (Dessie and Getachew, 2016), as it has been bred for superior growth through selection and strain crossing. This finding of considerable differences in live body weight among chicken strains is in line with those of previous studies (Mulugeta *et al*, 2020; Alemu *et al*, 2021; Guni *et al*, 2021; Kassa *et al*, 2021). Sasso chickens have also been reported to be superior in growth compared to Koekoek and Sasso-RIR crosses in Ethiopia and were recommended for semi-scavenging production systems (Fekede *et al*, 2021). There is thus a need for the selection and improvement of the growth potential of local chickens to take full advantage of their adaptive potential and genetic variability with respect to various environmental challenges (Osei-Amponsah *et al*, 2013). Our findings indicated a significant ($p \leq 0.05$) effect of management system on age at first egg in Kuroiler chickens. Kuroiler chickens raised under intensive management laid significantly earlier (22.3 weeks

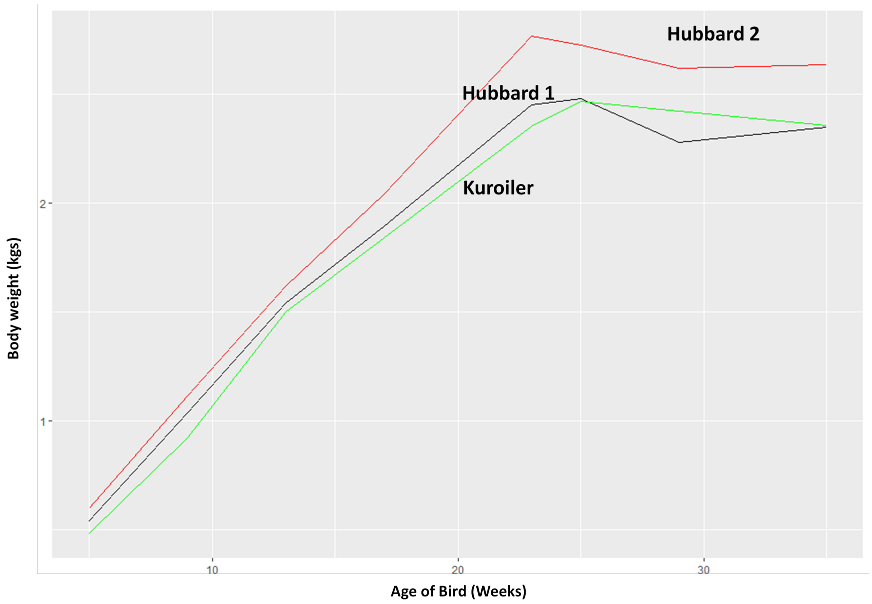

Figure 2. Growth performance of experimental chickens

old) than those raised under semi-intensive management (25 weeks old). Additionally, Kuroiler chickens raised under intensive management grew significantly ($p \leq 0.05$) faster than those under semi-intensive production systems (Table 1).

Egg production performance

The egg production performance of the Kuroiler and the two Hubbard lines was also superior to that of local Ghanaian chickens. The age at first egg (AFE) for the Hubbard birds was 17.5 weeks compared to 28 weeks for the local chickens, and the expected egg number and egg weight (Figure 3) of the Hubbard chickens increased with age.

We further compared the hatching performance of fertilized Kuroiler and Hubbard eggs under Ghanaian conditions, based on the data received from the hatchery operator and shown in Table 2. Both genotypes recorded a relatively high percentage hatched on fertile ($\geq$ 83%). Egg hatchability is affected by egg physiology, egg size, environment (bird nutrition and handling of eggs), bird genotype, genetic diversity and their interactions. Hence, the current results could not be solely associated with the genetic makeup of birds. The hatchability percentages of 83 and 85% of incubated Kuroiler and Hubbard eggs, respectively, and can be considered satisfactory, although a higher hatchability of 87.8% has been reported for indigenous chickens in the forest and savannah zones of Ghana (Osei-Amponsah *et al*, 2014). Comparison of hatching performance based on the proportion Z-Test indicated significantly ($p < 0.001$) higher fertility of Hubbard chicken eggs compared to Kuroiler eggs (Table 2), which can be attributed to variations in egg storage and handling by the two hatchery operators.

Egg production performance of Kuroiler and the two Hubbard lines studied was superior to that of local chickens kept under similar management conditions in Ghana (Osei-Amponsah *et al*, 2015). Kuroiler birds raised intensively under on-station management in Tanzania had an age at first egg of 22.7 weeks whilst 24.8 weeks was achieved for on-farm semi-scavenging management. In other studies, egg production traits of chickens selected for fast growth (Sasso, Bovans and Koekock) were generally higher than those of local chickens, with variations observed across the genotypes (Guni *et al*, 2021). The fact that chickens in the present study began laying from week 23 may imply an adaptation strategy for survival under semi-intensive production conditions. Egg production is very demanding of nutrients; therefore, under free range, it is likely that the bird must first build its reserves adequately before engaging in this nutrient-demanding activity and hence adapt to start later rather than earlier. The mean egg weight, albumin height and Haugh unit of Kuroiler chickens were all significantly ($p \leq 0.05$) heavier than those of the indigenous birds; however, the shell thickness and yolk colour were not significantly different (Table 3).

The relatively higher egg weights obtained for Kuroiler chickens compared to local chickens can be attributed to genetic differences. Both albumin height (AH) and Haugh unit were positively and significantly related to egg weight (Moula *et al*, 2013; Osei-Amponsah *et al*, 2014; Bekele *et al*, 2022). Kuroiler eggs in this study were superior to the eggs from local chickens in terms of average albumin height and Haugh unit, similar to their mean egg weight. Previous findings indicate that local chicken eggs have relatively stronger shell and yolk ratios than Sasso T44. However, the egg quality of local chickens is lower than that of Sasso T44 chickens because of the negative correlation between yolk ratio and AH, the main determinant of egg quality (Osei-Amponsah *et al*, 2014). Haugh unit

Table 1. Range and mean body weight of Kuroiler chickens (±SE) by management system and sex at week 17. Within-rows means followed by different superscripts are significantly ($p \leq 0.05$) different.

		Intensive	Semi-Intensive
Cockerels (Males)	Range (g)	1,000–3,940	700 – 3,920
	Mean (g)	2,231.65^{a}±29.63	1,851.2^{b}±28.33
	N	536	530
Pullets (Females)	Range (g)	920–4,000	610–3,630
	Mean (g)	1,799.41^{a}±18.35	1,696.55^{b}±23.04
	N	619	540
All	Range (g)	920–4,000	610–3,920
	Mean (g)	2,005.2^{a}±18.12	1,806.79^{b}±18.63
	N	1,155	1,070

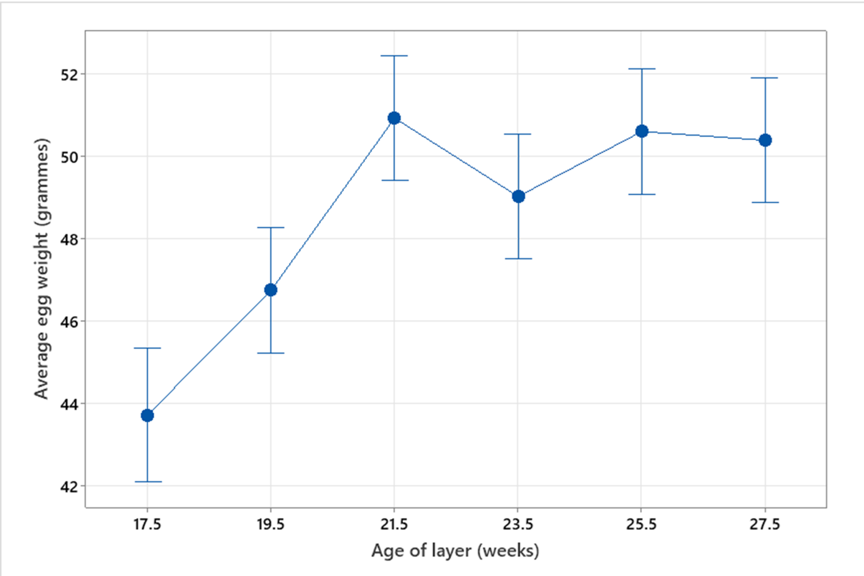

Figure 3. Variation of egg weight of Hubbard chickens by age of bird under a semi-intensive system in Ghana

Table 2. Hatching performance of introduced chicken strains. *, the hatching performances of both Hubbard lines were computed by the hatchery operator together. #, significant proportional differences (Z statistics) are indicated by $p \leq 0.05$. Within rows, proportions followed by different superscripts are significantly different ($p \leq 0.05$).

Parameter	Chicken strains		Z Statistic	p-value #
	Kuroiler	Hubbard*		
Eggs received (N)	10,080	10,080		
Eggs set (N)	9,980	9,427		
% Egg set	99^{a}	93^{b}	20.54	< 0.001
Fertile eggs (N)	8,700	8,671		
% Fertile	87^{b}	92^{a}	-10.92	< 0.001
Infertile (N)	1,280	750^{b}		
% Infertile	13^{a}	8	11.08	< 0.001
% Hatched on fertile	83^{b}	85^{a}	-3.59	0.0003
% Hatched on set	73^{b}	78^{a}	-8.09	< 0.001

Table 3. Egg quality trait parameters of Kuroiler and local chicken ecotypes of Ghana. Within-rows means followed by different superscripts are significantly ($p \leq 0.05$) different.

Parameters	N	Range	Kuroiler	Forest	Coastal Savannah
Egg weight (g)	180	32.2–101.8	$88.8^{a}\pm9.42$	$58.70^{b}\pm9.9$	$52.50^{c}\pm10.3$
Albumin height (mm)	180	2.1–5.5	$3.94^{a}\pm0.68$	$3.54^{a}\pm0.93$	$3.10^{b}\pm0.52$
Shell thickness (mm)	180	0.24–0.48	0.39±0.05	0.38±0.04	0.38±0.04
Yolk colour	180	1.0–11.0	5.80±2.01	6.27±2.26	6.43±2.79
Haugh unit	180	43.3–97.6	$77.30^{a}\pm9.85$	$73.40^{a}\pm9.05$	$66.40^{b}\pm11.7$

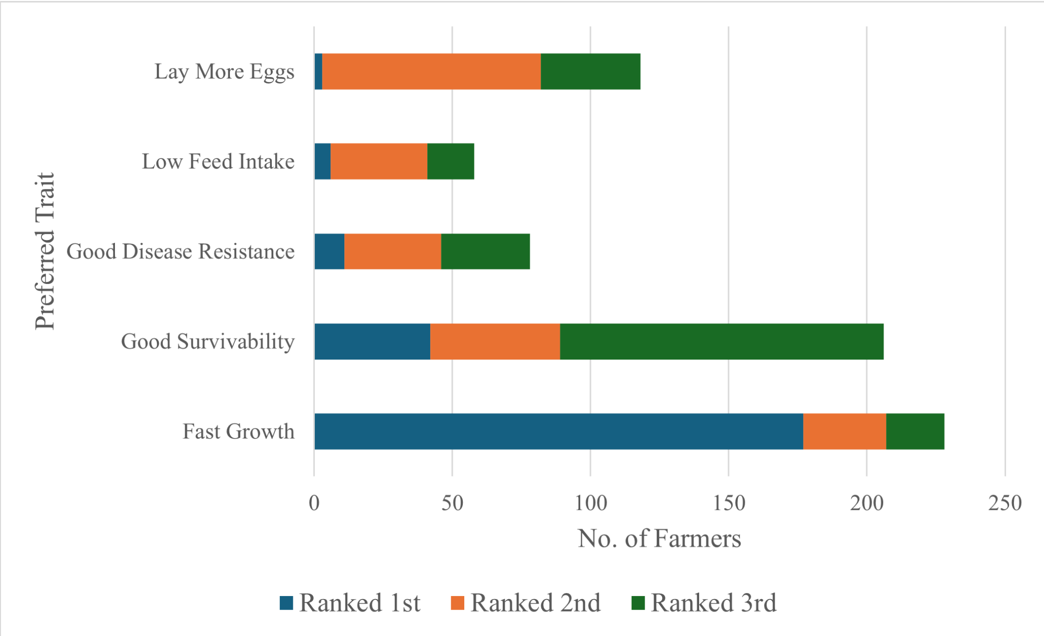

Figure 4. Distribution of farmers' most preferred traits in chickens

of eggs from the local chickens was lower than that of exotic chickens (Osei-Amponsah *et al*, 2014; Kejela *et al*, 2019). The mean Haugh unit of local chickens in Ghana ranged from 64.97 to 67.34, lower than that of naked-neck and normal-feathered chickens in Nigeria, which were 73.22 and 71.40, respectively (Yakubu *et al*, 2008; Osei-Amponsah *et al*, 2014).

Farmer perception and acceptance of introduced chicken genotypes

In terms of trait preferences, farmers were asked to rank ten traits (fast growth, good survivability, good disease resistance, low feed intake, laying more eggs, laying big eggs, good mothering, plumage colour, tough meat and soft meat). Fast growth, good survivability, good disease resistance, low feed intake and increased egg number are the most preferred traits in this study (Figure 4). The result of 'fast growth' and 'increased egg number' was expected. This is because, smallholder poultry farmers in sub-Saharan Africa mainly keep chickens for their meat and eggs hence these traits are of much importance to them (Sonaiya and Swan, 2004; Ochieng *et al*, 2013; Melesse, 2014). The 'good survivability' and 'good disease resistance' trait preferences are consistent with previous studies (Faustin *et al*, 2010; Terfa *et al*, 2019). Diseases in all poultry enterprises can lead to huge economic loss hence farmers' choice of 'good survivability' and 'good disease resistance' is not surprising (Dar *et al*, 2018).

Beneficiary farmers provided positive accounts of experimental birds. They attested to the high performance of both Kuroiler and Hubbard in terms of their body weight, egg size and egg number compared to the local chicken. The socioeconomic gains and prestige these birds have brought to them in their communities were emphasized. Almost all beneficiary farmers mentioned income generation through the sale of larger and more eggs as well as cockerels. The adaptation abilities of the introduced birds were evidenced by the relatively low mortality and their resilience to environmental and farmer management conditions. This led to non-beneficiary poultry farmers expressing interest in the TPGS project and requesting inclusion in any future initiatives. The farmers showed a strong preference for the introduced breeds, as they were found to be more market oriented (Bamidele *et al*, 2023). Furthermore, the use of improved tropically adapted chicken breeds in smallholder flocks in sub-Saharan Africa led to increased production and productivity, generating more income while contributing to food security and social and ecological resilience (Birhanu *et al*, 2023). As highlighted in the literature, livelihood enhancement programmes often provide beneficiaries with poultry birds and feed to contribute towards food security and income generation (Singh *et al*, 2022).

Conclusion

This study's intervention of introducing improved, dual-purpose chicken breeds to smallholder farmers aligns with previous findings, demonstrating the potential to significantly enhance livelihoods through the adoption of better-suited poultry genetics. The fast-growing and productive nature of the introduced chicken strains, particularly in terms of egg production, suggests a high likelihood of acceptance among poultry farmers in Ghana. Although the introduced breeds are more effectively managed under intensive systems, they have also shown resilience and satisfactory performance in semi-intensive and extensive production systems. These findings, along with supportive evidence from other studies, underscore the potential of these dual-purpose chickens to support faster income generation for smallholder farmers under prevailing production conditions in Ghana. The introduction of adapted, dual-purpose chicken genotypes, such as the Kuroiler and Hubbard chickens has shown promising results in enhancing productivity and market-oriented performance. This study thus provides valuable insights for stakeholders to make informed decisions on local chicken breed diversification, conservation and improved production through efficient management, breeding and nutrition practices. The government and relevant stakeholders should work to ensure that tropically adapted chicken strains, selected for improved production, are made widely accessible to smallholder farmers. This can significantly boost poultry production and income generation across rural farming communities. Future initiatives should include comprehensive economic assessments, particularly cost-benefit analyses, to evaluate the long-term profitability and sustainability of the introduced chicken breeds. Such data will guide strategic genetic improvement programmes and investments in the poultry sector. To maximize the benefits of the new chicken strains, farmers should be trained in efficient management practices, including breeding, feeding and health care. This will boost productivity and profitability of the introduced poultry under varied production systems. The Ministry of Food and Agriculture should develop supportive frameworks that promote the distribution and management of the introduced chicken lines as well as financial and technical support, alongside market linkages, to enhance the success of TPGS and similar interventions.

Authors contribution

Richard Osei-Amponsah: conceptualization, supervision, data analysis, preparation of initial draft, review and approval of final draft. Ricky Aboagye Poku: data collection, review and approval of final draft. Ebenezer Agyemang Duah: Data collection, data analysis, review and approval of the final draft. Augustine Naazie: supervision, data analysis, review and approval of the final draft. Raphael Ayizanga: data collection, data analysis, review and approval of final draft. Harrisson Njamba: data collection, data analysis, review and approval of final draft. Wondmeneh Esatu: sourcing of fertilized eggs, review and approval of final draft. Mulugetta Y. Birhanu: sourcing of fertilized eggs, review and approval of the final draft. Tadelle Dessie: Conceptualization, fund acquisition, review and approval of the final draft.

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Conflict of interest statement

The authors declare no conflicts of interest.

Data availability

The authors affirm that all data necessary to confirm the conclusions of the article are presented within the article, figures and tables. Raw data analyzed for this article are available from the corresponding author.

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