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ANIMAL HUSBANDRY & VETERINARY SCIENCE | RESEARCH ARTICLE

Performance of local and local x improved chicken crosses under semi-intensive management system in Northern Uganda

Samuel Ochora¹, Junior Senyonga Kasima^{1*}, Wilfred Marion Okot¹ and Elly Kurobuza Ndyomugenyi¹

Abstract: Despite the efforts to improve Uganda's chicken production through cross-breeding, limited research has been conducted to establish the performance of local x improved chicken crosses under the dominant management systems used by chicken rearing households. The current study aimed to assess the performance of local x improved chicken crosses under semi-intensive management system in Pader and Agago districts of Northern Uganda, where crossing of local with imported Kuroiler chickens has been promoted over time. A cross-sectional survey using a semi-structured pre-tested questionnaire and observation was conducted in two purposively selected



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PUBLIC INTEREST STATEMENT

Chicken production is an important venture that has the potential to improve the livelihoods of smallholder rural communities in Uganda. Nevertheless, Uganda's chicken population is dominated by the indigenous chickens which are characterized by low egg production and slow growth rate. Crossing the local chickens with imported Kuroilers has been used as a strategy by several farmers to improve the performance, especially in terms of egg production, of their chicken enterprises. Limited information, however, exists on how these crosses perform under free-ranging and semi-intensive systems of management, yet this would guide policy on decisions to improve the performance of the chicken subsector, especially among smallholder communities. The current study, therefore, highlights the performance, in terms of egg production and hatchability, of crosses of indigenous Ugandan chickens and the imported Kuroiler. The results from the current study are essential in informing policy makers on strategies to improve smallholder chicken production systems in Uganda.

sub-counties per district among 246 respondents to establish the sociodemographic characteristics of chicken farmers and reasons for crossing. Using a Completely Randomised Block Design, an experiment was set up to compare the performance of local chickens and local x improved chicken (Kuroiler) crosses in terms of egg production and hatchability. All respondents practiced crossing with the aim of enhancing egg production in their chicken flocks. Under semi-intensive management system, hatchability of the eggs from crossbred chickens did not differ ($P \geq 0.05$) from that of the eggs laid by the local chickens. In conclusion, although crossbred chickens exhibited hybrid vigour in terms of egg production under free range and semi-intensive systems, the hatchability of the eggs from crossbred chickens raised under semi-intensive system did not differ from that of eggs from local chickens. Future research should consider establishing the quality attributes of eggs of the local x improved chicken crosses in the dominant management systems among chicken keeping households in Uganda.

Subjects: Agriculture & Environmental Sciences; Plant & Animal Ecology; Development Studies

Keywords: Kuroiler; crossbreeding; egg production; hatchability; local chicken

1. Introduction

Globally, poultry production contributes significantly to rural household income and nutritional security. This is mainly through the highly nutritious eggs which are either sold or consumed by the chicken farmers (Gulilat et al., 2021; Ndyomugenyi & Ebong, 2016). This important role of poultry production, coupled with it being a ready source of cheap and protein-rich meat has caused a growth in poultry production world over (FAO, 2008). Currently, the global poultry industry is constituted of more than 23 billion birds (Mottet & Tempio, 2017; Tainika & Duman, 2019), with the United States of America having the highest poultry population of approximately 7 billion birds (FAO, 2018, 2022; United States Department of Agriculture, 2021).

Africa's poultry production is still low, although a potential increase is foreseen, especially in chicken production, owing to increasing demand for chicken meat and eggs (NEPAD, 2022; Shumye et al., 2022). In Uganda, poultry production is still very low (44.6 million birds) compared to the other East African countries like Tanzania (83.28 million birds) and Kenya (48.9 million birds) (Mujyambere et al., 2022; Pius et al., 2021).

Among the poultry species kept in Uganda, indigenous chickens are the most dominant, being kept by over 90% of poultry farmers (Augustine & Shukla, 2017). The dominance of indigenous chickens in Uganda is attributed to the desirable traits that they possess, in particular, the tastier meat and eggs, and good mothering ability (Magala et al., 2012). In spite of these desirable attributes, indigenous chickens exhibit slow growth rate and lay fewer eggs compared to improved breeds (Habte et al., 2013). As a result, depending on these indigenous chickens to boost Uganda's chicken production may not be a feasible pursuit.

In an attempt to improve productivity of Uganda's chicken sub-sector, the government of Uganda imported Kuroiler chickens in 2009 from India. The Kuroiler chickens were particularly introduced for their high egg production capacity which is up to 200 eggs per hen per year as opposed to the 40 eggs per year laid by an indigenous chicken in Uganda (USAID, 2017). To augment government efforts, local non-government organisations have promoted cross-breeding between the local and Kuroiler chickens in Agago and Pader districts of Northern Uganda. This, they did in an effort to develop more resilient chickens (crossbreeds) that can withstand the prevailing draught conditions, but still perform better than the local chickens. Despite the efforts to promote crossbreeding of local chickens with Kuroiler chickens, limited

research has been conducted to establish the performance of the resultant crossbreeds in the two districts. This is notwithstanding the possible importance of this information in guiding policies to scale up and commercialize crossing between indigenous and improved chickens all over the country. This study, therefore, established the performance of the local and local x Kuroiler chicken crosses in the two above mentioned districts of Northern Uganda.

2. Methodology

2.1. Study area

The study was conducted in Agago (02°50'N 33°20'E) and Pader (02°50'N 33°05'E) districts of Northern Uganda. In these two districts, crossbreeding of local and Kuroiler chicken has been promoted so as to improve chicken production within the two districts. Agago district is located approximately 370 kilometres north of Uganda's capital city, Kampala. The district occupies 3,496 square kilometres. Pader district is located approximately 417 kilometres north of the Uganda's capital city, Kampala. The district occupies 3,362.5 square kilometres.

2.2. Assessment of the performance of chickens resulting from crossing of local and Kuroiler chickens under farmers' free-ranging conditions

A cross-sectional survey was conducted in two purposively selected sub counties per district, where crossbreeding has been promoted. In Agago district, the sub-counties of Paimol and Patongo were selected while Pader and Pajule Town Councils were selected in Pader district. A total of 246 respondents participated in the study. The sample size was determined using the formula developed by Charan and Biswas (2013):

$$n = Z^2 pq / e^2$$

where

n = sample size; p = proportion of interest within the two districts (Proportion of local and improved chicken crosses in the districts); $q = 1 - p$ (Proportion of local chickens in the two districts); Z is the statistics for level of confidence which is conventionally 1.96, P was estimated to be 0.8 and e (error of precision) was at 0.05;

$$n = (1.96)^2 (0.8) (1 - 0.8) (0.05)^2 = 246$$

The data were collected using a pretested semi-structured questionnaire and observations. The data were collected on the socio-demographic characteristics of the respondents, reasons for crossing and the performance of crossbred chickens under farmers' free-ranging conditions. Data on socio-demographic characteristics of the respondents and reasons for crossing were summarised in Statistical Package for Social Sciences (SPSS Version 21.0 package) and analysed using descriptive statistics. Data on the performance of crossbred chickens under free-range conditions were summarised in excel spreadsheet (Excel 2016) and imported to R software, Version 4.2.3 (R Core Team, 2023). The difference in mean egg production and hatchability of eggs laid by local chickens and their crosses with Kuroiler chickens under farmers' free-ranging conditions was established using the student t -test at 5% level of significance.

2.3. Determination of performance of local and Kuroiler chicken crosses under the semi-intensive management system

A Completely Randomized Block Design (CRBD), which lasted for 12 weeks, was set up to compare the performance of local chickens and local x Kuroiler crosses. Each treatment was replicated three times with each replicate having 10 birds giving a total of 60 birds. Local and local x Kuroiler chicken crosses at the onset of laying (24 weeks) were obtained from farmers and the experiment set up under semi-intensive management system. This was conducted in homes of selected chicken farmers. Three farmers were selected and each farmer acted as a block hosting one replicate of local chickens and one of crossbred chickens. Selection of the local birds was done following the parameters described by

Ssewanyana et al. (2008), while the local x Kuroiler chickens were identified following the procedures by Roothaert et al. (2011) and Ssewanyana et al. (2008).

A deep litter system with a free-range area was used for the study. The litter material was maintained at a level of 150 mm from the floor with a space allowance of 100 mm feeding/drinking space and 180 mm roosting space given per bird (indoors) and 1,600 mm of space in the free-range area per bird. An east-to-west orientation of the poultry unit was used to ensure that the chickens receive the best available light and temperature. Since the birds were past the brooding stage, no artificial lighting and temperature modification were provided. This was done to imitate the farmer conditions in the study area. The composition of the experimental diet is shown in Table 1. Water was provided *ad libitum*. Leafy vegetables (*Amaranthus spp*) were provided in the free-ranging area to supplement the layer diet. Biosecurity measures were followed with strict observance of the vaccination schedules, especially against Newcastle disease according to the local veterinary protocols. Laying hens were allowed to lay eggs in the individual nests provided. Thereafter, the eggs per clutch were incubated. During the experiment, some deaths occurred and only eight birds, and hence clutches, were used considered per replicate. Data were collected on egg production (number of eggs laid per clutch) and hatchability ((number of chicks hatched/number of eggs set to incubate per hen) × 100). The data were summarized in excel spreadsheet (Excel 2016) and imported to R software, Version 4.2.3 (R Core Team, 2023). The mean difference in performance of local chickens and local x Kuroiler chickens was separated using a student *t*-test at 5% level of significance.

3. Results

3.1. Assessment of the performance of chickens resulting from crossing of local and Kuroiler chickens under farmers' free-ranging conditions

3.1.1. Socio-demographic characteristics of the chicken farmers

Most chicken farmers were females, married, and had not attained any formal education (Table 2). The average age of a chicken farmer in the current study was 44 years, while each chicken rearing household had at least 7 members.

Table 1. Composition of the experimental diets

Feedstuffs	% Composition
Maize bran	50
Fish meal	6
Sunflower seed cake	14
Premix	0.5
White table salt	0.5
Lake Shells	5.0
Concentrate (koudijs™)	24
Total	100
Calculated nutrient composition (% unless otherwise stated)	
Metabolisable energy (Kcal/kg)	2,800
Crude Protein	16
Methionine	0.35
Lysine	0.73
Phosphorous	0.36
Sodium	0.185
Calcium	4.2

3.1.2. Reasons for crossing local chickens with Kuroiler chickens

All farmers practiced crossing of local chickens with Kuroiler chickens (Table 3). The primary reason for crossing was to improve egg production.

3.1.3. Egg production and hatchability of local x Kuroiler chicken crosses under free-range management system

Crossbred chickens raised under the free-range system laid more eggs ($P \leq 0.05$) than did the local chickens raised under the same system (Table 4). In the same way, the hatchability of eggs of crossbred chickens raised under the free-range system was higher ($P \leq 0.05$) than that of the local chickens.

3.2. Performance of the local x Kuroiler chicken crosses raised under semi- intensive management system

The number of eggs laid by crossbred chickens under the semi-intensive system was higher ($P \leq 0.05$) than the number of eggs laid by the local chickens (Table 5). However, there was no

Table 2. Socio-demographic characteristics of chicken farmers in Agago and Pader districts

Variable	Category	Number of respondents (N=246)	% of respondents
Gender	Male	108	43.9
	Female	138	56.1
Marital status	Married	197	80.1
	Single	17	6.9
	Divorced	11	4.5
	Widowed	21	8.5
Level of education	No formal education	105	42.7
	Primary	92	37.4
	Secondary	37	15.0
	Tertiary	12	4.8
	Minimum	Maximum	Average
Age (years)	19	89	43.9 $\pm$ 14.5
Household size	1	15	6.8 $\pm$ 2.7

Table 3. Reasons for crossing local chickens with Kuroiler chickens

Variable	Number of respondents (N=246)	% of respondents
Crossing of chicken		
Yes	246	100.0
No	00	00
Reason for crossing		
Getting better quality chicks than for local chicken	28	11.4
Improved egg production	129	52.4
Obtain improved breeds	02	0.8
Acquire higher prices than local chicken	22	8.9
Off springs grow faster than local chicken	40	16.3
Off springs are more resistant to diseases than pure Kuroilers	25	10.2

Table 4. Egg production and hatchability of local x Kuroiler chicken crosses under free-range management system

Variable	Breed		SEM	P-value
	Local	Cross		
Number of eggs per clutch	12.829 ^a	20.198 ^b	0.246	0.000
Hatchability per clutch	69.872 ^a	84.476 ^b	1.339	0.000

Note: Means with different superscripts within the same row are significantly different at 5% level of significance; SEM = Standard Error of the Means.

Table 5. Performance of local and crossbred chickens under semi-intensive management system

Variable	Breed		SEM	p-value
	Local	Cross		
Number of eggs per clutch	14.226 ^a	21.719 ^b	1.217	0.004
Hatchability per clutch	87.594	85.519	4.492	0.668

Note: Means with different superscripts within the same row are significantly different at 5% level of significance; SEM = Standard Error of the Means.

difference ($P \geq 0.05$) in hatchability between the eggs laid by the crossbreeds and those laid by the local chickens under the semi-intensive system of management.

4. Discussion

4.1. Assessment of the performance of chickens resulting from crossing of local and Kuroiler chickens under farmers' free-ranging conditions

4.1.1. Socio-demographic characteristics of the chicken farmers

The study revealed a higher percentage (56.1%) of female chicken farmers than their male counterparts. High participation of female farmers in chicken production could be because chickens are easier to handle compared to bigger livestock species like pigs and cattle which require much energy to control. The females can, therefore, easily manage the chickens. In addition, raising chicken requires low capital investment and small space requirement. As a result, the resource-constrained female farmers in the rural communities can be able to sustain chicken enterprises. Therefore, most of chicken-related activities in chicken-keeping households have been reported to be dominantly managed by women (Fida et al., 2018). In this regard, chicken production is viewed as a potential means of improving the livelihoods of female farmers in Uganda (Khaita et al., 2022). Previous studies also reported high female populations of chicken farmers of up to 83.0% (Islam et al., 2021), 69.6% (Ngongolo et al., 2021) and 57.1% (Bessell et al., 2020) in different countries.

Most of the farmers were married (80.1%), and these might have viewed chicken production as a potential means of raising income to meet their household needs. The chickens grow faster, are highly prolific, have a ready market and are a cheap protein source, especially for rural households. These can, therefore, be an immediate income and protein source in rural households. High participation of married farmers in chicken production, of up to 64.5% and 86%, has been reported by Islam et al. (2021) and Natukunda et al. (2011), respectively. The higher returns on investment within rural chicken production systems also make chicken production a viable enterprise for meeting the household needs among married farmers (Tainika & Duman, 2019).

Most of the chicken farmers had not attained formal education, and this is characteristic of most rural livestock keeping households in Uganda. However, this is costing the development of chicken production in the country as illiterate farmers can hardly adopt to new improved chicken production practices. This augments the findings by Yitbarek et al. (2016) who reported that effective management of poultry enterprises is significantly affected by the level of education of the farmer. Similar findings were also reported by Meher et al. (2021).

Furthermore, the average age of chicken farmers was 44 years. At this age, most farmers in Uganda are already married and have started weakening to manage large livestock like cattle. Therefore, they might opt for chicken production, since chickens are easy to handle. In agreement with the current findings, a comparable age of 44.7 years was reported by Fitsum et al. (2017). To the contrary, however, the average age of a chicken farmer in the current study is higher than the 38 years reported by Islam et al. (2021), 35.7 years (Yadessa et al., 2017) and ≤30 years (Natukunda et al., 2011).

The average household size of a chicken keeping household in the current study was 6.8 members, which is similar to the 7 members reported by Gebre-Egziabher (2007) but higher than the national average of 4.6 persons per household (UBOS, 2020). The difference between the current and national figures could be because the current study mainly concentrated in the rural districts where household sizes are usually high due to low cost of living, vast land and early marriages. Contrarily, lower household sizes of 5, 5.8, 4.1 among chicken farming households have been reported by Mahoro et al. (2017), Fitsum et al. (2017), and Zewdu et al. (2013), respectively.

4.1.2. Reasons for crossing local chickens with Kuroiler chickens

The findings revealed that all chicken farmers practiced crossing of local and Kuroiler chickens. The primary reason that farmers gave for crossing their local chickens with imported Kuroiler chickens was to improve egg production. As evidenced in earlier studies, crossing of local and improved chicken breeds has been utilised to improve the egg production traits of local chickens in different parts of Africa (Kedija et al., 2020; Lozano-Jaramillo et al., 2019). In agreement, it has been affirmed that crossing local with improved chickens actually increases egg production and other performance traits in chicken (Fulla, 2022; Taye et al., 2022). Furthermore, the high management costs of the pure Kuroiler birds, which the local farmers could not sustain, might also have driven them to crossbreeding. Pure Kuroiler operations were also reported to have failed especially among smallholder farmers in Ethiopia, because farmers could hardly sustain the high management costs (Kassa et al., 2021).

4.1.3. Egg production and hatchability of local x Kuroiler chicken crosses under free-range management system

Under free-range system of management, the crossbred chickens laid 18.6 eggs per clutch which is higher ($P \leq 0.05$) than the 12.8 eggs laid by the local chickens. The higher egg production of local x Kuroiler crosses might be inherited from the parent Kuroiler chickens which have a high annual laying capacity of up to 200 eggs (USAID, 2017). On the other hand, the low egg production levels of the local chickens could be attributed to the inherent low laying capacity, an attribute characteristic of Ugandan indigenous chicken. In other earlier studies, similar numbers of eggs (12.1, 13 and 12.63 eggs) were reported among indigenous chicken flocks by Hirwa et al. (2019), Kyarisiima and Kugonza (2014) and Addisu et al. (2014), respectively. Contrary to the current findings, higher egg numbers of 14.8 and 15.7 eggs per clutch were reported among indigenous chickens by Zereu and Lijalem (2016) and Moges et al. (2010), respectively.

Furthermore, the hatchability of eggs laid by the crossbred chickens under the free-range system was higher than that of eggs laid by the local birds. These results agree with the findings by Fayeye and Ogundere (2017) who reported increase in hatchability among crosses of local chickens and Goliath chickens, as compared to the pure local chickens. In addition, Ahmad et al. (2019) reported an increase in hatchability of crosses of Rhode Island Red and Naked Neck chickens when they were raised under free-range conditions than the pure Naked Neck chickens under the same system. To the

contrary, however, Kidie (2019) reported no difference in hatchability of eggs of local chicken and for the crosses of Local and Kuroiler chickens. In the same line, Pagala et al. (2020) also reported no significant difference in hatchability when local Bangkok chickens were crossed with laying chickens, although the authors did not identify the laying chickens used in their study.

4.2. Performance of the local and local x Kuroiler chicken crosses raised under semi-intensive management system

Under semi-intensive management system, the crossbred chickens laid more eggs than the local chickens but there was no difference in hatchability of eggs laid by the two groups of chickens. The local x Kuroiler crosses might have inherited the high egg production trait from the parent Kuroiler chickens which have a high annual laying capacity of up to 200 eggs (USAID, 2017). A higher egg production among crossbred chickens than the indigenous chickens was also reported by Pius et al. (2021). Conversely, the pure indigenous birds have generally been reported to have a low egg production levels (Hirwa et al., 2019). This level of egg production reveals a similar trend as when the birds were raised on free-range system, implying that the management system may not necessarily influence the egg production capacity of local chickens. On the other hand, the hatchability of eggs of improved chicken crosses did not differ from that of eggs of local chickens. Since the Kuroiler chickens are non-broody, it could be that even the resulting crosses are not effective in incubating the eggs. Contrary to the current findings, Wolde et al. (2021) reported higher hatchability of eggs of local chickens than either the Sasso-RIR or their F1 crosses. This low hatchability of eggs from the crosses in the current study might, therefore, not be enough to negate the actual hatchability of eggs from crosses of local and Kuroiler chickens. Incubating through artificial conditions might necessitate being experimented before concluding that the eggs from the crosses of local and Kuroiler chickens have an equal hatchability as those from the pure local chickens.

5. Conclusion

The current findings have revealed that chicken keeping is mainly undertaken by female farmers. All farmers practiced crossing of local chickens with the imported Kuroiler chickens so as to improve egg production in their flocks. In line with this pursuit, it can be concluded that the farmers' intention of improving egg production through crossing of the local and imported Kuroiler chickens has been achieved. This has been evidenced by the higher number of eggs laid by the crosses as compared to the pure local chickens. In addition, it is also clear that the local x Kuroiler chickens can thrive in the prevailing draught conditions without having their performance compromised. Therefore, the government can ably promote for scaling up of crossbreeding between the local and imported Kuroiler chickens for improving the country's chicken sub-sector and poultry sector at large.

However, more research should be conducted to assess the quality attributes of eggs and meat from local x Kuroiler chicken crosses. Willingness-to-pay studies should also be conducted among different market niches for the eggs and meat of local x Kuroiler chicken crosses.

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Disclosure statement

No potential conflict of interest was reported by the authors.

Data availability statement

All the necessary data for the study will be availed on request.

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