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Original Research Article

A comparative performance of indigenous chicken in Baringo and Kisumu Counties of Kenya for sustainable agriculture

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Atela J. A*.[1] ,Ouma P. O.,[2] Tuitoek J.[1] , Onjoro P. A.[1] and Nyangweso S. E[3].

[1]Animal nutrition Group, Department of Animal Sciences, Egerton University, P.O Box 536, Egerton-20115, Kenya.
[2]Agricultural Education, University of Eldoret, P.O. Box 1125 Eldoret, Kenya
[3]The Biochemistry Department; Egerton University, P.O Box 536, Egerton-20115, Kenya.

*Corresponding Author
Email: judithatela@gmail.com
ookouma@gmail.com

The population of the world continues to increase especially in developing countries calling for increased food production which puts great pressure to develop a more sustainable agricultural economic activity throughout the world. The demand for white meat from chicken as a source of proteins has also increased. Production of free ranging indigenous chicken could provide solution to cheaper proteins at lower production costs. Nutritional studies conducted on indigenous chicken, *Gallus domesticus* showed that improved productivity can be achieved through improved feeding using locally available feed and supplementation. The indigenous chicken sector plays an important role in rural livelihoods and has great potential for development. A survey was conducted in April, 2015 in Baringo and Kisumu counties in Kenya to obtain information on commonly used feedstuffs, household characteristics, purpose of keeping chicken, flock size, flock management, performance parameters, feeding practices and prices of eggs and live birds. Inferential and descriptive statistical analysis was done using SPSS. The results showed that many young and educated men in Baringo County are beginning to venture in IC keeping contrary to the notion that IC farming was meant for women and the uneducated. The men are becoming more interested in IC farming probably because the young educated men are beginning to see the economic viability of IC business. The difference in the performance of indigenous chicken between the two counties was not significant ($p<0.0064$). There was no significant disparity between the two counties in terms of the feeds the farmers used ($p<0.8413$).

Key words: Feed resources, performance, free ranging, indigenous chicken, sustainable agriculture

INTRODUCTION

The world's population continues to increase with about seventy percent of the increase being in developing countries. Demands on food have become higher calling for increased food production by seventy percent. In third world countries about 3 billion people are supported by agricultural systems (FAO, 2008). Agriculture contributes 30% of the Gross Domestic Product (G.D.P), 75% of the employment and provides nearly all national food requirements in Kenya (Government of Kenya (GoK), 2001). Increased production of goods and services has been sought through different combinations of labour, raw materials, accumulated capital and available technology. This has resulted in inefficient natural resource management, higher energy demand and increased use of agrochemicals to increase production (FAO, 2012).

The concept of sustainable agriculture has evolved to respond to ecological problems posed by adoption of modern agriculture which is characterized by labour saving characteristics of Green Revolution innovators and increased intensification of capital through introduction of

high input agricultural technologies (Amekawa, 2010). Throughout the world agriculture is under pressure to develop to a more sustainable economic activity. Sustainability issues in agriculture in developed countries are concerned with food quality and food health while in developing countries the concern is on poverty and population pressure. Sustainable agriculture globally aims to achieve environmental sustainability, economic profitability and productivity in terms of maintaining food supplies to the non-farm population and support for rural community (Bowler, 2002).

Sustainable agriculture proponents advocate against indiscriminate use and ineffective regulation of chemicals and hormones. The greatest technical challenge is to use eco-effective strategies that are truly sustainable in the sense that that they do not themselves inflict damage on ecological resources as well as the atmospheric conditions on which the future depends (IFPRI, 2012). The keeping of free-range chicken in rural areas in the tropics as a strategy towards sustainable agriculture as well as urban and peri-urban agriculture had not come into focus until quite recently. Indigenous chicken are important source of eggs, quality white meat as protein food and income for the majority of the people living in the rural areas. The smallholder farmers usually let the chicken scavenge for feed around the household during the daytime and in some areas, it is custom to supplement the birds' diet with cereal grains like maize, millet or sorghum and occasionally household kitchen leftovers (Kingori et al*.,* 2010). Besides these feed supplements, free-range indigenous chicken are typically kept with the use of no or few inputs such as anthelminthics or vaccinations. About 90-95 % of the chicken reared in backyards by rural households in most developing countries is based mainly on the scavenging system with between 5-50 birds are raised per household (Olwande et al., 2009).

The egg and meat outputs of indigenous chicken are generally low due to poor nutrition, diseases, predators, parasites and Nematodes (Olwande et al*.,* 2012). Their productivity is normally low due to poor feed conversion efficiency, low adoption of modern technologies and genotype (Khobondo et al., 2015). The smallholder farmers usually let the poultry scavenge for feeds around the household during the day and let them in at night for shelter. In some areas, it is a custom to supplement the birds' diet with cereal grains like millet or sorghum, maize and occasionally household food leftovers. Besides these feed supplements, free-range chicken are typically kept with the use of little or no inputs such as vaccinations and antibiotics. Compared to industrialized production, the eggs and meat output are generally low due to malnutrition (Gakige et al*.,* 2015).

Agriculture in the world is in a transition as researchers, educators, environmentalists and farmers take on the responsibility of developing agricultural production systems that are ecologically, economically and socially sustainable by adopting new policies, management plans, and technology (Minarovic, 1995). Sustainable agriculture as a philosophy and system provides agricultural needs for the present and future generations of the 21st Century concerned with meeting complications of effects brought about by conventional agriculture (Qamar, 2002; Rasul and Thapa, 2003; Shariate and Hosseyni, 2003). However, sustainable agriculture should be within the context of sustainable development. Two hypotheses were tested in this survey i.e. there are no statistically significant differences in indigenous chicken keeping systems in Baringo and Kisumu Counties and that there are no differences in performance in production systems used by the indigenous chicken farmers in Baringo and Kisumu Counties.

In Kenya indigenous chicken play a significant role in alleviating poverty. However, the chickens need feeds that provide them with necessary nutrients for performance parameters such as egg and meat production. These requirements are not met adequately by the free-range production system due to the low inputs associated with the scavenging system. It is therefore important to evaluate the systems used in indigenous chicken production and extra effort put in the management of the indigenous chickens in terms of supplementary feeding and genetic selection (Kingori et al*.,* 2010). This will enable improved body weights, final weight gain, clutch sizes, egg hatchability and increased number of chicks weaned per hen. Some indigenous chicken have actually proved to have higher number of eggs laid per clutch per year than commercial ones (Bebora et al., 2005).

MATERIALS AND METHODS

A suitable interview schedule based on the scope of the study was developed and piloted at randomly chosen divisions in Kisumu and Baringo Counties which were not targeted for study. The survey was conducted with 100 farmers per county derived from purposively selected divisions from each county. Interviews were conducted in vernacular languages, Swahili or English depending on the level of education of the respondent. The main features in the interview schedule were to obtain information on commonly used feedstuffs, household characteristics such as age, gender and education, purpose of keeping chicken, flock size, flock management, performance parameters, feeding practices and prices of eggs and live birds. Most questions asked were open ended questions which allowed for explanation and self expression. The enumerators ticked the answers given by farmers against a prepared checklist for easy analysis. Sampling was done to purposively cover only farmers keeping indigenous chicken. Data was analyzed using SPSS version 17 software and independent t- test was used to test for significance between the variables in the two counties.

To determine feeding value and utilization of ingredients fifteen IC aged between 15-20 weeks sourced from Kisumu and Baringo were allocated in 5 cages (3 birds each) and allowed a free choice diet of various feedstuffs such as

ochonga, millet, rice germ, sorghum, maize, growers mash and water provided adlibitum. They were fed in the cafeteria feeding system for a period of 21 days and the feed intake for each ingredient weighed daily. The weights of chicken were taken weekly.

For aflatoxin extraction a total of 16 samples were brought from IC farmers during the survey from Baringo and Kisumu counties. To avoid the sampling error due to highly heterogeneous nature of fungal distribution, each 2Kg composite sample collected from Indigenous Chicken farmers from both Counties and was a composite of all samples (200grammes of each sample). Each sample was taken to the laboratory in one batch within 24hr of collection and stored at 4 degrees Celsius in the refrigerator and stored until analysis. All samples were ground to a homogeneous particle size and sub-samples of 500grams each were analyzed for aflatoxins. The concentration of total TA in the feed samples was determined by a direct competitive Enzyme-Linked Immunosorbent Assay (ELISA), using Helica Total Aflatoxin Assay Kit.

All the data was subjected to analysis of variance using SAS (version 9).Where there was a significant F-test, the least significant difference (LSD) method was used to separate the means (Steel and Torrie, 1980). Data was stored and edited using appropriate computer packages before any subsequent analysis done to eliminate all incomplete and inconsistent records. Simple statistical analysis was carried out to generate descriptive statistics and analysis of variance (ANOVA) using a computer-based statistical software program (SPSS version 17). The results were presented in form of descriptive tabular summaries. Thereafter a further analysis of the respective data was carried out. For the production (households) level, the principal component analysis technique was done using SAS (SAS User's Guide, 2000). The group of variables to be used in the principal component analysis was selected on the basis of themes that were considered centrally important not only to the observed heterogeneity among households, but also to the expected eventual interventions and development of strategies.

RESULTS AND DISCUSSION

Indigenous chicken farmer characterization by gender

There was a total 75 male farmers who practiced indigenous chicken farming as compared to 125 females. Most female participants were from Kisumu unlike Baringo where most of them were males. Women participated more in indigenous chicken farming as compared to males in both counties. This could be probably due to the fact that many are housewives who have been keeping chicken by tradition However, the difference between female and male farmer participation in indigenous chicken farming was not statistically significant (p-value=0.270). Indigenous chicken rearing is an activity for women customarily in most African cultures (Islam et al., 2014). Male farmers from Kisumu County frequently stated that more profit was made through other activities while female farmers indicated that indigenous chicken production would generate income and create supplementary income for the household in addition to their husband's earnings. In a similar study, Olwande et al., (2009) reported that women and children were responsible for most of the indigenous chickens' daily management activities and that most decisions to dispose of the chicken and their products were done by women. Characterization of farmers for indigenous chicken was also done by age per county and Figure 1 shows the results.

On average, the age of a farmers participating in indigenous chicken farming from both Counties was 40 years. There was no significant age difference between the two Counties. (P-value=0.195). Most of the farmers were in the age bracket of 26-45 years age in both Counties. In this study the younger (16-25) and older (66-85) farmers were from Baringo than Kisumu. It appeared that the younger men of lower age strata from Baringo have taken up indigenous chicken farming very seriously probably because they are beginning to see the economic viability of indigenous chicken farming as a profitable business. Farmer characterization was also done by education level by gender (Figure 2)

Farmer education level

There was a significant difference in levels of education in the two counties (p-value=0.002). More men farmers were better educated than women in both counties. However, in terms of primary school education level majority were women compared to men in both counties. More farmers from Baringo County were better educated than Kisumu County where a higher number had lower formal education. Low levels of education observed in this study may explain the idea of keeping and reliance on indigenous knowledge for management by the indigenous chicken farmers. Education level has positive correlation with management of chicken, feeding and performance of indigenous chicken, the more educated the persons are, the more likely they are to invest in better feeding and management of chicken resulting in higher performance

Production systems by County

This study showed that the predominant indigenous chicken production system was free range system. There was significant difference between the two counties in terms of production systems in practice. More farmers in Baringo practiced free-range system (67) compared to Kisumu (42) who mostly practiced semi confined. This implies that farmers in Kisumu supplement their chicken feed more due to the semi confinement and also keep less number of chickens. Few farmers practice confined production system in both counties. Comparisons were made by county on production system (Table 1), the ecotypes (Table 2), feed types (Table 3), and health

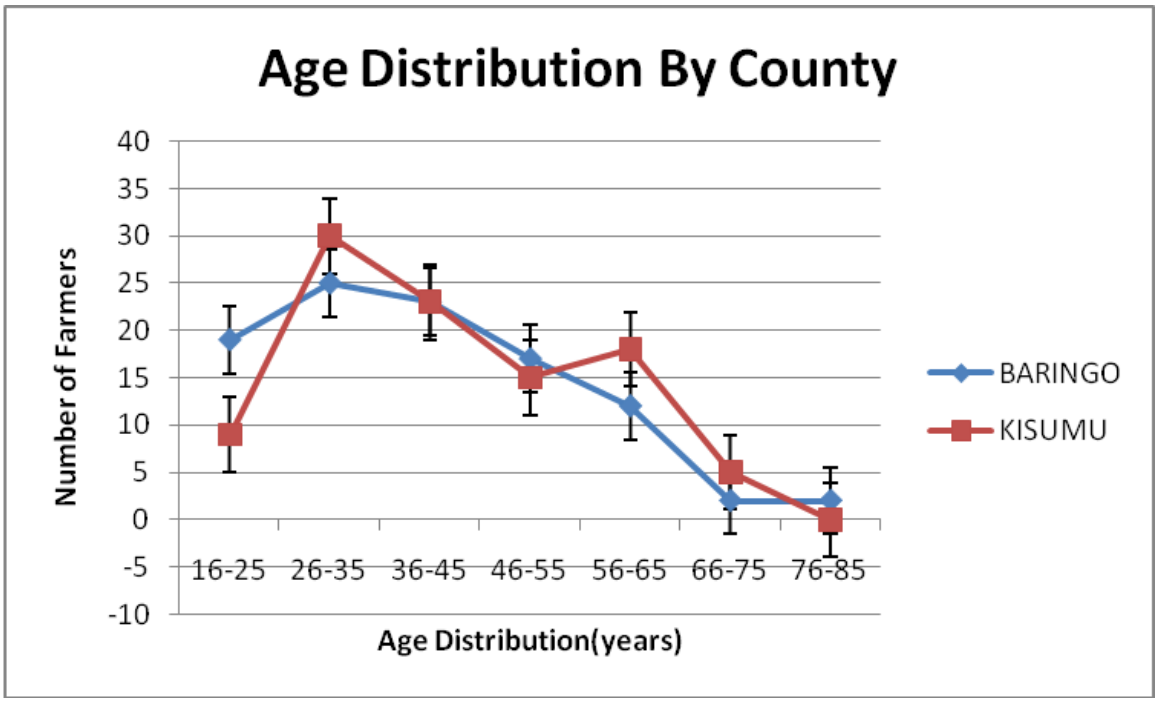

Figure 1: Indigenous chicken farmer distribution by age by County

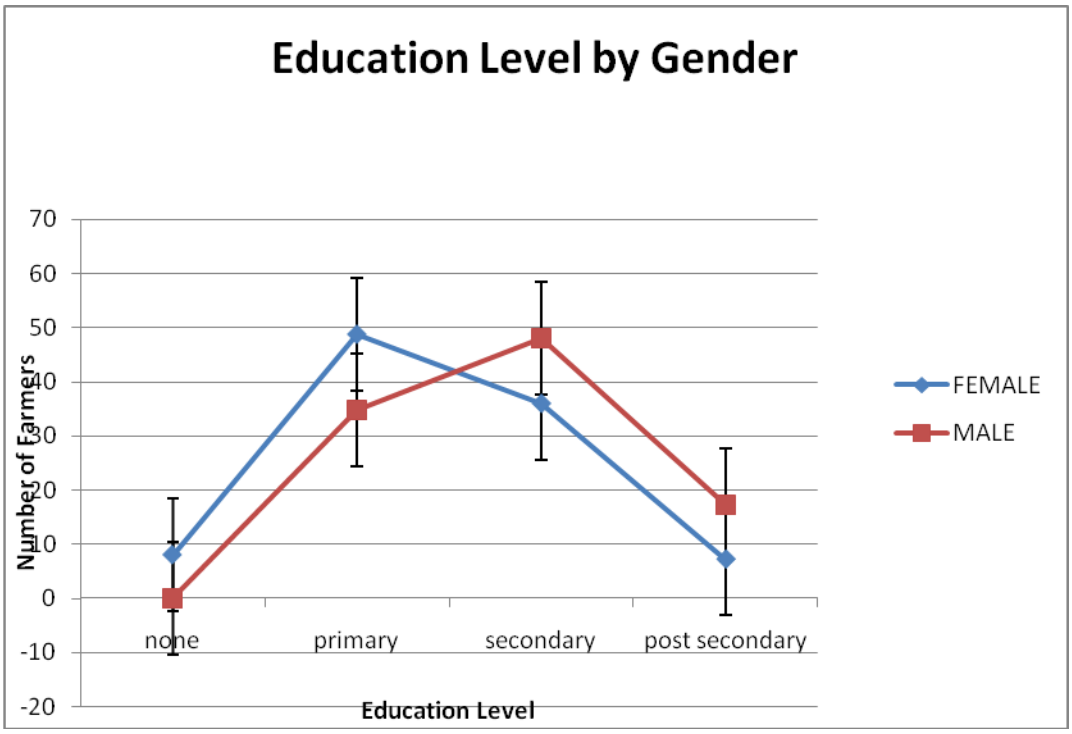

Figure 2: Education level by gender

providers (Table 4) and constraints to production (Table 5).

Morphological characterization of indigenous chicken in this study showed some variation in appearance. There was no significant difference between the ecotypes kept in the two Counties. All the ecotypes in Baringo and Kisumu were similar however Baringo county had the highest number of normal feathered and total indigenous chicken kept

Table 1. Production System by County

Production system	Baringo	Kisumu	P-value
Free range	67	42	0.002
Semi Confined	29	53	
Confined	4	5	

Table 2. Genotypes by County

Ecotype	Baringo	Kisumu	p-value
Dwarf type	59	35	0.372
Giant type	116	75	
Normal Feathered	4317	2266	
Naked Neck	145	123	
Total	4637	2499	
Mean	43.37	24.99	

Table 3. Feeding system by County

Feed Type	Baringo	Kisumu	P-value
Kitchen left over	1	5	0.060
Cereal grains	8	5	
Commercial feeds	4	0	
All Above	87	90	

Table 4. Health Service provider by County

Service Provider	Baringo	Kisumu	P-value
Agro vet shops	60	50	0.006
Public Service	9	27	
Private Vets	9	10	
None	22	13	

Table 5. Common farmer constraints to production

Constraints	Baringo	Kisumu	P-Value
Lack of Feeds	3	1	0.562
Diseases &Parasites	10	10	
Management Problems	1	0	
All the Above	86	89	

compared to Kisumu. The naked type, dwarf and giant type were distributed almost equally in each of the counties There was no significant disparity between the two counties in terms of the feeds they used. The farmers in Kisumu did not use commercial feeds to supplement feeding to their birds at all and so their indigenous chicken delayed in maturity in terms of point at lay and crow compared to those in Baringo. Majority of farmers in the study got their services from the agro-vet shops. The animal health service delivery was generally poor with less of the farmers served by the Government and private animal health service providers in both counties. There was a tendency of the farmers in Kisumu to rely on public/government services. Government services tend to be cheaper compared to private vets but offer poorer in terms of services in control of diseases and parasites. Most of the farmers on their own, bought veterinary products for the chicken for the treatment and control of diseases & parasites from agro-vet shops.

There was no significant difference in terms of constraints faced in both Counties. Farmers from both Counties had similar constraints such as diseases, parasites, lack of feeds and lack of management knowhow in indigenous chicken production. Kugonza et al., (2008) reported that mortality rates of 77% for indigenous chicken in Uganda were attributed to diseases and wild animals.

Table 6. Performance of indigenous chicken in different production systems

	Production System		
Performance variables	Free-range	Semi Confined	Confined
Eggs produced per clutch	14.82[a]	16.76[b]	16.56[b]
Number of clutches per year	2.88[a]	2.99[a]	3.00[a]
Number of eggs incubated per clutch	10.61[a]	11.78[b]	12.56[c]
Eggs hatched per incubation	9.46[a]	10.33[b]	10.78[c]
Number of chicks weaned per hen	6.83[a]	7.22[a]	6.56[a]
Age at first laying in months	5.76[a]	5.65[a]	5.33[b]
Age at first crow in months	5.95[a]	5.95[a]	6.22[b]
Age at culling in years	1.88[a]	2.00[a]	2.03[a]

[abc] superscripts that are different in the same row indicate differences (P=0.05)

Table 7. Performance of indigenous chicken by County

	County		
Performance variables	**Baringo**	**Kisumu**	**χ2**
Eggs produced per clutch	15.52	15.86	0.68
Number of clutches per year	2.96	2.90	0.58
Number of eggs incubated per clutch	11.11	11.25	0.77
Eggs hatched per incubation	9.96	9.79	0.70
Number of chicks weaned per hen	7.32	6.63	0.13
Age at first laying in months	5.43	5.96*	0.00
Age at first crow in months	5.59	6.34*	0.00
Age at culling in years	2.07	1.99	0.53

*=Values with asterix are significantly different

Table 8. Mean Market price of indigenous chicken products

County	**Cock (Kshs)**	**Pullet (Kshs)**	**Hen (Kshs)**	**Egg (Kshs)**
Baringo	549.5±9.85	331.7±8.31	412.3±9.39	12.0±0.35
Kisumu	572.5±8.34	378.1±6.41	456.2±6.02	18.0±0.35
Mean	561.5±8.34	354.9±5.49	434.3±5.77	15.0±0.33
χ2-value	0.01	0.00	0.00	0.00

There is need to address the problems by targeting farmer groups in order to solve the constraints and improve production of indigenous chicken in both Counties.

Performance of Indigenous Chicken

The survey also sought to compare the performance variables for free range production and semi confined and confined indigenous chicken production systems. The performance is as shown in Table 6. The performance variables was much lower for those of free range production system compared to semi confined and confined chicken.

In this study there was no significant difference in the above performance parameters in the two counties. The mean egg produced per clutch was 16 eggs in about 3 clutches with 63% hatching and 70% chicks weaned. At the traditional farm level, average egg production of indigenous chicken in Kenya and other African countries is about 40-100 per year which is laid in 3-4 clutches, each consisting of 12-20 eggs (Olwande et al., 2009). In a similar study by Aboe et al*., (*2006) in Ghana, eggs per clutch ranged between 4-19 with a mean of 13 eggs. The clutch size in this study was 3 with 16 eggs per clutch, which projects to 48 eggs per year. This is much lower than 300 eggs produced by exotic chicken under tropical conditions. Egg production, nevertheless could be increased by reducing the laying cycle by restricting prolific birds from brooding and incubating their own eggs (Kugonza et al., 2008). In order to determine if there existed any statistical differences in performance a comparison was done for the two counties. Table 7 gives a comparison of production by county.

The results showed that sexual maturity was attained at the age of 6 months for both male and female chicken, though the chicken in Baringo attained maturity earlier than those in Kisumu in terms of age at first laying and crow probably because they use commercial feeds to supplement their chicken. The age at culling was 24 months. These findings generally agree with those carried out on

indigenous chicken in Uganda (Kugonza et al., 2008). Aboe et al. (2006) also reported 6-7 months sexual maturity for male and female chickens in Ghana.

The mean market price for the various products of indigenous chicken was also compared and the results are shown in Table 8.

The mean prices of selling eggs, pullets, mature hens and cocks were Ksh 15, Ksh 355, Ksh 434 and Ksh 562 respectively. The mean prices in Kisumu were higher than mean prices in Baringo probably due to high demand but less production/supply. Live birds and eggs were sold at the nearest local market for the protein requirements, during the time of need for cash or when there was an outbreak of disease among birds within the estimated area of neighborhood. Eggs were sold when conditions indicated that their hatching was not required and live chicken from farmers were transported to the nearest market at farm gate prices, thus partly contributing to the low productivity of indigenous chicken for sale to urban markets. Eggs were also sold within households or through the local shop outlets. Live birds were sold when aged six months or when old enough to meet their maintenance requirements (King'ori et al., 2010). More farmers in Baringo kept chicken for income unlike in Kisumu where a huge population did it for both consumption and income.

CONCLUSIONS AND RECOMMENDATIONS

1. Many young and educated men in Baringo County are beginning to venture in IC keeping contrary to the notion that IC farming was meant for women and the uneducated. The men are becoming more interested in IC farming probably because the young educated men are beginning to see the economic viability of IC business.

2. IC farmers in Baringo use commercial feeds to supplement their chicken compared to their counterparts in Kisumu who do use commercial feeds to supplement at all. Due to improved feed supplementation with commercial feeds, the IC came into lay and crow earlier than those from Kisumu County.

3. There are significant differences in feeding strategies and performance of IC among the pastoral and fishing communities in both Counties.

4. Baringo County had the highest total number of IC and normal feathered ecotypes, nearly double the number kept in Kisumu County. This was probably due to more land available, better market and more educated young men entering into IC business as opposed to semi confined subsistence system in Kisumu due lack of enough land, low levels of education and confinement during cropping seasons and thieves.

Recommendations

1. Commercialization of IC production should be promoted among the farmers in Kisumu as indigenous chicken rearing has very high potential and is environmentally and socially sustainable. Indigenous chicken farming is likely to enhance food quality and food security which has been induced by climate change as well as population pressure.

2. Several mitigation measures to address rearing, feed supplementation, disease and parasite control and predation that would make indigenous chicken farming sustainable.

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Competing interests

The authors declare that they have no competing interests.

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