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Research Article

Keywords: Breeding objectives, Genetic diversity, Indigenous chickens, Morphometric traits, Phenotypic characterization

Posted Date: October 19th, 2026

DOI: <https://doi.org/10.21203/rs.3.rs-10863216/v1>

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Additional Declarations: No competing interests reported.

Phenotypic Characterization and Breeding Objectives of Indigenous Chickens in Selected Districts of Kellem Wollega Zone Oromia Ethiopia

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ARTICLE INFO

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ABSTRACT

This study was conducted in "selected districts" of the Kellem Wollega Zone in Oromia, Ethiopia to evaluate the "characterization and assess the breeding objective of indigenous chickens." The districts of Sayo, Dale Wabara and Lalo Kile were chosen because of their indigenous chicken populations and the potential for production. A total of 380 households were randomly. 594 Chickens, 300 females and 294 males were used to study morphometric and qualitative traits. Both primary and secondary data were collected. SPSS ver 26. Sas 9.4 Software were used to analyze quantitative data while descriptive summaries were used to describe qualitative characteristics. The effects of district, agro-ecology and sex were studied using the General Linear Model (GLM). The results showed that districts and agro-ecologies differed significantly in terms of productive performance ($P < 0.05$). Males were found to have linear body measures and a higher body weight than females showing clear sexual differences. Wing span, neck length and back length were strongly linked to body weight through correlation analysis showing that these traits are important for selection. Significant differences were also found in traits, which means that indigenous chicken populations have a wide genetic resource. Farmers mainly favored traits like egg production, disease resistance, fast growth and good mothering ability, which influenced their breeding goals. In conclusion the native chickens, in the study area show a lot of diversity and adaptive features. To improve production indigenous chicken community-based breeding strategies that focus on farmers preferred traits and local environmental conditions are recommended.

INTRODUCTION

Previous attempts to improve indigenous chickens by combining them with exotic chickens have been largely unsuccessful, as exotic chickens breeds tends to perform poorly under farmer management condition which is characterized by limited technological support in areas lacking sufficient new technology, poorly defined breeding objectives and insufficient consideration need and condition of farmers (Muluneh *et al.*, 2023; Birhan *et al.*, 2025). Various researchers (Halima, 2007; Eskindir *et al.*, 2013; Fitsum, 2016; Tesfahun *et al.*, 2019) have reported the phenotypic characterization of local chickens and the breeding preferences of individuals in certain regions of the country. Despite

some studies, there has been limited research on the phenotypic characterization of local chickens and the breeding preferences of individuals in the West Oromia region, particularly in the Kellem Wollega zone. Appropriate design of breeding programs is impossible for local chicken ecotypes that have not been adequately characterized either phenotypically. Therefore, this research was designed with general onjectives to characterize phenotypic indigenous chicken and assess breeding objectives of local chickens in selected districts of kellem Wollega zone of Oromia Ethiopia.

MATERIALS AND METHODS

Study area

The study was carried out in three districts of Kellem Wollega Zone, Oromia Regional State, western Ethiopia, namely Sayo, Dale Wabara and Lalo Kile. These districts were purposively selected for their large indigenous chicken populations, production potential, and representation of the zone's midland and lowland agro-ecologies.

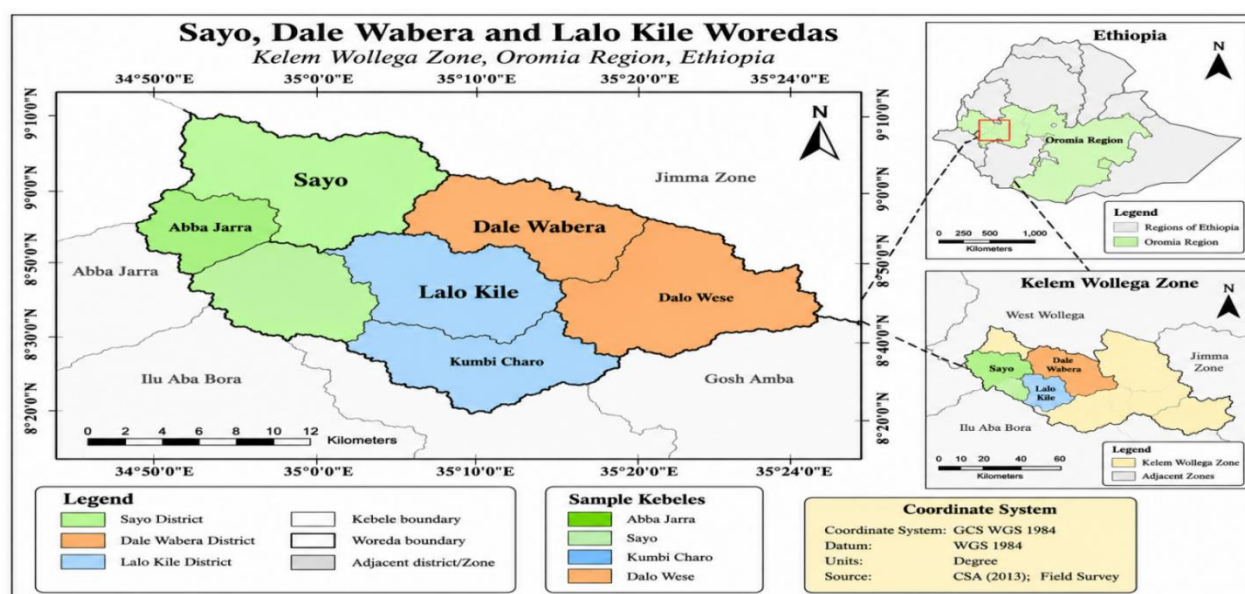


Figure 1: Map of the study area

Sampling method and sample size

Sampling Methods and Sample Size Determination

Methods of Sampling. The districts of Sayo, Dale Wabara, and Lalo Kile were specifically selected based on the potential production and the accessibility of road. The agro-ecological zones of the districts were classified as midland, lowland, and highland; the midland and lowland were specifically selected due to their high coverage. From these zones, three lowland and six midland kebeles were selected. After this a list of farmers' households that produced chicken locally was selected. Therefore, from those households, farmers were selected at random to take part in this study.

Sample size determination. The total sample size for the household was determined by using Cochran's (1977) formula for an infinite population (infinite population $\geq 10,000$).

$$n_0 = Z^2(p)(q) / e^2 \dots\dots\dots (equ.1)$$

Where, n_0 = Desired sample size according to Cochran's (1977) formula when population is greater than 10,000, Z^2 = standard normal deviation (1.96 for 95% confidence level); $P = 0.5$ (proportion of population to be included in sample, i.e., 50%) $q = 1 - 0.5$, that is, 0.5; e^2 = degree of accuracy desired (0.05). So, in this finding the sample size will be:

$$n_0 = (1.96)^2(0.5) \times (0.5) / (0.05)^2 = 384.16 \dots\dots\dots (equ.2)$$

Based on the above calculation, a total of 380 households were randomly selected for interview from a total of 39,871 households currently engaged in local chicken rearing at the zonal level. The study purposively selected three districts (Sayo, Dale Wabara, and Lalo Kile) based on their potential in local chicken production.

Within these districts, the number of households currently engaged in local chicken rearing are as follows: Sayo: 5,677 households, Dale Wabara: 5,130 households and Lalo Kile: 5,240 households.

Using proportional allocation, the sample size from each district was determined as: 129, 123, and 128 households from Sayo, Dale Wabara, and Lalo Kile districts respectively. Selection of kebeles and respondents within each district was carried out considering accessibility, agro-ecology, and the potential of local chicken rearing. Respondents were randomly selected from each kebele to ensure representatives of the study area respondents.

Methods of Data Collection

Survey Data Collection. Both primary and secondary data sources were used for this study. The primary data were collected from 380 indigenous chicken-keeping households using a semi-structured questionnaire, administered with the assistance of development agents. The questionnaire prepared for the collection of socio-economic characteristics of households, livestock composition, productive and reproductive permanence of indigenous chickens, major production constraints and challenges, farmers' trait preferences and breeding objectives and breeding, selection, and culling practices. Secondary data on livestock population, climate, crop production, and human population were collected from the respective District Agriculture and Natural Resource Offices.

Morphometric traits. From a total of 594 indigenous chickens reared by farmer (300 females and 294 males) purposively selected from midland, and lowland agro-ecologies for phenotypic characterization. Data on nine morphometric traits were scored following the descriptor list of FAO (2012) guidelines for

phenotypic characterizations of chickens were: body weight, body length, back length, chest circumference, wing span, neck length, wattle length, shank length and shank circumference. Similarly, the qualitative traits including feather morphology, feather distribution, plumage color, shank color, ear-lobe color, ear color, and comb type were recorded through visual appraisal, following FAO (2012) descriptors.

Statistical Analysis. Data on qualitative traits will be coded and statistically analyzed using SPSS software (SPSS ver. 26). Data on morphometric parameters will be analyzed using GLM procedures by fitting the district, agro-ecology and sex as independent variables. Mean comparisons will be conducted using LSD Test. The values will be considered significant at $P < 0.05$.

Morphometric traits will be analyzed using the following model:

$$Y_{ijk} = \mu + D_i + B_j + S_k + e_{ijk}$$

Y_{ijk} = the observations of dependent variables μ = overall mean of the observed variable B_i = the effect due to i -th agroecology (i = lowland, and midland) D_j = the effect due to j -th district (j = Sayo, D/Wabara and Lalo Kile) S_k = the effect due to k -th sex of chickens (k = male, female) e_{ijk} = random residual error

For farmers' trait preferences and breeding objective, an index will be used. The index will be calculated using the following formula:

Index = $\Sigma [(n \times \text{number of households ranked 1st}) + ((n-1) \times \text{number of households ranked 2nd}) + \dots + (1 \times \text{number of households ranked last})]$ for one trait, divided by the Σ of the same expression for all traits in both agroecologies. Where: n = number of traits under consideration. The variable with the highest index value will be the highest economically important trait (Gizaw *et al.*, 2010).

Funding Declaration

This research did not receive any specific grant or funding from public, commercial, or not-for-profit funding agencies.

Approval

The study was approved by the Institutional Animal Care and Use Committee, Dambi Dollo University, Ethiopia.

Accordance

All animal handling procedures were performed in accordance with the FAO (2012) Guidelines for Phenotypic Characterization of Animal Genetic Resources.

Anesthesia/Euthanasia

"This study did not utilize anesthesia, sedation, or euthanasia, since all methods employed were non-invasive." Trained enumerators gently and briefly held the chickens by hand for body weighing, linear body measurements, and visual evaluation of qualitative traits, adhering to FAO (2012) guidelines. No samples were taken, and no medications were given. Right after measurement, all birds were returned unharmed to the flocks of their owners. "None of the birds were harmed for this study's purposes."

Every modification is marked in the updated manuscript. We trust the manuscript is now appropriate for advancement.

Ethics and consent to participate:

"The chickens used in this study were owned by the participating farmers. Prior to data collection, the purpose and procedures of the study were explained to each household head in the local language (Afaan Oromoo), and verbal informed consent was obtained from all owners both for their participation in the survey and for the handling, measurement and visual assessment of their chickens. Written consent was not sought because of the low literacy level in the rural study setting and the non-invasive nature of the procedures. Participation was voluntary, and respondents were free to withdraw at any time. Confidentiality of the information provided was maintained throughout the study."

Ethical Approval and Accordance

This study did not involve any clinical trial and was therefore not applicable for registration. All procedures involving live animals were approved by the Institutional Animal Care and Use Committee, Dambi Dollo University, Ethiopia, in accordance with the FAO (2012) Guidelines for Phenotypic Characterization of Animal Genetic Resources. Verbal informed consent was obtained from all household respondents prior to their participation in the survey, and confidentiality of the information provided was maintained throughout the study. Chickens were briefly and manually restrained for phenotypic measurement and visual trait assessment; no anesthesia, euthanasia, or invasive sampling was performed, and all handling caused minimal stress or discomfort to the chickens. All authors consent to the publication of this manuscript.

Data Availability Statement

The datasets generated during and/or analysed during the current study are available from the corresponding author on reasonable request.

RESULTS AND DISCUSSION

Quantitative (morphometric) traits

Significant sex differences were found for most quantitative body measurements of the indigenous chickens (Table 1). Males were significantly heavier

(2.77 ± 0.024 kg) than females (1.87 ± 0.015 kg), with an overall mean body weight of 2.32 ± 0.023 kg ($P < 0.001$). Males also had significantly greater body length (36.14 ± 0.257 cm vs 33.16 ± 0.182 cm), back length (32.37 ± 0.096 cm vs 27.00 ± 0.100 cm) and

wingspan (38.80 ± 0.146 cm vs 26.33 ± 0.123 cm) than females ($P < 0.001$). Females had slightly but significantly longer shanks than males (12.11 ± 0.049

cm vs 11.72 ± 0.060 cm; $P < 0.001$). Comb length and wattle length did not differ significantly between sexes ($P > 0.05$).

Table 1 Mean ($\pm$ SE) quantitative body measurements of indigenous chickens

Parameter	Male (n=294)	Female (n=300)	Total (n=594)	Sig.
Body weight (kg)	2.77 ± 0.024^a	1.87 ± 0.015^b	2.32 ± 0.023	***
Body length (cm)	36.14 ± 0.257^a	33.16 ± 0.182^b	37.66 ± 0.168	***
Back length (cm)	32.37 ± 0.096^a	27.00 ± 0.100^b	29.66 ± 0.130	***
Comb length (cm)	3.08 ± 0.058^a	3.16 ± 0.021^a	3.12 ± 0.031	ns
Wingspan (cm)	38.80 ± 0.146^a	26.33 ± 0.123^b	32.50 ± 0.273	***
Wattle length (cm)	3.86 ± 0.020^a	3.85 ± 0.021^a	3.85 ± 0.015	ns
Shank length (cm)	11.72 ± 0.060^b	12.11 ± 0.049^a	11.92 ± 0.039	***

*a, b Means with different superscripts within a row differ significantly ($P < 0.05$); *** $P < 0.001$; ns, not significant.*

Males were consistently heavier and larger-framed than females, a pattern reported widely in Ethiopian and African indigenous chicken populations and generally attributed to sex-linked hormonal and skeletal growth effects (Dana *et al.* 2010, Getachew *et al.* 2023). The absence of a sex effect on comb and wattle length suggests that these soft-tissue traits respond more to environmental and nutritional factors than to sex alone, whereas the slightly longer shanks of females may reflect differences in foraging behaviour and adaptation to local terrain rather than

overall body size (Dana *et al.* 2011).

Correlation among body weight and linear body measurements

Wingspan showed the strongest positive correlation with body weight ($r = 0.82$, $P < 0.01$), followed by back length ($r = 0.56$, $P < 0.01$) and neck length ($r = 0.59$, $P < 0.01$). Body length was negatively correlated with body weight ($r = -0.34$, $P < 0.01$), while comb length showed no significant association with body weight ($r = 0.01$, $P > 0.05$).

Table 2 Pearson correlation coefficients among body weight and linear body measurements

Trait	BW	BL	BackL	CombL	WS	NL	WaL	ShL
BW	—							
BL	-0.34^{**}	—						
BackL	0.56^{**}	-0.15^{**}	—					
CombL	0.01	0.03	-0.06	—				
WS	0.82^{**}	-0.48^{**}	0.77^{**}	0.02	—			
NL	0.59^{**}	-0.50^{**}	0.28^{**}	0.26^{**}	0.60^{**}	—		

Trait	BW	BL	BackL	CombL	WS	NL	WaL	ShL
WaL	0.22**	0.37**	-0.04	0.14**	0.04	0.03	—	
ShL	-0.11*	0.88**	-0.05	0.16**	-0.26**	-0.08*	0.40**	—

BW, body weight; *BL*, body length; *BackL*, back length; *CombL*, comb length; *WS*, wingspan; *NL*, neck length; *WaL*, wattle length; *ShL*, shank length. * $P < 0.05$; ** $P < 0.01$.

The strong association between wingspan and body weight suggests that wingspan can serve as a practical field indicator of live weight where weighing equipment is unavailable, consistent with earlier Ethiopian and African studies identifying wing-related measurements as important determinants of growth and market weight (Nigussie *et al.* 2015, Dana *et al.* 2011). The moderate positive correlations of back length and neck length with body weight indicate that continuous axial skeletal growth contributes to overall body mass, so indirect selection on these traits could incrementally improve body weight in breeding programmes for indigenous chickens.

Qualitative traits

Feather distribution, plumage colour, shank colour, ear-lobe colour, head feathering and comb type all

varied significantly with sex ($P < 0.001$; Table 3). Normal feathering was the most common phenotype overall (70.4%), followed by naked-neck (17.8%) and feathered-shank-and-feet types (11.8%). Plumage colour was highly heterogeneous, with multicoloured birds predominating (33.0%), followed by black-with-white-stripe (18.7%) and greyish plumage (12.5%); solid white (6.2%) and black (6.1%) were least common. Yellow shanks were most frequent overall (46.0%), particularly in males, while black shanks were more common in females. Red ear lobes were most frequent overall (39.2%), and double combs predominated overall (58.1%), especially in males. Comb colour, in contrast, was uniform across the population, with red combs predominating (56.7%) and no significant sex effect ($P > 0.05$).

Table 3 Qualitative characteristics of indigenous chickens in the study area (%)

Trait / category	Male (%)	Female (%)	Total (%)	χ^2 test
Feather distribution				
Normal feathered	40.74	29.63	70.4	***
Naked neck	5.05	12.79	17.8	
Feathered shank and feet	3.70	8.08	11.8	
Plumage colour				
White	4.04	2.19	6.2	***
Black	3.87	2.19	6.1	
Red	9.26	2.36	11.6	
Greyish	5.22	7.24	12.5	

Trait / category	Male (%)	Female (%)	Total (%)	χ^2 test
Multicolour	13.97	19.02	33.0	
Black with white stripe	8.25	10.44	18.7	
White with red stripe	0.84	1.68	2.5	
Bunama	4.04	5.39	9.4	
Shank colour				
White	10.77	5.56	28.8	***
Red	4.04	5.39	16.3	
Yellow	31.31	13.47	46.0	
Black	3.37	26.09	8.9	
Ear-lobe colour				
White	6.90	29.29	20.4	***
Red	36.03	7.58	39.2	
Blue/green	2.69	3.03	9.1	
Yellow	3.87	10.61	31.3	
Comb type				
Single	10.44	31.48	41.9	***
Double	39.06	19.02	58.1	
Head feathering				
Crest/gutya	22.05	40.57	62.6	***
Muffs	11.62	9.93	21.5	
Beard feathers	15.82	0.00	15.8	
Comb colour				
Red	28.28	28.45	56.7	ns
Pale pink/white	10.94	11.11	22.1	
Darker	10.27	10.94	22.1	

*** $P < 0.001$; ns, not significant. Percentages are of overall total ($N=594$) unless otherwise indicated.

The high phenotypic diversity in qualitative traits reflects the wide genetic base maintained under

traditional, largely uncontrolled mating. The naked-neck phenotype is likely to confer thermoregulatory advantages in the warm agro-ecological zones of the study area (FAO 2012, Dana *et al.* 2010), while the predominance of multicoloured plumage is consistent with the effects of prolonged random mating and limited controlled selection reported elsewhere in Ethiopia (Nigussie *et al.* 2015, Dana *et al.* 2011). The comparatively low sex effect and uniformity of comb

colour is consistent with patterns typically observed in sexually mature, traditionally managed flocks (Moreda and Shimeles 2023). Correlations among qualitative traits were generally weak (Table 4), indicating that these traits are largely inherited independently a favourable feature for breeding programmes, since selection on one visible trait is unlikely to cause substantial unintended change in others.

Table 4 Pearson correlation coefficients among qualitative morphological traits

Trait	PC	SHC	ELC	CombC	EC	HF	CT	FD
PC	1	0.083*	-0.063	0.025	-0.049	-0.064	0.074	0.071
SHC		1	0.048	-0.002	-0.006	0.013	0.089*	0.044
ELC			1	-0.016	-0.063	-0.129**	-0.123**	0.128**
CombC				1	-0.013	0.028	0.012	0.037
EC					1	-0.052	0.005	-0.007
HF						1	0.138**	-0.161**
CT							1	-0.168**
FD								1

*PC, plumage colour; SHC, shank colour; ELC, ear-lobe colour; CombC, comb colour; EC, eye colour; HF, head feathering; CT, comb type; FD, feather distribution. *P<0.05; **P<0.01*

Breeding objectives

The purposes of keeping indigenous chickens differed between agro-ecologies (Table 5). In the midland, egg production for sale ranked first (rank index, RI = 0.19), followed by egg consumption (RI = 0.18) and chick sale (RI = 0.17). In the lowland, replacement-stock

production ranked first (RI = 0.21), followed by egg consumption (RI = 0.20) and chick sale (RI = 0.19). Meat consumption ranked fourth in both agro-ecologies, while ceremonial and festival use ranked last in both, despite its cultural importance.

Table 5 Rank index (RI) for objectives of keeping indigenous chickens by agro-ecology

Objective	Midland RI	Midland rank	Lowland RI	Lowland rank
Replacement stock	0.15	5	0.21	1
Egg consumption	0.18	2	0.20	2

Objective	Midland RI	Midland rank	Lowland RI	Lowland rank
Egg for sale	0.19	1	0.16	5
Meat consumption	0.16	4	0.17	4
Chick for sale	0.17	3	0.19	3
Ceremonies/festivals	0.14	6	0.07	6

In the midland, the priority given to egg sales reflects greater market integration and the role of eggs as a key household income source (Halima *et al.* 2007, Tadelle *et al.* 2003), whereas in the lowland, the emphasis on replacement-stock production reflects strategies to sustain flock size under greater mortality risk from heat stress, disease and feed scarcity (FAO 2014, Alemayehu *et al.* 2018). Egg consumption ranked second in both zones, underscoring the nutritional importance of indigenous chickens for household food security, while the low ranking of ceremonial use

indicates that economic and nutritional functions dominate everyday management decisions.

Farmers' trait preference

Body weight was the most preferred trait in both the midland (RI = 0.22) and lowland (RI = 0.19), followed by egg production (RI = 0.15 and 0.18, respectively) and adaptability (RI = 0.14 and 0.16). Hatchability ranked fourth in both zones (RI = 0.14), while plumage colour, comb type and mothering ability were less strongly preferred (Table 6).

Table 6 Farmers' trait preference index (RI) for local chickens by agro-ecology (N=380)

Trait	Midland RI	Midland rank	Lowland RI	Lowland rank
Body weight	0.22	1	0.19	1
Egg production	0.15	2	0.18	2
Adaptability	0.14	3	0.16	3
Hatchability	0.14	4	0.14	4
Plumage colour	0.13	5	0.13	5
Comb type	0.11	6	0.10	6
Mothering ability	0.10	7	0.09	7

The consistent preference for body weight reflects its direct link to meat yield and market value (Gudiso *et al.* 2019), while the preference for egg production and adaptability reflects the importance of resilience under low-input scavenging systems (Wong *et al.* 2017). The high rank given to hatchability highlights the value

farmers place on reproductive efficiency for sustaining flocks without artificial incubation.

Selection criteria and mating and culling practices

Most respondents (89.2%) reported practising phenotypic selection of breeding stock. Egg production (38.9%) and mothering ability (31.8%)

were the main criteria for selecting females, while growth performance (40.5%), comb type (30.8%) and plumage colour (28.7%) were the main criteria for males. Selection was based mainly on body weight (55.3%) or finger-spacing between the pelvic bones as an indicator of laying potential (44.7%). Uncontrolled mating remained the dominant breeding practice (78.95%), especially in the lowland (82.86%). Reduced productivity (38.95%) and old age (31.32%) were the leading culling criteria, and selling was the most common culling method (67.89%), particularly in the lowland (76.43%).

The high level of awareness of selection practices demonstrates the widespread application of traditional, knowledge-based breeding among smallholders, though the near-total absence of controlled mating limits the potential for systematic genetic improvement, consistent with broader findings

CONCLUSION

This study demonstrated that indigenous chickens in Kellem Wollega Zone possess considerable phenotypic diversity in both quantitative and qualitative traits, reflecting a broad genetic base shaped by traditional, largely uncontrolled management systems and adaptation to distinct agro-ecological conditions. Significant sex-based dimorphism was evident, with males consistently exceeding females in body weight and most linear body measurements, while females showed slightly longer shanks. Wingspan, back length and neck length were strongly correlated with body weight, indicating their practical value as indirect selection criteria for live weight estimation in the absence of weighing equipment. Marked variation in qualitative traits—including plumage colour, comb type, shank colour and feather distribution—further confirmed the heterogeneous and non-descript nature of the

on smallholder indigenous chicken systems in Ethiopia (Alemayehu *et al.* 2018, Abebaw and Abate 2018).

The indigenous chickens of Kellem Wollega Zone show substantial phenotypic variation in both quantitative and qualitative traits, reflecting a broad genetic base and strong adaptation to local agro-ecological conditions. Farmers place greatest value on body weight, egg production, adaptability and hatchability, but the continued reliance on uncontrolled mating constrains systematic genetic improvement. Community-based breeding programmes that build on these trait preferences and agro-ecological differences, while conserving the existing genetic diversity, could substantially improve the productivity of these populations.

local chicken population, a consequence of prolonged random mating rather than deliberate selection.

Agro-ecology strongly influenced both production performance and farmers' breeding priorities.

Lowland chickens exhibited earlier maturity and higher body weight, whereas midland chickens performed better in reproductive traits such as hatchability, clutch size and egg production, reflecting differing adaptive strategies to environmental stressors. Correspondingly, farmers' breeding objectives varied by agro-ecology, with midland farmers prioritizing egg sales and lowland farmers emphasizing replacement-stock production, underscoring the influence of market access and flock-sustainability risks on management decisions. Across both zones, body weight, egg production, adaptability and hatchability emerged as the most preferred traits, while phenotypic selection—though widely practised—was undermined by the near-

universal persistence of uncontrolled mating, which limits the potential for systematic genetic improvement.

Overall, the findings confirm that the indigenous chicken population of Kellem Wollega Zone

Authorship Contribution Statement

Degefu Jabesa: conceptualization, data collection, formal analysis, writing – original draft. Kirubel Paulos: supervision, methodology, writing – review and editing. Melkamu Tilahun: data collection, data curation. Mesfin Bekele: data collection, validation. All authors read and approved the final manuscript.

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