Vol. 14(4), pp. 84-95, October-December 2023
DOI: 10.5897/IJLP2023.0834
Article Number: AC82A8771448
ISSN 2141-2448

http://www.academicjournals.org/IJLP

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International Journal of Livestock Production

Full Length Research Paper

Phenotypic and production characteristics of locally adapted pig ecotypes in South-Western Agro-ecological Zone, Uganda

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Received 23 August, 2023; Accepted 12 October, 2023

The study to document phenotypic characteristics of locally adapted pigs was carried out in South-Western Agro-ecological Zone (SWAEZ) Uganda. 784 households were included; keeping a total of 3032 pigs including piglets. Only one adult pig in each household was used for recording of phenotypic characteristics. These included 252 males and 1032 females totalling 1284 pigs. Piglets (0-3 months old) constituted a slightly bigger percentage of the population 1149 (38%), followed by adult females 1084 (34%), growing females 361 (11.9%), growing males 252 (8.3%) and adult males (7.8%), respectively. Locally adapted pigs displayed unique phenotypic characteristics, which differentiated them from exotic breeds. In this study, the key body features of the pigs included skin colour and pattern, type of head, ear orientation, tail, backline, and number of teats in addition to herd related data. The data was subjected to the analysis of variance and Chi-square test procedures in SPSS 2016 to compare prevalence of traits in the different districts. Majority of the pigs had black skin colour with long straight hair, with small body weight and long thin snouts and semi-lop ears projecting forward. Herd size was between 1 and 7 majority being piglets. Widespread phenotypic and genetic characterisation should be undertaken for effective conservation planning and sustainable utilization of locally adapted pigs.

Key words: Phenotypic characterisation, locally adapted pigs, South-Western Agro-ecological Zone (SWAEZ), Uganda.

INTRODUCTION

The livestock sector is an essential part of Uganda's agriculture and is of historical and strategic importance to the country's economy. Livestock, in general, plays an important role in many families in Uganda, including raising household incomes, social status and contributing to food security (MAAIF, 2020). Livestock rearing activities grew by 7.9% in 2019-2020, the highest growth recorded in the last 10 years (MAAIF, 2020; UBOS,

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2020). The Ugandan government and donors have particularly focused on livestock as an opportunity for smallholder farmers in the general efforts to reduce poverty through the commercialization of agriculture and particularly pig farming (Arvidsson et al., 2022). Many pigs in Uganda are crossbred as most farmers obtain pigs from local markets or their nearest neighbours which are of unknown breed or crossbred type (Muhanguzi et al., 2012; Marshall, 2020). Exotic and hybrid pig breeds are often preferred because they grow fast. It has been reported that many animals are composites of different pig breeds and the best levels of crossbreeding for particular production systems are largely unknown (Babigumira et al., 2021), and there is fear that indigenous local pig breeds are threatened with extinction (AU-IBAR, 2019b). Reports that emerged in the past decade revealed a lack of comprehensive information on the locally adapted pig population fragments or sub-structures, and their geographical distributions in the developing world, a reason they are often referred to as 'non-descript' (FAO, 2012) or as “indigenous”, “local” or “unimproved” breeds (AU-IBAR, 2016). The genetic heritage of the local African pig populations has been reported to be extremely mixed, is threatened by genetic erosion and progressive loss of genetic diversity (AU-IBAR, 2015). A recent study noted that locally adapted pigs are likely to be lost before they are described and their characteristics documented (Mosweu et al., 2020), signaling the urgency to address this knowledge gap.

There are claims that the pig sector in Uganda has been ignored in almost all development interventions in the livestock sector (Twine and Njehu, 2020). There is low prioritization of the sector in general by the government despite growing pork demand (Wairagala et al., 2016). There is hardly any recorded data on local pig breed performance or even on the trade-offs of keeping different pig breeds/pig-systems (Marshall, 2017). Locally adapted pigs in Uganda have been reported to unique traits of resilience to parasites, tolerance to diseases and that they can cope with almost any feed (Marshall, 2020; Noce et al., 2015). There is therefore need to document the unique phenotypic characteristics of these pig populations, to inform strategies aiming at conservation of the pigs whose population is declining (Kampire et al., 2023) and have been side-lined for commercial production (Weka et al., 2021). There is anecdotal and unpublished information that local pigs in Africa have genotypes that make them less susceptible to infection than improved international breeds (Mujibi et al., 2018). This implies that selection for adaptive traits, in particular, will become very relevant with the current trend in climate change (Onzima, 2019; Hoffmann, 2013). There is severe danger of losing the local pig populations because of the rush for farmers to satisfy the high demand of pork (Hlongwane et al., 2020; Weka et al., 2021).

In this paper, we describe the phenotypic characteristics of locally adapted pigs in five selected districts in South Western Agro-ecological Zone (SWAEZ). Furthermore, we evaluate their production parameters to provide reference geared towards assessing their value. The findings of this study are useful for assessing the degree of threats related to conservation and the sustainable utilization of the locally adapted pigs of Uganda.

METHODOLOGY

Study area

A cross-sectional study was conducted in five selected districts in the South Western Agro- Ecological Zone (SWAEZ) of Uganda, previously described in Kampire et al. (2023) as part of a larger study (Figure 1).

Selection of study participants

Pig farmers rearing locally adapted were identified using purposive, snowball and multi-stage sampling methods. Participants for this study were identified purposively and only those with at least four adult locally adapted pigs were considered. The farmers had to have an experience of five years and above in rearing pigs.

Data collection

Data were collected from households keeping locally adapted pigs using structured questionnaires, on-site observation and physical measurement of pigs using FAO (2012) guidelines for phenotypic characterisation. Measurements were done in the mornings by a trained registered veterinary practitioner. Only one adult pig (one-year-old and above) from the farmer who met the earlier criteria was selected per household for body measurements to assure uniform comparison. A total of seven hundred ninety-four pigs were sampled from 36 parishes in the five districts.

Phenotypic characteristics

Data collected was both qualitative and quantitative: the hair shape, length and density; coat colour pattern, head profile, ear type and orientation, skin condition, tail and backline types. The quantitative variables were: body weight, body length, and number of teats. Other characteristics were: herd level data such as temperament of the animals, adaptability traits, type of holding, herd size and composition, mating practices, use of the animals and also information on origin and development of breed types as well as the reasons why farmers keep locally adapted pigs. The body weight of the pigs was estimated using the weight estimation band.

Statistical analysis

Preliminary data analysis such as homogeneity test, normality test, and screening of outliers was employed before conducting the main data analysis. Data was analysed using SPSS Computer package (SPSS, 2016) and Minitab (2018). Past software was used to calculate for diversity indices of the qualitative traits. Chi-square tests were performed to analyse for the variations in the phenotypic characteristics of animals across the different districts at 95%

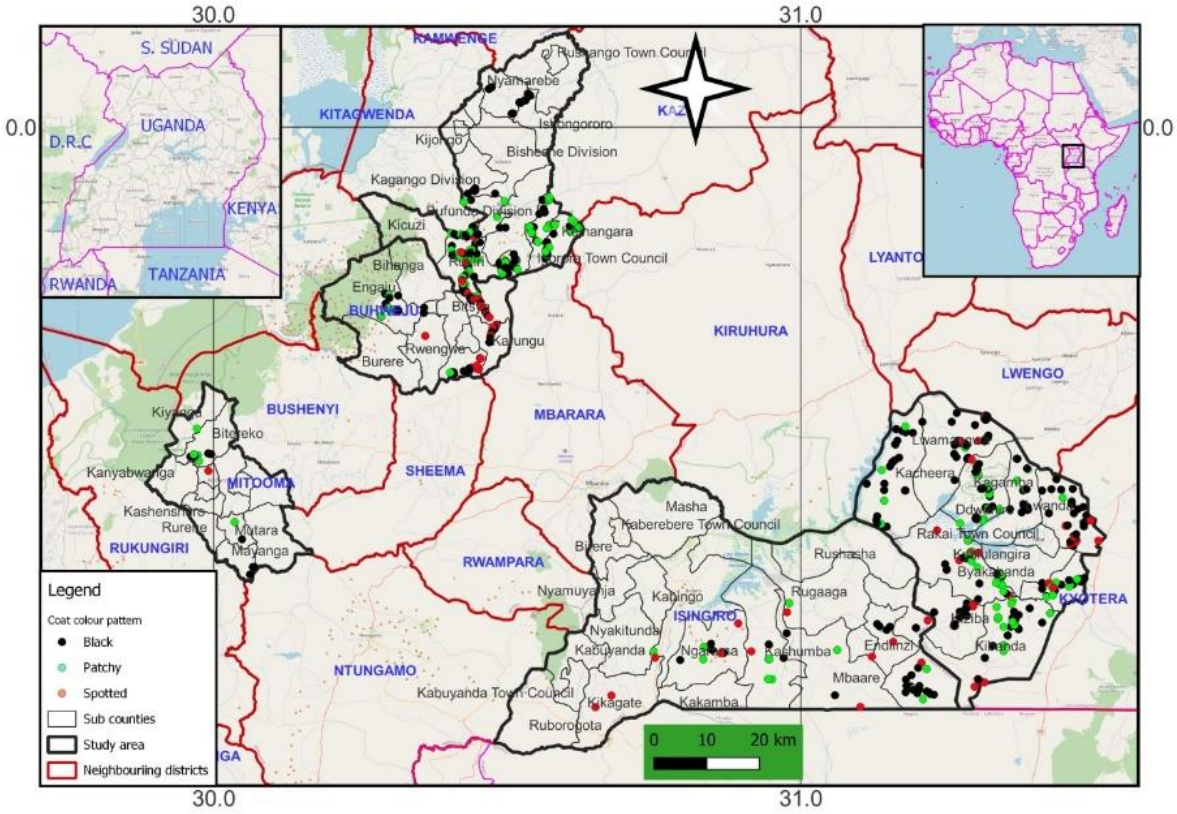

Figure 1. Location of farmers keeping different locally adapted pigs (extracted by plotting farm coordinates in Arc GIS software).

confidence level and principal component analysis was done to check association of the quantitative traits within the population.

RESULTS

A total of seven hundred and ninety-four (794) households participated in the study. Altogether, they kept a total population of 3032 locally adapted pigs including piglets. The number of pigs whose phenotypic characteristics were recorded included 252 males and 1032 females totaling to 1284 pigs. Piglets (0-3 months old) constituted a slightly bigger percentage of the population 1149 (38%) followed by adult females 1084 (34%), growing females 361 (11.9%), growing males 252 (8.3%) and adult males (7.8%), respectively.

Phenotypic qualitative characteristics

Hair type and density in the different locally adapted pig ecotypes

Majority of the pigs had long, dense and straight hair. Several combinations of hair types were observed (Table 1) in the different districts.

Coat colour and pattern

Of the 794 pigs, 517 (65.1%) were plain black, 159 (20.0%) were patched and 118 (14.9%) were spotted (Table 2). The distribution of the different colour patterns varied significantly in the different districts (p=0.000).

Snout orientation and head profile

The snouts of most pigs were long and thin (651/794, 82%) while 143 (18%) had short and cylindrical snouts. Majority of the pigs had a straight head profile (468, 58.9%) while 326 (41.1%) had concave (dished) heads, respectively (Figure 2).

Type of ears and orientation

Three types of ear orientation were seen among the 794 pigs: 426 (52.4%) had semi-lop ears; 237 (29.8%) - droopy; 141 (19.3%) – erect ears. Majority 636 (80.1%)

Table 1. Hair qualities as observed in the locally adapted pigs in the study districts.

Hair	Buhweju	Mitooma	Ibanda	Rakai	Isingiro	No. of pigs (%)
Curly	1	0	50	95	21	167 (7)
Straight	134	22	151	244	83	634 (26.6)
Short	0	1	64	74	23	162 (6.8)
Long	135	21	139	256	78	629 (26.4)
Dense	132	21	181	228	85	647 (27.1)
Sparse	3	1	25	100	17	146 (6.1)

Table 2. Coat colour and pattern of locally adapted pigs across the study districts.

District	No. of pigs with colour pattern			X^2 value	P-value
	Plain black	Patchy	Spotted		
Buhweju	80	23	32		
Mitooma	15	5	2		
Isingiro	64	15	24		
Ibanda	125	64	15	41.812	0.000
Rakai	233	52	45		
Total	517	159	118		
Percent	65.11	20.02	14.9		

had ears projected forward while for 158 (19.9%) pigs, they projected upwards.

Nature of the skin, tail type, and backline shape

Six hundred and fifty-eight (82.9%) pigs had smooth skin coat while 136 (17.1%) had wrinkled skin. The tails were mostly straight (602, 75.8%); 192 (24.2%) had curled (kinked) tails. Most of the pigs (647, 81.5%) had a straight backline; 147 (18.5%) had swayed (curved) backlines. The variation of the different qualitative characteristics along the different colour patterns is shown in Tables 3 and 4.

There was high diversity among many of the features except for skin type. A distinct and clear difference was observed about the ear, head profile, tail type and hair type, length and density. Differences among the pigs with the different colour types in terms of hair density, orientation of the ear, and backline shape were not highly diverse (Table 4).

Anthropometric characteristics

Anthropometric measurements of adult pigs varied in the locally adapted pig population. The smallest pig weighed 10.03 kg and the heaviest 83.2 kg (Table 5). Body weight, body length, and chest girth are important factors among the locally adapted pig population whereas the other traits were not significant in influencing the observed differences as shown in the PCA plot (Figures 3 and 4). The ecotypes clustered together across all the traits considered indicating a strong relationship.

Production characteristics of the locally adapted pigs

Temperament, adaptability traits and production system

In relation to temperament, the study relied on responses from the farmers; 641 (80.7%) pigs were reported to be placid and friendly, 34 (4.3%) and 119 (15%) had moderately aggressive. Information on pig adaptability traits was also based on recollection by the farmers since there was no recorded data; 721 (91%) farmers reported that the pigs were resistant to diseases and parasites; 317 (40%) reported tolerance to drought and 359 (45.3%) to heat. All farmers practiced peasantry agriculture and the pigs were majorly tethered 642 (81%), the rest 152 (19%) were kept under some form of shelter or housed.

Herd size and composition

Herd size ranged from one to seven with an average of four pigs per household. There were 1149 (38%) piglets, 1032 (34.5%) breeding sows (adult females), 252 (8.3%) replacement gilts (young female pigs beyond three

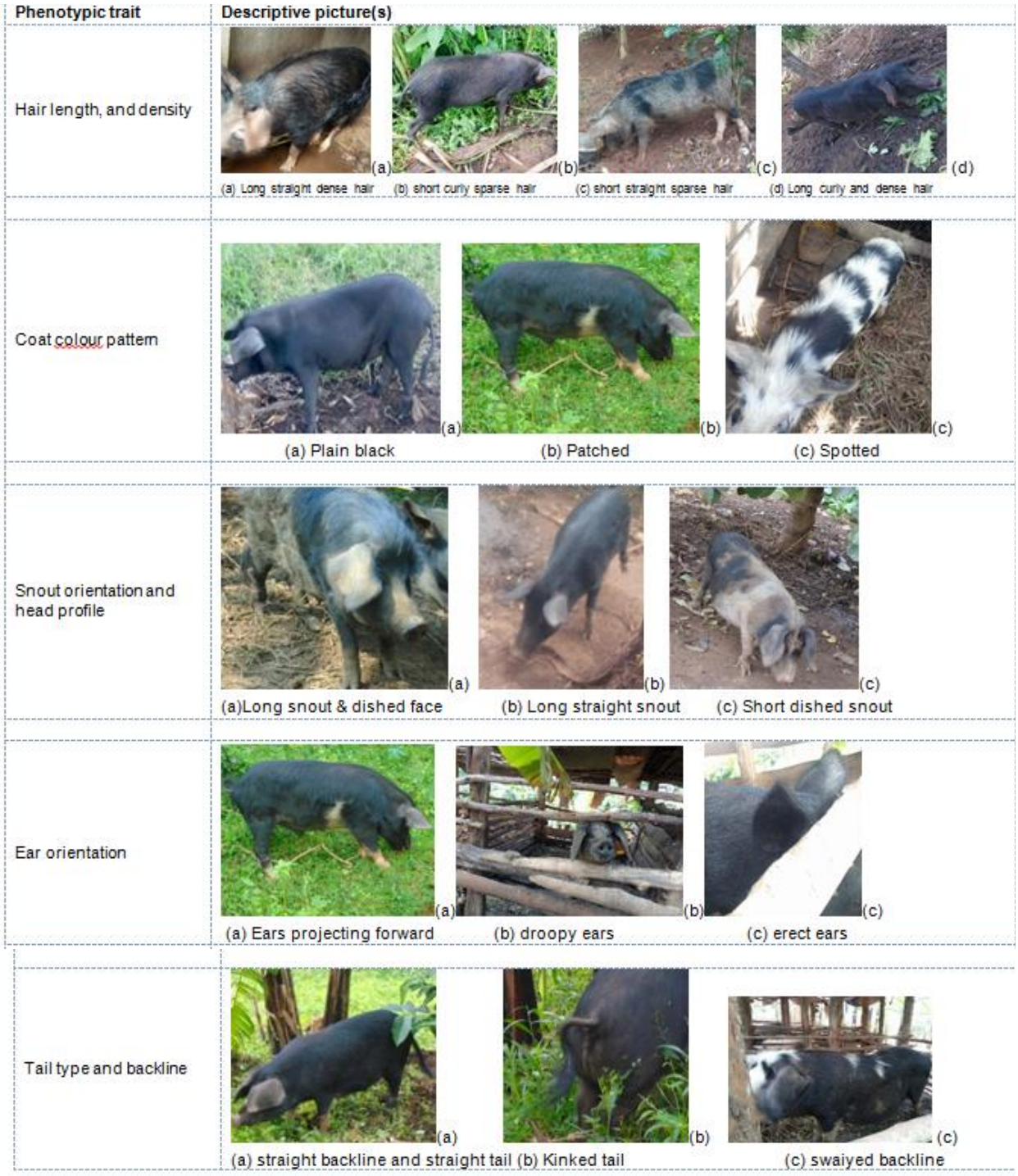

Figure 2. Qualitative phenotypic characteristics.
Source: All pictures taken by Kampire between 2019 and 2021.

months of age) and growing young males, and 238 (7.8%) adult boars. The number of boars could not exceed one at any given household (Table 6) since they are thought to consume a lot of food which is always not enough. The cost of hiring a boar is cheaper than the food it consumes for a given period of time.

Farmers used uncontrolled, non-seasonal and natural type of mating using boars born on the same farm or

Table 3. The distribution of the various qualitative characteristics among the three colour patterns.

Characteristic feature		Colour pattern			Total
		Black	Patched	Spotted	
Hair type	Curly	110	35	17	162
	Straight	407	124	101	632
Hair length	Short	108	26	27	161
	Long	409	133	91	633
Hair density	Dense	418	128	101	647
	Sparse	99	31	17	147
Nature of snout	Long and thin	410	137	104	651
	Short and cylindrical	107	22	14	143
Head profile	Concave	259	68	38	365
	Straight	258	91	80	429
Ear type	Droopy	156	56	25	237
	Semi-loop	272	73	59	404
	Erect	89	30	34	153
Ear orientation	Forward	416	126	94	636
	Upwards	101	33	24	158
Skin type	Smooth	515	155	118	788
	Wrinkled	02	4	0	06
Tail type	Straight	406	114	82	602
	Kinked	111	45	36	192
Backline shape	Straight	423	124	99	646
	Swayed	93	35	19	147

Table 4. Shannon's diversity indices for the different qualitative traits within the different ecotypes and among the total population.

Feature	Shannon's diversity indices of the qualitative traits			
	Black	Patched	Spotted	Population
Hair type	0.5176	0.5271	0.4123	0.5059
Hair length	0.5125	0.4455	0.5378	0.5042
Hair density	0.4884	0.4933	0.4123	0.4791
Nature of snout	0.5099	0.402	0.3642	0.4715
Head profile	0.6931	0.6826	0.6284	0.6899
Ear type	1.002	1.04	1.034	1.022
Ear orientation	0.4939	0.5107	0.5051	0.499
Skin type	0.02535	0.1175	0	0.04444
Tail type	0.50201	0.5958	0.6151	0.5532
Backline shape	0.4717	0.5271	0.4414	0.4794

Table 5. Anthropometric characteristics.

Variable (cm)	Mean ± SD
Body weight	43.84 ± 22.58
Body length	83.91 ± 17.09
Head length	28.12 ± 5.86
Ear length	17.27 ± 3.73
Tail length	23.83 ± 6.80
Chest length	72.12 ± 17.16
Teat number	12 ± 2

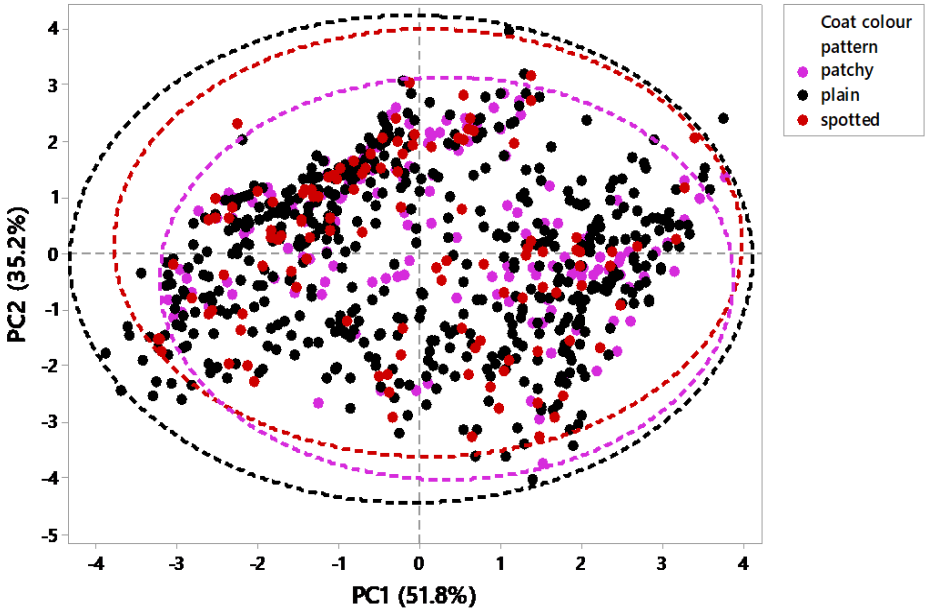

Figure 3. PCA relationship plot of the quantitative variables among the ecotypes.

borrowing from the nearest neighbour in exchange for a piglet at birth or hiring at a given fee.

Reason for rearing locally adapted pigs

The main reason for keeping pigs was income generation (Table 7). When asked why they kept locally adapted pigs, 401 (51.1%) farmers reported limited financial resources as a major factor. Other farmers 252 (32.1%), however, loved and valued the locally adapted pigs because of their advantages over exotic breeds shown in Table 7.

Reproductive performance of locally adapted pigs

Productivity in piggery was measured by reproductive performance. The data was obtained by recollections from farmers keeping the pigs. The average age of the pigs at first farrowing was 11.62 months with a standard deviation of 0.97. The mean number of farrowings reported for a Soar was 5 while mean number of piglets was 4 (Table 8). Litter size increased with the number of farrows. When litter size was compared with the number of farrows in the different districts, significant variation was seen only at the second farrow.

DISCUSSION

This study is the first attempt in Uganda to describe locally adapted pig ecotypes, characterize them, and record their morphological and reproductive performances. The National Animal Genetic Resources Centre and Data Bank, an institution in charge of conserving genetic resources in Uganda has limited

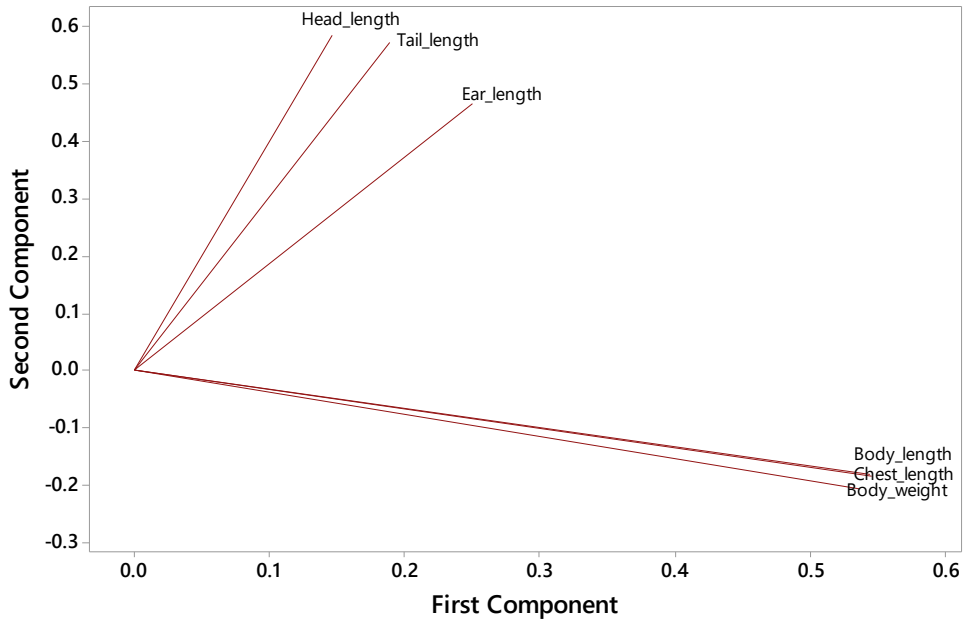

Figure 4. Loading plot of body weight-chest length.

Table 6. Herd size along sex and age groups with standard deviations.

District	Herd size	Breeding sows	Boars	Growing males	Replacement gilts	Piglets
Buhweju	3 ± 2	1 ± 0	1 ± 0	1 ± 0	1 ± 1	2 ± 2
Ibanda	4 ± 2	1 ± 1	1 ± 0	1 ± 1	2 ± 1	3 ± 2
Isingiro	3 ± 2	1 ± 1	1 ± 0	1 ± 1	2 ± 1	2 ± 1
Mitooma	2 ± 1	1 ± 1	1 ± 0	1 ± 1	1 ± 0	2 ± 1
Rakai	3 ± 2	1 ± 1	1 ± 0	1 ± 1	1 ± 1	3 ± 2

Table 7. Reasons for keeping pigs.

Reasons for keeping pigs		Responses from farmers N (%)
General reasons for keeping pigs	Income	736 (92.7)
	Manure	418 (42.9)
	Pork (eating at home)	295 (37.2)
	Socio-economic	180 (22.7)
	Socio-cultural	50 (6.3)
Reasons for keeping locally adapted pigs	Limited resources	401 (51.1)
	Not being a member of the ruling political party	132 (16.8)
	Advantages over exotic breeds	252 (32.1)

phenotypic and performance data on a limited number of exotic pigs with these pigs kept under relatively good management conditions (Marshall, 2015) but none for locally adapted pig types. Local African pigs have been sufficiently discredited (AU-IBAR, 2016) in comparison to exotic breeds disregarding the other values they provide to

Table 8. Reproduction performance.

Farrow order	Mean number of piglets per farrow ±SD	p-value
1st Farrow	4±1	0.098
2nd Farrow	4±1	0.000
3rd Farrow	7±1	0.033
4th Farrow	10±0.0	0.858
5th Farrow	10±1	0.226
6th Farrow	4±1	0.194

especially small-scale pig keepers.

Locally adapted pigs displayed a variety of phenotypic characteristics. Plain black breeds constituted the bigger percentage of the whole population similar to what has been reported elsewhere (Swart, 2010; Halimani et al., 2012; Kalita et al., 2018) as dominating the local pig populations. Given the indiscriminate crossbreeding among the locally adapted pigs and the exotic breeds, the black coloured pigs can be considered to still represent the pigs that were originally introduced and hence more local (Ssewannyana, 2004; Noce et al., 2015; Twine and Njehu, 2020) than those with other colour patterns. A certain skin colour of pigs seems to correlate with particular breed types in the community though not absolute; this is related to what has previously been reported in other studies; other colour types may either be crosses or exotic pigs (Zaake, 2019). Crossing a locally adapted sow with Camborough, Large White or Landrace boar could have resulted into litter with piglets of many colours similar to what was observed by Marshall (2015). The display of features such as droopy ears, white coat, and longer bodies characteristic of white pigs suggests that crossing with exotic breeds like the Landrace at some stage cannot be ruled out (Mbaga et al., 2005). The phenotypic plastic responses of the different ecotypes is an indication of genotype × environment interaction resulting from variations in production environments and feeding regimes (Kebede et al., 2022).

The body weight (kg) was comparable to what has been reported elsewhere in Kenya (Ogara, 2011); local breeds of pigs generally tend to be smaller in size and are often mistakenly thought to be inferior to commercial breeds (Mbaga et al., 2005). A small body size is one of the characteristics used to differentiate these breeds from the exotic breeds (Wang et al., 2015), with the assertion that local breeds are generally small (Halimani et al., 2012). The small size translates into small feed requirements, which makes them very suitable for their production environment, where resources are always limiting. This could also be related to the fact that locally adapted pigs often do not receive a lot of attention compared to exotics and crossbreeds which are economically more valued and are perceived to be less resistant in the prevailing production environment (Dione et al., 2022; Arvidsson et al., 2022). Lower feed intake could have resulted in lowered reproductive performance and growth similar to what was reported by Renaudeau et al. (2012) and Zaake (2019). Although locally adapted pigs generally had small body size, they were reported to have good disease tolerance, corroborating with information in a previous report by Marshall (2020). The small body size, low- production level, and some special morphological traits (properties of the skin or hair) also correlates with the high heat tolerance reported for tropical local breeds (Renaudeau et al., 2012). Exposure of livestock to elevated temperature is thought to decrease body weight and growth rate (Marai et al., 2007; Sejian, et al., 2012) because most locally adapted pigs are often exposed through tethering (Kampire et al., 2023). Improved housing and feed management can improve production of the locally adapted pigs without necessarily changing breeds.

Herd size was small at an average of four animals per household, the majority being piglets; with very few farmers owning boars. This is similar to what has been reported elsewhere (Halimani et al., 2012). Farmers not keeping many boars is a deliberate decision to reduce feeding costs and this is similar to what Nantima et al. (2015) reported. Small herds coupled with the small numbers of boars places the locally adapted pigs at risk of inbreeding (Halimani et al., 2012) further reducing genetic diversity.

The study identified limited human or season controlled breeding practices. Farmers relied on natural mating using the males available on their farms but outsourced from a different farm or within the neighbourhood at a fee or giving back a piglet after birth similar to reports from earlier studies (Tatwangire, 2013; Nantima et al., 2015; Babigumira et al., 2022). The only breed control measure was avoidance of mating of close relatives similar to what was reported by Ouma et al. (2015). Consequently, the genetic pool of the locally adapted pigs continues to be diluted through crossbreeding with exotic boars. A study conducted among 42 of the African Union countries found out that 38 (81%) of the countries identified crossbreeding

crossbreeding of livestock as the main threat to extinction of breed numbers and diversity (AU-IBAR, 2019a). In Uganda, the distribution of exotic breeds usually in pairs (gilt and boar) is a continuing program by both the government and other development partners (FAO, 2009). This should be accompanied with regulation and monitoring of the level of crossbreeding with the exotic breeds (Kampire et al., 2023).

The main objective of keeping pigs was for income generation. However, the reasons for keeping locally adapted pigs amidst increasing levels of intensification of production systems and promotion of exotic breeds to meet the increasing demand for pork was limited income. The locally adapted breeds are commonest in productions systems where resources are limited while improved commercial/exotic breeds are common in production systems that are aimed at satisfying the increasing demand (RoBler, 2005). In fact, local breeds have been excluded from commercial production systems (Weka et al., 2021; Kampire et al., 2023); an intentional program to keep the locally adapted pigs should be initiated since the exotic breeds have penetrated into the rural areas where the locally adapted pigs were known to be predominant.

The most dominant holding system was tethering; the piglets, whenever present, were allowed to roam around probably because they escape through small gaps in the structures for housed pigs and difficult to confine in a tethering system. Extensive free range production system was not encountered probably due to population growth (Ouma et al., 2015). This scenario points to the fact that indeed husbandry practices are changing. Where locally adapted pigs were housed, the greater intention was to replace them with crossbreds or exotic breeds suggesting that the current numbers of local breeds in the study districts will reduce further and yet indigenous breeds can be used as a form of genetic insurance against expected global modifications of production systems and environmental challenges (Collingbourne, 2019). There needs to be positive control and proper planning of crossbreeding programmes that will result in stabilized composites breeds increased breed diversity but also allow access to a wide range breed that provide varied products (AU-IBAR, 2019a).

Farmers reported that locally adapted pigs were more adaptive to the local environment than the exotic breeds and crossbreds in terms of disease resistance, drought and heat tolerance similar to what has been reported elsewhere (Marshall, 2015; Twine and Njehu, 2020). This presents the existing ecotypes with genetic resource that is essential for a changing climate. Some farmers still acknowledged the value of local pigs and indicated a resolve to keep them mostly because of their ability to survive under harsh conditions (Onzima, 2019). Africa's farm animal genetic resources (FAnGRs) are renowned for their adaptability and the majority of countries have at least one livestock breed that is considered well adapted to suit the local environment challenges, such as heat stress, diseases, parasites and limited availability of feed and water (AU-IBAR, 2019b) and the locally adapted pigs belong to the resources. And since the frequency and intensity of droughts in sub-Saharan Africa have increased (Nagasha et al., 2019), the exotic breeds may not do well when the situation gets worse as they are thought to be more vulnerable to subsequent droughts and climate change that may lead to more severe animal losses (AU-IBAR, 2019b).

The productivity of the pigs was within the range of what has been reported elsewhere (AU-IBAR, 2016). Age at first farrowing was late to allow the gilts attain reasonably bigger sizes. Local pigs also tend to be slow growing and late maturing, a factor responsible for the late age at first farrowing (Babigumira et al., 2022). Sows were kept longer until sixth farrowing for maximum profit; this was an effort to help farmers break even since financial return is projected to occur at the third farrowing (Stalder et al., 2003). In some cases, however, reducing the weaning age and the farrowing interval were applied to substantially improve profitability (Greve, 2015).

Conclusion

Locally adapted pigs displayed varying phenotypic characteristics indicating that crossbreeding has seriously influenced the occurrence of the different phenotypic features. Some farmers who appreciate the unique features of the locally adapted pigs and still keep them, should be identified and given incentives which will be a big step towards the continued use and hence conservation of the locally adapted pigs. Development of new and existing niche markets or marketing strategies can help to overcome the continual state of decline of indigenous breeds by raising their visibility and promoting their continued breeding. Programmes and actions that support the elevation and promotion of the locally adapted pigs should be consolidated amidst the continued supply and promotion of exotic breeds which threaten the numbers and could cause possible extinction of the locally adapted pigs. These should be closely monitored and controlled.

The general body size was small. Feeding should be improved to improve the production of the pigs without necessarily changing the production systems. There is an urgent need to expand phenotypic characterization of indigenous livestock population *in situ* over a large geographic scale accompanied with genetic characterization for better understanding before drawing any conservation plans. Given the current harsh production circumstances and potential for significant future changes in production conditions and production goals, the value provided by indigenous genetic diversity

will be secured through characterization, conservation, and development of breeding programs.

The government in partnership with researchers should work towards establishing the national performance recording schemes or breeding centres for all breeds without bias since diversity ensures diverse sources of foods in the unpredictable future. These centres can receive performance records from individual farmers' herds or flocks, analyse the data centrally and the results are returned to the farmers for their selection and management decisions.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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