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RESEARCH ARTICLE

Animal Science

Kinniya cattle: A locally bred draught cattle population in Sri Lanka

KGCB Wijebandara[1*], M Hans[2], I Ratheefa[2], MS Kurukulasuriya[3] and GLLP Silva[4]

[1] *Postgraduate Institute of Agriculture, University of Peradeniya, Peradeniya, Sri Lanka.*
[2] *Government Veterinary Surgeon's Office, Kinniya, Sri Lanka.*
[3] *Department of Animal Science, Faculty of Animal Science and Export agriculture, Uva Wellassa University of Sri Lanka, Badulla, Sri Lanka.*
[4] *Department of Animal Science, Faculty of Agriculture, University of Peradeniya, Peradeniya, Sri Lanka.*

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Abstract: Indigenous cattle in Sri Lanka consists of several geographically isolated populations. Due to lack of descriptive information, they remained non-descriptive. With isolated breeding with directional selection, some of these populations have developed unique features allowing the opportunity to establish indigenous breeds. The Kinniya cattle population is one such breed, which is featured by unique selection and breeding system under specific management circumstances. This study was carried out to identify the unique characteristics in Kinniya cattle, while unveiling the associated social, cultural and economic background. Comparison of the distribution and characteristics of Kinniya cattle of those with different indigenous cattle populations in Sri Lanka was done using descriptive statistics. The results revealed that the Kinniya cattle are reared extensively in large herds, and bull calves are selected for well-defined draught characters at three months of age. Having undergone directional selection for generations, the population has now stabilized to feature well developed horns with uniform orientation, prominent hump and dewlap. The comparison with other populations revealed that, despite the ancestral similarities that could exist with the Thamakaduwa cattle, Kinniya cattle showed a distinct morphometric attribute. The study disclosed the directional selection and breeding strategies adopted by the communities over generations, and the distinct herd management strategies adopted have helped developing the uniqueness of Kinniya cattle as a separate indigenous population in Sri Lanka and the only population bred for draught purpose.

Keywords: Draught animals, indigenous cattle, Kinniya cattle, phenotypic characterization.

INTRODUCTION

Sri Lanka is an agricultural country possesing a variety of natural resources and a rich biodiversity. Crop and livestock farming is one of the oldest economic activities in Sri Lanka and it has been the main livelihood since ancient civilizations in the country. Livestock production performs a key role in national agricultural sector, within which cattle are the prominent contributor (Chandrasiri, 2002). The total cattle population in Sri Lanka in 2023 has been estimated as 1.2 million, where majority of them (0.83 million) are indigenous (Department of Census and Statistics, 2023). Sri Lankan indigenous cattle are of the Zebu type, which being raised over generations and are well adapted to harsh rural environments, especially with heat tolerance and disease resistance (Silva et al., 2010). Even though these cattle are triple purpose (milk, draught and meat) animals, they are poor milk producers. Irrespective of the purpose of keeping, adaptation to the indigenous harsh environment, especially under the rural smallholder system, is a significant feature (Silva et al., 2008).

* Corresponding author (chamodbhashitha138@gmail.com; https://orcid.org/0009-0003-6684-6244)

Some Sri Lankan cattle, are differentiated as distinct indigenous types as Batu, Thawalam, Thamankaduwa and Cape/Hatton cattle. Of these, Cape cattle is now considered as an extinct (Chandrasiri, 2002). These indigenous cattle types can be identified as geographically distinct populations such as North Central, Northern, Southern, Thamakaduwa and Thawalam which represent the general indigenous cattle populations. Despite geographical separations and phenotypic variations, indigenous cattle remain as non-descript populations owing to gaps in information generated through systematic investigation (Silva et al., 2010). In addition to the clearly differentiated indigenous types, there are isolated groups in Sri Lanka, selected over generations. These populations are managed for specified attributes, and are found in limited numbers in isolated pockets. Kinniya cattle are one such population, which are specially used for draught purpose. Kinniya cattle, regionally called 'Naattu maadu' (Vernacular Tamil name for local cattle) are found in the Kinniya, Muthur and Verugal regions, where Kinniya serves as the predominant distribution center. Kinniya cattle are distinguished from other indigenous cattle populations mainly by the specified morphological features; especially the prominent and long horns, well developed hump and dewlap of the males, and the white coat colour. A local pastoral community in the Kinniya region has reared cattle over generations. This suggests that Kinniya cattle have evolved through the selection of early Indian White cattle which existed in the region. Still, selection can be observed in the Kinniya population, where cows are bred with selected bulls which have prominent draught morphology (Wijebandara & Silva, 2024).

Analyzing the indigenous cattle and their associated sociocultural environment is important for understanding the dynamics of the production environment. This will also support the global effort in describing indigenous farm animal genetic resources aiming to provide society with a greater range of options to meet future challenges (FAO, 2007). Hence, this work was carried out to identify the population specific phenotypic characteristics of the Kinniya cattle, and their uniqueness compared to other indigenous cattle populations in Sri Lanka, while exploring the social, cultural and economic background associated with the indigenous cattle production in Kinniya region of Sri Lanka.

MATERIALS AND METHODS

Sampling location and selection of Kinniya cattle

Kinniya cattle for phenotypic characterization were selected based on the population distribution data gathered from the regional office of Kinniya Veterinary Division, Sri Lanka. There were 20–30 isolated breeding herds in the region with 50–70 animals per herd. Thirty mature animals including six males and 24 females of

Table 1: Description of morphometric measurements

Measurement	Description
1. Head length	Distance from the nape to the rostral end of the muzzle
2. Face length	Distance from the widest part of head to rostral end of muzzle
3. Face width	Distance of the widest points of the head
4. Ear length	Distance from the root to the end point of ear
5. Ear width	Distance of the largest points of the ear
6. Horn length	Distance from the base of horn to the tip
7. Muzzle circumference	The circumference of the muzzle over the nostrils
8. Body length	The horizontal distance from the point of shoulder to pin bone
9. Rump height	Distance from the bottom of the hind foot to the highest point between hooks
10. Heart girth	Circumference just behind the forelegs
11. Whither height	Distance from the bottom of the front foot to the highest point over wither
12. Tail girth	The biggest circumference at the base of the tail
13. Rump width	The distance between the points on either side of the animal located at one half of the distance measured from ventral point
14. Tail length	Distance from the base of the tail proximal end of the first coccygeal bone to the distal end of the last coccygeal bone

4-8 years of age were subjected to morphological and morphometric characterization from six different herds (an average of five animals per herd) which represented approximately 2.5% of the total Kinniya cattle population in Kinniya veterinary division.

Morphological and morphometric data collection

Six descriptive traits, *viz*., hair coat colour, dewlap development, hump development, horn morphology, hoof colour and tail switch colour were considered for morphological traits along with morphometric measurements recommended for phenotypic characterization by the Food and Agriculture Organization (FAO, 2012). Accordingly, fourteen morphometric traits, *viz*., head length, face length, face width, ear length, ear width, horn length, muzzle circumference, body length, rump height, heart girth, whither height, tail girth, rump width, and tail length were measured. A full description of each morphometric measurement is given in Table 1. All measurements were taken using a scaled band and a scale ruler as illustrated in Figure 1.

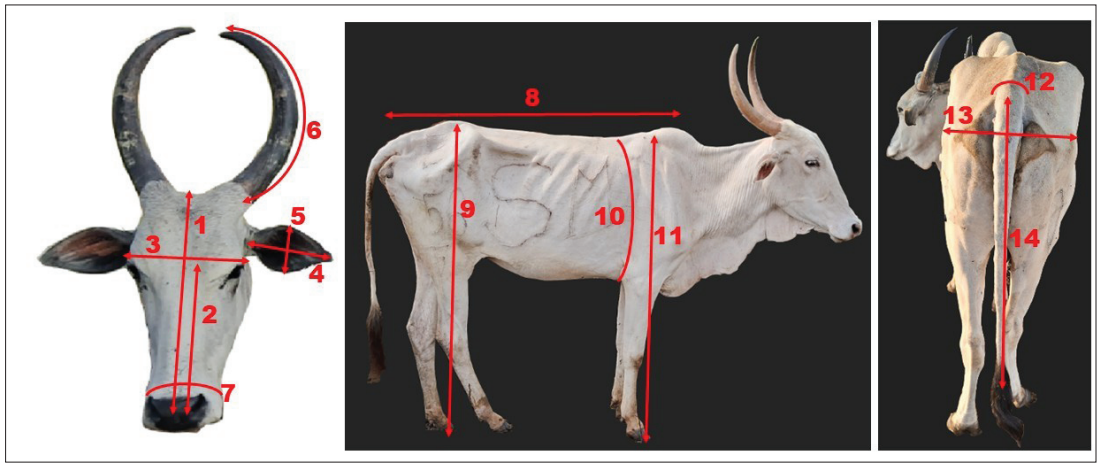

Figure 1: Measurement of morphometric indices of Kinniya cattle

Data analysis

Descriptive statistics for all morphometric measurements of Kinniya cattle were calculated using R 4.4.0 software (R core team 2023). To compare the morphometric characteristics of Kinniya cattle (both bulls and cows) with those of other indigenous cattle population which have the closest similarity, an independent two-sample t-test was performed using summary statistics (means, standard deviations, and sample sizes). This test was selected because the available reference data provided sample means and variances rather than population parameters, making a one-sample *t*-test inappropriate. Since the population standard deviations were unknown, the t-statistic (rather than a z-statistic) was used for hypothesis testing. Morphometric traits compared included heart girth, height at withers, rump height, rump width, body length, head length, face width. Reference data for these traits were obtained from previously published studies on Sri Lankan indigenous cattle (Silva et al., 2010; Wijebandara et al., 2022). Additionally, the observed morphometrics of Kinniya cattle were compared with the regional Zebu cattle populations to identify the phenotypic similarities and possible genomic inheritances.

RESULTS AND DISCUSSION

Distribution of Kinniya cattle and the system of operation

Kinniya cattle are natively distributed in mainland and peninsula (predominantly Kinniya, Muthur and Verugal divisions) of Trincomalee district of Sri Lanka where Kinniya serves as the predominant distribution center. This region is located at 8°20’ - 8°60’N and 81°10’ - 81°40’ E in the Low Country Dry Zone (Figure 2).

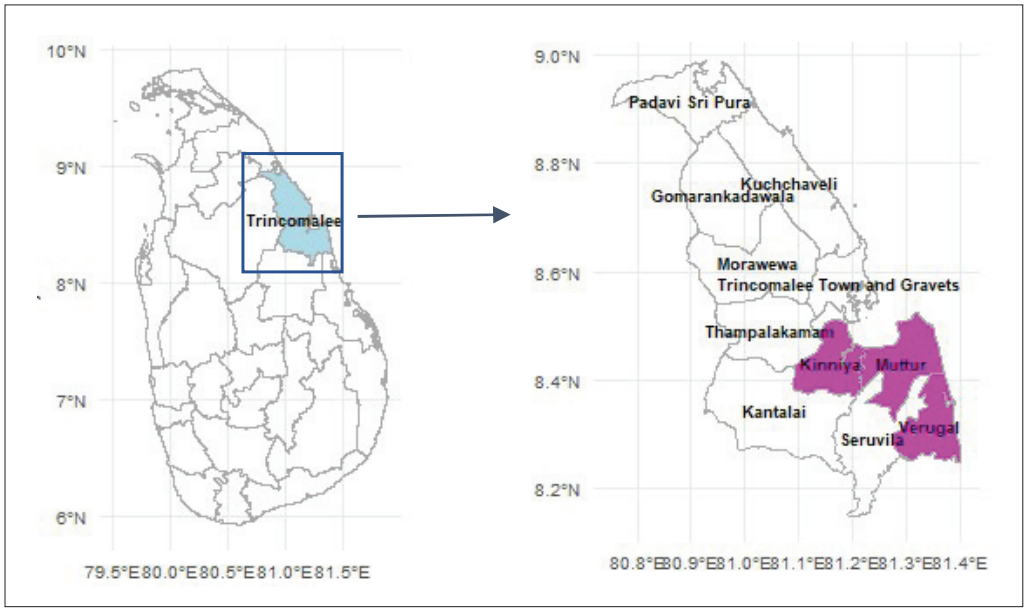

Figure 2: Distribution of Kinniya cattle

The main economic activity in the area is fishing and related industries like dry fish production. Rain fed crop production is also a major activity in the backland area. Although there are no proper irrigation channels in the area, small tanks are used to store rainwater. Only one season of rain fed paddy cultivation (September to January: north-east monsoon/Maha season) and the irrigated seasonal crop (Maize, chilli) production are the agricultural activities. Salt production and animal farming are other income generating activities together with trading, especially in the commercial areas.

Kinniya cattle are bred naturally. In a herd of about 70 animals, one or two breeding bulls with well-developed body structure with desired morphologies such as well-developed horns, hump and dewlap (Figure 3) are kept for breeding purposes. A minimum number of bulls are kept in a herd to minimize management difficulties caused by aggressive behaviour.

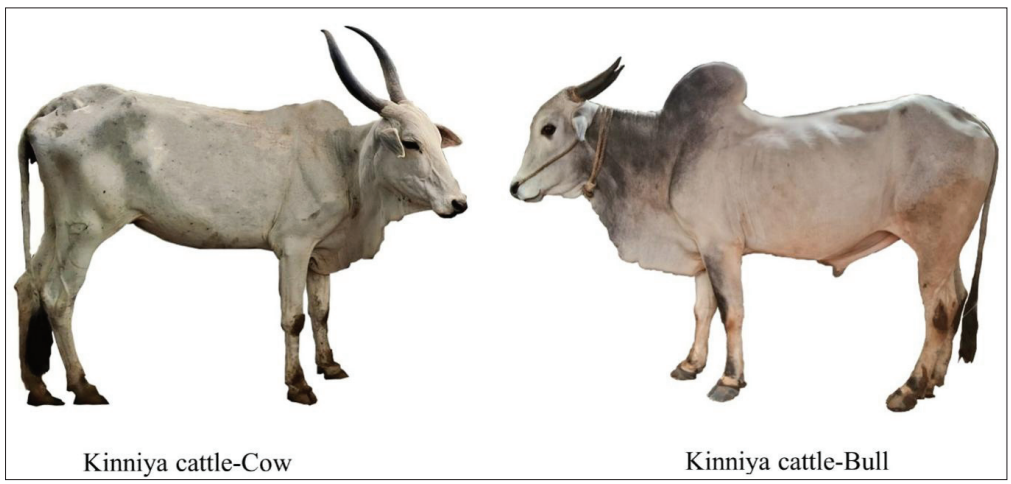

Figure 3: Male and female animal of Kinniya cattle

Rotating of bulls among herds is practiced to prevent inbreeding. Around three months of age, the appropriate males for draught purpose, especially for pulling carts (Figure 4), are chosen based on their morphological characteristics by visual observations, particularly the horns and hump. The bulls used for human transportation (Figure 4B) are subjected to castration to ensure the tamed behavior whereas others remain intact.

Figure 4: Pulling carts used mostly for the delivery of firewood and goods in the surrounding areas of Kinniya (A) and for tourism purpose (B) in Sigiriya and Habarana areas

Kinniya cattle are managed under semi-nomadic management strategies. Bulls which are selected and raised for pulling carts are managed intensively at the stalls established in the backyards of cattle owner. There are two to three such bulls in a stall where they are fed mainly with hay and concentrates. Those which are not selected for draught activities are reared in extensively managed herds with 50 – 70 animals on average (Figure 5). A herdsman who is employed by cattle owners looks after the animals under extensive conditions. Skin branding is the only identification method used.

Figure 5: Extensively manages Kinniya cattle herds

During the paddy cultivating season, cattle herds are moved to the uncultivated, mainly forest areas around 20 to 30 km away from the Kinniya region. During the day, animals in the forest are allowed to graze freely, and at night they are kept in temporarily established paddocks next to the forest area (Figure 6-A). During the rainy seasons, if the surrounding forest areas get flooded, animals are fed with tree fodder inside the paddocks. A

herd of 50 – 70 animals is kept in a roughly 50 m × 60 m paddock. Animals are brought back to the villages during the harvesting season and kept in temporarily built paddocks at night on rental basis. The paddocking area is an elevated area of a harvested paddy field (Figure 6-B). The land rent is settled with milk, manure, calves, or rental fees for the landowner. During the day, the animals are let loose to graze freely in the harvested fields. Rain-fed tanks next to the paddy fields provide water during the day. However, animals have no access to food or water during the night.

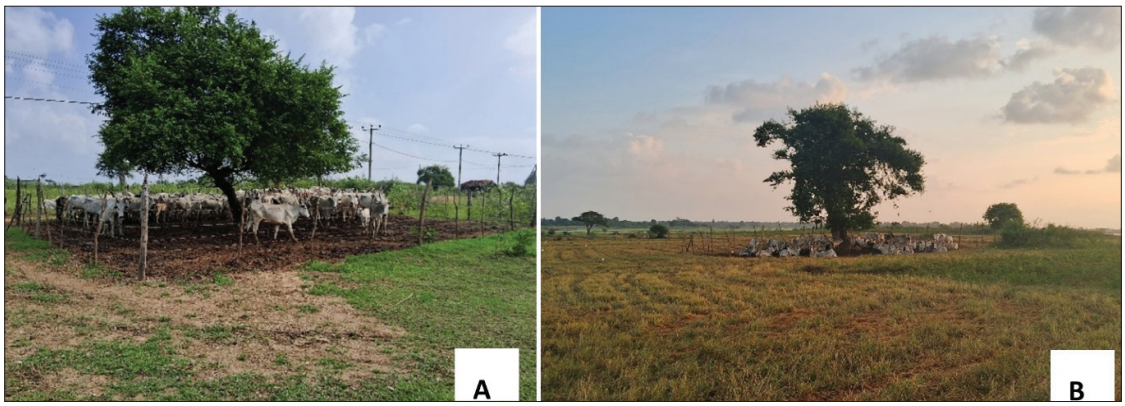

Figure 6: Temporarily established paddocks; A: paddock next to forest area, B: paddock on an elevated land of a paddy field

Abeygunawardena et al. (1997) have identified two distinct local cattle production systems based on the agro-ecology, rainfall pattern and cropping system in the dry zone of Sri Lanka, namely, dry zone traditional village system and dry zone irrigated settlement system. The dry zone traditional village system is characterized by extensive management, communal grazing during day time, keeping in paddock at night, and milking in the morning. Primary source of income of about 92% of the traditional dry zone villagers is cattle rearing. Although most of the operations within Kinniya cattle farming are aligned with the dry zones traditional village system. Management practices such as movement of herds regularly and cyclically based on the seasonal availability of pasture and water resources caused the Kinniya cattle farming to emerge as a semi-nomadic management system with some deviation from it. These specified management practices are essential for the animals' survival and well-being, especially under arid or semi-arid conditions.

Meat is the primary production associated with Kinniya cattle farming. Mature, well-built animals typically weigh 250-350 kg. Milk production is not a priority as a cow produces only 1-3 L of milk per day. and lactation lasts approximately for six months. There is no formal milk collection chain linked with the farms. Local vendors visit herds to collect milk which is sold within the village. Productive lifespan of an animal is 8-10 years and the older animals that are not productive are culled. According to Abeygunawardena et al. (1997), 45% of the income of the dry zone cattle farming came from selling animals for meat, 34% from selling milk and the balance from selling manure (12%), draught associated services and selling animals for draught. Pagthinathan & Sathiyasegar (2013) reported that in the dry zone indigenous cattle management system, the average milk yield was 1.7 L per animal per day and around 22.5% of farmers kept cattle for meat purposes.

Phenotypic characterization and identification of unique phenotypes of Kinniya cattle

In general, Kinniya cattle are white in their hair coat. But the bulls typically have shaded areas of darker hair, ranging from grey to black, especially on the head, neck, hump, and knees, whereas cows have almost white hair. Dewlap and hump are prominently developed in males. Around 70% of the cows have curved horns while others have straight horns oriented upward. In selected bulls, horns are usually trimmed and polished to maintain their appearance at the carts. Hoof and tail switch color is black in both bulls and cows (Figure 3). Compared to other local cattle in the country, Kinniya cattle show

a relatively large body structure. Table 2 provides the comparison of Kinniya cattle morphometrics together with the values reported for other indigenous cattle in the country. The specific morphometrics of Kinniya cattle are listed in Table 3.

Table 2: Morphometrics [Mean ± SD (cm)] of Kinniya and other indigenous cattle in Sri Lanka.

Morphometric characteristic	Sex	Northern Dwarf [f]	Northern	Southern	North Central	Thawalam	Thamakaduwa	Kinniya [g]
Heart girth	Male	110.0 ± 2.5^{a}	110 ± 19^{ab}	125 ± 14^{ab}	132 ± 9^{bc}	140 ± 12^{bc}	150 ± 16^{cd}	167.6 ± 6.7^{d}
	Female	105.2 ± 3.4^{a}	111 ± 18^{b}	125 ± 13^{c}	132 ± 9^{d}	N/A	131 ± 13^{d}	144.8 ± 4.9^{e}
Height at withers	Male	90.1 ± 3.0^{a}	93 ± 8.7^{ab}	96 ± 9^{ab}	101 ± 7^{b}	112 ± 09.6^{c}	123 ± 16^{cd}	130.4 ± 7.3^{d}
	Female	88.1 ± 1.5^{a}	94 ± 8.5^{b}	96 ± 9^{b}	101 ± 6^{c}	N/A	118 ± 20^{d}	117.0 ± 2.3^{d}
Rump height	Male	97.4 ± 1.5^{a}	N/A	N/A	N/A	N/A	N/A	135.5 ± 1.5^{b}
	Female	94.5 ± 2.2^{a}	N/A	N/A	N/A	N/A	N/A	124.3 ± 3.1^{b}
Rump width	Male	N/A	29 ± 4^{a}	30 ± 5^{a}	32 ± 3^{a}	31 ± 4.6^{a}	33 ± 3^{a}	35.6 ± 2.5^{a}
	Female	N/A	30 ± 4^{a}	30 ± 5^{a}	32 ± 3^{b}	N/A	38 ± 5^{c}	33.9 ± 1.8^{d}
Body length	Male	N/A	97 ± 9^{a}	97 ± 12^{a}	103 ± 3.8^{a}	116 ± 10^{b}	128 ± 33^{abc}	126 ± 3^{c}
	Female	N/A	97 ± 9^{a}	97 ± 11^{a}	106 ± 8.8^{b}	N/A	109 ± 5^{c}	114 ± 3^{d}
Head length	Male	N/A	35 ± 3^{a}	38 ± 5^{abc}	41 ± 3^{bc}	44 ± 4^{b}	41 ± 2^{c}	52.5 ± 1.4^{d}
	Female	N/A	35 ± 3^{a}	38 ± 5^{b}	41 ± 3^{c}	N/A	41 ± 3^{c}	43.8 ± 2.2^{d}
Face width	Male	N/A	12 ± 1^{a}	16 ± 2^{bc}	16 ± 1^{b}	14 ± 3^{c}	16 ± 2^{bc}	19.5 ± 0.7^{d}
	Female	N/A	12 ± 1^{a}	16 ± 2^{b}	16 ± 2^{b}	N/A	14 ± 2^{c}	17.2 ± 0.6^{d}

[a,b,c,d] Values with different superscripts differ significantly ($p < 0.05$). Measurements for indigenous cattle types were based on Silva et al., 2010, except for those values followed by [f] Wijebandara et al., 2022 and [g] from the present study. N/A – Not available

Table 3: Additional morphometric measurements [Mean ± SD (cm)] recorded for Kinniya cattle

Sex	Face length	Ear length	Ear width	Horn length	Muzzle circumference	Tail length	Tail girth
Male	36.5 ± 1.4	18.6 ± 0.7	9.5 ± 0.5	34.7 ± 2.9	42.3 ± 1.4	103.3 ± 5.2	20.3 ± 0.5
Female	34.8 ± 3.6	18.4 ± 0.8	8.7 ± 0.5	44.3 ± 6.1	36.9 ± 1.4	93.9 ± 2.6	18.2 ± 0.9

Morphometric characteristics of Kinniya cattle demonstrate several unique features that distinguish them from other indigenous Sri Lankan cattle, while showing strong similarity to Thamankaduwa cattle. Most of the morphometric measurements of Kinniya cattle exhibit higher values ($p < 0.05$) than those of Southern, Northern, and Thawalam cattle, indicating a comparatively larger body frame and better-developed skeletal structure. For instance, the heart girth of Kinniya cattle bulls (167.6 ± 6.7 cm) exceeds ($p < 0.05$) that of Southern (125 ± 13.7 cm) and Northern cattle (110 ± 18.9 cm). Their body length (126 ± 3 cm in bulls) is also greater ($p < 0.05$) than the corresponding measurements of Northern and Southern population. Height at withers in Kinniya cattle (130.4 ± 7.3 cm) is also higher than ($p < 0.05$) Northern and Southern cattle populations, again positioning Kinniya animals toward the upper end of the national cattle morphometric spectrum. Cranial measurements show the similar trend where Kinniya cattle head length and Face width are higher ($p < 0.05$) than values reported for other indigenous cattle populations in Sri Lanka. Despite these larger overall dimensions, their morphometric profile aligns most closely with Thamankaduwa cattle ($p > 0.05$), as seen in comparable measurements. Collectively, these results suggest that Kinniya cattle are larger than most Sri Lankan cattle types and morphometrically most similar to the Thamankaduwa breed.

The identified morphometrical differences of these indigenous cattle might be due to ancient, demographic related introductions and geographical distributions. These indigenous cattle populations are well adapted and managed for different purposes. Batu cattle are the prominent type of indigenous cattle, reared especially for milk, meat, and draught, which is similar to most Zebu type cattle found in the tropics (Silva et al., 2010). Batu cattle are the descendants of early archaic cattle (since 543 BC) in Sri Lanka with little relation to the Indo-Pakistani zebu. Thawalam cattle is specially a selected cattle population for pack animal morphology, different from other indigenous cattle (specially from Batu cattle), where breeding and rearing are done in isolated highlands in Central and Uva provinces of Sri Lanka. Generations of breeding in isolation has made them to emerge as a separate type of cattle that now possess different body conformation to rest of the indigenous cattle found in Sri Lanka (Silva et al.,2008). The Northern Province dwarf cattle population is phenotypically short compared to the other local cattle populations in Sri Lanka which are mainly reared for milk, meat, draught and manure and also a small proportion of males are reared mainly for breeding and traditional gaming activities. These population has exhibited a close evolutionary divergence with south Indian dwarf cattle populations according to mitochondrial Cytochrome Oxidase Sub-unit I based phylogenetic analysis (Wijebandara et al., 2022). Thamankaduwa cattle, reared for meat and draught, are found predominantly in the Eastern region of the country and it is believed that they originated through the cross breeding of ancient Lankan cattle with Indian white cattle breeds (Nadheer, 2005; DAPH, 2010; Silva et al., 2010; Shanjayan and Lokugalappatti, 2015). Kinniya cattle also have distributed with close geographical proximity to the areas where Thamankaduwa cattle have distributed. In addition to these specified populations, the Northern, North Central and Southern cattle represent the regionally localized Zebu cattle, with close morphology as Batu cattle (Silva et al., 2008). As indicated by Abeygunawardena et al. (1997), the majority (90%) of the indigenous cattle are distributed in the dry and intermediate zones of Sri Lanka. The district wise geographical distribution of the identified indigenous cattle types within the country is shown in Figure 7.

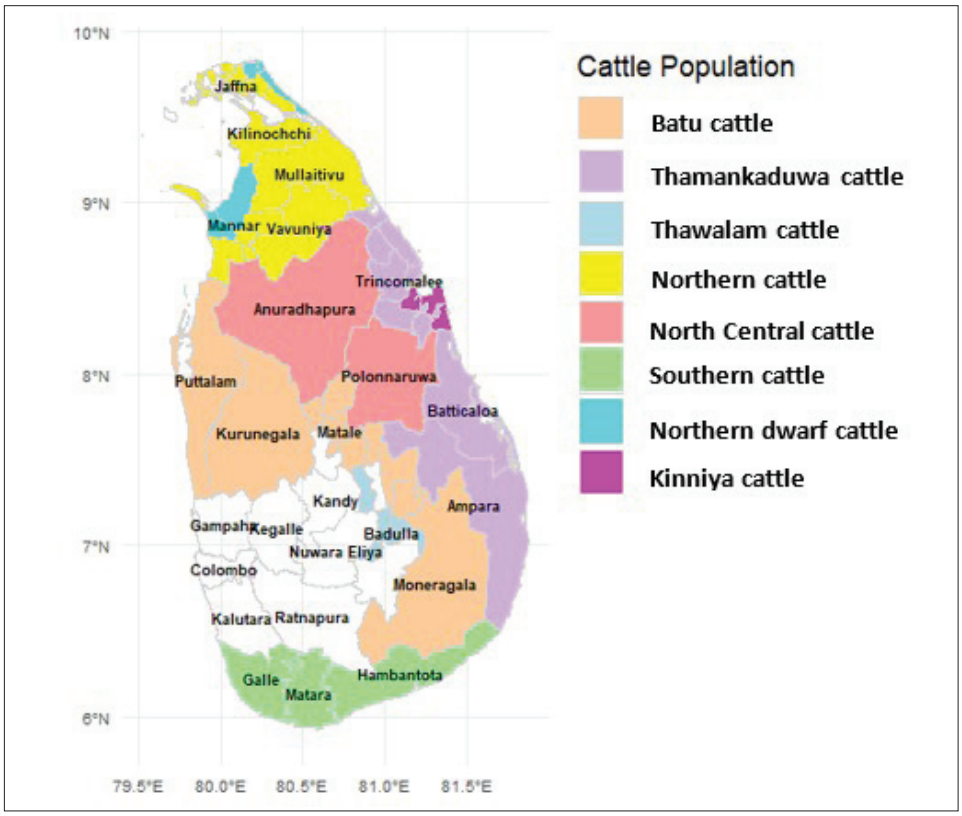

Figure 7: District wise geographical distribution of the indigenous cattle populations in Sri Lanka

Given the morphometric and geographical similarities between Kinniya and Thamankaduwa cattle (Table 2 and Figure 7), the *t* distribution analysis was carried out to assess the phenotypic deviation of the two cattle populations. The local pastoral community has been rearing Kinniya cattle over generations in the Kinniya region. This suggests that most likely Kinniya cattle have been evolved from the Indian white cattle, which were historically present in the region. The Kinniya cattle are being subjected to directional selection for draught morphology. This evolutionary process is similar to the origin of Thamankaduwa cattle, which are considered as the crossbred of ancient Lankan cattle with Indian White cattle breeds such as Tharparkar, Khillari, Hariana and Kangayam (Nadheer, 2005; DAPH, 2010; Silva et al., 2010; Shanjayan and Lokugalappatti, 2015; Lokugalappatti et al., 2023). Therefore, the recorded values for Kinniya and Thamankaduwa cattle were compared with the available reference morphometrics of Indian White cattle breeds (Table 4).

Table 4: Morphometric comparison [Mean ± SD (cm)] between Kinniya, Thamankaduwa and Indian white cattle breeds

Morphometric characteristic	Sex	Kinniya	Thamakaduwa [d]	Khillari [e]
Heart Girth	Male	167.6 ± 6.7[a]	150 ± 16[b]	173.4 ± 0.4[a]
	Female	144.8 ± 4.9[a]	131 ± 13[b]	156.8 ± 0.3[c]
Height at withers	Male	130.4 ± 7.3[a]	123 ± 16[a]	136.5 ± 0.2[a]
	Female	117.0 ± 2.3[a]	118 ± 20[a]	126.5 ± 0.2[b]
Rump width	Male	35.6 ± 2.5[a]	33 ± 3[a]	N/A
	Female	33.9 ± 1.8[a]	38 ± 5[b]	N/A
Body Length	Male	126 ± 3[a]	128 ± 33[ab]	144.1 ± 0.3[b]
	Female	114 ± 3[a]	109 ± 5[b]	132.2 ± 0.3[c]
Head length	Male	52.5 ± 1.4[a]	41 ± 2[b]	53.4 ± 0.3[a]
	Female	43.8 ± 2.2[a]	41 ± 3[b]	49.6 ± 0.1[c]
Face width	Male	19.5 ± 0.7[a]	16 ± 2[b]	20.5 ± 0.1[c]
	Female	17.2 ± 0.6[a]	14 ± 2[b]	18.9 ± 0.1[c]
Ear length	Male	18.6 ± 0.7[a]	N/A	22.1 ± 0.1[b]
	Female	18.4 ± 0.8[a]	N/A	21.5 ± 0.1[b]
Horn length	Male	34.7 ± 2.6[a]	N/A	47.9 ± 2.2[b]
	Female	44.3 ± 6.1[a]	N/A	46.3 ± 0.2[a]
Tail length	Male	103.3 ± 4.7[a]	N/A	111.7 ± 0.2[b]
	Female	93.9 ± 2.6[a]	N/A	105.1 ± 0.2[b]

[a,b,c] Values with different superscripts differ significantly ($p < 0.05$). [d] Silva et al., 2010, [e] Gokhale et al., 2009

Results indicated that, Kinniya cattle bulls are significantly differed from Thamankaduwa cattle bulls when head length and face width ($p<0.05$) were considered, whereas measurements of cows were significantly different in heart girth and face width ($p<0.05$). Additionally, these populations exhibit sex-based differences in their morphometric characteristics. Similar observations of sex-based differences in the morphometric traits within indigenous cattle populations have been previously reported by several studies (Dhal et al., 2007; Kayastha et al., 2011; Chandran et al., 2014; Jain et al., 2018; Mohan et al., 2025). Sex-based differences in morphometric traits in cattle largely reflect sexual dimorphism, driven by both hormonal and genetic mechanisms. In bulls, higher levels of androgens stimulate bone apposition, muscle mass accumulation, and prolonged growth, resulting in greater body size, heart girth, and linear measurements, whereas in females, estrogens contribute to earlier closure of growth plates and reduced periosteal expansion (Gibson et al., 2011). At the genomic level, sexually dimorphic loci associated with size and muscularity have been identified in cattle, demonstrating that male and female

growth trajectories are regulated in part by sex-specific expression of key genes (Doyle et al., 2021). Moreover, phenotypic studies across indigenous cattle populations had consistently found that males significantly exceed females in height, heart girth, and body length, reflecting not only endocrine effects but also evolutionary and functional roles, as example; larger males can confer greater performance for work or competition, while females prioritize reproduction (Fetene et al., 2025).

The morphometric comparison of Kinniya cattle with Thamankaduwa cattle and the reference Indian White cattle breeds further supports the hypothesis of a shared ancestry and parallel evolutionary processes. The height at withers of Kinniya bulls (130.4 ± 7.3 cm) lies between Thamankaduwa (123.0 ± 16.0 cm) and the larger Indian breeds such as Khillari (136.5 ± 0.2 cm) indicating an intermediate body stature consistent with partial Indian White cattle influence. Heart girth values of Kinniya bulls (167.6 ± 6.7 cm) exceed those of Thamankaduwa (150 ± 16 cm) and align more closely with heavier Khillari type (173.4 ± 0.4 cm). Cranial measurements also reinforce this pattern; Kinniya bulls' head length (52.5 ± 1.4 cm) is higher than ($P < 0.05$) Thamankaduwa (41 ± 2 cm) and approaches the longer-headed Khillari breed (53.4 ± 0.3 cm), while face width value (19.5 ± 0.7 cm) is intermediate between Thamankaduwa and Indian White breeds, reflecting a shared *Indicine* craniofacial morphology. The ear length of Kinniya cattle (18.6 ± 0.7 cm in males) exhibit close values for Khillari (22.1 ± 0.1 cm) and falls within the elongated-eared phenotype characteristic of tropical *Bos indicus* cattle (Mohan et al., 2025). Additionally, tail length in Kinniya cattle (103.3 ± 4.7 cm in bulls) is comparable to Khillari (111.7 ± 0.2 cm), suggesting retention of Indian white cattle ancestral morphology.

These observations confirm the morphological deviation of directional selection, despite the possible common ancestral path of the Kinniya and Thamankaduwa cattle populations. As listed in Table 4, Kinniya cattle has responded to the directional selection and breeding strategies adopted. This was further evidenced in Figures 8 and 9 where the visual comparison against body and horn characteristics of Thamankaduwa cattle are shown in detail. Kinniya bull possesses well-developed horns, hump and dewlap as well as the shaded areas with dark hair, ranging from grey to black (Figure 8), and the uniform orientation in horns which are straight and curved (Figure 9). Directional selection and isolated breeding may have helped Kinniya cattle to evolve as a separate population with distinguishable unique phenotypes. Despite the genetic similarities that could exist between the Kinniya cattle and Thamankaduwa cattle populations, the unique morphology and distinct herd management strategies found in the present study could be the evidences for recording the uniqueness of the Kinniya cattle. The morphological features of Kinniya cattle reported in this study could be useful in future referencing to track the deviation of the Kinniya cattle population owing to isolated breeding and directional selection for draught morphology.

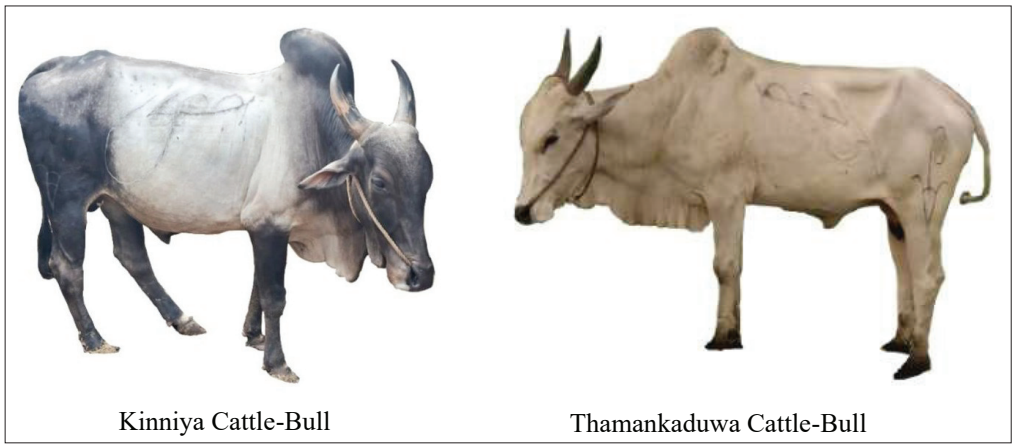

Figure 8: Morphological difference between Kinniya and Thamankaduwa cattle bulls

Thamankaduwa cattle

Kinniya cattle

Figure 9: Uniform orientation in horn morphology (straight or curved) in Kinniya cattle with comparison to Thamankaduwa cattle

Phenotypic characterization plays a crucial role in the breeding management and conservation of indigenous cattle breeds, particularly because distinct breeds are adapted to different production environments and ecological zones, with some demonstrating exceptional resilience to extreme heat and disease outbreaks (Hoffmann, 2010). By documenting morphological, adaptive, and functional traits in the animals' original production environments, characterization provides the foundational information needed to design appropriate and sustainable breeding programs tailored to village conditions (Fetene et al., 2025). Detailed morphometric profiling enables the identification of unique breed-specific attributes, detection of within-breed variation, and recognition of superior individuals for selective breeding, thereby helping to prevent genetic dilution caused by uncontrolled crossbreeding (FAO, 2012). Furthermore, phenotypic characterization highlights adaptive traits such as heat tolerance, disease resistance, and structural conformation suited to local systems which are essential for community-based breeding initiatives aimed at improving productivity without compromising breed integrity (Rege & Okeyo, 2006). In regions where genomic tools are limited, phenotypic data offer a practical and cost-effective means of identifying at-risk populations, prioritizing breeds for conservation, and formulating both in situ and ex situ conservation strategies (FAO, 2013). As many valuable animal genetic resources are linked to marginal environments and pastoral communities (Fetene et al., 2025), phenotypic characterization ensures proper documentation, utilization, and sustainable development of these genetic resources and thereby supporting long-term breed conservation and climate-resilient livestock production (Mustefa, 2023).

Several studies conducted on production system, morphology and morphometrics analysis of local cattle have implicated their importance in identifying unique characteristics to effectively incorporate them into breeding activities. As examples, Islam et al., (2022) has reported the importance of Malaysian Kedah-Kelantan cattle for meat associated breeding through phenotypic and morphometric associated selection. Kumar & Singh (2008), has reported the effects of livestock production systems and their changing dynamics on farmers across different agro-ecoregions of India. This research further revealed the potential benefits that Kinniya cattle could deliver for the production system where it plays a central role as a key genetic resource in the given socio-cultural environment. Stakeholders can make well-informed decisions about resource allocation and development projects that improve the quality of life for local pastoral communities by acknowledging the intrinsic value of this indigenous cattle population. Utilizing the unique traits of Kinniya cattle and adopting sustainable practices can boost the rich cultural heritage embedded within Sri Lankan agriculture. Even though the Kinniya cattle population differed phenotypically from the many other local cattle populations in the country, it is important to uncover their genomic linkages to methodically investigate the origin and evolution as a separate population. Also, further research into phenotypic and genetic differentiation is crucial for their long-term preservation and sustainable utilization in Sri Lanka's agricultural sector.

CONCLUSION

This study identified the population-specific phenotypic characteristics of the Kinniya cattle and demonstrated their distinctiveness compared to other indigenous cattle populations in Sri Lanka. The findings highlight that Kinniya cattle possess a unique phenotype shaped by long-term directional selection and breeding practices associated with the traditional draught-based production system. The study also documents the social, cultural, and economic importance of these cattle to the communities in the Kinniya region, underscoring their integral role in local livelihoods. To further validate and strengthen these findings, future research incorporating genomic analyses is recommended.

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