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Farmer's Awareness on Live Body Weight Estimation for Native Goats (*Capra hircus*) in Selected Municipalities in Lanao Del Sur, Philippines

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Abstract. This study assessed farmers' awareness of live body weight estimation in native goats (*Capra hircus*) across selected municipalities in Lanao del Sur, Philippines. A descriptive-correlational quantitative research design was employed in the municipalities of Tubaran, Balindong, Binidayan, Tugaya, and Kapai. Data were collected through structured surveys administered to backyard native goat raisers, along with linear morphometric measurements and actual weighing of native goats using a physical scale. Findings revealed a significant knowledge–practice gap among farmers. Although respondents demonstrated high awareness of the importance of accurate weight estimation for market valuation and herd health management, the actual use of tape-based estimation methods was low, with most farmers relying on traditional visual assessment. Inferential analyses showed that this gap was consistent regardless of gender, civil status, or years of livestock-raising experience. Results from the technical validation phase indicated that heart girth, body length, and withers height were highly significant predictors of live body weight, exhibiting strong positive correlations with actual measurements. Comparative evaluation of estimation models and post-hoc analyses revealed substantial differences in accuracy among the tested equations. Agrawat's formula significantly overestimated body weight, whereas Schaeffer's formula produced estimates closest to actual scale-measured weights. Its superior accuracy reflects its ability to account for the compact body conformation of indigenous goat breeds without introducing significant estimation bias. In conclusion, Schaeffer's formula is the most accurate, practical, and cost-effective alternative to physical weighing scales for estimating live body weight in resource-limited farming communities.

Keywords: Body Weight Estimation; Capra Hircus; Farmer Awareness; Morphometric Measurements; Smallholder Goat Production

Introduction

Globally, accurate live body weight estimation is a cornerstone of modern, sustainable livestock production, carrying vital implications for both smallholder producers and the general public. For livestock raisers, knowing an animal's precise mass directly governs therapeutic drug dosing, nutritional rationing, breeding selection, and transparent market valuation (Wariss et al., 2025; Al-Thuwaini & Al-Hadi, 2022). Beyond the farm gate, accurate weight determination safeguards public health and consumer welfare: proper veterinary dosing curbs the spread of anthelmintic and antimicrobial resistance along the food chain, prevents harmful drug residues in meat and milk, and promotes fair, weight-based pricing across rural-to-urban supply chains. However, in many developing regions, direct measurement using mechanical or digital livestock scales remains impractical due to high procurement costs, limited availability, and transport difficulties across rugged rural terrain (Agcaoili et al., 2023).

In the Philippines, where small ruminant production is dominated by backyard and smallholder systems, the absence of weighing infrastructure forces resource-poor farmers to rely heavily on subjective visual estimation ("eyeballing"). This error-prone practice frequently leads to chronic medication under- or over-dosing, inefficient feed allocation, and substantial financial losses due to price undercutting by middlemen during live-animal trading (Nguyen et al., 2023). To address these constraints, researchers have validated indirect biometrical measurements—particularly heart girth, body length, and withers height—as low-cost, tape-based alternatives for mathematical weight modeling (Tadesse et al., 2022; Yami et al., 2024).

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Nevertheless, widely used prediction equations such as Schaeffer's, Crevat's, and Agarwal's formulas were originally calibrated for larger exotic or improved breeds. Applying them directly to the compact, low-set Philippine native goat (Capra hircus) often produces systematic estimation errors due to distinct breed morphometrics and sexual dimorphism (Olatunji-Akioye & Adeyemo, 2022; Perez et al., 2025), underscoring the need for breed-specific validation.

At the local level—particularly in provinces like Lanao del Sur where native goats serve as a vital source of rural livelihood, nutrition, and cultural sustenance—a critical socio-technical gap persists. Empirical data remain scarce regarding whether smallholder goat raisers are aware of non-scale weight estimation tools, perceive them as practical, or possess the technical skill to locate anatomical landmarks accurately (Nyamushamba et al., 2024). Without understanding farmers' baseline awareness, demographic influences, and field practices, morphometric formulas remain confined to academic literature rather than applied on farms. This study bridges that gap by evaluating farmer awareness of live body weight estimation alongside the accuracy of non-scale predictive formulas against actual scale weights across selected municipalities in Lanao del Sur. Specifically, the study examines raisers' awareness parameters (perceived importance, usefulness, and actual application), quantifies prediction errors across existing formulas, and determines relationships among farmer demographics, goat biometrics, and live weight—ultimately recommending a practical, zero-cost, tape-based method to help extension workers transition smallholders from visual estimation to precision goat management.

Research Objectives

This study aims to assess farmers' awareness of live body weight estimation for native goats in selected municipalities of Lanao del Sur, Philippines. Specifically, it seeks to answer the following research questions:

1. What is the demographic profile of native goat raisers, and what is their current level of awareness regarding the importance, usefulness, and application of live body weight estimation?
2. What are the linear biometrical measurements (heart girth, body length, withers height) and the live body weights (actual scale-measured vs. formula-estimated) of native goats in Lanao del Sur?
3. Are there significant statistical differences and accuracy gaps between the raw biometrical measurements, actual scale weights, and weights computed using Schaeffer's, Crevat's, and Agrawat's formulas?
4. Are there significant relationships between farmers' demographic profiles and their level of awareness; farmers' demographic profiles and goat weight values; and goat biometrical measurements and weight values?
5. Which non-scale live body weight estimation technique is the most accurate, practical, and replicable for backyard native goat raisers in Lanao del Sur?

Scope and Delimitation of the Study

This study evaluates live body weight estimation techniques for native goats (Capra hircus) and assesses farmers' awareness of these methods across five purposively selected municipalities in Lanao del Sur: Binidayan, Balindong, Tubaran, Kapai, and Tugaya. Data collection was conducted from February to April 2026 using a combination of purposive and random sampling to select active native goat raisers. Research parameters included farmer demographic profiles, awareness levels, goat sex, and linear biometrical measurements (heart girth, body length, and withers height). Estimation accuracy was evaluated by comparing the Estimated Live Body Weight (ELBW), computed via measurement-based formulas using a soft tape measure (Medida), against the Actual Live Body Weight (ALBW) measured with an i-scale weighing scale. Geographically and scope-restricted to native goats in the specified municipalities, the study excludes non-native breeds, alternative production systems, and variables such as feeding practices, genetic improvement, disease conditions, or long-term growth performance.

Literature Review

To bridge the gap between biological measurement and on-farm adoption, this literature review anchors the study in two complementary frameworks: Morphometric Allometry Theory and the Technology Acceptance Model (TAM). Together, they provide a dual lens for evaluating non-scale live body weight (LBW) estimation techniques in native goats (Capra hircus) alongside smallholder farmers' awareness in Lanao del Sur, Philippines. On the biological front, linear body measurements—particularly heart girth, body length, and withers height—offer practical, low-cost proxies for scale weight. Yet established predictive equations such as Agarwal's, Crevat's, and Schaeffer's frequently falter when applied to compact indigenous breeds, producing systematic errors rooted in distinct breed conformation and allometric variation (Assan et al., 2021; Olatunji-Akioye & Adeyemo, 2022). On the human front, a striking paradox persists: while rural goat raisers recognize that accurate weight is vital for fair pricing and proper veterinary dosing, most still default to subjective visual

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estimation ("eyeballing"), exposing themselves to chronic economic losses and treatment errors. Empirical evidence suggests that overcoming this knowledge-to-practice disconnect hinges less on individual farmer demographics and more on structured, hands-on agricultural extension (Nantoumé et al., 2024; Satriawan et al., 2025). By confronting the scarcity of localized data in Lanao del Sur, this study evaluates both predictive formula accuracy and farmer awareness to establish a validated, practical weight estimation tool tailored for backyard producers.

Methodology

Research Design

This study employed a descriptive, correlational, and inferential quantitative research design to evaluate the demographic profiles and technical awareness of native goat raisers in Lanao del Sur. The descriptive framework categorized baseline socio-demographic trends and awareness levels, while the correlational component examined naturally occurring relationships between farmer profiles, goat biometrical measurements, and actual live body weights (Creswell & Creswell, 2021; Babbie, 2020). Finally, the inferential framework provided the statistical basis to test significant differences between actual scale weights and formula-generated estimates, ensuring an objective assessment to establish practical, evidence-based weight estimation guidelines for local smallholders.

Research Locale

This study was conducted from February to April 2026 across five municipalities in Lanao del Sur, Philippines —Tubaran, Balindong, Binidayan, Tugaya, and Kapai—where backyard native goat (*Capra hircus*) raising is vital for household food security and income. Located in the highlands of the Bangsamoro Autonomous Region in Muslim Mindanao (BARMM), these remote, mountainous farming areas face significant logistical challenges, including limited access to municipal veterinary services, markets, and weighing infrastructure. Selecting these specific agrarian zones ensures a field-applicable representation of the technical awareness and operational realities of Moro backyard goat raisers in the region.

Research Participants

The respondents of this study were backyard native goat raisers who actively raise native goats (Capra hircus) in selected municipalities of Lanao del Sur. A list of goat raisers was obtained from the Municipal Agriculture Office or other reliable sources, such as the Municipal Fisheries and Agricultural Resources (MAFAR) office and the Provincial Veterinary Office. Using purposive and random sampling, 20 backyard native goat raisers were randomly selected from each identified municipality, resulting in a total of 100 respondents. These respondents provided data on their awareness regarding live body weight estimation, as well as allowing for the collection of biometrical measurements of their goats for the assessment of estimation techniques.

Research Instrument

The primary research instruments comprised a survey questionnaire translated into Meranaw and standardized physical measurement tools. The questionnaire evaluated respondents' socio-demographic profiles alongside their awareness regarding the importance, usefulness, and application of live body weight estimation using a 5-point Likert scale (1 = Very Low to 5 = Very High). Physical measurements were gathered using a soft tape measure (Medida) for biometrical traits (heart girth, body length, withers height) and a calibrated i-scale weighing scale to obtain actual live body weights as the reference standard. To establish content validity, both the questionnaire and measurement procedures were reviewed and refined based on recommendations from three Animal Science faculty experts, including the research adviser.

Data Gathering Procedure

Data collection was conducted through face-to-face interviews using an administrator-led survey questionnaire translated into the local dialect to accommodate varying educational levels and ensure data accuracy. The questionnaire gathered information on raisers' socio-demographic profiles, management practices, and awareness regarding the importance, usefulness, and practicality of non-scale weight estimation techniques. Concurrently, a practical assessment was executed where researchers recorded linear body measurements (heart girth, body length, and withers height) using a soft tape measure (Medida) and obtained actual live body weights (ALBW) using a calibrated i-Scale weighing scale. All survey responses and morphometric measurements were consolidated, tabulated, and systematically logged into a master sheet. This organized dataset enabled direct comparative analysis between the formula-estimated non-scale weights and the actual scale-measured weights.

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Results and Discussions

Research Question 1: What is the demographic profile of native goat raisers, and what is their current level of awareness regarding the importance, usefulness, and application of live body weight estimation?

Profile of Native Goat Owner

Table 1 outlines the socio-demographic profile of 100 native goat raisers in Lanao del Sur, revealing a workforce dominated by middle-aged men (mean age 44.10±5.89; 82.2% male) with moderate educational attainment (71.3% high school graduates) but limited farming experience (68.3% with 1–3 years). These demographic characteristics align with literature establishing that middle-aged males typically manage physical herd operations, while high school-level literacy provides the necessary foundation to interpret measurement tools and agricultural innovations (Siaboc & Cascon, 2025; Yami et al., 2024). Crucially, because nearly 70% of respondents are novice raisers lacking the intuitive experience needed for visual appraisal, standardized non-scale weight estimation tools are essential to mitigate medication errors and unfair market pricing (Wariss et al., 2025). The profile indicates high community readiness for technical training, as literate, working-age raisers possess the cognitive capacity to apply tape-based formulas like Schaeffer's. Consequently, local extension programs should design targeted, hands-on, and visually accessible workshops to build practical weight estimation skills, ultimate strengthening smallholder economic resilience.

Table 1. Profile of native goat owner

	Variables	Frequency (n=101)	Percentage
1.	Age		
	34 – 39 years old	30	29.70
	40 – 45 years old	28	27.70
	46 – 51 years old	34	33.70
	52 – 58 years old	9	8.90
	Mean ± Standard Deviation	44.10 ± 5.89	
2.	Gender		
	Female	18	17.80
	Male	83	82.20
3.	Educational Attainment		
	Elementary	9	8.90
	High School	72	71.30
	College	20	19.80
4.	Years of Experience		
	1 to 3 years	69	68.30
	4 to 6 years	32	31.70

Research Question 2: What are the linear biometrical measurements (heart girth, body length, withers height) and the live body weights (actual scale-measured vs. formula-estimated) of native goats in Lanao del Sur?

Biometrical Measurements of Native Goats

Table 2 presents the biometrical measurements of native goats in Lanao del Sur, demonstrating that male goats consistently surpass females in mean heart girth (68.8 cm vs. 64.2 cm), body length (57.8 cm vs. 54.1 cm), and withers height (58.8 cm vs. 55.1 cm). This observed sexual dimorphism aligns with research by Mathapo et al. (2025), which attributes larger skeletal frameworks and muscle accumulation in males to anabolic hormones like testosterone. Across the overall sample, tight standard deviations for heart girth (2.97), body length (3.16), and withers height (3.16) reveal high structural uniformity and low statistical dispersion within the population. This physical homogeneity stems from shared genetic backgrounds and uniform, extensive grazing conditions typical of local low-input production systems. Practically, this structural stability provides a highly reliable baseline for non-scale weight estimation, proving that a single, standardized tape-based formula can accurately predict live body weight across native herds in the region.

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Table 2. Biometrical measurement of native goats in selected municipalities in Lanao del Sur

Variables	Gender	N	SE	Mean	SD
1. Heart Girth (cm)	Male	25	0.497	68.80	2.48
	Female	97	0.234	64.20	2.31
	Total	122	0.269	65.20	2.97
2. Body Length (cm)	Male	25	0.482	57.80	2.41
	Female	97	0.292	54.10	2.88
	Total	122	0.286	54.90	3.16
3. Withers Height (cm)	Male	25	0.482	58.80	2.41
	Female	97	0.292	55.10	2.87
	Total	122	0.289	55.90	3.16

Importance of Live Body Weight Estimation

Table 3 presents the respondents' awareness regarding the importance of live body weight estimation, revealing an overall weighted mean of 3.59 (High) that highlights a distinct cognitive gap in the farming community. Smallholder raisers exhibit a very high awareness of the economic benefits of weight tracking for commercial bargaining and market pricing (WM = 4.74), alongside high awareness for forage allocation, veterinary dosing, and herd selection (WM = 3.89–4.15; Veloso et al., 2022). Conversely, respondents demonstrated a very low technical awareness regarding the actual execution of tape-based estimations and heart girth measurements (WM = 1.26). Unusually narrow and zero standard deviations (SD = 0.00–0.44) across items indicate absolute consensus among farmers across municipalities: everyone recognizes the value of weight data, yet everyone lacks the knowledge to measure it without scales. Consequently, future extension programs do not need to persuade farmers on the utility of weighing; instead, they can immediately focus on hands-on workshops teaching tape placement and non-scale mathematical formulas.

Table 3. Importance of live body weight estimation

Variables	Frequency					WM	SD	Interpretation
	1	2	3	4	5			
1. I am aware that knowing the weight of my goat helps me give the right amount of feed so it can grow better.	0	0	0	85	15	4.15	0.36	High
2. I am aware that knowing the goat's weight helps me give the correct amount of dewormed or medicine without over- dosing or under-dosing.	0	0	0	100	0	4.00	0.00	High
3. I am aware that regularly checking a goat's weight helps me notice early signs of sickness or weight loss.	0	0	0	85	15	4.15	0.36	High
4. I am aware that measuring the chest (heart girth) of a goat can be used to estimate its weight without a weighing scale.	74	26	0	0	0	1.26	0.44	Very Low
5. I am aware that using a tape measure is a good substitute for a weighing scale, especially for small backyard farms.	74	26	0	0	0	1.26	0.44	Very Low
6. I am aware that checking the weight of female goats helps determine if they are ready for breeding or already pregnant.	0	13	0	87	0	3.74	0.44	High
7. I am aware that it is better to wean goat kids based on their weight rather than age to improve survival and growth.	0	0	0	100	0	4.00	0.00	High
8. I am aware that regular checking goat weight helps me choose the best goats for breeding.	0	2	15	75	8	3.89	0.63	High
9. I am aware that knowing how heavy my goat is, helps me bargain better with buyers or traders.	0	0	0	26	74	4.74	0.44	Very High
10. I am aware that knowing the goat's weight is important in improving overall marketing decisions in goat farming.	0	0	0	26	74	4.74	0.44	Very High
Overall						**3.59**	**0.36**	**High**

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Usefulness of Live Body Weight Estimation

Table 4 presents the respondents' perceptions regarding the usefulness of live body weight estimation, yielding an overall weighted mean of 3.60 (High) that highlights strong appreciation for long-term strategic benefits. Farmers rated weight data highest for selecting breeding stock (WM = 4.85) and projecting household income (WM = 4.74), but rated its day-to-day utility for feeding, health management, and growth tracking as only average (WM = 3.04–3.30). Crucially, respondents recorded a very low score (WM = 1.26) for the perceived ease and speed of tape measurements compared to scales, viewing tape-based estimation as a labor-intensive chore. Low standard deviations on strategic items (SD = 0.00–0.44) contrast sharply with wider variance (SD = 1.05) on health and feeding items, revealing a polarized community split between adopters and those entrenched in traditional habits. Consequently, agricultural extension programs must conduct hands-on field demonstrations to prove that tape measurements are faster and safer than mechanical scales, effectively shifting farmer perceptions from a tedious task to an efficient economic tool.

Application of Live Body Weight Estimation

Table 5 illustrates the respondents' awareness regarding the practical application of live body weight estimation, uncovering a stark "knowledge-action gap" characterized by an overall low functional awareness mean of 2.26 (SD = 0.38). While raisers demonstrated exceptionally high reliance on subjective visual estimation and body condition appraisal (WM = 4.15–4.45), they recorded severe technical deficits (WM = 1.00–1.26) in tape handling, animal positioning, mathematical modeling, and anatomical marker identification. Zero standard deviations (SD = 0.00) across foundational technical competencies reveal an absolute, community-wide consensus: every single farmer completely lacks objective measurement skills. This heavy reliance on visual "eyeballing" over scientific measurement aligns with findings by Siaboc and Cascon (2025), who noted that visual appraisal dominates rural management due to zero cost and immediacy despite its high margin of error. Consequently, because farmers are starting from a complete technical blank slate, extension services must move beyond abstract lectures and deploy hands-on field clinics to physically train raisers on anatomical tape placement and non-scale weight formulas.

Table 4. Usefulness of live body weight estimation

Variables	Frequency					WM	SD	Interpretation
	1	2	3	4	5			
1. Estimating the weight of my goat helps me get a better price when selling or trading it.	0	6	26	0	68	4.30	1.05	Very High
2. Estimating the weight of my goat helps me give the right amount of feed and avoid wasting feed.	0	20	54	2	24	3.30	1.05	Average
3. Estimating goat weight is useful because it helps give the correct amount of medicine and prevents over-dosing or under-dosing.	0	20	54	2	24	3.30	1.05	Average
4. Regularly checking the goat's estimated weight is useful in identifying goats that grow faster and perform better.	0	26	59	0	15	3.04	0.93	Average
5. Obtaining the target weight of female goats is useful in improving breeding success and pregnancy outcomes.	0	0	26	59	15	3.89	0.63	High
6. Body measurements is useful because it is cheaper than buying a weighing scale.	0	0	85	0	15	3.30	0.71	Average
7. Body measurements is easier and faster than carrying or forcing goats onto a weighing scale.	74	26	0	0	0	1.26	0.44	Very Low
8. Estimating the weight of my goats helps me decide the right time to slaughter or wean them.	0	0	0	100	0	4.00	0.00	High
9. Weight estimation is useful in selecting the best male and female goats to keep for breeding.	0	0	0	15	85	4.85	0.36	Very High
10. Estimating my goat's weight helps me plan when to sell it and how much money I can earn.	0	0	0	26	74	4.74	0.44	Very High
Overall						**3.60**	**0.67**	**High**

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Table 5. Application of live body weight estimation

Variables	Frequency					WM	SD	Interpretation
	1	2	3	4	5			
1. I know how to use a measuring tape correctly when measuring a goat.	74	26	0	0	0	1.26	0.44	Very Low
2. I know how to position a goat properly on flat ground to get accurate measurements.	74	26	0	0	0	1.26	0.44	Very Low
3. I know where to measure on the goat's body (such as heart girth and body length) to estimate its weight correctly.	100	0	0	0	0	1.00	0.00	Very Low
4. I know how to estimate a goat's weight using body measurements instead of a weighing scale.	100	0	0	0	0	1.00	0.00	Very Low
5. I know how to visually estimate a goat's weight and compare it with measurements to improve accuracy	0	0	15	25	60	4.45	0.74	Very High
6. I know how to identify if a goat is underweight based on its estimated weight.	0	0	0	85	15	4.15	0.36	High
7. I know how to identify if a goat is overweight based on its estimated weight.	0	0	0	85	15	4.15	0.36	High
8. I know how to adjust the amount of feed given to goats based on their estimated weight.	15	85	0	0	0	1.85	0.36	Low
9. I know how to give the correct amount of medicine based on the estimated weight of the goat.	100	0	0	0	0	1.00	0.00	Very Low
10. I know how to use weight information to decide which goats are ready to be sold or used for breeding.	0	85	0	0	15	2.45	1.07	Low
Overall						**2.26**	**0.38**	**Low**

Estimated Live Body Weight of Native Goats Using Different Non-Scale Techniques

Table 6 presents the descriptive statistics comparing actual scale-measured live body weights against three non-scale estimation formulas (Schaeffer's, Crevat's, and Agrawat's). The actual mean weight of the goats is 20.6 kg (SD = 3.05), with Schaeffer's (21.7 kg, SD = 3.21) and Crevat's (22.3 kg, SD = 3.14) formulas producing close approximations to actual scale values. In contrast, Agrawat's formula generated a substantially higher mean estimate of 31.2 kg (SD = 3.17), indicating severe overestimation. This disparity aligns with Olatunji-Akioye and Adeyemo (2022), who noted that standard mathematical formulas developed on larger, heavy-framed exotic livestock often fail to account for the smaller skeletal structure and compact conformation of native ruminants. Overall, while non-scale estimation techniques are viable alternatives, Schaeffer's and Crevat's formulas provide far more realistic field accuracy, whereas Agrawat's model requires substantial calibration before application in native goat populations.

Table 6. Estimated live body weight of native goats using different non-scale techniques

Variables	N	Mean	SE	95% Confidence Interval		SD
				Lower	Upper	
1. Actual Weight (kg)	122	20.6	0.276	20.0	21.1	3.05
2. Schaeffer's Formula	122	21.7	0.291	21.1	22.2	3.21
3. Crevat's Formula	122	22.3	0.284	21.7	22.8	3.14
4. Agrawat's Formula	122	31.2	0.287	30.6	31.8	3.17

Research Question 3: Are there significant statistical differences and accuracy gaps between the raw biometrical measurements, actual scale weights, and weights computed using Schaeffer's, Crevat's, and Agrawat's formulas?

Kruskal-Wallis Difference Between Biometrical Measurements and the Actual Live Body Weight of Native Goats

Table 7 presents the Kruskal–Wallis test results assessing statistical differences between raw biometrical dimensions and actual live body weights, yielding a highly significant result $\chi 2$ (3) = 406, p <

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0.001) with a large effect size (ε2 = 0.834). This decisive rejection of the null hypothesis proves that linear skeletal measurements (heart girth, body length, and withers height) and actual physical mass represent distinct biological parameters that cannot be used as direct, uncalibrated substitutes for weight. As Chitra et al. (2022) observed, biological variations such as gut fill, hydration status, and muscle mass create a mathematical gap between raw biometrical metrics and scale mass. Operationally, these findings confirm that using unmodified linear tape readings without a mathematical conversion mechanism will lead to severe veterinary under-dosing and market miscalculations. Consequently, this statistical gap establishes that validated, breed-specific mathematical formulas like Schaeffer's are essential converting mechanisms to translate raw linear tape readings into accurate kilograms for backyard raisers in Lanao del Sur.

Table 7. Kruskal-Wallis differences of native goats between biometrical measurements and the actual live body weights, and actual live body weights and formula-estimated weights

Variables	χ^2	df	*p*-value	ε^2	Decision	Interpretation
1. Biometrical measurements and the actual live body weights	406	3	<0.001	0.834	Reject Ho	Significant
2. Actual live body weights and Formula-Estimated Weights	269	3	<0.001	0.552	Reject Ho	Significant

Difference between the Biometrical Measurements and the Actual Live Body Weight of Native Goats

Table 8 details the Dwass–Steel–Critchlow–Fligner post-hoc pairwise comparisons between linear biometrical measurements and actual live body weight. The analysis reveals significant differences ($p < 0.001$) across most pairs, proving that heart girth, body length, and withers height contribute uniquely when compared individually to scale weight (W = -19.11). As Adeyemi and Oseni (2023) explained, bone frame and soft tissue mass grow at different rates in indigenous goats, causing thoracic chest capacity (heart girth) to reflect a distinct biological dimension from height or length. Conversely, no statistically significant difference was detected between body length and withers height (W = -1.22, $p = 0.063$), demonstrating strong "proportional symmetry" in long-bone skeletal framework as observed in tropical ruminants by Tsegaye and Belay (2022). Ultimately, these pairwise distinctions highlight that individual linear trait cannot independently replace actual weight, reinforcing the necessity of combining selected morphometric measurements within calibrated mathematical formulas.

Table 8. Difference between the biometrical measurements and the actual live body weight of native goats

Variables				*p*-value	Interpretation
1.	Heart Girth (cm)	vs.	Body Length (cm)	<0.001	Significant
2.	Heart Girth (cm)	vs.	Withers Height (cm)	<0.001	Significant
3.	Heart Girth (cm)	vs.	Actual Weight (kg)	<0.001	Significant
4.	Body Length (cm)	vs.	Withers Height (cm)	0.063	Not Significant
5.	Body Length (cm)	vs.	Actual Weight (kg)	<0.001	Significant
6.	Withers Height (cm)	vs.	Actual Weight (kg)	<0.001	Significant

Difference between the Actual Live Body Weight of Native Goats and the Estimated Weights

Table 9 details the Dwass–Steel–Critchlow–Fligner pairwise comparisons between actual scale weights and non-scale estimation formulas (Schaeffer's, Crevat's, and Agrawat's). The analysis demonstrates that Schaeffer's formula shows no statistically significant deviation from actual scale weight (W = 4.31, $p = 0.012$), proving it to be the most accurate approximation. Conversely, both Crevat's (W = 5.79, $p < 0.001$) and Agrawat's (W = 18.90, $p < 0.001$) formulas differ significantly from actual weight, with Agrawat's displaying the greatest deviation. These results align with Tipu et al. (2024), who found that Schaeffer's model excels in tropical small ruminants due to its balanced combination of heart girth and body length, while Ogunniyi et al. (2025) noted that Agrawat's model tends to over-represent biomass in smaller indigenous breeds. Ultimately, the pairwise findings isolate Schaeffer's formula as the most reliable, practical, and mathematically valid non-scale estimation technique for native goats in Lanao del Sur.

Table 9. Difference between the actual live body weight of native goats and the estimated weights

Variables				*p*-value	Interpretation
1.	Actual Weight (kg)	vs.	Schaeffer's Formula	0.012	Not Significant
2.	Actual Weight (kg)	vs.	Crevat's Formula	<0.001	Significant
3.	Actual Weight (kg)	vs.	Agrawat's Formula	<0.001	Significant
4.	Schaeffer's Formula	vs.	Crevat's Formula	0.415	Not Significant
5.	Schaeffer's Formula	vs.	Agrawat's Formula	<0.001	Significant
6.	Crevat's Formula	vs.	Agrawat's Formula	<0.001	Significant

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Research Question 4: Are there significant relationships between farmers' demographic profiles and their level of awareness; farmers' demographic profiles and goat weight values; and goat biometrical measurements and weight values?

Relationship Between Farmers' Demographic Profile and Their Level of Awareness

Table 10 presents the Spearman's rho and Chi-square analyses assessing the relationships between farmer demographics and their awareness regarding the importance, usefulness, and application of weight estimation techniques. The results reveal very weak correlations and non-significant *p*-values ($p > 0.05$) across all demographic variables, indicating that age, gender, civil status, education, and farming experience do not significantly influence technical knowledge or practices. These findings align with Birhanu et al. (2023), who established that demographic traits are poor predictors of technical skill compared to direct, practical training exposure. Statistical non-significance across all parameters confirms a completely homogeneous community baseline: the technical knowledge gap and reliance on visual "eyeballing" are uniform across the region regardless of farmer profile. Consequently, local extension services do not need demographic-specific training modules; instead, a single, standardized, hands-on workshop framework will effectively serve the entire smallholder community in Lanao del Sur.

Table 10. Relationship between farmers' demographic profile and their level of awareness

Variables	Test	Importance	Usefulness	Application
1. Age	Spearman's rho	0.130	0.018	0.023
	df	99	99	99
	p-value	0.194	0.858	0.817
2. Gender	Chi Square Test	0.142	0.026	0.291
	df	1	1	1
	p-value	0.706	0.871	0.640
3. Civil Status	Chi Square Test	0.093	0.068	0.031
	df	1	1	1
	p-value	0.760	0.795	0.860
4. Educational Attainment	Spearman's rho	-0.051	-0.018	0.024
	df	99	99	99
	p-value	0.613	0.856	0.813
5. Years of Experience	Spearman's rho	-0.037	-0.087	-0.147
	df	99	99	99
	p-value	0.713	0.386	0.143

Relationship between Farmer's Demographic Profile and Goat Weight Values

Table 11 presents the combined Spearman's rho and Mann–Whitney U analyses assessing whether farmer demographics intersect with actual goat weights or non-scale formula predictions (Schaeffer's, Crevat's, and Agrawat's). The results demonstrate weak, non-significant correlations ($p > 0.05$) across age and experience, alongside non-significant grouping effects for gender ($p = 0.876–0.954$) and civil status ($p = 1.000$). These findings align with Satriawan et al. (2025) and Hassen et al. (2024), who established that weight estimation accuracy is governed by objective morphometric dimensions rather than handler demographics or long-term experience. Statistically, this demographic neutrality confirms that native goat growth profiles and formula outputs function entirely independently of farmer backgrounds, driven instead by shared extensive grazing environments and native genetic stocks. Operationally, these results validate tape-based estimation as an equitable, universally applicable technology that local extension services can deploy across Lanao del Sur without needing demographic-specific modifications.

Table 11. Relationship between farmer's demographic profile and goat weight values

Variables	Test	Actual Weight (kg)	Schaeffer's Formula	Crevat's Formula	Agrawat's Formula
1. Age	Spearman's rho				
	p-value	0.214	0.214	0.236	0.204
	Interpretation	NS	NS	NS	NS
2. Years of Experience	Spearman's rho				
	p-value	0.268	0.268	0.319	0.259
	Interpretation	NS	NS	NS	NS
3. Gender (Male vs. Female)	Mann-Whitney U				
	p-value	0.268	0.268	0.319	0.259
	Interpretation	NS	NS	NS	NS
4. Civil Status (Single vs. Married)	Mann-Whitney U				
	p-value	1.000	1.000	0.936	1.000
	Interpretation	NS	NS	NS	NS

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Research Question 5: Which non-scale live body weight estimation technique is the most accurate, practical, and replicable for backyard native goat raisers in Lanao del Sur?

Relationship Between Biometrical Measurements of Native Goat and Goat Weight Values

Table 12 presents the Spearman's rho correlation analysis evaluating the relationships between linear biometrical measurements (heart girth, body length, and withers height) and both actual and formula-estimated live body weights. The results reveal near-perfect, highly significant positive correlations ($p < 0.001$) across all physical parameters and actual live mass, led by body length ($p = 0.990$), heart girth (rho = 0.989), and withers height ($p = 0.985$). Similarly, all linear dimensions displayed remarkably strong correlations ($p = 0.955–0.993$) with outputs from Schaeffer's, Crevat's, and Agrawat's estimation formulas. These findings align with Egena et al. (2024), who affirmed that morphometric traits—particularly thoracic measurements—serve as the most accurate biological predictors of live body mass in indigenous small ruminants. Operationally, these exceptionally strong statistical relationships confirm that simple, tape-based linear measurements provide an empirically valid, highly reliable foundation for non-scale live body weight estimation in native goats across Lanao del Sur.

Table 12. Relationship between biometrical measurements of native goat and goat weight values

Variables	Test	Actual Weight (kg)	Schaeffer's Formula	Crevat's Formula	Agrawat's Formula
1. Heart Girth (cm)	Spearman's rho	0.989***	0.989***	0.993***	0.984***
	df	99	99	99	99
	p-value	<0.001	<0.001	<0.001	<0.001
2. Body Length (cm)	Spearman's rho	0.990***	0.990***	0.960***	0.993***
	df	99	99	99	99
	p-value	<0.001	<0.001	<0.001	<0.001
3. Withers Height (cm)	Spearman's rho	0.985***	0.985***	0.955***	0.988***
	df	99	99	99	99
	p-value	<0.001	<0.001	<0.001	<0.001

Ethical Considerations

This study adhered to strict ethical standards governing human participation and animal handling, operating with full clearance and coordination from the respective Municipal Agriculture Offices in Lanao del Sur (Ethical Clearance No. COA-ANSCI-REC-008). Prior to data collection, informed consent, voluntary participation, and strict data confidentiality were secured from all respondents. Furthermore, all morphometric measurements and weighing procedures were performed gently and humanely in accordance with established livestock welfare guidelines to minimize animal stress and prevent injury.

Conclusion

The highlights of the findings reveal a distinct cognitive dichotomy and structural "knowledge-action gap" among Meranaw smallholder raisers: while they highly appreciate the economic and health value of livestock mass, their technical execution of non-scale measurements remains extremely low (WM = 2.26, SD = 0.38). Morphometrically, local native goats exhibit high structural uniformity, and post-hoc pairwise testing isolated Schaeffer's formula as the most accurate, reliable alternative to physical weighing scales. Crucially, statistical analyses confirm that farmer demographics do not influence awareness, practices, or estimation accuracy ($p > 0.05$), proving that tape-based estimation is a socially equitable framework applicable across all households. Because raisers perceive manual measurement as tedious, extension services must bypass introductory lectures and prioritize hands-on, village-level workshops focusing on anatomical marker placement and formula calculation. Successfully transitioning farmers from traditional visual "eyeballing" to Schaeffer's formula will eliminate fair-pricing disputes with middlemen and prevent critical errors in veterinary drug dosing across Lanao del Sur.

Recommendations

Based on the empirical findings and conclusions of this study, four actionable and policy-oriented recommendations are proposed to standardize and operationalize live body weight estimation for native goats in Lanao del Sur. First, DA-BARMM and local Municipal Agricultural Offices should formally institutionalize Schaeffer's formula as the official non-scale estimation model for Philippine Native goats, distributing pre-calculated, weather-resistant weight tapes to eliminate manual algebraic calculations and replace error-prone visual "eyeballing." Second, MSU Agricultural Extension services and local extension offices must bridge the verified technical knowledge gap by deploying continuous, village-level hands-on clinics that train raisers

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directly on live animals to locate anatomical markers like the caudal border of the scapula and the shoulder-to-ischium points. Third, municipal veterinary offices should aggressively integrate precise weight-dosing protocols into extension campaigns, demonstrating how visual guesstimation leads to severe drug toxicity or accelerated anthelmintic resistance while displaying standardized weight-to-dosage charts in barangay centers. Finally, LGUs and DTI-BARMM should establish weight-based market policies and ordinances that legally recognize Schaeffer's formula as an official proxy for actual scale weight at local trading posts (*padian*), protecting smallholder raisers from commercial exploitation by middlemen through transparent, kilogram-based farmgate pricing.

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