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Review Article

Live Body Weight Estimation in Small Ruminants-A Review

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ABSTRACT

Proper measurement of live body weight, which often is hard in the village settings due to lack of weighing scales, is a prerequisite for achieving so many lofty goals that are always associated with either medical or economic status of the animals. Under standard conditions, properly calibrated livestock scales are the most accurate and consistent method for determining body weight. Under farm conditions however, where scales and records may be absent, it may be difficult to know the weight of sheep and goats. Procedures for estimating weight of small ruminants in such conditions include the use of weight band, visual appraisal, and use of body linear measurements among others. All these measurements give estimates of the animals' live body weights however, it has been shown in many studies that the heart girth is the most appropriate and confident parameter in live weight estimations for sheep and goats.

Keywords: Estimation, Body Measurements, Lives Weight, Small Ruminants.

INTRODUCTION

Proper measurement of live body weight, which often is hard in the village settings due to lack of weighing scales, is a prerequisite for achieving so many lofty goals that are always associated with either medical or economic status of the animals. Knowing the live bodyweight of small ruminants is important for a number of reasons, such as for breeding, correct feeding and health (Slippers *et al*., 2000). Apart from taking live weight of meat animals, researchers also use other parameters such as body length, width of pelvis, height at withers and chest girths in order to adequately evaluate live animals (Atta *et al*., 2004). Under standard conditions properly calibrated livestock scales are the most accurate and consistent method for determining body weight. Under farm conditions however, where scales and records may be absent, it may be difficult to know the weight of sheep and goats (Abegaz and

Awgichew, 2009). Some of these standard weighing scales coupled with their shortcomings are too expensive for most of small farmers (Mahieu, 2011). This has forced many farmers to rely on estimates of body weights using certain number of body characteristics which can be measured readily (Alade *et al*., 2008). Among these, body measurements have been used to predict body weight in large domestic animals (Morison, 1949; Quin, 1980; Getenby, 1991; Thys and Harduoin, 1991; Mayaka *et al*., 1995; Mayeni and Slippers, 1997). For small ruminants studies in particular, sheep (Prasad *et al.*, 1990; Aziz and Sharaby, 1993; Enevoldsen and Kristensen, 1997; Valdez *et al*., 1997; Atta and El Khidir, 2004; Riva *et al*., 2004; Afolayan *et al*., 2006; Nayak *et al*., 2008; Otoikhian *et al*., 2008; Sowande and Sobola, 2008; Edea*et al.*, 2009; Getachew *et al*., 2009; Kunene *et al*., 2009; Cam *et al*., 2010a; Iqbal, 2010; Tadesse and Gebremariam, 2010; Oke and Ogbonnaya, 2011;Mohammad *et al*., 2012; Musa *et al*., 2012; Ravimurugan*et al*., 2013; Shirzeyli *et al*., 2013; Younas *et al*., 2013) and goat (Tandon, 1965; Mukherjee *et al*., 1981; Mohammed and Amin, 1997; Das *et al*., 1990; Prasad *et al*., 1990; Hassan and Ciroma, 1991; Ulaganathan *et al*.,1992; Slippers *et al*., 2000; Nsoso *et al.*, 2004; Singh and Mishra, 2004; Gül *et al*., 2005; Adeyinka and Mohammed, 2006; Khan *et al*., 2006; Moaeen-ud-Din *et al*., 2006; Rahman, 2007; Fajemilehin and Salako 2008; Pesmen and Yardimci, 2008; Cam *et al.*, 2010b; Tsegaye, 2013).
This review paper would therefore highlight the different methods used in estimating live body weights of small ruminants and also serves as a weight-taking guide to village farmers, extension agents, researchers as well as the small ruminant clinicians.

Procedures for estimating weight of small ruminants

- **Weight band:** A weight band is a specially marked tape used to measure the heart girth and convert that measurement to a fairly accurate estimate of the goat's live weight. De Villiers *et al*. (2010) described this procedure. Briefly, the weight band is wrapped directly behind the shoulder blade, down the fore-ribs, under the body behind the elbow and all the way around to the point behind the shoulder blade. The ends of the weight band are overlapped on top, on the goat's spine. Lastly, the resultant weight measurement is read off the weight band in kilograms.

- **Visual appraisal**: This skill is developed through practice by estimating the weight of numerous animals without a board or weigh band. Visual determination of the weight of animals is often faced by errors like using the same estimate for more than one breed of a particular species (Otoikhian, 2008). Body structure can be deceptive when estimating weight (Slippers *et al.*, 2000). For instance, Red Sokoto goats appear lighter than they actually are because of their light bones. Apart from bones and body structure problem in estimating weight, a white animal always looks bigger than it is (Otoikhian, 2008).

- **Body Linear Measurements**: There are a number of linear dimensions which can be used to quantify the size of an animal and to estimate weight. The most widely used body linear measurements include height at withers, heart girth, chest depth, body length, fore cannon bone, rump height, distance between eyes, ear length, ear width, paunch girth and tail length. Heart girth and cannon bone length are least affected by the posture of the animal. Abegaz and Awgichew (2009) described the linear measurement as follows:

- **Height at Withers (HAW)**. This measures the distance from the surface of a platform on which the animal stands to the withers. The measurement is best made with a special measuring stick made with two arms one which is held vertical and the other at right angles to it sliding firmly up and down to record height. The sheep or goat should stand squarely on all four legs. The legs should be equally spaced, and carry equal portions of its weight.

The vertical arm of the measuring device is placed on the ground and ensures it is at a right angle to the platform. Then the other shorter arm is slide down until it just touches the shoulder at the desired point. The vertical measuring device is withdrawn and the distance is measured with a measuring tape. Alternatively, the vertical arm could have the measuring scale inscribed onto it and height read directly. This method can be used alone or in combination with the other linear measurements to get more accurate results.

- **Heart Girth (HG) or Chest circumference**: Heart girth is a circumferential measure taken around the chest just behind the front legs and withers. The measurement should be taken to the nearest 0.5 cm. HG is a highly repeatable measure though it does vary somewhat with extremes of posture and perhaps as the animal breaths. It is the basis of the many weight tapes that are available for estimating animal weight as there is a good correlation between chest circumference and body weight, within breeds, sexes, and ages of stock. More reliable HG-live body weight relationships are obtained from mature animals. In excessively hairy small ruminants, make sure to compress the hair while measuring HG.

- **Body Length (BDL)**: Body length refers to the distance from the base of the ear to the base of the tail (where it joins the body). It can also be measured as the distance from base of tail to the base of the neck (first thoracic vertebrae), or to front of the chest or to tip of the nose. Extreme care is needed to ensure that the backbone is straight in both vertical and horizontal planes.

- **Hip Width (Pin Bone Width) (HW):** Hip width is the distance between the outer edges of the major hip bones on the right and left side. The hipbones are easily located and the distance between them easily measured with a pair of large, half round or oval shaped callipers.

- **Rump Height (RH)**: Rump height is the distance from the surface of a platform to the rump using a measuring stick as described for height at withers.

- **Fore Cannon Bone Length (CB):** This is the length of the lower part of the leg extending from the hock to the fetlock in hoofed mammals. It is a well-established fact that linear development of different bones in the body is strongly related. The different parts grow in proportion to one another. It should be possible to estimate the length of a bone which is difficult to measure indirectly through its correlation with a more accessible one. The fore cannon bone is the one most commonly used. To measure fore cannon length, have the sheep or goat either stand or be held sitting on its rump. Take the front leg and bend back the hoof at the pastern and the leg itself at the knee. Use a suitable pair of large callipers, or a ruler or a measuring tape to measure the length of the main lower leg bone. For greatest accuracy, standardize your measurements using the same bony protuberances in each animal.

- **Chest Depth (CD).** Chest depth measures the distance from the backbone at the shoulder (standardize on one of the vertical processes of the thoracic vertebrae) to the brisket between the front legs.

Prediction Models

Mathematical equations (Prediction models) can be developed based on large number of actual weight-linear measurement data discussed above. The equations change the linear

measurements into weight estimates, usually via a constructed table. Individual equations can be derived based on condition, sex and age of the animal.

How are the models generated?

After the body measurements, the data could be grouped on the basis of sex, age (which according to Mitchell (1982), is determined by counting the number of permanent incisors) and breeds. Then, depending on the design, different statistical methods could be used to analyzed the relationship between the live body weight and the body linear measurements. In most of the literature however, the relationships between the body weight and linear measurements, and among the linear measurements themselves are determined by the use of Pearson's Correlation Coefficients. The body weight would then be regressed on body linear measurements using general linear model and regression analysis to generate prediction models. To determine the best fitted regression model, coefficient multiple determination (R^2), residual mean square(MS_E), error standard deviation(SD_E) and range observed in the predicted weights could be used to evaluate and compare different regression models generated(Snedecor and Cochran,1989). Also, more than one linear measurement may be used in an equation to improve predictive ability as seen in the work of Pesmen and Yardimci (2008).

Many studies in literature have used one or more of the aforementioned statistical procedures in small ruminants to generate prediction models for estimating live body weight using body linear measurements. For instance, in sheep (Afolayan*et al*., 2006; Otoikhian, 2008; Ravimurugan *et al*.,2013; Tadesse and Gebremariam, 2010; Musa *et al*., 2012; Shirzeyli *et al*., 2013; Younas *et al*., 2013) and in goats (Atta *et al*., 2004; Moaeen-ud-Din *et al*., 2006; Alade *et al*., 2008 ; Pesmen and Yardimci, 2008; De Villiers *et al*., 2009; Mahieu *et al*., 2011; Tsegaye, 2013).

Also, though very few, the use of Regression Tree Method was used instead of Multiple Regression Analysis(MRA) in analysing multiple relationships among traits, in order to predict body weight using these body measurements (Eyduran *et al.,* 2008; Mendes and Akkartal, 2009; Topal *et al.,* 2010; Muhammad *et al.,* 2012). This is because; MRA produces biased estimates under some conditions, especially the multi-collinearity problem. (Keskin *et al*., 2007a, Keskin *et al*., 2007b; Eyduran *et al*., 2009; Eyduran *et al*., 2010).

Precautions while taking body linear measurements

Since the animal body movement and body posture can introduce errors into measurements and estimated weights, Abegaz and Awgichew (2009) suggested the following precautions to be taken in order to counteract these effects:

i. When possible, choose measurements that are little affected by the animal's posture
ii. Standardize the position of all animals that are to be compared
iii. Be patient and wait for an animal to stand correctly.

CONCLUSION

Although all the linear measurements discussed above give an estimate of the animals live body weight, yet it has been shown in many studies (Yarkin *et al*., 1961; Tuncel, 1982; Valdez *et al*., 1982; Hassan and Ciroma, 1990; Koyuncu and Tuncel, 1992; Ozturk *et al*., 1994; Mohammed *et al*., 1996; Atta and El Khidir, 2004; Pesman and Yardimci, 2008) that the heart girth is the most appropriate and confident parameter in live weight estimations for sheep and goats.

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