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Patterns of Growth of Bali Cattle Body Dimensions

[1] I Putu Sampurna, [2] I Ketut Saka, [3] Gst. Lanang Oka, [4] Sentana Putra
[1] Laboratory of Biostatistics, Faculty of Veterinary Medicine, University of Udayana
[2, 3, 4] lecturer Doctoral Program of Animal Husbandry, University of Udayana, Denpasar, Bali, Indonesia

tegehkori@gmail.com

ABSTRACT

The aim of this study was to determine the patterns of growth of Bali cattle body dimensions. The study used completely randomized design consisting of three factors, i.e., sex, growth period and the time of measurement. The main factors are sex (entire male/bull and female) and the period of growth (aged 0-4 months, aged 5-9 months, aged 10-14 months, aged 15-19 months, aged 20-24 months and aged 25-29) and each combination of sex and growth period had six replicates, thus number of cattle used was 2 x 6 x 6 = 72 heads**.** The sub-factor is the time or frequency of measurement, which is performed once every month as often as five times; hence the data obtained everybody dimensions are 2 x 6 x 6 x 5 = 360 pieces.Results of the study showed that there were no differences in body dimensions of the entire male (bull) and the female calves at birth. However, the more mature of the entire male calves the larger the size of their body dimensions compared to those of the females calves. Both the entire male and female cattle had a sigmoid growth curve. The inflection points of dimension growth curves of the female were achieved at earlier age compared to those of the entire male cattle. Each dimension had its respective inflection point at which the growth rates of the body dimensions started to decrease. Growth rates of the length dimensions of the both sexes began to decrease (slower) before they reached 5 months of age, excepted the horns that reached a slower rate after 10 months of age. Height dimensions growth rates of the both sexes started to decline before they reached 4 months of age. Growth rates of the entire male and female circumference dimensions were achieved after they aged 4 months and before 4 months, respectively. Chest and waist depths growth rates of the entire males became slower after 3 months of age while those of the females before 2 months old. Growth rates of neck depths of the entire males decreased at the age of 7.8 months, while those of the females at the age of 4.1 months. Growth rates of the head and cheek depths of the both sexes became slower before they reached 3 months of age, while those of the neck widths were slower after 6 months of age. Growth rates of the chest, waist and ass widths entire male and female calves became slower after 4 months and before 4 month of age, respectively.

Keywords: *Bali cattle, body dimensions, pattern of growth, growth rate, and inflection point*

1. INTRODUCTION

The term of growth may be applied to a cell, organ, tissue, an animal and animal population. Growth according to Williams (1982) is the change in the shape or size of an animal that can be expressed by the length, volume or mass. According to Swatland (1984) and Aberle *et al.* (2001) growth can be assessed as an increase in height, length, weight, and circumference, that occurs in young, healthy cattle, and fed, drank and got decent shelter. Increased little body size could cause a proportional increase in body weight, because weight is a function of volume. Growth of animals has three aspects, firstly, an increase in body mass (bodyweight) per unit of time and, secondly, the changes in measurement of body dimension and, thirdly, the change in form or composition resulting from different growth rates of the component parts.

Growth is a process that occurs in every living thing and can be expressed in measurements of body dimensions, body volume and body mass (bodyweight). Growth is influenced by internal factors i.e. Genetic, species, age, and sexual hormones, and external factors such as feeds and environment. Body size of cattle, when projected with time or age will form a curve, when acceleration of growth force (growth accelerating force) is predominating, growth rate will increase, otherwise the growth rate will decline if growth retarding force is predominating.

Growth and development of body parts are stimulated by physiological demands resulted from increasing functional activities of their composing component of the body parts, so that each body part has a different growth rate and has an inflection point at different ages..

The purpose of this study was to assess at what age there is a measurement difference between the male and female body dimensions in Bali cattle. In addition the objective of this study is to determine the pattern of body-dimensions growth and their inflection points each body dimension of Bali cattle.

2. RESEARCH METHODS

2.1 Experimental Design

The study used completely randomized design consisting of three factors, i.e., sex, growth period and the time of measurement. The main factors are sex (male and female) and the period of growth (aged 0-4 months, aged 5-

9 months, aged 10-14 months, aged 15-19 months, aged 20-24 months and aged 25-29) and each combination of sex and growth period had six replicates, thus number of cattle used was 2 x 6 x 6 = 72 heads**.** The sub-factor is the time of measurement, which is performed once every month as often as five times; hence the data obtained for everybody dimensions are 2 x 6 x 6 x 5 = 360 pieces.

The mathematical model of the research design.

$Y_{ijkl} = \mu + J_i + P_j + JP_{ij} + €_{ijk} + W_l + JW_{il} + PW_{jl} + JPW_{ijl} + €_{ijkl}$
i = 1, 2; J = 1,2,3,4,5,6; k =1,2,3,4,5,6 dan l = 1,2,3,4,5

2.2 Location and Time Research

The study was conducted in the village of Getasan, district of Petang, Badung regency, Bali. The research was conducted during the period April to December 2012.

2.3 Determination of Total Research Samples

Samples used for research materials (Bali cattle) is raised by the small farmers in Getasan village, district of Petang, Badung regency, Bali. The number of samples used in the study were 72 heads Bali cattle, consisting of 36 males and 36 females of various age groups. Samples taken were cattle which have been judged had sound or normal body conditions, healthy, their body dimensions were proportional to their age, they were not emaciated (body condition scores of medium or higher) that were indicated by measurements of their chest circumferences, and not stunted that were shown by their body lengths and heights, a minimum size $\bar{X} - SD$.

2.4 Research Variables

The independent variables in this study were sex (male and female), a period of growth (age group) and time or frequency of measurement. The dependent variables in this study are body dimensions of the cattle including: dimensions of length, circumference, height, and width. Controlled variable is stud or semen used in insemination program applied to the cows studied, the treatment of the parens (dams and sire) and the state of cattle that meet requirements of the standard as well as normal and healthy.

2.5 Research Instruments

The equipments used in this research were vernier caliper and meter brand of Bravo Veterinary Equipment and assisted with laser meter Extech, with an reading accuracy of 0.1 cm and capable of measuring 5 cm - 20000 cm. Vernier caliper that has measurements of length or height 0-225 cm, and meter with a maximum length of 250 cm**.**

2.6 Measurement Body Dimensions

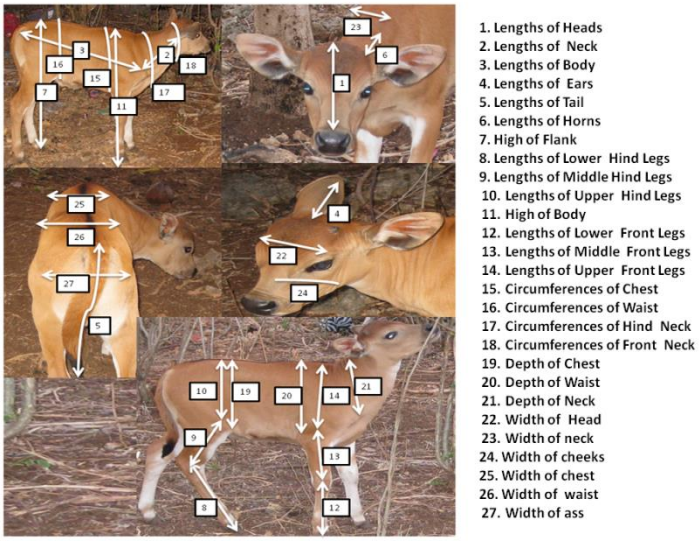

Fig 2.1: Measurement Body Dimensions

2.7 Data Analysis

To determine the affects of sex, period of growth, the frequency/time of measurement and the interaction between sex, growth period and frequency of measurements, it has been performed analysis of variance.

For the purpose of examining differences in body size between the males and the female on their growth period or on a certain age then it has been performed estimation average at 5% significance level.

The model used is a model with a sigmoid equation: $Yi = \frac{A}{1 + be^{-kX}}$

or in the linear form

$$\hat{Y}i = Ln\left(\frac{A - Yi}{Yi}\right) = \beta_0 + \beta_1 Xi$$

A value is determined based on the largest value of **Yi**, ie **A> Yi** largest and provide considerable value R and the minimum residual. Based on these equations it is obtained **b = $e^{\beta o}$** and **k =-β1**, or the maximum speed achieved at the point of inflection $X = \frac{1}{k}(Lnb)$. Body Dimensions of adult size (B) is achieved if a constant growth rate began reaching 95% of the size of the maximum size (B = 0.95 A), the age when they reach adult size is:

$$X = \frac{1}{-k} Ln\left(\frac{A - B}{Bb}\right) = \frac{1}{-k} Ln\left(\frac{0{,}0526}{b}\right).$$

Testing accuracy and thoroughness of the model or pattern of growth is done with the **F**-test and test correlation coefficient (**R**).

3. RESULT AND DISCUSSION

3.1 Growth Patterns of Bali Cattle Body Dimensions

The results of measurements on the body dimensions of Bali cattle aged 0-29 months, after performing the analysis of variance and estimation test on the mean showed that all of the entire males (bulls) and the females bali cattle from birth to 1 month old had no significant different (P> 0.05) body dimensions between the both sexes. Furthermore, after more than 1 month old there were differences between the body dimensions of the entire males and the females, but at what age it was started to have significant differences (P <0.05), it was depending on the each body dimensions. Horn lengths of the entire males began from the age of 2 months were significantly longer (P<0.05) than those of the females. This occurred because eruption of the entire males horns began at the age of 2 months, while those of the females began the eruption at the age of 3 months. The head widths of the entire males after 3 months old were significantly wider (P<0.05) than those of the females. Length of the heads, necks, bodies, ears and tails; lengths of lower, middle and upper hindlegs; length of the middle and upper forelegs of the entire males were significantly longer (P<0.05) than those of the females began at 5 months old of age. Furthermore, the width of necks, cheeks and chests of the entire males started from the age of 5 months were significantly wider (P <0.05), than those of the females. Circumference of hindparts of necks (base of necks) and foreparts of necks (top of necks) of the entire males started from the age of 6 months were significantly (P <0.05) larger than those of the females. Also, the width of waists of the entire males began from the age of 6 months were significantly (P <0.05) wider than those of the females. Length of lower forelegs, circumference of chests, depth of chests and necks started from the age of 13 months the entire males were significantly higher (P <0.05) than those of the females. Circumference of waists and depth of waists, started at 16 months of age the entire males (bulls) were significantly larger (P <0.05), than those of the females. Whereas height of flanks and height of bodies began from the age of 22 months the entire males were significantly higher (P <0.05) than those of the females. In addition, the width of asses began from the age of 22 months the entire males were wider (P <0.05), than those of the females.

Based on the results of regression analysis on the growth patterns of body dimensions of the entire male and female bali cattle it was evidenced that the curve followed sigmoid models, and between the entire male and female curves were separated and the more mature their age the larger the separation and both sexes reaches the inflection point at different ages. The inflection point indicated the order of growth i.e. body dimensions which have the earlier inflection points grew earlier and reached the maximum size at a younger age. Based on the results of the regression-correlation analysis of the obtained results of sigmoid models correlation (R) were highly significant (P <0.01) and each body dimension has different growth rate and maximum size and reached their inflection points at different ages

The results of this study was in accordance with those of Brody (1974) who indicated that the growth of animals measured in body weight or carcass weight or organs, tissues or certain body parts, when plotted on graph paper against their age showed a sigmoid shaped curve. Later study conducted by Sampurna (1992) found that the pattern of growth of organs, and body parts of broiler chickens evidenced that the curves followed a sigmoid shaped. The males reached the inflection point at a more mature age than the female broilers, besides that the males reached heavier maximum size that than that of the females. These results are also parallel with those of research done by Tazkia and Angraeni (2009) who reported that growth curves of measurement of body dimensions and body weight in dairy cows of FH in general was sigmoid pattern. These founds reflected that the growth of cattle initially occurred since they are born, then undergo acceleration phase until it reaches the point of inflection, thereafter the cattle reach mature body size and began from this phase has occurred a slowing growth phase until the growth was relatively constant.

Earlier study carried out by Sudarmono and Sugeng (2008) showed that after the calf was born its growth rate become faster until weaning age is reached. From weaning age, until the age of puberty, the growth rate remained rapid. From the age of puberty until the marketing age, however, the growth rate began to decline and continually decline until adult age is reached and then eventually the growth ceased. Weight growth of Bali cattle cease at the age of 4 years, and reach an average body weight of 300-400 kg.

The curves of sigmoid growth patterns of the lengths of body, tail, and neck are presented in Figure 4.1. From the figure it is clear that the lines of length curves of body, tail and neck of the entire males and females at birth are very close together or they are in the same lengths; the older their ages, the larger the dimensions of the entire males than the females.

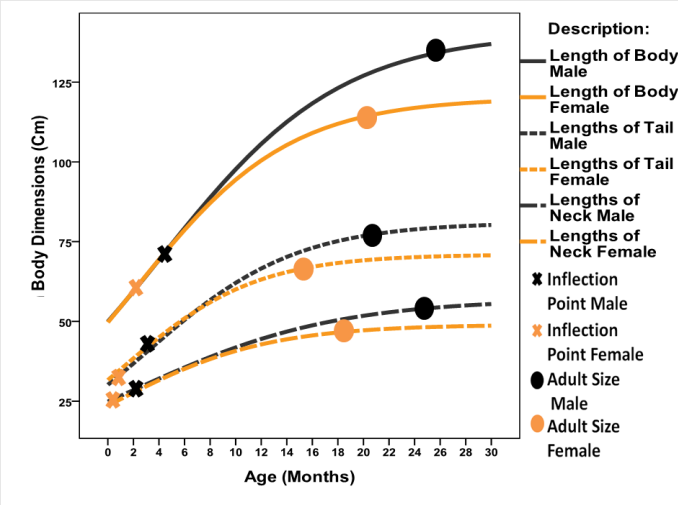

Fig 3.1: Sigmoid Curves of Body, Tail and Neck Lengths of Bal Cattle

Body lengths the entire males reached mature size at the age of 25 months and that of the females at 20 months old, the maximum lengths of the entire males and the females were 140.50 cm 120.10 cm, respectively. Tail lengths of the entire males reached mature sizes at the age of 20 months and those of the female at 16 months old, the maximum lengths of the entire males and the females were 81.05 cm 71.01 cm, respectively. Neck lengths the entire males reached mature size at the age of 25 months and the females at the age of 18 months, the maximum lengths of the entire males and the females were 57.05 cm 49.005 cm, respectively.

The curves of growth sigmoid patterns of the length of head, ears and horns are shown in Figure 4.2. From the figure it is indicated that the lines of length curves of heads and ears of the entire males and the females at birth are very close to each other or they are in the same lengths; the older their ages the larger the dimensions of the entire males than those of the females. While the entire male and female horns were not erupted yet at birth or had length of 0 (zero); eruption of the entire males horns occurred at the age of 2 months, while those of the females were erupted at the age of 3 months, as their age increased, the horn length of the entire males became much longer than that of the females.

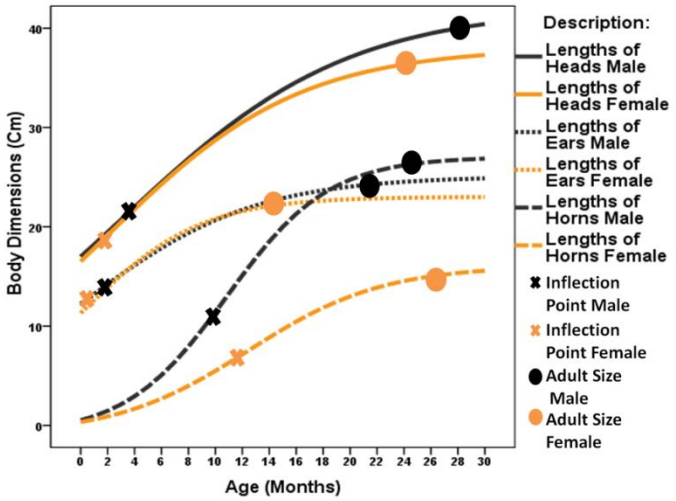

Fig 3.2: Sigmoid Curves of Head, Ears and Horns Lengths of Bali Cattle

Head lengths of the entire males reached mature size at the age of 28 months and that of the females at 23 months old; the maximum head lengths of the entire males and the females are 42.05 cm and 38.05 cm, respectively. Ear lengths of the males reached mature sizes at the age of 19 months and those of the females at 13 months old; the maximum ear lengths are 25.10 cm in the entire males and 23.02 cm in the females. Horn lengths of the entire males reach mature size at the age of 25 months and those of the females at 27 months old; the maximum horn lengths of the entire males and the females were 28.0001 cm 17.01 cm, respectively.

Results of Regression analysis of sigmoid model found length dimension measurements of the entire males reached higher maximum sizes than those of the females. Lengths of heads, necks, bodies, ears and tails of the entire males reached an inflection points at a more mature age than those of the females.

The results of this study indicated that the entire males had longer length dimensions than those of the females. Based on their inflection points, the sequence of length dimensions growth of the entire males and the females were started from the length of ears, then they were followed by neck, tail, head, body and the latest was the horn lengths.

The curves of sigmoid growth patterns of the heights of body and flank are illustrated in Figure 4.3. The figure demonstrated that the lines of the height curves of body and flank of the entire males and the females at birth are very close to each other or they are in the same height; the older their ages the higher the height dimensions of the entire males than those of the females.

After reaching more than 18 months of age (sexual maturity), the height of body was higher than the height of flank in the entire males, i.e. reach a maximum height of 130.00052 cm and 127.001 cm, respectively, whereas heights of flank and body in the females are almost in similar height i.e. reached a maximum heights of 115.0005 and 115.50005 cm, respectively. Heights of flank and body in entire males reach mature sizes at the age of 18 months and 20 months, while those of the females reached mature sizes at the age of 13 months and 14 months, respectively

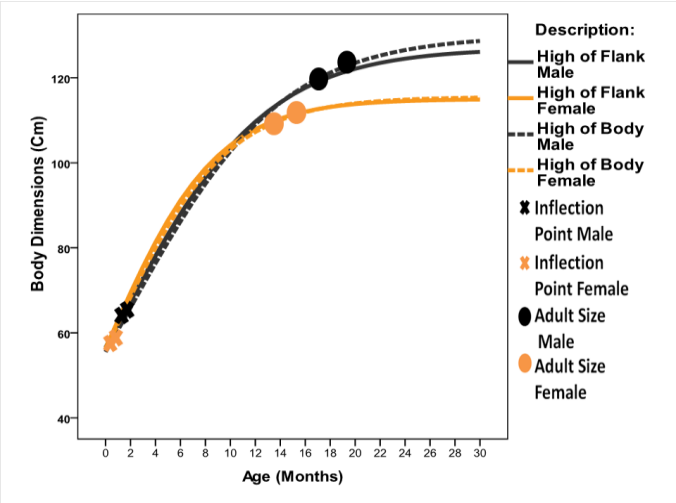

Fig 3.3: Sigmoid Curves of Body and Flank Heights of Bali Cattle

Curves of sigmoid growth patterns of the lengths of lower, middle and upper hindlegs were shown in Figure 4.4. The figure indicated that at the time of birth the lines of the length curves of lower hindlegs of the entire males and the females, also middle and upper hidlegs of the entire males and the females are very close to each other or they are in the similar lengths; the more mature their ages the longer the length of the hidlegs of the entire males than those of the females. Lengths of the lower hindlegs of the entire males and the females reached inflection points at the youngest age, then they are followed by the lengths of middle hindlegs, and the latest were lengths of upper hindlegs. Lengths of lower hindlegs of the entire males and the females reached adult sizes at the age of 20 months and 19 months, and reach the maximum lengths of 51.004 cm and 48.16 cm, respectively. Lengths of middle hindlegs of the entire males and the females reached adult size at the same age i.e 28 months; the maximum lengths of the entire males and the females were 47.05 cm 46.10 cm, respectively. Lengths of the upper hindlegs of the entire males and the females reached mature size at the same age i.e. 20 months and the maximum lengths of the entire males and the females were 50.0002 cm 49.01 cm, respectively.

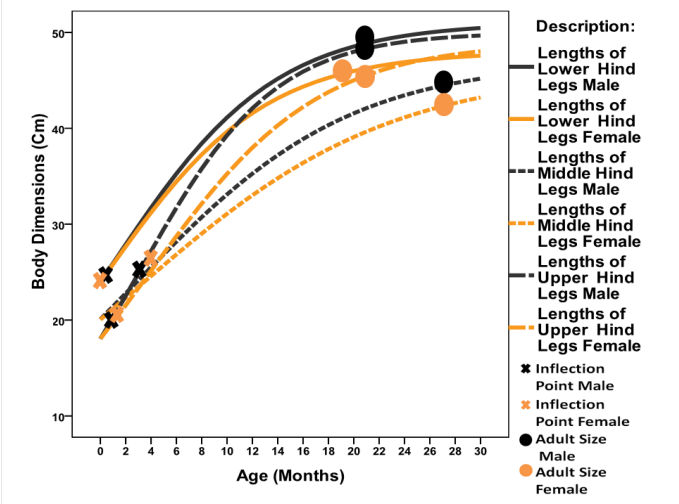

Fig 3.4: Sigmoid Curves of Lower, Middle and Upper Hindlegs Lengths of Bali Cattle

The curves of sigmoid growth patterns of the lengths of lower middle and upper forelegs are illustrated in Figure 4.5. The figure indicated that at the time of birth, the lines of the lower forelegs length curves, also the middle and upper foreleg length curves of the entire males and the females are very close together or they are almost equal in lengths; the more mature the age, the longer foreleg lengths of the entire males than the females. The lengths of lower forelegs of the males and the females reach the inflection points at the youngest age, then they are followed by the lengths of middle forelegs, and the latest are the lengths of the upper forelegs.

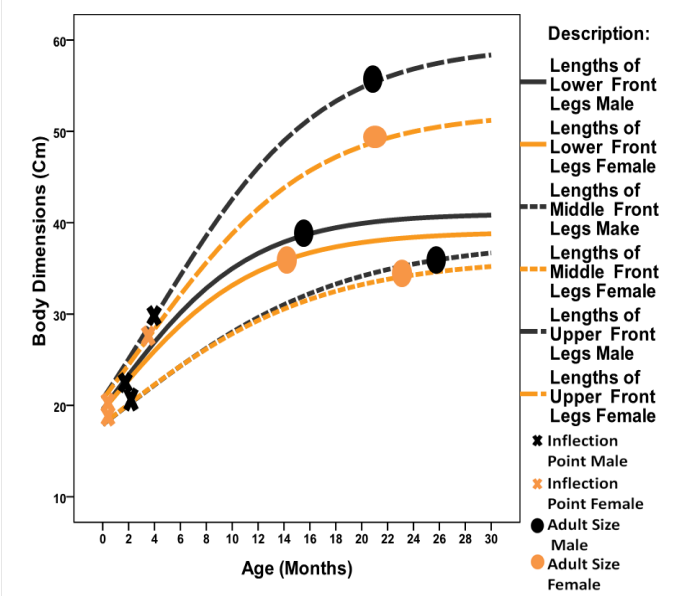

Fig 3.5: Sigmoid Curves of Lower, Middle and Upper Forelegs Lengths of Bali Cattle

Lengths of the lower forelegs of the entire males reach mature size at the age of 17 months and that the females at 16 months old; the maximum lengths of the entire males and the females were 41.0002 cm and 29.0006 cm, respectively. Lengths of the middle forelegs of the entire males reached adult size at the age of 27 months and that of the females at the age of 24 months; the maximum length of the entire males and the females are 38.00013 cm and 26.10 cm, respectively. Lengths of upper forelegs of the entire males and the females reach mature size at the age of 23 months; the maximum lengths of the entire males and the females are 59.40 cm and 52.10 cm, respectively.

Regression analysis results of sigmoid models of height dimensions evidenced that height of body and length of the lower, middle and upper, forelegs, as well as heights of flank and lengths of the lower, middle and upper hidlegs of the entire males reach higher maximum size than that of the females. Heights of body and length of the lower leg, as well as height of the flank and lengths of the lower, middle and upper hindlegs of the entire males reach inflection points at more mature age than those of the females, while the lengths of the middle and upper forelegs of the entire males reached inflection points at a younger age than those of the females.

Results of this study indicated that the entire males have higher height dimension than those of the females. Based on the inflection point, the growth sequences of the fore and hindlegs of the entire males and the females began from the lengths of lower, middle and ended at the upper fore and hindlegs.

Curves of sigmoid growth patterns of the circumference dimensions on the entire male and the females are shown in Figure 4.6. From the figure it was evidenced that at the time of birth, lines of circumference dimension curves of the entire males and the females are very close together or almost at similar in circumference dimensions; the more advance their ages the larger the circumferences dimensions of the entire males than those of the females.

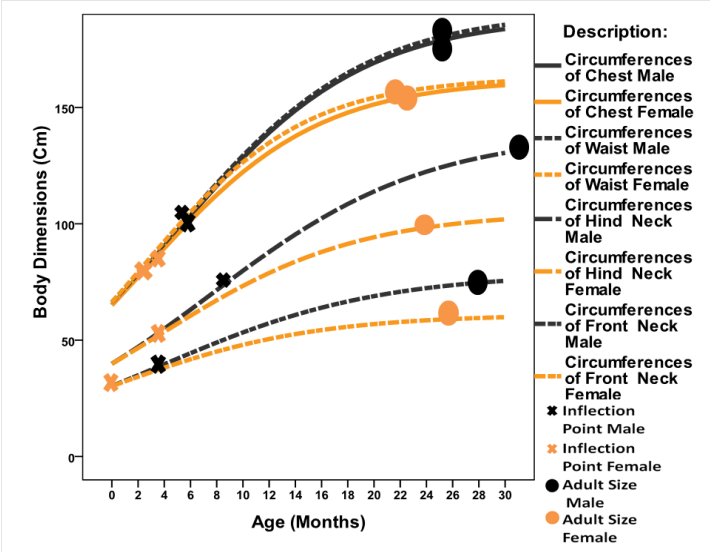

Fig 3.6: Sigmoid Curves of Chest, Waist, Rear and Fore Part of Neck Circumferences of Bali Cattle

Circumferences of chest and waist of the entire males reach adult size at the same age of 26 months; the maximum sizes are 189.10 cm and 191.31 cm, respectively. while the females reach mature size at the age of 22 months and 21 months, respectively; have the maximum size of 162.05 cm and 163.01 cm' respectively. Circumferences of rear parts of neckt of the entire males reach mature size at the age of 32 months and those of the females at 26 months old; the maximum size of the entire males and the females are 139.10 cm and 105.01 cm, respectively. Circumferences of four parts of neck of the entire males reach mature size at the age of 28 months and those of the females at the age of 22 months; the maximum size of the males and the females are 78.70 cm and 61.03 cm, respectively.

Regression analysis results of sigmoid models of the circumference dimensions confirmed that the entire males reach a larger maximum sizes than those of the females. Circumferences of chest, waist, circumferences rear part of neck and of fore part of neck of the entire males reach inflection points at a more mature age than those the females.

Results of this study showed that the entire males have larger circumference dimensions than those of the females. Based on the inflection points of the earliest circumference dimension developed is that of fore part of neck and the latest circumference dimensions developed is that of the rear part of neck, while the circumferences of chest and waist developed at the same time. Circumferences of the rear part of neck of the entire males reach the inflection points at the most mature age namely at the age of 7.5 months, in comparison with other circumference dimensions.

Curves of sigmoid growth patterns of the depth dimensions of the entire male and the females is depicted in Figure 4.7. The figure show that at the time of birth the depth dimensions of chest and waist of the males and the females are almost in equal depth dimensions or their curve lines are very close together; the more developed the maturity of the entire males the greater the depth dimensions of the males than those of the females.

Depth dimensions of chest of the entire males reach adult sizes at the age of 27 months and those of the females at 17 months old; the maximum depths of the entire males and the females are 76.50 cm and 59 001 cm, respectively. Depth of waist dimensions of the entire males reach mature sizes at the age of 25 months and those of the females at 17 months old; the maximum depth dimensions of the males and the females are 65.00035 cm and 56.01 cm, respectively. Depths of neck of the entire males and the females at birth almost in the same size, the more develop their ages, the larger the depth dimensions of the entire males than those of the females; the entire males reach mature size at the age of 29 months and those of the females at 21 months old; the maximum depth of the entire males are 57.55 cm and those of the females are 44.10 cm.

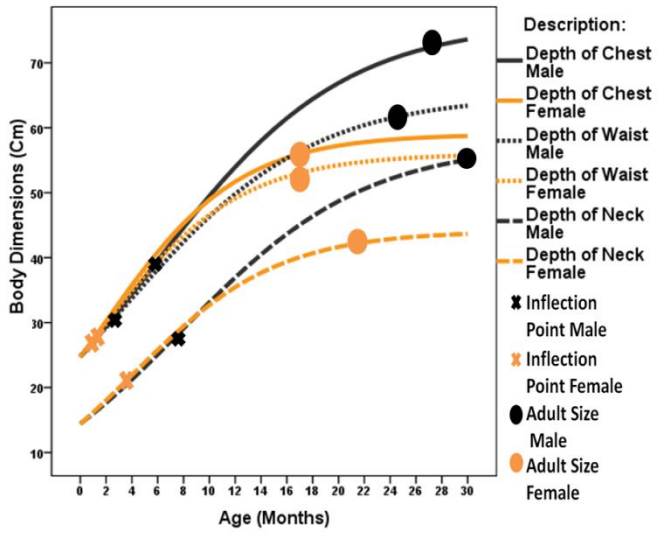

Fig 3.7: Sigmoid Curves of Chest, Waist and Neck Depths of Bali Cattle

. Results of analysis of sigmoid regression models indicated that depth dimensions of the entire males reach a higher maximum sizes than those of the females. Depth dimensions of chest, waist and neck of the entire males reach the inflection points at a more mature age than those of the females. Based on the inflection points of the entire males and females, the earliest depth dimensions developed are chests and then they are followed by the waists and then the latest developed are depths of necks.

Curves of sigmoid growth patterns of the widths of heads, cheeks and necks of the entire males and the females are depicted in Figure 4.8. The figure illustrated that at the time of birth width dimensions of heads, cheeks and necks of the entire males and the females are almost in equal sizes or the curve lines are very close to each other; the more mature their ages, the width dimensions of the entire males are greater than those of the females.

The head widths of the entire males reach mature sizes at the age of 27 months and those of the females at the aged of 25 months; the maximum widths of the entire males and the females are 23.021 cm and19 001 cm, respectively. Cheeks widths of the entire males reach adult size at the age of 21 months and those of the females at 20 months old; the maximum width dimensions of the entire males and the females are 30.0012 cm and 28.0001 cm, respectively. Neck widths of the males and the females reach mature size at the age of 28 months; the maximum width dimensions of the entire males and the females are 24.34 cm and 20.10 cm, respectively.

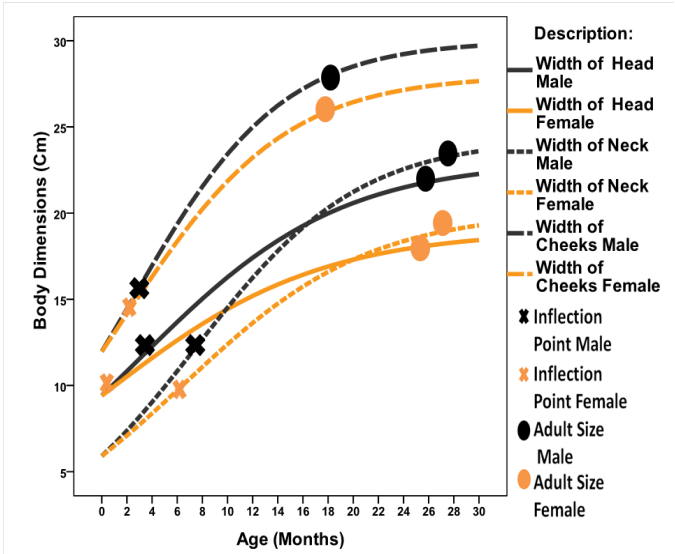

Fig 3.8: Sigmoid Curves of Head, Neck and Cheeks Widths of Bali Cattle

Curves of growth sigmoid growth patterns of chest, waist, and ass widths the entire males and the show that at the time of birth widths of chest, waist, and ass of the entire males and females is almost equal in width or their curve lines are very close to each other; the more mature their ages, the larger these entire males body dimensions than those of the females (see Figure 4.9).

Chest widths of the entire males and females reach mature size at the age of 23 months; the maximum chest widths of the entire males and the females are 43.012 cm and 39.01 cm, respectively. Waist widths of the entire males reach mature size at the age of 26 months, while those of the

females reach adult size at 20 months old; the maximum widths of the entire males and the females are 50.0032 cm and 40.05 cm, respectively. Ass widths of the entire males reach mature size at the age of 24 months and those of the females at 23 months old; the maximum widths of the entire males and the females are 39.056 cm and 33.01 cm, respectively.

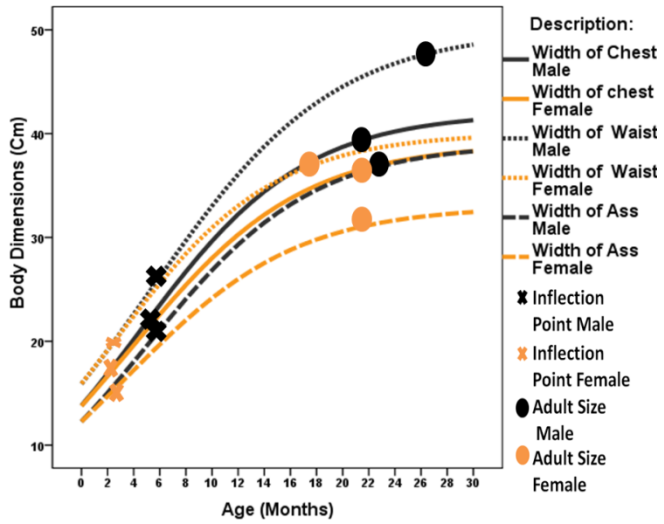

Fig 3.9: Sigmoid Curves of Head, Neck and Cheeks Widths of Bali Cattle.

The results of the regression analysis sigmoid models evidenced that width dimensions of the entire males reach larger maximum sizes than those of the females. Width dimensions of the entire males reaches the inflection points at more mature ages than those of the females. Based on the inflection points, in the entire males and the females, the earliest developed are widths of the heads , then they are followed by widths of cheeks, then in the entire males they are followed by widths of chests , asses and waists, while the females followed by the widths of waists, asses and chests. Widths of necks are the latest width dimensions developed, either in the entire males or in the females.

Body dimensions of the entire males reach larger maximum sizes than those of the females and the entire males (bulls) reach inflection points earlier (at younger ages) than those of the females. This occur because of the influence of testosterone hormone, which stimulate growth of the long bones, increased androgen hormones secretion during appearance of secondary sex signs in the males followed by faster growth (Soeparno, 2005) and due to different physiological and functional demands in the males and the females (Field and Taylor, 2003). While estrogen is more effective in promoting the epiphyseal closure of longbones (e.g. limb bones), therefore, the females stop growing earlier (at a younger age) than that of the males, so the males grow faster, reach adult age (physiological maturity) later (at older age) than that of females (Nasrul, 2012). The primary effect of testosterone on protein metabolism is to stimulate protein synthesis in muscle rather than to decrease catabolism or decrease the conversion of amino acids to urea and decrease body fat content or deposition (Soeparno 2005). Testosteron produced by the testes stimulates muscle growth by increasing protein synthesis, which work together with androgens, particularly on forequarter muscles of the entire male animals, such as the neck, shoulder and chest muscles showed a greater growth progression than those of the females and castrated males (steers). Androgens also functioned to stimulate the deposition of salts (minerals) and matrix on surface of preexisting bone that causes increased bone growth compared to the female animals and castrated males (Nasrul, 2012).

Differences in physiological and functional demands also resulted differences in a growth sequence of between the body dimensions in the entire males and the females. Dimension of lengths which functioned earlier will grow first than those functioned later. Lengths of ears firstly developed due to the functional demands which must be fulfilled soon just after the calves are born, then they are followed by lengths of neck and tail, this occur because these body part which is the most actively moving at the time of a calf is suckling to its dam is neck and it is followed by movement of its tail. Length of head develops earlier than length of body because according to Palsson (1955) (cited by Pomeroy, 1978), the region of the cranium, besides the region of the metatarsal and metacapal, is one of the centre of body growth where is a primary wave of growth derived and then moving forwards toward the facial region of the head and backward to the lumbar region. Moreover, inside the cranium region there is a cranial cavity where one of the part of the central nervous system is situated i.e. the brain. The central nervous system is the earliest developing part of the body followed by bone then by muscle and lastly by fat. Therefore, functionally, the cranium and hence the length dimension of the head is needed to be early developed in order to be able safely protect the brain. Length of horns is the length dimension of the rearmost developed. This case is due to functional demands, where the horns functioned only as a weapon used to protect themselves from possible aggression from other animals.

Lenghts of lower hindlegs and forelegs firstly developed, then they are followed by the middle and the latest developed is the lenght of upper hindlegs and forelegs. These results confirmed the earlier research findings that besides the region of cranium as had been mentioned above, the metatarsal (ossa metatarsalia) and metacarpal (ossa metacarpalia) are the second centre of body growth hence a secondary wave of growth starting from these regions and moving down to the digits and upwards along the limbs and trunk to the lumbar region. Thus the lumbar region is the last part of the body to attain its maximum growth rate

hence is the latest developing part of the body (Palsson, 1955, cited by Pomeroy, 1978; Brody (1974), Swatland (1984), and Sampurna and Suata (2010).

Circumference of the rearpart neck in the entire males are rearmost developed due to the occurrence of the dewlap growth, so this part is the rearmost developed compared to the that of chest and flank. The entire males Bali cattle whenever they are continually raised for more than 5 years old, a high fat deposition may occur not only under their skin (subctaneous fat) also either between one muscle to others (intramuscular fat), or may occurred between the muscle bundles or between the muscle fibers (intramuscular fat). Therefore, it may happen that the circumference dimensions where a high deposition rate of fat occurred, the dimensions may exceed the maximum size; the case is not regarded as dimension growth since deposition of fat in the fat depots is not being part of the growth process so it is excluded from growth. .This matter, however, has become a controversial issue in discussion amongst the researchers. Excessive energy content of the feed consumed will be stored as fat depot in various parts of the body in the forms of carcass fat and internal or non carcass fats. The fat cells, either in the animal or human body can multiply (hyperplasia) and increasing in size (hypertrophy) or getting bigger. The fat cells may increase in size 6 times of the normal size (Arini, 2012).

Depth dimension of waist growing first, then it is followed by the depth of chest and the lastly depth of neck. This is because of the fat deposition under the skin (subcutaneous fat) between muscles (intramuscular fat) or between muscle bundles which attached to the connective tissues (perimysium) that envelope each the muscle bundle. The fat depositions may locate between muscle bundles or fibers referred to intramuscular fat (marbling) when the animals have a high energy intake of the feed consumed. These fat cells are bound in the arteries which then penetrate into the muscle. Adipose tissue continually developed during weight growth and the increase rate is not the same in all adipose tissues (Nasrul, 2012). Widths of cheeks and head developed earlier than that of widths of chest, waist and ass; this was due to the different functional demands and its composing components. Parts of the body which functioned later, and the composing components mostly consisting of muscle and fat, then they will develop later compare to the composing constituent consisted of bone, and successively, the central part (lumbar region) is the last part of the body in cattle to reach its maximum growth rate and therefore is the latest developing part of the body. These results were in agreement with those of Swatland (1984) and Aberle et al. (2001).

Dimension of lengths of the females have reached the maximum mature size at the age of 23 months, except the lenght of horns at the age of 27 months. Heights of flank and body of the females attain adult size at a fairly young age i.e. at 13 months old and 14 months, while parts of fore and hidlegs on average reach the mature size at the age of 23 months. Circumferences of chest and waist attain mature size at the age of 22 and 21 months, respectively. Depths of chest and waist reach mature size at the age of 17 months; Widths of ass, waist band width of chest on the female bali cattle have reached mature size at the age 20-23 months. Body part which play an important role in cattle reproduction, especially in the females, at the first mating the dimensions of body should have reached mature size. Heifers should be mated if the growth of the muscles of the animals is well and perfectly developed (Natasasmita. and Mudikdjo. 1980). First mating in cattle should be done if the size of the body have approached to maximum (a target weight), so the ration consumed mostly destined for fetal growth and do not meet with difficulties at calving (Murtidjo, 1990). Heifers of the first mating are still growing, but will grow slower, because fetuses have priorities over growth of the dams at the time of pregnancy for nutrients consumed by the dams (Tillman et al, 1984). Based on the body dimensions the bali cattle females when they are first mated at the age of 21 months, their body sizes are sufficient to support the growth of their fetuses in their wombs. Mostly raising of the bali cattle females destined for breeding in order to produce calves. Breeding stock of good quality is preferably selected in accordance with the standards of the cattle breed concerned. Other aspects used in the selection criteria breeding stocks are genetical traits, health, and their body sizes and when they pregnant, the maximum size of certain body parts should have been reached so that the difficulties encountered at calving are minimal (Hidayat, 2010).

Dimensions of length and height of the entire male bali cattle reach an average mature size at the age of 25 months, the dimensions of circumference reach adult size at the age of 26-32 months, the dimensions of width reach mature size at the age of 25-29 months. Similarly, the dimension of width that describe growth and development muscles and fat deposition in various fat depots reach mature size at the age of 23-28 months. Based on the growth patterns of body dimensions, the bali cattle entires male is ready to be fattened at the age of 25 months. Cattle fattening is the raising mature cattle in order to attain a high weight gain and to poduce meat in a relatively short fattening period ie 3-5 months. Cattle raised for the fattening purpose it was expected that their body dimensions which describe the development and growth of muscles and fats will reach their inflection points at a more mature ages, so that by the time of fattening they are going to have high growth rate and thus reach a higher marketing weights, so economically will get more profit. Fattening of cattle should be done after the skeleton has reached mature size and development and growth of muscles and fats do not reach the maximum yet, so when they encounter feedlot fattening they will reach the optimal growth, since most of the available nutrients for them are utilized for muscle formation and fat deposition

Body parts of cattle that describe the growth of muscle and fat deposition, their potentials become higher when the body parts reaching their inflection points at a higher mature ages (Haripin, 2005). Bali cattle aged 24 months required fattening period of about 12 months.

4. CONCLUSIONS

a. Length of horns started significantly different (P <0.05) at the age of 2 months, width of head at the age of 3 months, lengths of head, neck , body , ears, tail; lower, middle and upper hidlegs, middle and upper forelegs; and upper, width of neck, widths of cheeks and chest started at the age of 5 months. While circumferences of fore part and rear part of neck, and width of waist started at the age of 6 months; lengths of lower forelegs, circumference of chest, width of chest and neck started at the age of 13 months, circumference of waist band width of waist started at the age of 16 months, width of ass, height of flank and body started at the age of 22 months.
b. Body dimensions of the entire male and the female Bali cattle have sigmoid growth patterns and each body dimension, however, have different growth rate.
c. Body dimensions of the female Bali cattle have an inflection point at a younger age than that of the entire male Bali cattle, and each body dimension reached inflection points and mature sizes at different ages.

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BIOGRAPHIES

I Putu Sampurna, born in the village,Kalianget, Buleleng, Bali, Indonesia May 3, 1958,. Got an Engineering degree in Faculty Husbandry, University of Udayana 1983, Bridging Programe Mathematics ITB 1988, Master of Science in Applied Statistics IPB 1992, Doctoral Animal Husbandry University Udayana 2013. The writer is a lecturer at the Laboratory of Biostatistics, Faculty of Veterinary Medicine, and Udayana University.

Ketut Saka, I GST Lanang Oka and Sentana Putra, lecturer Doctoral Program of Animal Husbandry, University of Udayana