Research Article

Growth Traits of Swamp and Murrah Buffalo Croses in North Sumatra, Indonesia

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Abstract | This research aims to determine the growth of crosses between Swamp and Murrah buffaloes in Humbang Hasundutan Regency, North Sumatra, Indonesia by measurement of body size and body weight. We used 80 buffalo crosses at ≤ 6, 7–12, 13–18, and 19–24 months of age. The research methods used census and survey methods with purposive sampling techniques for determining the research location. We observed variables such as body weight, chest circumference, body length, and shoulder height. Data analysis was carried out descriptively based on arithmetic mean, standard deviation, and coefficient of variance. The result showed that the body weights of male and female buffalo crosses at <6, 7–12, 13–18, and 19–24 months were 210.26 and 196.48, 304.14 and 288.42, 399.46 and 394.12, and 430.85 and 423.16 kg, respectively. The chest circumference of male and female buffalo crosses at ages ≤ 6, 7–12, 13–18, and 19–24 months were 122.57 and 117.44, 152.13 and 147.54, 177.72 and 176.5, and 184.83 and 183.5 cm, respectively. The body lengths of male and female buffalo crosses at ages ≤ 6, 7–12, 13–18, and 19–24 months were 94.14 and 89.64, 108.92 and 101.85, 126.44 and 115.25, and 140 and 135.63 cm, respectively. The Shoulder height of male and female buffalo crosses at ages ≤ 6, 7–12, 13–18, and 19–24 months were 89.64 and 87.81, 113 and 105.42, 125 and 120.5, and 138.83 and 124.25 cm, respectively. The body lengths of male and female buffalo crosses at ages ≤ 6, 7–12, 13–18, and 19–24 months were 94.14 and 89.64, 108.92 and 101.85, 126.44 and 115.25, and 140 and 135.63 cm, respectively. The male and female buffalo crosses from Swamp and Murrah buffaloes have body weight, chest circumference, body length, and shoulder height that increased with age, and the average was higher than Swamp and lower than Murrah buffaloes.

Keywords | Body weight and length, Buffalo crosses, Chest circumference, Murrah buffalo, Shoulder height, Swamp buffalo

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INTRODUCTION

Buffalo is a large livestock that can survive, produce, and reproduce in low-quality feed conditions and harsh macroclimatic circumstances. Buffaloes are more advantageous than cattle, they have a more efficient digestive system for digesting low-quality local feed (Wanapat, 2009; Pineda et al., 2021) and more economic Dhilod et al. (2018) where buffalo meat is more profitable because the cooking losses are lower than beef (Mendrofa et al., 2016). Buffaloes developed in Indonesia are divided into three types; Swamp, Murrah, and Local Buffaloes. Swamp buffalo represent almost 95% of the Indonesian buffaloes with a great variety of colors, sizes, and behaviors, the remaining 5% include Murrah buffalo (River buffalo) which survive in North Sumatra (Budi, 2007). Generally the color of the Murrah buffalo is black, while the color of the Swamp buffalo tends to be gray (Zhang et al., 2020). The majority of the Swamp buffalo population is found in China, In-

dia and Southeast Asia including Indonesia, because these buffalo are abundant in swampy areas (Asiti, 2018; Pineda et al., 2021). The Murrah Buffalo is a type of buffalo that has a wallowing habit in clear water. The population of these buffaloes has spread from India to Egypt and Europe (Zhang et al., 2020). The Indonesian buffaloes population is low compared to other large livestock, due to the lack of reproduction indicated by the long calving interval (Fayed, 2018). The low population growth rate will result in low livestock productivity.

Livestock productivity is reflected in the growth rates, and livestock growth can be measured by increasing body weights that can be determined by measuring chest circumference, body length, and shoulder height (Kamprasert et al., 2019). Measurement of body weights can be used as a reflection in calculating feed requirements, monitoring growth, and setting selling prices (Erat, 2011). The body weight of an animal can be determined by weighing it, but weighing facilities are not always available and cannot be brought to the field. Overcoming this by estimating body measurements using a stick and gauge. Body size can identify patterns of the physiological maturity of livestock so that it can be used as a parameter for estimating livestock body weight (Kamprasert et al., 2019). Chest circumference has a very important role in estimating body weight with a coefficient such as 90.97% (Haryanti et al., 2018). One of the efforts to increase livestock productivity is improving the genetic aspect, namely the application of reproductive biotechnology with estrus synchronization techniques through crossing using Artificial Insemination (AI).

Crossing aims to combine two different characters from two breeds to produce a generation with larger body weights, fast growth and higher productivity. Buffalo crosses have been carried out in many countries such as the Philippines, Thailand, China, and Indonesia. The buffaloes that were crossed in Indonesia were the Swamp and the Murrah buffalo. The first generation (F1) from these crosses had higher body size, body weight, and milk production (Yore et al., 2018). Humbang Hasundutan Regency is one of the regencies in North Sumatra which has crossbreeding between Swamp and Murrah buffalo using Artificial Insemination (AI) techniques. This crossing has been carried out since 2015 by using Murrah buffalo semen obtained from the North Sumatra and Lembang Artificial Insemination Center and has succeeded in producing the first derivative (F1) in the hope of having a large body weight and fast growth. From the description above, the aim of this study was to determine the growth of crosses between Rawa and Murrah buffaloes in Humbang Hasundutan Regency, North Sumatra by measuring body size and weight.

MATERIALS AND METHODS

The material used in this study was Swamp and Murrah buffaloes crosses in Lintong Nihuta (15 villages), Parlilitan (11 villages), and Paranginan (6 villages) of Humbang Hasundutan Regency. Humbang Hasundutan Regency is located in the central of North Sumatra Province with geographic boundaries to the north by Samosir Regency, to the south by Central Tapanuli Regency, to the west by Pakpak Bharat Regency and to the east by North Tapanuli Regency. The climate of this region is classified as wet tropical with temperatures 17°C–29°C and relative humidity about 85.94%. Rainfall is quite high every month so as to ensure the availability of water for buffalo, which generally have a simple housing system and many are even never cages.

Figure 1: The location of Humbang Hasundutan Regency

The understudy with a total sample size of 80 heads animals were grouped into four groups concerning age (≤ 6, 7–12, 13–18, and 19–24 months). Feed is given twice a day before being grazed in the morning and after being grazed in the afternoon, while concentrate is never given. Drinking water is provided ad libitum. We used the survey method and direct observation of the field. Sampling was carried out using the census method with all members of the population as a sample. The research site was determined using a purposive sampling method based on the crossbreeding of Rawa and Murrah (F1) buffaloes in Humbang Hasundutan Regency. The variables observed in this study are:

Buffalo Body Weights (**BB/kg**) = (chest circumference; cm + 22)²/ 100
Chest Circumference (**cm**) is measured using a gauge encircling the chest cavity behind the shoulder or the elbow of the front limbs perpendicular to the body axis.
Body Length (**cm**) is measured as the straight distance from the shoulder bulge or humeral tubercle to the sitting bone or ischial tubercle.
Shoulder Height (**cm**) is the highest distance from the shoulder to the ground
The data obtained were analyzed descriptively and presented in the form of arithmetic mean, standard deviation, and coefficient of variance.

RESULT AND DISCUSSION

Body Weight

The average body weight of male and female buffalo crosses between Rawa and Murrah buffaloes of different ages (Table 1) tends to increase with age. This is because male and female buffalo crosses are almost or about to enter maturity (2.5–3 years) and are in the growth phase. After reaching maturity the growth curve will decrease until the body matures and continue with fat accumulation. This is following Hilmawan et al. (2021) who reported that a growth pattern is a simple form with a growth rate starting in early life, then a significant increase after reaching sexual maturity until it is constant with the elderly.

The male buffalo crosses have a higher average body weight than the females, this is due to the influence of androgen hormones. According to Gibson et al. (2021), androgen hormones function to stimulate growth, muscle development, and organ development so that they function optimally. The average body weight of male and female buffalo crosses between Swamp and Murrah buffaloes (Table 1) is higher than the Swamp buffalo from Aidil's research (2010), at the age of 6–12, 13–18, and >18 months with body weights of 272.25, 273.03, and 314.16 kg for males and 252.60, 298.81, and 302.69 kg for females, respectively. The average body weight of the buffalo crosses under study was lower than that of male and female Murrah buffaloes from Gerly et al. (2012), namely 474 and 432 kg and from Yadaf and Vijh (2021) namely 533,76 and 465,07 kg respectively.

The higher body weight of the Swamp and Murrah crosses was attributed to the use of semen from Murrah male and Rawa female buffaloes, with characteristics of the meat type and short stature. Therefore, crossing a Rawa female with a Murrah male buffalo will produce F1 that is larger than the Swamp buffalo. Following De Melo et al. (2018) and Azmi et al. (2021) the productivity of Swamp and Murrah crosses had a 40% higher body weight gain than Swamp buffaloes.

The body weight of the buffalo crosses in our study was lower than that of the Murrah buffaloes. This is because the F1 crosses between Rawa buffalo and Murrah males have the proportion of blood from each parent, namely 50% Rawa and 50% Murrah so their derivatives (F1) are lower than Murrah buffaloes. Following Yore et al. (2018), crosses between two breeds will produce a 50:50 blood proportion from their parents in the first cross, and if a backcrossing was carried out it will produce a 75:25 ratio of male and female blood. The body weight of male and female crosses between Swamp and Murrah buffaloes aged ≤ 6, 7–12, 13–18, and 19-24 months had a coefficient of variance of less than 20%. This means that the body weight of the male and female buffalo crosses is uniform.

The Body Sizes

The body measurements of male and female buffalo crosses of Swamp and Murrah buffaloes concerning ages such as chest circumference, body length and shoulder height are listed in Table 2.

Chest Circumference

The chest circumference of male and female buffalo crosses of Rawa and Murrah buffaloes concerning ages (Table 2) had an average increase with age. This is because the male and female buffaloes were in a phase towards the peak of rapid growth before maturity (2.53 years) and after that, they will have fat accumulation. Following Hilmawan et.al (2021) the growth curve consists of three parts; an accelerated phase, a linear phase with very fast growth in a very short time (sexual maturity), and ends in a slowing period that gradually decreases until the livestock reaches maturity. This was synchronized with Minervino et al. (2020) who revealed that the chest circumference will increase with age.

The average chest circumference of males and females crosses of Rawa and Murrah was higher than that of the Swamp buffalo from Aidil's study (2010) at 6–12, 13–18, and >18 months, they had chest circumferences of 138, 163.10, and 183.4 cm, respectively for males and 125.75, 139.50, and 182.8 cm for females. This is due to the existence of crosses between the two breeds which can produce a heterosis effect, thus showing the average chest circumference of buffalo crosses is higher than their parents. Heterosis is the superiority of the generation (F1) over the average parent, due to the expression of a greater number of alleles, and causes F1 to be more resistant with faster and bigger growth compared to its parents (Nakadate et al., 2003). As stated by Andri (2008), the chest circumference of male and female buffalo crosses of Rawa and Murrah in North Sumatra has a fairly high heterosis effect, reaching 16.47% and 4.11% for females.

The coefficient of variation of chest circumference of male and female crosses of Rawa and Murrah buffaloes (Table 2) showed that at ages ≤ 6, 7–12, 13–18, and 18–24 months have uniform coefficients of variation ranging from 2, 25% –12.48%.

Table 1: Average Body Weights of Male and Female Crosses from Swamp and Murrah Buffaloes Concerning Ages

Age (month)	Body Weights (Kg)					
	Male			Female		
	Sum (head)	Mean ± SD	CV (%)	Sum (head)	Mean ± SD	CV (%)
≤ 6	14	210.26±32.77	15.59	18	196.48±39.15	19.93
7–12	12	304.14±35.11	11.54	13	288.42±33.76	11.71
13–18	9	399.46±31.31	7.84	4	394.12±13.94	3.54
19–24	6	430.85±23.83	5.53	4	423.16±20.75	4.90

Table 2: The Body Measurements of Male and Female Buffalo Crosses of Swamp and Murrah Buffaloes Concerning Ages

Body Size	Age (Month)	Male			Female		
		Sum (head)	Mean ± SD	CV (%)	Sum (head)	Mean ± SD	CV (%)
Chest Circumference	≤ 6	14	122.57±11.62	9.48	18	117.44±14.66	12.48
	7–12	12	152.13±10.19	6.70	13	147.54±10.34	7.01
	13–18	9	177.72±8.01	4.51	4	176.5±3.51	1.99
	19–24	6	184.83±5.60	3.03	4	183.5±4.12	2.25
Body Lengths	≤ 6	14	94.14±11.97	12.72	18	89.64±9.67	10.79
	7–12	12	108.92±7.22	6.63	13	101.85±9.71	9.54
	13–18	9	126.44±13.63	10.78	4	115.25±10.78	9.36
	19–24	6	140±10.08	7.20	4	135.63±20.29	19.39
Shoulder Height	≤ 6	14	89.64±8.03	8.95	18	87.81±7.66	8.72
	7–12	12	113±20.45	18.09	13	105.42±18.97	17.99
	13–18	9	125±7.63	6.11	4	120.5±2.38	1.98
	19–24	6	138.83±20.49	14.75	4	124.25±14.28	11.33

Body Lengths

The body length of Swamp and Murrah buffalo crosses at various ages (Table 2) has an average increase with increasing age. The growth in male buffalo body length of Swamp and Murrah crosses was higher than that of the females. This was caused by the influence of androgens in males, which affect bone growth. Following Gibson et al. (2021) androgen hormone can stimulate bone growth whereas estrogen infemale has an indirect effect on bone growth (humerus and femur). The average body length of male and female crosses of Rawa and Murrah was higher than that of the Swamp buffalo from Aidil's research (2010) where at ages 6–12, 13–18, and 19-24 months, the body length was 96.65, 116.58, and 134.45 cm respectively for males and 90.45, 112.20, and 124.1 cm for females. This was caused by the semen quality used in this cross which at least fulfills the Indonesian National Standard so that it has a higher productivity performance in its offspring. Following De Melo et al. (2018) the results of crossing the Swamp and Murrah buffaloes showed better growth and production performance than the Swamp buffalo.

The higher average of crosses compared to their parents is due to crosses between lines so that a combination of new genes will cover unwanted genes so that the offspring provide better performance than the two parents (Nakadate et al., 2003). Following Andri's research (2008), heterosis in body length of male and female crosses of Rawa and Murrah buffaloes in North Sumatra showed a fairly high heterosis effect, namely 10.99% and 6.80%.

The male and female crosses between Rawa and Murrah buffalo at ≤ 6, 7–12, 13–18, and 18–24 months have a coefficient of variance of less than 20%.

Shoulder Height

The average shoulder height of male and female crosses of Rawa and Murrah buffaloes (Table 2) has good growth because the average shoulder height of these crosses increases with increasing age. Gerli et al. (2012) stated that age has a close relationship with changes in body shape. Crossed male buffaloes have a higher average shoulder height than female buffaloes. This is thought to be due to the influence of androgen hormones in males and estrogen in females. Male cattle have androgen hormones that can increase body size and stimulate protein formation so that their growth is faster than in females. The estrogen in females can limit the growth of tubular bones followed by the growth of lower shoulder height than males (Gibson et al., 2021).

The average shoulder height of male and female crosses of Rawa and Murrah buffaloes was higher than that of Swamp buffalo from Aidil's (2010) at 6–12, 13–18, and >18 months with a shoulder height of 104.95, 111.70, and 123.33 cm respectively for males and 99.25, 114.20, and 122.38 cm for females. The higher mean shoulder height of the crosses in our study compared to the Swamp buffalo was due to differences in the genetic quality of the bulls used for mating. Following Praharani and Sianturi (2018), differences in crossbreed performance from their parents are caused by the introduction of males outside the population, while local cattle use males from within the population which are suspected of having a high rate of inbreeding due to the traditional breeding system.

The shoulder height of male and female crosses of Rawa and Murrah buffaloes at ≤ 6, 7–12, 13-18, and 18–24 months have a coefficient of variance of less than 20%, which ranges from 1.98%–18 .09%.

CONCLUSION

The growth of buffalo crosses of Swamp and Murrah buffaloes in Humbang Hasundutan Regency, North Sumatra has body weights, chest circumferences, body lengths, and shoulder heights which increase with age and also have higher averages than Swamp buffaloes.

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CONFLICT OF INTEREST

The authors have declared no conflict of interest.

AUTHORS' CONTRIBUTIONS

All authors contributed equally to the manuscript.

NOVELTY STATEMENT

This research is an initial report to look at the increase in productivity resulting from crossing murrah buffalo and swamp buffalo in terms of body weight, chest circumference, body length, and shoulder height.

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