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Productive Potency of the Endangered Taro White Cattle Population Reared Under Conservation Management System in Bali, Indonesia

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Abstract | Taro white cattle is one of local cattle breed in Bali which tropically well adapted to local environment and raised by farmers in limited area of Taro Village, district of Tegalalang, Gianyar Regency. The purpose of this study was to study the productive potency of Taro white cattle under conservation management system. The data pertain to 42 indigenous cattle of different sexes and ages. The productive potency evaluation included body weights, chest circumferences, body lengths, and height at withers. Productive potency data obtained were classified according to age group and sex of the animal. Descriptive statistic used to analyze facts of productive potency of Taro white cattle. Results showed that average birth weight, chest circumferences, body length, and height at withers of Taro white calves were 11.7 ± 0.18 kg, 58.4 ± 2.25 cm, 63.0 ± 2.16 cm, and 55.9 ± 1.47 cm, respectively, where their dams had 206.5 ± 13.45 kg, 152.0 ± 5.0 cm, 114.1 ± 2.99 cm and 109.3 ± 1.87 cm, respectively. It was clear that all body linear measurement of Taro white cattle significantly increased with the advancement of age in male. However, there were no significant differences in body linear measurement in female cattle. The average of body linear measurement of Taro white cattle males was higher ($p<0.05$) than of Taro white cattle females. The chest circumferences measurement can be used to predict the live body weight of Taro white cattle. The information generated from this study will be used for planning Taro white cattle genetic resources management.

Keywords | Endangered species, Conservation, Germplasm, Productive potency, Taro white cattle

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INTRODUCTION

In Bali Island, there are two types of cattle breeds known, Bali cattle and Taro White cattle. The Bali cattle is cattle breed from Indonesia with potential as meat producer. While the Taro White cattle is a unique group cattle with a very small number of population and only can be found at Taro village, Gianyar Regency, Bali Province. They are kept by farmers in conservation management system (Sarini et al., 2020). Until now, the origin of this cattle is unknown, but the people of Taro believed that Taro White cattle calf they brought originally from India by the great Rishi Markandeya (Heryani et al., 2016).

Recently, the phenotype and genotype of Taro White cattle are subject to several research projects. Taro white cattle breed is least known cattle breed in Indonesia. Taro white cattle possess special features in their appearance and body characteristics. The Taro white calves are born with clear white coat colour that tends to change to a permanent pinky white and ivory white at six months of age. The white coat is the characteristic colour of Taro white cattle.

The Taro white cattle start grow horns at the first time at 3 to 4 months of ages. Males have more developed horn than females. The horns are warp and straight orientation. Based on the orientation there are 8 variation of horn types (Sarini et al.,2020). Calves born having eyes with pale irises around the pupil.

Taro white cattle are important cattle in Bali because their function in social culture roles for the Balinese people and in Bali Hindu ceremony. The Balinese people considered that Taro white cattle are sacred cattle (Pujaastawa and Suwena, 2013). All Taro white cattle regardless their sex, teeth dentition, or physiological status were treated well like human beings from the day of their births until deaths whether due to too old or newly born calves' mortality or other reasons. Like a newborn in the beliefs of Balinese Hinduism, newborn calf or dead cattle are also made birth and death ceremonies under Balinese Hindu beliefs. In social culture roles, the people particularly at Taro Kaja Village considered that the animals were had roles in religious ceremonies and non-medical healing. Taro white cattle are not kept for consumption, so they have never been killed, slaughtered, sold, and not used as draught animals. Although the treatment of cattle is considered irrational, it is believed that this treatment will bring economic benefits and provides benefits for the environment. For instance, the community earns from wages obtained as compensation for maintenance as well as income in the form of donations from tourists visiting the place.

The Taro white cattle breeds in Bali have been subjected for a long process of natural selection, and they are tropically well adapted. However, these breeds are not well characterized adequately. Very little research has been done in uncovering on this breed. Perhaps of ignorance or not interesting to be investigated because these cattle cannot be utilized as meat production. Several documented scientific information have been written by some experts in the context of local wisdom behind the Taro white cattle myths (Pujaastawa and Suwena, 2013); morphometric characteristics (Heryani et al., 2016); challenge, and improvement of Taro white cattle (Yasa et al., 2015); forage management in supporting Taro white cattle conservation (Suarna et al., 2016; 2017). With lack information on their productivity. In our preliminary study, we were observed a total of 57 Taro white cattle (Yasa et al., 2015), however, in 1965, the total population of Taro white cattle were more than 100 cattle. In 2011, the total number of Taro white cattle are 25. Since 2011, the population tends to increase. Based on the current numbers of population and the following classification is used by The International Union for Conservation of Nature (IUCN) Red List Categories and Criteria: Version 3.1 (2012), Taro white cattle is classified as endangered breeds. Therefore, the conservation of these indigenous breeds is important. In order to avoid the danger of extinction. This study was undertaken to study the productive potency of Taro white cattle under conservation management system, as part of strategy for breed improvement program.

MATERIALS AND METHODS

Study Area

This study was conducted at Taro White cattle conservation,Taro Kaja Village, Tegallalang District, and Gianyar Regency. Taro Village is located between $8^0 19' 4''$ to $8^0 29' 38''$ south and $115^0 15' 18.8''$ to $115^0 19' 40.8''$ east and the altitude from 600–750 m above sea level. Taro Village's temperatures are between 19 and 27.5^{0}C, relative humidity of 67%, annual average rainfall of 959.2 mm and average wind velocity of 3 to 9 knots (Meteorological, Climatological, and Geophysical Agency of Indonesia, 2019)

The Animal and their Management

Morphological characters and body measurements were obtained from 42 cattle of different ages, which 28 were male and 14 were female. Age of the cattle was estimated by the stage of eruption of permanent pair of incisors. Cattle of three years old and above were selected for this research. The feeding and management systems at the area were similar. Animals were managed in an extensive system.

Data Collection

The present study covered different morphological characters which included body weight, chest circumferences, body length, height at withers of animals. Body weight (kg) estimated and measured before morning feeding by using digital scale that had accuracy to 0.1 kg. Chest circumferences (cm): was a circumferential measurement taken around the chest just behind the front legs and behind the scapula. Body length (cm): was measured from *scapula* to the *tuber ischii*, by using stick measure that had accuracy to 0.1 cm. Height of withers is vertical distance from the surface of plane to the highest point in of the shoulder between withers (Vanvanhossou et al., 2018). The measurements were made using a cattle measuring stick.

Data Analysis

The data of productive potency were classified according to sex and ages of the animal. The t-test was done to examine whether there are significant differences in the potency between the sex and ages of animal. The analysis of projection flock size was based on researcher own calculation by calcultate the number of productive females, calving interval, newborn calf, and calf mortality.

RESULTS AND DISCUSSION

Dynamic flock size and composition of Taro white cattle

The present study counts the total population of 57 Taro white cattle being conserved at Taro Kaja Village (Table 1). This population indicated that there were increased from 30 cattle in 2010 reported by Dharmawan et al. (2010), then it increased by 15 cattle over the seven years (Suarna et al., 2017) then increase until 57 cattle in 2020. However, this population is still smaller compared to the population in 2001. Suarna et al. (2016) reported the population was 150 cattle in 2001. In December 2018, there were 52 Taro white cattle and in December 2019, there two old females were dead and seven calves were born. Based on current data, there are 15 productive females, it will be projected that in 2025 the cattle population will become 202 cattle. Within this population 65 productive female cattle are predicted. It means at the end of 2025 the Taro white cattle will be still considered as endangered species (Table 2).

The projection of the total number of productive cows is very important in the context of conservation of Taro White cattle. By analyzing the potential of productive females under conservation management system in the village of Taro Kaja, it will be estimated succeeded producing at least 100 productive females of Taro white cattle by 2027. This projection is different from the projections reported by Yasa et al. (2015). In year 2027, Yasa et al. (2015) estimated that the projection productive females of Taro white cattle were 104.

Productive potency of Taro white cattle

No data were available on productive and reproductive performance of Taro white cattle. At the beginning of this study, data relating to productive potency were recorded. During the data collection, seven dams gave birth to seven calves with the average birth weight of 11.7 ± 0.18 kg (Table 3). The birth weight of this cattle in this study were found to be lower than the result of other studies of Bali cattle. In Bali cattle measurement average for birth weight were reported to be 18.0 ± 1.4 kg for male Bali calves and 17.9 ± 1.3 kg for female (Gunawan and Jakaria, 2011), 18.0± 1.4 kg for male Bali calves and 17.9 ± 1.3 kg for female (Setiyabudi et al., 2016) and 17.28 ± 0.93 kg in Bali cattle that raised in mountainous areas and 16.46 ± 0.40 kg in Bali cattle that raised in the lowlands (Pemayun et al., 2020) respectively. Suryani et al. (2017) also reported that provision higher level of energy ration fed to seven months of pregnancy of Bali cows improved birth weight of their calves ranging from 17.3 ± 0.8 kg to 18.0 ± 0.8 kg. The average of chest circumferences, body length, and height at withers of Taro white calves were 58.4 ± 2.25 cm, 63.0 ± 2.16 cm, and 55.9 ± 1.47 cm, respectively, and these measures were higher than Bali calves (Nugraha et al., 2016).

Table 1: Dynamic flock size and composition of Taro white cattle from 2001 to 2020.

Year	Total population (Head)	Composition of flock size
2001	150	--
2010	30	--
2011	25	--
2013	34	Productive females = 12 Bulls = 16 Female calves = 3 Male calves = 3
2014	34	--
2015	42	Female calves (<1 year) = 6 Productive female (1-2 year) = 2 Productive females (2-3 year) = 3 Productive females (>4 year) = 6 Male calves (<1 year) = 8 Bucks (>4 year) = 17
2016	33	Productive females = 16 Bulls = 8 Young cattle = 9
2017	45	White bulls = 21 Black bulls = 4 Red bulls = 3 White females = 16 Red female = 1
2018	33	Productive females = 16 Bulls = 8 Young cattle = 9
2019	57	--
2020	57 .	Female calves (< 1 year) = 6 Young females (1-2 year) = 8 Productive female (2 year) = 1 Productive females (3-4 year) = 3 Productive females (4-5 year) = 11 Young male (1 year) = 1 Bulls (2-3 year) ls = 6 Bulls (3-4 year) = 6 Bulls (>4 year) = 15

The productive potency in adult Taro white cat tle compared to other indigenous cattle of Bali were lower might be due to differences of genetic make up of growth traits of different breeds. The morphometric measurements in adult cattle were variation existed might be due to differences of genetic make up of growth traits of different breeds or types and different feeding and management systems (Hadiuzzaman et al., 2010).

The average body weight for Taro white cattle dams was 206.5 13.45 kg. In this study it was observed that size of

Table 2: Projection of composition and flock size of Taro white cattle in 2025

Year	Total population (Head)	Composition of flock size
2025	202.5 .	Female calves (<1 year) = 21 Young females (1-2 year) = 18.25 Productive female (2-3 year) = 14.50 Productive females (3-4) = 11.50 Productive females (>4 year) = 7.5 Productive females (5 year) = 6 Productive females (6 year) = 8 Productive females (7 year) = 1 Productive females (8 year) = 3 Productive females (9 year) = 11 Male calves (10 year) = 21 Young males (1-2 year) = 18.25 Bucks (2-3 year) = 14.50 Bucks (3-4) = 11.50 Bucks (>4 year) = 7.5 Bull (6 year) = 1 Bulls (7 year) = 6 Bulls (8 year) = 6 Bulls (9 year) = 15
2025	306	Productive females = 104

Table 3: Morphometric measurements of calf and dam of Taro white cattle

Physiological status	Parameters	N	Mean ± SEM	Min.	Max.
Born calf	Body weight (kg)	7	11.7 ± 0.18	11.0	12.5
	Chest circumferences (cm)	7	58.4 ± 2.25	53.0	69.0
	Body length (cm)	7	63.0 ± 2.16	58.0	72.0
	Height at withers (cm)	7	55.9 ± 1.47	52.0	62.0
Dam	Body weight (kg)	7	206.5 ± 13.45	150.7	267.3
	Chest circumferences (cm)	7	152.0 ± 5.00	138.0	179.0
	Body length (cm)	7	114.1 ± 2.99	104.0	124.0
	Height at withers (cm)	7	109.3 ± 1.87	102.0	115.0

Table 4: The body morphometric measurements of Taro white cattle

Parameters	N	Mean ± SEM	Range	Min.	Max.
Body weight (kg)	42	242.4 ± 12.2	262.1	120.1	382.2
Chest circumferences (cm)	42	156.2 ± 2.7	73.6	114.8	188.4
Body length (cm)	42	119.2 ± 2.1	50.0	89.4	139.4
Height at withers (cm)	42	115.2 ± 1.4	37.0	99.4	136.4

Table 5: Morphometric measurements of Taro white cattle for different sex and age.

Parameter	Sex	Body measurements (mean ± SE) by sex and age			
		1.5-2.0 year	2.0-2.5year	2.5-3.5 year	>3.5 year
Bodyweight (kg)	M	63.5	139.9 23.5	227.4 ± 66.2[a]	318.4 ± 37.6[b]
	F	144.1 ± 43.1	150.7	174.4 ± 31.3[a]	229.6 ± 60.8[a]
Chest circumferences (cm)	M	99.2	132.4 ± 10.7	154.4 ± 20.4[a]	170.5 ± 8.1[b]
	F	130.4 ± 13.6	138.6	138.5 ± 10.2[a]	157.1 ± 12.0[a]
Body length (cm)	M	67.2	97.8 ± 7.1	113.8 ± 12.7[a]	131.8 ± 4.3[b]
	F	101.2 ± 10.9	104.8	113.1 ± 4.8[a]	119.7 ± 9.1[a]

Height at withers (cm)	M	80.4	104.7 3.8	114.8 ± 5.9[a]	124.2 ± 5.7[b]
	F	101.5 ± 5.6	106.4	105.6 ± 5.8[a]	112.4 ± 5.7[a]

Note: Different superscripts in the same row show a significant difference in order of 5% (P <0.05).

dams affects the calf birth weight. These results are in line with the results of research on the productive potential of cattle reported by Suryani et al. (2017). Productive potency in cattle is usually related to the size and age of the dams. The larger dams usually produce larger calves (Suryani et al., 2017).

Body Linear Measurement of Taro white cattle

The descriptive analysis of the body morphometric measurements 42 individuals of Taro white cattle is presented in Table 4. The average of the body weight, chest circumferences, body length, height at withers of animals was 242.4 ± 12.2 kg, 156.2 ± 2.7 cm, 119.2 ± 2.1 cm, and 115.2 ± 1.4 cm, respectively.

The average of body linear measurement of males Taro white cattle was higher than of females Taro white cattle. This result was comparable to data that found in cow (Polak and Frynta, 2010). In this study, the age category not influenced the body linear measurements (p>0.05). There was no significant difference (p>0.05) in body weight, chest circumferences, body length and height at withers for different ages in female cattle (Table 5). However, ages of cattle showed significant effect on body weight, chest circumferences, body length and height at withers in male cattle (p<0.05). This difference of the body linear measurements was occurred due to females had complex functions than of males. This study was confirmed by Daza et al. (2014) who reported the average daily gain were higher in males than females.

There is a close relationship between body weight and body linear measurements. In this study it was revealed that Taro white cattle had strong positive correlations between chest circumferences with body weights and had the highest value of R^2 = 0.9749 (Figure 1). The correlation between chest circumferences with body weights in this study showed that same result was reported by Sahu et al. (2017). Generally, heart girth accepted as the most satisfactory single predictor of live weight in cattle (Lukuyu et al.,2016; Tebug et al., 2016; Ashwini et al., 2019). The correlations reported above are similar to other studies that found a correlation between body weight and chest circumferences of 0.75–0.88 (Doloksaribu et al., 2010; Zurahmah and Enos, 2011; Dhanny et al, 2015). To ensure high prediction accuracy, it was necessary to include chest circumferences traits for body weight estimation.

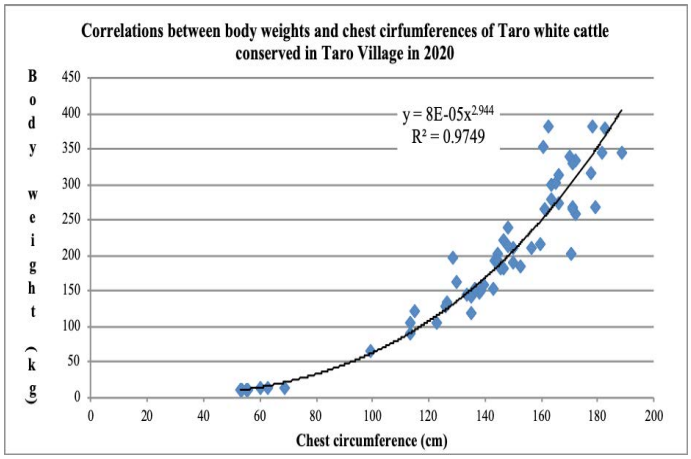

Figure 1: Correlation between body weights and chest circumferences of Taro white cattle reared at Taro Conservation in 2020.

CONCLUSION

The present study provides the first prominent published body linear measurements of Taro white cattle. From the results, it was clear that all body linear measurements of Taro white cattle significantly increased with the advancement of age in male. However, there were no significant differences in body linear measurement in female cattle. The average of body linear measurement of males Taro white cattle was higher than of females Taro white cattle. The chest circumferences measurement can be used to predict the live body weight of Taro white cattle.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

AUTHORS CONTRIBUTION

All the authors contributed significantly to the paper. Anak

Agung Oka designed the study, analyzed and interpreted the data, and drafted the manuscript, I Gusti Agung Arta Putra, I Wayan Suarna, Lindawati Doloksaribu, I Ketut Puja, collected the data and also contributed to manuscript preparation.

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