Growth Performance of On-Farm Male Fattening Bali Cattle Fed with Fodder Obtained from Dry Land Farming Diversification in West Timor

Grace Maranatha[1], Marthen R. Pellokila[2], Arnold E. Manu[1], Yohanis Umbu L. Sobang[1], Jacob Nulik[3], and Fredeicus Dedy Samba[1]

[1]Faculty of Animal Science, Nusa Cendana University, Kupang, Indonesia
[2]Faculty of Agriculture, Nusa Cendana University, Kupang, Indonesia
[3]Animal Research Center of Indonesian National Research and Innovation Agency-BRIN
***Corresponding author email: gmar.timore2367@gmail.com**

Abstract. This study aims to determine the effect of feeding fodder obtained from diversified dry land farming on daily weight gain, chest girth, shoulder height, and body length of male fattening Bali cattle. This study used a double Latin square design (LSD) with 4 treatments, namely T0 = local feed of farmers in Timor (farmer model). T1 = Diversified farm feed (T1 + mulato grass), T2 = T1 + legume *Clitoria tarnatea*, T3 = T2 + horticulture by-product using 4 periods as replicates. The livestock observed were eight male Bali cattle aged eight months to one year and weighed 97-121 kg (average 108.5 kg). The results showed that the feeding fodder obtained from the diversified farming had a significant effect (P<0.05) on daily body weight gain but not significant (P>0.05) on the linear body size measurements (chest girth, shoulder height, and body length). Considering the economical and convenient features, T2 feed treatment provided a greater contribution of 21.74% compared to control.

Keywords: growth performance, bali cattle, farming diversification, on-farm, fodder

Abstrak. Penelitian ini bertujuan untuk mengetahui pengaruh pemberian pakan yang diperoleh dari hasil diversifikasi usahatani di lahan kering terhadap pertambahan bobot badan harian lingkar dada, tinggi bahu dan panjang badan sapi bali jantan yang digemukkan. Penelitian ini menggunakan rancangan bujur sangkar latin ganda (RBSL) dengan 4 perlakuan yaitu T_0; pakan lokal peternak di Timor. T_1; Pakan hasil Diversified usaha tani (model petani + rumput mulato), T_2; T_1+legum Clitoria tarnatea, T_3; T_2+hortikultura dan 4 periode sebagai ulangan. Ternak yang diamati berjumlah 8 ekor sapi Bali jantan milik peternak dengan rentang umur 8 bulan - 1 tahun dan bobot badan berkisar 97-121 kg (rata-rata 108,5 kg). Hasil penelitian menunjukkan bahwapemberian pakan hasil diversifikasi usahatani memberikan pengaruhyang nyata (P<0,05) terhadap pertambahan bobot badan harian dan tidak nyata (P>0,05) terhadap ukuran linear tubuh sapi bali jantan. Hasil penelitian ini menyimpulkan bahwa pakan hasil diversifikasi usahatani di lahan kering berpengaruh nyata terhadap pertambahan bobot badan harian, dan tidak berpengaruh nyata terhadap lingkar dada, tinggi bahu dan panjang badan sapi bali jantan, namun Secara ekonomis dan kemudahan penggunaan pakan pakan dengan komposisi perlakuan T_2 memberikan kontribusi yang lebih besar yaitu 21,74% dibandingkan dengan perlakuan kontrol.

Kata kunci: kinerja pertumbuhan, sapi Bali, diversivikasi usaha tani, petani-peternak

Introduction

Ruminant maintenance is strongly influenced by the quality and quantity of feed. East Nusa Tenggara (ENT) has a very limited availability of quality feed in the dry land area due to a lack of information and breeders' initiatives regarding the importance of feed cultivation to meet the nutritional needs of livestock. Another important factor is scarce water supply during dry season. These are obstacles for breeders because they still rely on traditional cultivation which depends greatly on the availability of local feed from pastures, forests, riverbanks, and house yards; consequently, failure to meet nutritional needs of livestock. According to Sobang (2005), the provision of feed by breeders on Timor Island still inadequately fulfill dry matter demand for ruminants.

This brings further consequence to the low performance of livestock growth because the feed given is not able to meet the needs for livestock's basic living and production. On the other hand, breeders cultivate their land only for producing food crops. For this reason, it is necessary to implement diversifications of farming to produce food and feed, in order to better optimize land use for meeting the basic needs of humans and livestock. According to Suharto (2008), agriculture and livestock business through farm diversification can increase profits because it allows synergy between production and marketing of agricultural and livestock products.

The current research is focused on the effects of feed obtained from farming diversification on daily weight gain, chest girth, shoulder height, and body length of male Bali cattle in the feedlot. The result of the experiment is expected to obtain an economically good quality feed composition able to increase beef cattle performances.

Materials and Methods

An experiment was conducted to investigate the effect of feeding fodder from diversified farm on the performance of Bali cattle during 25 weeks at Oeletsala Village in Taebenu Sub-District of Kupang District East Nusa Tenggara. The experiment was conducted in the Latin Square with 4 treatments and 4 replicate periods. The treatments in the experiment included:

T0: Local feeds are usually fed to cattle by farmers in Timor,
T1: Feed from diversified Farming T0 + mulato/Hun Tetus grass,
T2: Feed from diversified farming T1+ legume Clitoria tarnatea,
T3: Feed from diversified farming T2 + horticultural product.

The nutrient content and ingredients for treatment feed is presented in Table 1, while Table 2 presents the nutritional content of the diversified farming and farmer feed components. The experiment used 8 heads of male Bali cattle aged eight months to one year, weighed 97-121 kg (averagely 108,5 kg) and 5,22% CV. Each animal was allocated in individual pens of 1.5mx2m facilitated with feed and water troughs. Forage feed was offered as much as 10% of body weight. The recorded parameters on daily basis were body weight gain, chest girth, shoulder height, and body length according to Fattah (2016).

Procedure of Variable Measurements

Linear Body Measurements

Chest girth was measured by encircling the chest behind the elbow joint perpendicular to the vertical plane of the body using the rondo meter which can then be seen in linear figures of the body in units of cm. Body length measurements are measured from the lateral line of the lateral *Tuberosity from the Os humerus* (front of the shoulder joint) to the *Tuber ischii* (back edge of the sitting bone hump) using an Extech laser. Body height was measured from the highest point of the shoulder to the floor on the front legs using a measuring stick.

Measuring Body Weight

Body weight was measured by estimating linier body using German-made rondo measuring tape which shows cm unit on the left side and kg unit on the right for measuring chest girth and body weight, respectively. The equipment included the sonic scales with 1000 kg capacity and 0.5 kg sensitivity, weighing scales of 100 kg capacity and 100 g sensitivity from Morris.

Tabel 1. Nutrition content of treatments' feed

Treatment	%DM	OM (%DM)	CP (%DM)	Fat (%DM)	CF (%DM)	CHO (%DM)	NFE (%DM)	Energy MJ/kg DM	Energy KCal/kg DM
T_0	31.93	72.41	9.98	5.83	19.40	55.60	36.20	14.27	3,397
T_1	42.36	73.14	11.42	7.62	23.73	54.10	30.37	14.73	3,505
T_2	44.40	73.81	13.57	7.39	23.25	52.86	29.61	14.95	3,560
T_3	45.19	74.12	14.32	7.43	22.86	52.36	29.50	15.07	3,587

Note: *Nutrition analysis was conducted at the Feed Chemistry Laboratory, Faculty of Animal Husbandry, Undana. Feed samples were taken 10% of the feed offered to the animals every day and then composited at the end of the experiment for analysis.*

Tabel 2. Nutrition content diversified farming feed and local feed by farmers

Ingredients	%DM	OM (%DM)	CP (%DM)	Fat (%DM)	CF (%DM)	CHO (%DM)	NFE (%DM)	Energy MJ/kg DM	Energy Kcal/kg DM
Mulatto/Hun Tetus grass	80.80	72.84	6.60	6.46	23.36	59.78	36.42	14.15	3,368.13
Clitoria tarnatea	84.10	76.56	20.55	3.72	22.41	52.29	29.88	15.30	3,641.90
Corn straw	82.81	70.46	5.42	2.81	30.19	62.23	32.04	13.04	3,104.31
Leucaena leucocephala	82.63	74.77	19.23	6.17	20.88	44.37	23.49	16.15	3,844.65
Acacia leucophloea	81.80	72.84	9.06	5.46	18.36	57.32	38.96	14.32	3,408.76
Ficus Sp.	78.10	70.56	7.15	3.72	21.41	59.69	38.28	13.33	3,173.44
Ceiba pentandra	74.81	71.46	8.47	1.95	16.95	61.04	44.09	13.28	3,161.44

Note : Nutrition analisys was conducted at feed chemistry Faculty Animal Husbandry-Undana.

Daily body weight gain (DBWG)

$$DBWG = \frac{W2 - W1}{t}$$

Note:
W^1 = Initial body weight (Kg)
W^2 = Final body weight (Kg)
t = Duration of fattening (day/s)

Daily chest girth gain (DCGG)

$$DCGG = \frac{CG2 - CG1}{t}$$

Note:
CG^1= Initial chest girth (cm)
CG^2= End Chest Girth (cm)
t = Duration of fattening (day/s)

Daily Body Length Gain (DBLG)

$$DBLG = \frac{BL2 - BL1}{t}$$

Note:
BL^1= Initial body length (cm)
BL^2= Final Body Length (cm)
t = Duration of fattening (day/s)

Daily Shoulder Height Gain (DSHG)

$$DSHG = \frac{SH2 - SH1}{t}$$

Note:
SH^1= Initial shoulder height (cm)
SH^2 = End Shoulder Height (cm)
t = Duration of fattening (day/s)

Data Analysis

Data obtained were tabulated and subjected to Analysis of Variance (ANOVA) according to Latin Square Design (LSD) to observe the effects of treatments according to Steel and Torrie (1995).

Results and Discussion

Cattle growth is influenced by several factors, including the number of daily nutrient requirements which depend on the growth phase (breed, sex, and quality and quantity of feed). The nutrients in the feed consumed are utilized for basic life, and any excess will be used to increase the growth of livestock through metabolism and conversion into muscle and fat tissue. It is crucial to evaluate and determine the effect of treatment on the growth performance of fattening Bali bulls (see Table 3).

Daily Weight Gain of Fattening Male Bali Cattle

Data Table 3 shows that feeding fodder obtained from diversified farming has a significant effect (P <0.05) on daily weight gain of fattening male Bali cattle. This effect is due to differences in the nutritional content of feed between local breeders' feed and obtained from diversified feed through cultivation and diversification of food and forage plants in one land. The diversification is conducted through the introduction of forage plants in the form of grass legumes so that the feed produced can meet nutritional needs, especially protein, and energy for livestock to live and produce. According to Wahyono et al., (2011) a higher consumption of protein and energy will result in a faster growth rate.

The results of Duncan's test showed that the T0 treatment was significantly different from the T1, T2, T3 treatment. This difference shows that diversified farming feed is quite efficient because it provides a higher daily weight gain compared to the local feed provision by farmers, as well as being able to stimulate the growth of livestock and shorten the length of time to raise cattle so that it is expected to increase farmer's income, compared to only depending on local feed with relatively low nutritional quality.

Tabel 3. Average daily weight gain and linear body measurements

Parameter	Treatments				P-Value
	T_0±SD	T_1±SD	T_2±SD	T_3±SD	
DBWG (kg/h/d)	0.28±0.02^{a}	0.45±0.04^{b}	0.49±0.03^{b}	0.43±0.03^{b}	0.03*
DCGG (cm/h/d)	0.11±0.02	0.14±0.01	0.16±0.02	0.13±0.01	3.82^{ns}
DSHG (cm/h/d)	0.09±0.01	0.12±0.02	0.14±0.01	0.12±0.02	4.16^{ns}
DBLG (cm/h/d)	0.09±0.01	0.13±0.02	0.14±0.01	0.11±0.01	4.21^{ns}

Note: *significantly affected (P<0.05), ^{ns}not significantly affected (P>0.05)

Tabel 4. Average intake and nutrient digestibility

Parameter	Treatments				P-Value
	T_0	T_1	T_2	T_3	
DMI (g/h/d)	2,992.61^{a}	4,041.85^{b}	4,402.21^{b}	4,279.33^{b}	0.021*
OMI (g/h/d)	2,166.87^{a}	2,956.05^{b}	3,249.40^{b}	3,171.76^{b}	0.016**
CPI (g/h/d)	328.51^{a}	461.42^{b}	597.27^{c}	612.97^{c}	0.001**
Energy I (kcal/h/d)	10,166.11^{a}	14,170.62^{b}	15,672.88^{b}	15,350.44^{b}	0.010**
DMD (%)	61.75^{a}	73.94^{b}	74.98^{b}	72.80^{b}	0.004*
OMD (%)	58.04^{a}	70.50^{b}	71.11^{b}	70.43^{b}	0.046*
CPD (%)	45.06^{a}	61.39^{b}	64.05^{b}	68.31^{b}	0.005*
Energy D (%)	61.74^{a}	76.60^{b}	77.74^{b}	77.28^{b}	0.012**

*Note: author processed data, *significantly affected (P<0.05),**very significantly affected (P<0.01),*DMI= Dry Matter Intake, OMI=Organic Matter Intake, CPI= Crude Protein Intake, Energy I=Energy Intake, DMD= Dry Matter Digestibility, OMD=Organic Matter Digestibility, CPD=Crude Protein Digestibility.

According to Dhany et al. (2015), weight gain is influenced by feed quality and is efficient to be converted into body weight. The feed obtained from the diversified farming, however, showed no significant differences across T1, T2, and T3, which indicated that their qualities were sufficient to increase daily weight gain compared to T0. The T2, however, indicated better gain than the other two treatments (T1 and T3) although not statistically significant. Thus, the inclusion of legumes (such as Clitoriaternatea) into the ration seemed to produce better weight gain, but further investigation is needed to determine the proper content as previously reported in many experiments (Nulik, 2021;). Inclusion of Clitoriaternatea in the ration of beef cattle (Bali and Sumba Ongole cattle) has been shown to increase daily body weight gain, reduce calf mortality in Bali Cattle and maintain Body Score Condition of Sumba Ongole cattle (Mayberry et al., 2021).

In addition to being influenced by the nutritional content of treatment feed (Table 1), this difference is also evident from the differences in consumption and digestibility of livestock nutrients between treatments (Table 4). The differences in consumption (as expressed in DMI, OMI, and CPI) and nutrient digestibility are factors that distinguish the speed of growth of livestock. In other words, the higher the nutrient consumption, the more nutrients can be absorbed by the digestive system for metabolism process. According to Mappanganro et al. (2018), the difference in weight gain of male Bali cows in each treatment is determined by the amount of feed consumed, and that low body weight may be influenced by management factors, feed consumption, and feed nutrient. Campbell et al. (2003) stated that differences in the use of feed for each treatment are influenced by several factors, including the ability of livestock to digest feed ingredients, the adequacy of feed substances for life maintenance, growth, and body function, and the type of feed used. Despite the better intake (DMI, OMI, and CPI) as shown statistically in Table 4 as well as better CPI in T2, these treatments were not able to produce statistically significant differences in Daily Body Weight Gain (DBWG).

Linear Body Size of Fattening Male Bali Cattle

The data in Table 3 shows that the increase in the linear size of the livestock body, in this case the increase in chest girth, body length, and daily shoulder height, was not significantly affected ($P>0.05$) by the treatments. This shows that the provision of diversified feed has the same effect between treatments on the linear increase in the body of the livestock because the linear body of the livestock is influenced by bone growth that covers the entire body frame. This indicates that even though diversified feed is able to provide the nutritional elements livestock need to form muscle meat, it has not been able to provide the mineral elements that function for the growth of livestock body shells. According to Wayan et al. (2016), feeding with relatively similar vitamins, minerals, and water does not contribute to bone growth as a building block for the body. Dhany et al. (2015) stated that the provision of rations with different forage compositions did not provide a linear difference in the body size of the livestock, which included increased chest girth, body length, and shoulder height.

The increase in chest girth, which has no significant effect, also illustrates that the energy content of the treatment ration can meet the basic needs of life but is not sufficient for livestock production, which can be seen from the fat and muscle deposits in the chest. According to Gunawan et al. (2016), the increase in chest girth in Bali cattle is illustrated by muscle and fat growth. Also, Sampurna and Suatha (2010) reported that the better the growth of muscle and fat, the greater the increase in chest girth.

Meanwhile, the increase in shoulder height and body length, which showed no significant effect, also illustrates that these two parameters are closely related to bone growth. Therefore, it requires not only nutrients in the form of protein and energy but also calcium and minerals to support the growth of bones or body skeleton. According to Soetan et al. (2010), lack of calcium minerals can interfere with the digestive process, which has an impact on the growth of body's skeletal components. Pujiastari et al. (2015) stated that calcium in the body has an important role in bone formation. The response to feed improvement is very low to increase the growth of the body frame when it enters adult phase, and therefore, improved feed will only be directed to the formation of muscle meat and body weight. According to McDonald et al. (2002), the size of the shoulder height and body length is influenced by bone growth, whereas the age of the livestock increases, the bone growth will decrease.

Daily and linear body weight gain of livestock is closely related to meeting the needs of protein, energy, minerals, and calcium, protein and energy play a role in increasing rumen microbial activity, which is then metabolized into body products in the form of muscle tissue, meat, and fat, while calcium minerals serve as a precursor for the formation of animal bones. It also provides evidence that feed offered by conventional breeders has not been able to meet the nutritional needs of livestock, and the slower growth of livestock may impact the maintenance duration and income levels of breeders. On the other hand, diversified feed cannot meet livestock's need for minerals and calcium.

Conclusions

The results of this study concluded that the feed obtained from the farming diversification in dry land had a significant effect on daily body weight gain but no significant effect on chest girth, shoulder height, and body length of male Bali cattle. The economic and convenient use of feed in T_2 treatment provided a greater contribution of 21.74% compared to control.

Acknowledgement

Our gratitude goes to to DRPM Kemenristek/BRIN, for funding and support throughout this research. We also thank Kupang district government, especially the village of Oelatsala, for the permission to carry out this research.

References

Campbell, JR, MD Kenealy, and KL Campbell. 2003. Animal Sciences. The Biology, Care, and Production of Domestic Animals. 4th Edition. McGraw-Hill, London.

Dhany, KG, AA OKA, and NN Suryani. 2015. Response of body dimensions and the relation with body weight of bali cattle fed with ration containing composition of forage. Journal of Tropical Animal Science 3 (1): 29– 43. https://ojs.unud.ac.id/index.php/tropika/article/view/18505/12000

Fattah, S. 2016. Meat Livestock Management: Beef Cattle of The Pig. III. Undana Press. Kupang NTT. Pp 111-112

Gunawan IW, NK Suwiti, and P Sampurna. 2016.The effects of minerals on the chest girth, body lengthand body height of male bali cattle. Buletin Veteriner Udayana 8 (2): 128-134. https://ojs.unud.ac.id/index.php/buletinvet/article/view/23309/15315

Mappanganro R, MB Paly, K Kiramang, and R Nurhidayat. 2018. Effect of Brown Algae (Sargassum sp) on Bulls Bali Weight Gain. Jurnal Ilmu dan Industri Peternakan 4 (2): 139-148. DOI https://doi.org/10.24252/jiip.v4i2.9858

McDonald P, RA Edwards, JFD Greenhalgh, CA Morgan. 2002. Animal Nutrition. 6th. Ed. Scientific and Technikal Co. Pubhlished. In The United State with John and Sons. Tnc. New York. pp: 78-80.

Mayberry D, D Kana Hau, PR Dida, D Bria, J Praing, AD Mata, E Budisantoso, N Dalgliesh, S Quigley, L Bell, and J Nulik. 2021. Herbaceous legumes provide several options for increasing beef cattle productivity in eastern Indonesia. Animal Production Science, 61, 698-707. https://doi.org/10.1071/AN20545

Nulik J. 2021. Inovasi teknologi hijauan pakan berbasis legum di lahan kering iklim kering mendukung pengembangan ternak sapi Nasional. Orasi Pengukuhan Profesor Riset. IAARD PRESS, Badan Penelitian dan Pengembangan Pertanian Jln. Ragunan 29 Pasarminggu, Jakarta 12540 Telp.: +62-21-7806202, Faks: +62-21-7800644 Email: iaardpress@litbang.pertanian.go.id Anggota IKAPI No. 445/DKI/2012

Pujiastari NNT, P Suastika, and NK Suwiti. 2015. Kadar mineral kalsium dan besi pada sapi bali yang dipelihara di lahan persawahan. Bul. Vet. Udayana, 7(1): 67-72.https://ojs.unud.ac.id/index.php/buletinvet/article/view/19636/13035

Sampurna IP and IK Suatha. 2010. Pertumbuhan alometri dimensi panjang dan lingkar tubuh sapi bali jantan. Jurnal Veteriner, 11(1): 46-51.https://ojs.unud.ac.id/index.php/jvet/article/view/3381/2417

Sobang, YUL. 2005. Characteristics of rowdy cattle fattening system according to agro-climatic zone and its impact on farmers' income in Kupang Regency, NTT. Bulletin Nutrisi Fapet Undana, 8 (2), 71-76.

Soetan KO, CO Olaiya, and OE Oyewole. 2010 Theimportance of mineral elements for humans, domestic animals and plants: A Review. African J of Food Sci, 4 (5): 200-222. https://academicjournals.org/journal/AJFS/article-full-text-pdf/045441523024

Steel, RGD and JH Torrie. 1995. Statistical Principles and Procedures. Second Edition. Translated by: B. Sumantri. PT. Gramedia Pustaka Utama, Jakarta.

Suharto. 2008. The concept of integrated farming (integrated farming system) realizes success with independence. Training Materials for the Revitalization of Livestock Business Integration in the Farming Business System. Bogor and Solo, 21 February-6 March 2000. Bogor Research and Development Center. EAAP Publ. Denmark. 102: 117-120.

Wahyono, T, Suharyono, Irawan. 2011.Complete feed innovation on daily weight gain of male Ongole crossbreed cattle. Proceedings of the National Biology Seminar: Biology Innovation and Biology Learning July 1-2, 2011 to Build National Character, Department of Biology Education FPMIPA UPI ISBN 978-602-95207-1-2.

Wayan, GI, NK Suwiti, and P Sampurna. 2016. The effects of minerals on the chest girth, body lengthand body height of male Bali cattle. Buletin Veteriner Udayana. Vol 8 (2): 128-134.https://ojs.unud.ac.id/index.php/buletinvet/article/view/23309/15315