

# Intake, Nutrient Digestibility, and Growth Performance of Balinese Bulls Fattening on Various Types of Forages in Traditional Farm

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**Abstract.** This study aimed to evaluate the performance of Balinese bulls fattened by various forages on traditional farms. The study was experimental research using *Clitoria ternatea*, *Zea mays* fresh straw, *Pennisetum purpuphoides*, *Pennisetum purpureum*, *Sesbania grandiflora*, *Centrosema pubescens*, *Leucaena leucocephala*, and natural grass to fatten the livestock which were arranged for the farmers' habits in fattening. Variables measured included feed consumption and digestibility and livestock growth performance, including daily body weight gain (PBBH), feed conversion and efficiency, and feed cost per gain. The collected data were then analysed using descriptive analysis procedures. The results showed that fattening Balinese bulls with forage resulted in dry matter (DM) (kg/head/day) reaching 7.079, while crude protein (CP) and organic matter (OM) intake were respectively 1.053 and 6.440 (kg/head/day). The digestibility coefficient of dry matter was 56.68%, crude protein was 69.86%, and organic matter was 68.83%. The ADG obtained by livestock was 0.321 kg/head/day; meanwhile, the feed conversion and efficiency were respectively 23.664 kg.DM/kg.ADG and 4.619%; the feed cost per gain (IDR/kg.ADG) reached 10,813.85. To sum up, the use of various types of forage in fattening Balinese bulls on traditional farms indicates that DM, OM, and CP intake are relatively high, but it provides relatively low feed digestibility by mean of ADG, conversion, and feed efficiency are not optimal.

**Keywords:** Intake and digestibility, feed conversion and efficiency, fattening, growth, Balinese bulls

**Abstrak.** Penelitian bertujuan mengetahui kinerja sapi Bali jantan yang digemukkan dengan berbagai hijauan di Peternakan Rakyat. Perlakuan eksperimen disesuaikan dengan kebiasaan peternak dalam menggemukkan ternak. Jenis pakan yang diberikan selama penelitian adalah *Clitoria ternatea*, jerami *Zea mays* segar, rumput *Pennisetum purpuphoides*, rumput *Pennisetum purpureum*, *Sesbania grandiflora*, *Centrosema pubescens*, legum *Leucaena leucocephala*, dan rumput alam. Variabel yang diukur meliputi konsumsi dan pencernaan pakan dan kinerja pertumbuhan ternak yang meliputi penambahan bobot badan harian (PBBH), konversi dan efisiensi pakan, serta feed cost per gain. Penelitian ini menggunakan prosedur analisis deskriptif sebagai teknik analisis data. Hasil penelitian menunjukkan bahwa penggemukkan sapi Bali jantan yang diberi pakan berbagai jenis hijauan menghasilkan konsumsi bahan kering (BK) (kg/ekor/hari) mencapai 7,079 atau 2,509% dari BB. Sementara konsumsi protein kasar (PK) dan konsumsi bahan organik (BO) masing-masing adalah 1,053 dan 6,440 (kg/ekor/hari), Koefisien cerna BK sebesar 56,68 %; PK sebesar 69,86 %; dan BO sebesar 68,83 %. PBBH ternak yang diperoleh sebesar 0,321 kg/ekor/hari, konversi dan efisiensi pakan masing-masing sebesar 23,664 kg.BK/kg.PBBH dan 4,619 % serta feed cost per gain (Rp/kg.PBBH) mencapai 10.813,85. Dengan demikian, penggunaan berbagai jenis hijauan pada penggemukkan sapi Bali jantan di peternakan rakyat menghasilkan konsumsi BK, BO, dan PK yang cukup tinggi, namun memberikan pencernaan pakan yang relatif rendah, dengan PBBH konversi dan efisiensi pakan yang tidak maksimal.

**Kata Kunci:** Konsumsi dan pencernaan, konversi dan efisiensi pakan, penggemukkan, pertumbuhan, Sapi Bali Jantan

## Introduction

Fattening is the final phase of raising livestock to produce good-quality meat. Many factors influence the success or failure of a fattening business. Feed factors, management, and breeding factors become a magic triangle that needs farmers' attention seriously to obtain maximum results. The farmers' habits and goals

in raising livestock determine the feed quality given during the fattening process. Livestock fattening with a saving orientation towards food security and other needs usually does not have a clear fattening final target. While fattening with a business orientation, fattening marks such as final body weight and fattening duration are clear because it is related to economic efficiency.

In fattening carried out by the community, such as on the Island of Timor (especially West Timor), some farmers still carry it out with a saving orientation towards food and other needs. This has affected conditions such as poor feeding, relatively low weight gain, and too long fattening time. Thus, the expected economic impact is not noticeable.

The aspect of feed plays an essential role in fattening livestock. Consequently, paying attention to the availability, adequacy, and adequate nutritional content is necessary. In addition, the provision of feed must consider the aspects of economic efficiency. This is due to almost 70% of the costs spent to increase livestock productivity, mainly for feed procurement. Using good quality and adequate feed to meet livestock needs will maximise the growth of beef cattle production parameters such as daily body weight gain, carcass and meat production, intake, conversion, and feed efficiency.

Although aspects of feed quality and quantity are important, Balinese bull farmers often neglect this. After conducting field observations, the researchers found that farmers provided feed mainly in the form of available forage according to natural conditions. They offered this feed because there was a range of limiting factors - cost, climate, feed availability, and the purpose of the appropriate maintenance. In turn, this has negatively affected livestock productivity.

Forage is the main feed for ruminants to support maximum production performance (Hart et al., 2022). Farmers must consider its quality and quantity before giving it to their livestock. On the other hand, on the island of Timor, especially West Timor, farmers choose 100% forage usage for Balinese cattle in dry and rainy seasons. This has affected livestock growth in the rainy and dry seasons, including meat quality (Tahuk et al., 2018).

The fattening business's effectiveness can be

measured by livestock production parameters, including feed intake and digestibility, daily body weight gain, feed conversion and efficiency, and feed cost per gain. Understanding these various production parameters can contribute to the farmers' ability to evaluate the quality of feed used, livestock growth and management activities to support livestock productivity. Using forage as the sole feed will affect the intake and digestibility of feed nutrients and livestock growth performance. However, there is little information related to feed intake and digestibility for Balinese bulls on fattening with forage. Therefore, conducting this research to enrich this scientific information is essential.

## **Materials and Methods**

### **Experimental Design and Feed Treatment**

The study lasted three months and involved 9 Balinese bulls aged 2.5 - 3.5 years (with an average of 3.0 years, based on tooth estimation), with an initial body weight range of 227-290 kg (an average of  $257.40 \pm 23.60$  kg). The treatment was conducted in Bero Sembada Farmers Group, Laen Mane District, Belu Regency, East Nusa Tenggara. The study employed an experimental method with treatment adjusted to the farmers' habits in fattening Balinese bulls regarding feed management, feedlot pen, and health. Types of feed given during the study were *Centrosema pubescens*, *Clitoria ternatea*, *Zea mays*, *Pennisetum purpuphoides*, *Leucaena leucocephala*, natural grass, *Pennisetum purpureum*, and *Sesbania grandiflora*. The chemical composition of feed in this research is shown in Table 1.

### **Variables and research procedures**

Variables measured include intake and digestibility of dry matter, organic matter, and crude protein; and livestock growth performance, including daily body weight gain (DBWG), feed conversion and efficiency, and feed cost per gain.

Table 1. The feed chemical composition of the research on Balinese Bulls Fattening on various types of forage in traditional farm

	DM (%)	OM (%)	Ash (%)	CP (%)	EE (%)	CF (%)	NFE (%)	Energy (Kal/g) <sup>5</sup>
<i>Pennisetum purpuphoides</i> <sup>3</sup>	21.27	86.37	13.63	8.47	4.11	29.11	44.69	4007.778
Natural grass <sup>1</sup>	10.30	85.52	14.48	8.98	4.99	31.72	39.83	4202.087
( <i>Pennisetum purpureum</i> ) <sup>4</sup>	21.00	88.30	11.70	10.20	1.60	34.20	32.60	-
<i>Leucaena leucocephala</i> ) <sup>1</sup>	29.90	91,40	8.26	25.00	11.48	14.27	66.74	4903.413
<i>Zea Mays</i> fresh straw <sup>1</sup>	18.25	89.16	10.84	11.43	11.73	26.77	39.23	3966.922
<i>Sesbania grandiflora</i> <sup>2</sup>	27.87	91.50	8.50	27.37	3.93	7.30	52.90	4378.260
<i>Centrosema Pubences</i> <sup>1</sup>	36.87	92.02	7.91	10.17	8.48	35.06	38.38	4080.413
<i>Clitoria Ternatea</i> <sup>1</sup>	25.33	89.41	10.59	19.98	7.98	28.53	32.92	4374.276

Description: <sup>1</sup>In accordance with the analysis results of the Feed Biochemistry Laboratory, Faculty of Animal Husbandry, Gadjah Mada University. <sup>2</sup>In accordance with the analysis results of Feed Chemistry Laboratory, Faculty of Animal Husbandry, Nusa Cendana Univeristy, Kupang; <sup>3</sup>The average of analysis results of the Feed Biochemistry Laboratory, Faculty of Animal Husbandry, Gadjah Mada University and Feed Chemistry Laboratory, Faculty of Animal Husbandry, Nusa Cendana Univeristy, Kupang. <sup>4</sup>According to Rukmana (2005). <sup>5</sup>According to the Analysis Results of the Center for Food and Nutrition Studies, Gadjah Mada University; <sup>6</sup>Calculation Result: NFE = 100-Ash-CP-EE-CF

The equipment used in the fattening process was an individual feedlot pen with 9 plots measuring 1.5 x 2 m; a set of pen tools for the cleaning process, a digital livestock scale with a capacity of 2,000 kg is used to measure body weight, a feed scale with a capacity of 25 kg, as well as buckets and machetes. Besides that, the researchers provided a proximate tool for analysing the chemical composition in the feed. Faecal and feed samples were analysed at the Laboratory of Nutritional Biochemistry, Faculty of Animal Husbandry, Gadjah Mada University, Yogyakarta. The researchers collected each Balinese bull's faeces by total collection on the 57th day of the ongoing research to analyse the digestibility of the feed consumed. Fresh faeces were collected daily and directly measured, a 10% sample was taken and then sprayed with 10% formalin solution to avoid faecal decomposition and loss of faecal nutrients. Next, the faeces were dried in the sun. The researchers took faecal samples by collecting the faeces for 7 days, and then the faeces were mixed evenly. We then took a 10% sample milled with a 1 mm diameter Willey mill and brought it to the laboratory for proximate analysis.

Fresh feed intake is obtained from the difference between feeding and remaining feed intake (kg) divided by the study duration (days). Dry matter intake is calculated from feed intake (kg) multiplied by the dry matter content of the

feed (%). Organic matter and crude protein intakes are obtained from the feed's nutrient content multiplied by the feed's dry matter intake.

The digestibility of feed nutrients measured included DM, OM, CP, and energy. The dry matter digestibility (%) was measured using the following (Cullison,1979).

$$\text{Digestibility of DM (\%)} = \frac{A - B}{A} \times 100\%$$

Where: A: the average dry matter of feed consumed (g) and B: the average dry matter of excreted faeces (g).

The digestibility of feed nutrients was calculated using the following equation:

*Digestibility of nutrients (ND, %)*

$$= \frac{A \times a (\%) - B \times b (\%)}{A \times a (\%)} \times 100\%$$

Where: a = nutrient contents in feed A (%); b = nutrient contents in feces B (%)

*Digestible Nutrients (%)*

$$= \text{ND (\%)} \times \text{Feed Ingredients Nutrients (\%)}$$

Daily body weight gain (DBWG) is the final body weight minus the initial body weight divided by the duration of observation. Weighing was carried out per individual livestock at the beginning of the study and, after that, carried out every 2 weeks (14 days). This process was fulfilled to adjust the amount of feed given. In addition, it was carried out to obtain daily body

weight gain and livestock growth patterns. Feed conversion is acquired from dry matter intake (Kg.DM/day) divided by DBWG (Kg/day). Feed efficiency is obtained from DBWG (kg/day) divided by dry matter intake (Kg.DM) multiplied by 100%. Meanwhile, feed cost per gain (IDR /Kg.BWG/day) was obtained from daily feed costs (IDR) divided by DBWG (Kg/day).

### Data Analysis

The data were processed and analysed using descriptive analysis procedures according to the instructions of Domangue (2015) and using Statistical Product and Service Solution (SPSS) Version 25.

## Results and Discussion

### Feed intake

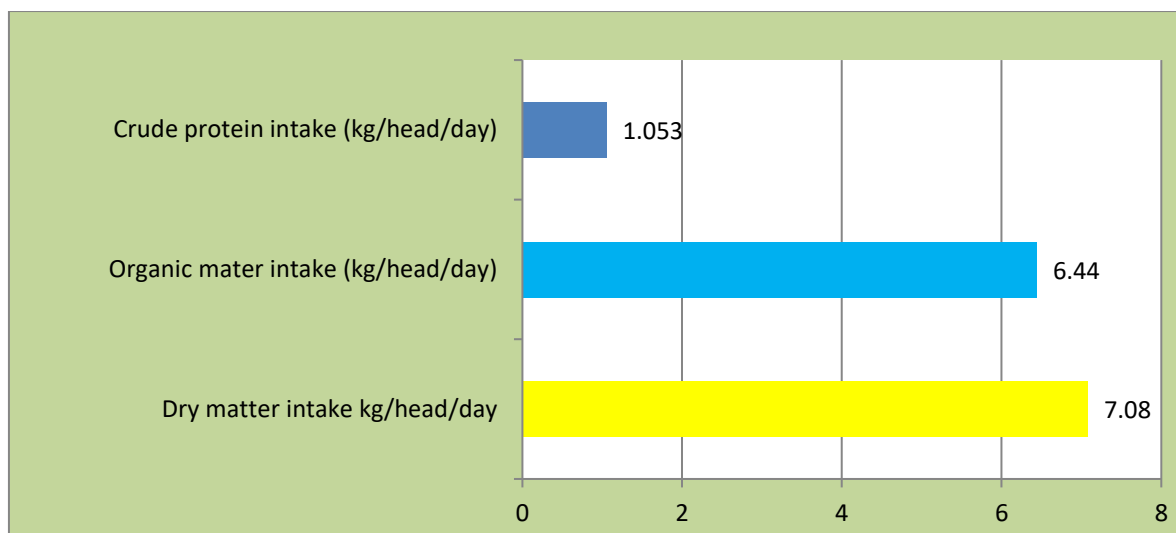
#### Dry Matter Intake

The average intake of dry matter (DM) per type of feed during the study can be seen in Graph 1. The finding revealed that dry matter intake was dominated by forage grass, especially 40.543% *Pennisetum purpuphoides*, followed by 35.471% *Leucaena leucocephala*, 11.979% fresh corn straw, and 9.790% natural grass; while other types of DM feed intake were relatively small. *Pennisetum purpuphoides* and *Leucaena leucocephala* dominated the DM intake because the Bero Sembada Farmers' group has forage gardens planted with *Pennisetum purpuphoides* and *Leucaena leucocephala* which are sufficient to meet the demand for animal feed. In addition, each farmer also plants a limited amount in each of their gardens. *Centrosema pubescens* and *Clitoria ternatea* were also developed in the forage gardens of the Farmers' Group, yet their numbers were still limited. This led to the amount given to livestock being relatively small, resulting in a low percentage of DM intake.

The total DM intake in this study was 7.079 (kg/head/day). If the DM intake is calculated based on body weight, it is 2.509% of the body weight of livestock (Graph 1). At this level of

intake, the nutrients obtained are sufficient to fulfil the needs of the cattle's bodies. The DM intake found in this study was higher compared to the reports of Mariani et al. (2013) on Balinese bulls which ranged from 4.97–5.40 kg/day. The result was also higher than that of Tahuk et al. (2017) on Balinese-fed rations with varying protein amounts in Smallholder Farms with DM intake which ranges from 4.60±0.60 to 7.76±0.28 kg/head/day. The result was consistently higher compared to the report by Badarina et al. (2017) on Bali cattle who obtained DM intake such as fermented concentrate rations made from palm sludge and local feed ingredients ranging from 4.41 ± 0.12 to 5.88 ± 0.59. Thus, the results of this study interpret that fattening Bali bulls with forage (green lot fattening) results in higher dry matter intake. Cattle consumed more dry matter because they were trying to fulfil their nutrient needs, especially feed energy. According to Parish (2018), beef cattle fattened at a target ADG of 0.5 kg/day have a feed dry matter intake requirement of 2.6% of body weight, with TDN and CP needs of DM respectively 54% and PK 9.2%. As a result, the DM intake in this study remains consistent with the previously indicated normal criteria.

Feed intake in livestock varies substantially depending on livestock species, body weight, body size, age and condition of livestock, physiological status, digestive tract condition and capacity, palatability of feed ingredients, types, and physical feed characteristics, energy content, water availability, and environmental conditions (Parish, 2018). Among the several determinant elements that influence feed intake, one of the parameters that affect the feed intake level is the feed's energy content. When there is less energy in the feed, the livestock will consume more feed to meet the energy needs of the feed. The primary purpose of livestock consuming feed is to fulfil their energy needs.



Graph 1. The average intake of DM, OM, and CP (kg/head/day) of Balinese bulls in fattening with various forages on traditional farms

When energy needs are attained, livestock will limit their feed intake (Yuliaty, 2013). Dry matter intake is closely related to digestible energy (DE) and metabolic energy (ME) consumption. In addition, livestock with different conditions also cause differences in nutrient requirements and feed intake levels (McLennan, 2015).

#### **Organic Matter Intake**

The average OM intake (kg/head/day) was 6.44 kg/head/day or 88.615% of the dry matter consumed (Graph 1). If calculated based on metabolic body weight, OM intake is about 91 g/kg BW<sup>0.75</sup>/day. The relatively high In this study, OM intake increased in concordance with DM intake. In addition to age, physiological conditions and initial body weight of the cattle studied were relatively uniform so that they gave the same response to the feed given. In addition, the ash intake in the study influenced the OM intake is also influenced by. The lower the ash intake, the higher the OM intake. Ash intake in the study was 0.832 kg/day.

This study's findings are higher compared to those of (Tahuk et al., 2022), who found OM consumption ranging from 2.992±0.503 to 3.702±0.354 kg/head per day in male Bali Cattle fed complete feed comprising fishmeal as a protein source. The discrepancies seen in this

study were caused by differences in genetics, age, physiological status of the animals, and feed raw material composition. Nutrient forage feed is digested less when compared to concentrate, so the OM intake will be higher to fulfill the fewer nutrient needs.

#### **Crude Protein Intake**

The average crude protein intake during the study was 1053 g/head/day or 14.947% of the total DM consumed by livestock (Graph 1). This relatively high CP intake was obtained from 632 g/head/day of *Leucaena leucocephala*, 209 g/head/day of *Pennisetum purpuphoides*, 100 g/head/day of fresh straw of *Zea mays*, and 66 g/head/day of natural grass.

According to the findings of this study, increasing the DM intake from forage legumes, particularly *Leucaena leucocephala*, increases the quality and palatability of feed, encouraging animals to consume it in large numbers. The CP intake is determined not only by the DM intake of the feed, but also by other aspects, including its digestibility, the effect of fermentation in the rumen, the influence of digestive enzymes, microbial metabolism, and feed quality (Tahuk et al., 2016).

The total crude protein requirement for 250 kg Bali cattle with a daily weight increase of 0.5

kg is 690.06 grams (Mariani et al., 2013). This CP intake of bulls is also higher than in the research report above, which means that the CP intake for the basic needs of livestock in this study has been fulfilled. Therefore, excess CP intake can be utilised to synthesise tendons to increase body weight gain. Even so, this relatively high intake of CP needs to be proportional to its digestibility. If CP intake is high but, on the other hand, the digestibility level is low, then it will not significantly impact livestock productivity (Tahuk et al., 2022).

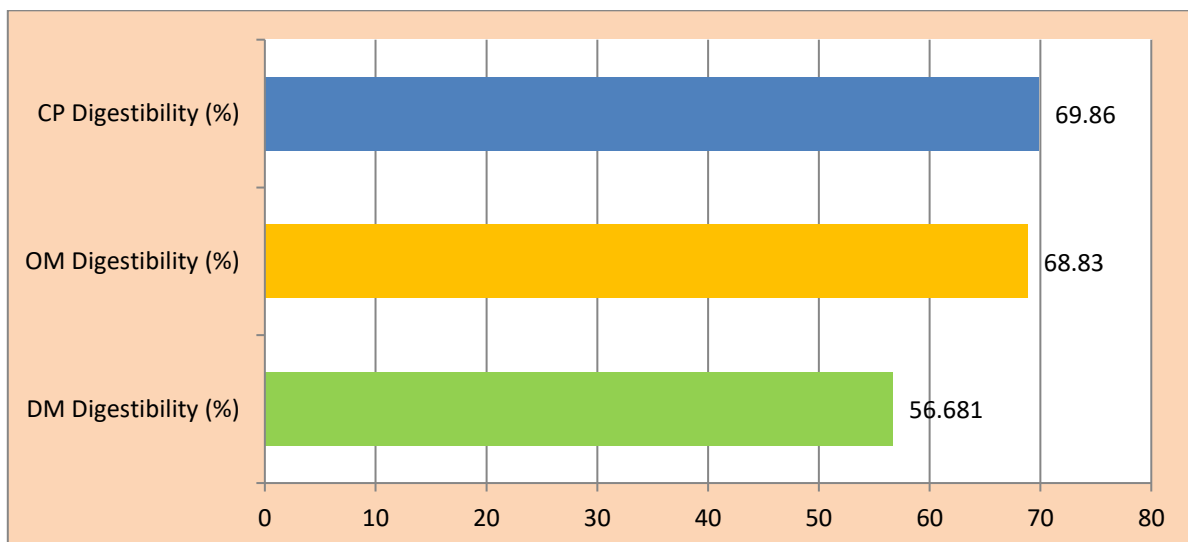
### Feed Digestibility

#### Dry Matter Digestibility

The DM digestibility in this study (Graph 2) was 4.02 kg (56.68 %) of the total daily dry matter consumed by livestock (7.08 kg). Kearl (1982) recommends that bulls weighing 250 kg with a daily weight gain goal of 0.75 kg/day require 6.4 kg of dry matter daily. Thus, the dry matter of feed obtained by male Bali cattle was observed to be lower. This relatively low dry matter digestibility can illustrate the feed quality used by farmers in fattening their livestock. It can be noted in this investigation that the feed

used is forage, such as *Pennisetum purpuphoide* and *Pennisetum purpureum*, which are considered the superior grass. This forage is partly cultivated by farmers to be given to their livestock. Even so, the farmers ignored the plant's growth phase when providing these two types of feed to their livestock. It impacts the formation of crude fibre, especially lignin, thereby inhibiting digestion by rumen microorganisms. Likewise, field grass given to livestock has exceeded the optimal growth phase, especially when high temperatures support it, so lignification accelerates. According to observations, the optimal growth of natural grass used as animal feed is usually from December to March. In addition, this study also used corn straw which has a relatively high crude fibre content.

According to Thulin et al. (2014), lignin is a significant component of plant cell walls that gives plants physical strength; high lignin concentrations in forages help protect cellulose and hemicellulose; nevertheless, higher lignin concentrations can reduce forage digestion. The lower the digestibility, the higher the lignin content (Zhong et al., 2021).



Graph 2. Digestible of DM, OM, and CP (%) of Balinese bulls when fattening with various forages in traditional farms

Plant species/varieties, plant development phases, plant fertility, and the temperature at which plants grow are all factors that influence feed digestibility, particularly forage. Variation in feed composition employed by farmers in livestock husbandry is also thought to be one of the causes of reduced feed digestibility (Oba and Kammes-Main., 2023). The presence of different types of feed influences the state of the rumen in addition to altering digestibility (Parish, 2018).

The chemical and physical components of the feed consumed by animals affect feed flow and digestibility from the rumen and reticulum (Lalman and Richard, 2017). Feed flow and feed digestibility from the rumen and reticulum depend on the chemical and physical compositions of the feed consumed by livestock (Lalman and Richard, 2017). Fibrous feed has low digestibility, and it is broken down slowly by rumen microbes because the first physical contact is slow, causing the activity of digestive enzymes to be delayed. As a result, there is feed retention in the rumen (Oba and Kammes-Main., 2023).

The DM digestibility value found in this study was lower than the 59.88 - 70.31% reported by Suryani et al. (2020) in Bali cattle fed a different energy-to-protein ratio. In this study, dry matter digestibility for Bali cattle was likewise lower than DM digestibility, which ranged from 64.94±3.78 - 73.14±6.30% for Bali cattle fed fermented concentrate rations based on palm sludge and local feed ingredients (Badarina, 2017).

#### **Organic Matter Digestibility**

The average OM digestibility in this study was 68.83% of the total organic matter consumed (Graph 2). Apart from being a source of energy and protein that livestock can use directly, this digested organic material can also be used for microbial protein synthesis, which is ultimately used to synthesise bodily tissues. Then, feeding 100% pasture to fattening Balinese bulls did not significantly increase OM digestibility. The low

OM digestibility is attributable to intake and the low digestion of dry matter. The majority of organic matter is a component of dry matter. Organic matter digestibility will be low if the dry matter is low (Parish, 2018).

The level of feed substance digestibility may ascertain the quality of the feed consumed by livestock. The feed quality is in line with the level of digestibility. Therefore, Wilson and Kalscheur.,2022 define dry matter digestibility as an index of the quality of feed ingested by an animal. Furthermore, OM digestibility is connected to the type of feed used in the study, particularly the forage quality. Thus, the quality of the feed also determines organic matter digestibility. The lignin content found in the feed will affect the OM digestibility of the feed (Thulin et al., 2014 and Zhong et al.,2021).

#### **Crude Protein Digestibility**

The average crude protein digestibility (Graph 2) was 740 g/head per day, or 69.86% of the total CP consumed, which was 1,075 g/head/day. CP digestibility is relatively low, which can impact the amount of protein that livestock can use to increase daily body weight gain as well as carcass and meat produced. Protein is an element of body structures, so if the digestibility is low, it will harm livestock growth. The low CP digestibility is related to rumen microbial activity in digesting feed and the low quality of feed used by farmers in raising livestock.

In the study, the forage source of fibre used was dominated by the fresh straw of *Zea mays* and fresh grass, totaling 65.386%. In contrast, the legume forages, including *Leucaena leucocephala*, *Sesbania grandiflora*, *Centrosema pubescens*, and *Clitoria ternatea* used only 34.640%. Using forage grass and rice straw increased the concentration of crude fibre, especially cellulose and hemicellulose, which can inhibit protein digestion by microorganisms. Rumen microbial activity in digesting feed will increase if appropriate nutrition, particularly

protein and energy, is provided (Tahuk et al., 2016).

The digestibility value of each feed or livestock is not constant, but it is influenced by various aspects, including chemical composition, food processing, the amount of food given, and the type of animal. (2017; Lalman and Richard). Feed digestibility is affected by factors such as feed chemical composition, digestive diseases, feeding frequency, feed processing, and the impact of associations and interactions in the feed (Wilson and Kalscheur., 2022). The digestibility of a feed ingredient decreases as the crude fibre content (CF) increases (Thulin et al., 2014). Although the crude protein digestibility was not noteworthy in this study, the amount of protein digested was sufficient to meet the fundamental needs of livestock. As a result, the excess digestible protein can be used to boost body weight gain and meat production.

When compared to other Balinese bulls, the CP digestibility achieved in this study was lower than the CP digestibility of Balinese bulls fed complete feed comprising fishmeal as a protein source, which had a crude protein digestibility ranging from  $77,602 \pm 7,641$  to  $80,413 \pm 6,753$  (Tahuk *et al.*, 2022). The difference that appeared in this study is related to genetic factors, the physiological status of livestock, and the composition of different feed ingredients.

### **Daily Body Weight Gain (DBWG)**

Production performance of Balinese bulls in the finishing phase using various types of forage, including DBWG, feed conversion, and efficiency, as well as feed cost per gain, are presented in Graph 3. Balinese bulls' average daily body weight gain (DBWG) in fattening with forage was 0.321 kg/head/day. This study described that fattening Balinese bulls in the finishing phase using 100% forage has not been able to obtain DBWG maximally. This daily weight gain is not comparable to DM intake, which reaches 7.63 kg/head/day or 2.737% of the livestock's body weight. According to Lewis

and Emmans (2020), increasing livestock body weight affects feed consumption.

The study's low daily body weight growth is attributed to the high quality of the meal used. This study's dry matter feed intake was 7.63 kg/day, while the dry matter digestibility was just 59.78%. The relatively low digestibility of dry matter is believed to be associated with quite high crude fiber (CF) intake, reaching 1.715 kg/head/day, with digestibility only reaching 49%. High CF intake will limit feed digestibility. Protein intake in this study was quite high, reaching 1.525 kg/head/day. However, its digestibility was only 68.62% or 0.71 kg/head/day. Even though protein digestibility is quite high, optimal utilisation must be supported by sufficient energy availability, especially easily digestible energy. If the cattle lack energy, then the utilisation of protein for the synthesis of body tissues will not be maximised. Energy in forages can be digested by rumen microbes from the crude fiber fraction which includes cellulose and hemicellulose, but rumen microbial activity for digestion is not optimal because cellulose and hemicellulose in the digestive process can be protected by lignin (Thulin et al., 2014; Zhong et al., 2021).

Higher protein and calorie consumption, according to Suryani et al. (2020), will result in faster growth. If nutrients are applied early in the growth period, the effect will be stronger. As a result, different nutrient treatments can be used to manipulate livestock growth. According to Marsetyo et al. (2012), one of the obstacles to increasing the growth of Balinese bulls raised on traditional farms is the lack of protein feed. Increasing the supply of energy to livestock will not contribute positively if it is not supported by adequate protein intake. In this study, CP intake was quite high (Table 3); but it was suspected that the livestock did not obtain maximum energy. As a result, the utilisation of protein for the synthesis of body tissues was not optimal.

According to Lalman and Richards (2017), energy is the main nutrient livestock needs for



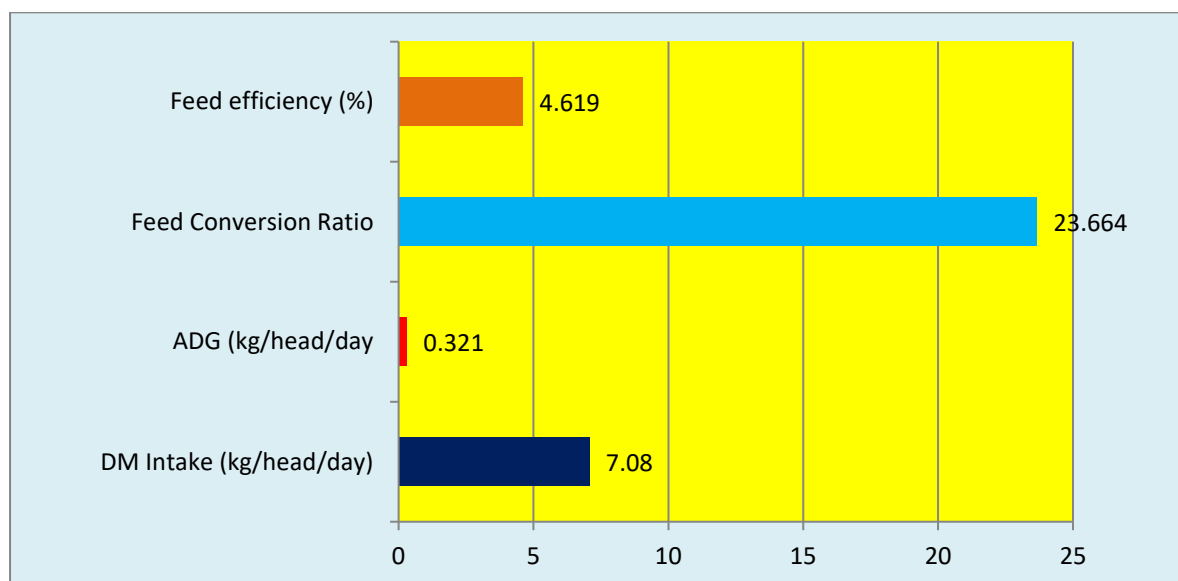
synthesising body tissues. Adequacy of energy in livestock can stimulate the growth of rumen microbes to synthesise microbial protein to fulfil host livestock for protein. Fattening aimed to produce high and efficient body weight gain and produce high-quality carcasses requires feed that contains high energy because livestock production will increase if the feed energy content is increased (Suryani *et al.*, 2020). The study's average energy intake (Total Digestible Nutrient/TDN) reached 68.48%; it was relatively high to increase weight gain. However, this depends on the livestock's basic need for energy. If the basic needs of life are getting higher, it will affect the lack of energy needed to fulfil production needs so that the weight gain of livestock is not optimal.

This relatively low daily body weight gain is also related to the satisfaction of essential life necessities. The main purpose of livestock consuming feed is to fulfil vital basic needs for their life. If the basic life needs of livestock are fulfilled, the excess nutrients consumed can be utilised for synthesising body tissues. According to Yuliaty (2013), if the nutritional demands for maintenance life are met, the excess will be transformed into fibrous tissue and fat, resulting

in the appearance of DBWG. This study's findings show that to increase weight gain in Balinese bulls, feed quality and amount must be considered. Livestock growth can be maximised per its genetic potential if it obtains high-quality feed accompanied by good management.

According to Alemneh and Getabalew (2019), gender, hormones, genetics, and castration factors all impact livestock growth. Gender and castration factors in this study were ignored because the animals were of the same sex and were not castrated, but genetic factors within the same breed and hormonal factors were thought to play an essential role in this study. Growth hormones improve cattle feed efficiency, protein deposition, and growth rate (Webb, 2019).

Daily body weight gain in this study was lower than in the report Tahuk *et al.* (2017) who obtained DBWG ranging from  $0.30 \pm 0.05 - 0.70 \pm 0.16$  in Balinese bulls that received 100% forage and added concentrate. Nonetheless, the weight gain of Balinese bulls obtained in this study was higher than reports by Rosnah and Yunus (2018), who obtained Balinese bulls' DBWG of  $0.28 \pm 0.259$  kg/head fattened with forage dominance in the form of *lamtoro*;



Graph 3. Animal Feed Intake (kg/head/day), DBWG (Kg/head/day), feed conversion, and efficiency (%) of Balinese bulls when fattening with various forages in traditional farms

as well as a report by Marsetyo et al. (2012) who obtained Balinese bulls' DBWG of  $0.232 \pm 0.03$  kg/head/day who received corn husks as the sole feed. But if the corn husk is added with *Gliricidia sepium*; as well as rice bran and coconut cake, the resulting DBWG increased by  $0.311 \pm 0.03$  and  $0.402 \pm 0.03$  kg/head/day, respectively; as well as it was higher than this research findings.

The lower results of this research with the various research results above illustrate that feed factors play an important role in improving the performance of beef cattle, besides age, genetics, and management factors. Livestock performance will not be maximised if they only get 100% forage. In addition, according to the growth pattern of the carcass component, the livestock will experience earlier and faster bone growth, followed by muscle growth; after puberty, the rate of muscle growth slows, and fat deposition increases. Muscle growth diminishes throughout the finishing period (fattening).

### Feed Conversion and Efficiency

Feed conversion and efficiency are essential parameters in fattening because they have economic implications, especially concerning feed costs. The average feed conversion (Graph 3) was 23.664 kg.DM/kg.DBWG, while feed efficiency was 4.619%. The results of this study illustrate that fattening Balinese bulls with forage and a predominance of dry matter intake derived from grasses requires a more significant amount of feed to increase 1 kg of body weight. Thus, the feed quality determines the feed conversion parameters.

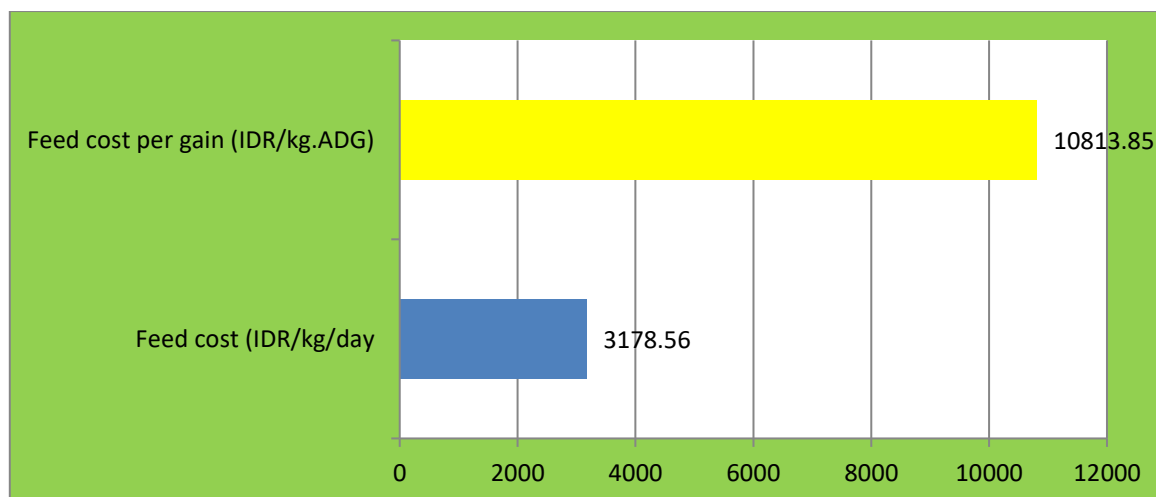
The feed conversion rate in this study was primarily determined by dry matter and the DBWG obtained. The average dry matter intake was 7.079; and relatively higher than the report of Mariani et al. (2013), who obtained dry matter consumption in Bali cattle by 4.97 – 5.40 kg/day or 2.6% of body weight (BW). However, dry matter intake was not followed by significant weight gain. In cattle fattening, the lower the feed conversion rate, the better; conversely, as

the number rises, the feed conversion rate decreases. (Tahuk et al., 2017). The low feed conversion value achieved in the fattening process, accompanied by low feed ration prices, will also have implications for increasing economic efficiency so that profits from fattening beef cattle will also increase (Tahuk et al., 2018).

This relatively high feed conversion demonstrates the low feed quality. Furthermore, it is influenced by the quality of the livestock reared (including the livestock's adaptation to the feed provided), the quality of the feed ingredients provided, and the feeding method utilised. According to Vickers (2019), factors influencing beef cattle feed efficiency include gender, body weight and growth performance, cattle genetics and health, stress, nutrition, and feeding management. This high feed conversion rate could also be attributed to the nutrients taken, which are nevertheless concentrated to meet basic life needs and other important needs associated with normal bodily functions.

According to Shike (2013), the value of feed conversion in ruminants is affected by feed quality, body weight gain, and digestibility values. If the feed is of higher quality, the livestock will grow quicker, and the feed conversion will be higher (Kenny et al., 2018).

The dry matter intake in this study was 7.079 kg/day, while the dry matter digestibility was only 59.58%. The low digestibility of dry matter feed indicates poor feed quality. The age of the cattle used in this study ranged from 2.5 – 3.5 years, which means that the accelerated growth phase has ended because the cattle have grown up. Thus, the growth efficiency in utilising optimal feed for growth has decreased. The feed conversion value in this study was smaller when compared to the research report by Tahuk et al.(2022) of Balinese bulls on a feedlot given complete feed containing fishmeal as a protein source with a feed conversion of  $4.529 \pm 0.262$  -  $5.707 \pm 0.939$  kg.DM/kg.DBWG.



Graph 4. Feed cost and feed cost per gain (IDR/kg) of Balinese cattle fattening with various forages in traditional farms

Changes in feed conversion rates are induced by changes in cattle genetics, age, sex, physiological status of livestock, and feed ingredient composition. Improvements in beef cattle feed efficiency, according to Kenny et al. (2018), have the potential to increase producer profitability while also lowering the environmental footprint of beef production.

This study's feed utilisation efficiency was 4.619%, which was still considered low. This low feed efficiency is due to the small daily weight gain obtained. During the study, the increase in DBWG was unrelated to the amount of dry matter intake acquired by livestock. The higher feed efficiency value in fattening cattle shows that livestock consumption contributes more to generating one unit of body weight growth, indicating that the farmers employed high-quality ration. Conversely, the value of feed efficiency is decreasing, as is the role of feed in boosting cattle body weight gain. The ability of livestock to digest feed ingredients, the adequacy of feed substances for basic life, growth, and body functions, and the type of feed utilised all influence feed efficiency (Shike, 2013; McGee, 2014; Kenny et al., 2018).

#### Daily Feed Cost and Feed Cost per Gain

Feed cost and feed cost per gain can describe the economic efficiency of livestock fattening by

farmers. The average daily feed cost required per head/day (IDR/kg) for each livestock was 3,178.56. Thus, a total of nine cows require feed costs of IDR28,607.06 every day. For 85 days, the feed cost for each livestock reached IDR270,177.78/head or IDR2,431,600.00 for 9 heads of cattle during the study.

Meanwhile, if the calculation was carried out on the average feed cost per gain (IDR/kg.DBWG/day) per head of livestock during the study, it was IDR10,813.85, or IDR919,177.00/head for 85 days of research. Thus, the total feed cost per gain of 9 heads of cattle during the implementation of the study reached IDR 8,272,593.02 (Graph 4).

According to the findings of this study, if fattening animals with forage only resulted in a daily weight gain of 0.321 kg/head/day, then the cost of feed required to create a higher daily weight gain unit was relatively high.

This high feed cost per gain can impact the wastage of feed and is non-economic because it increases the amount of feed needed to raise one unit of daily weight gain and increases the cost of feed needed. In addition, the time required to complete fattening according to the expected target weight is longer.

The feed cost per gain obtained in this study is less than that reported by Handayanta et al. (2017) from Ongole, Simmental Ongole, and

Crossed Limousin cattle fed on traditional farms in dryland farming, Gunung Kidul (IDR 46,166.62). The difference in feed cost per gain is determined by the feed quality and price used in the study and the different body weight growth of the livestock in the study. Using high-quality feed at the lowest possible cost to achieve optimal DBWG is thus a crucial issue to consider when fattening beef cattle.

Muyasaroh et al. (2015) define feed cost per gain as the number of feed expenses required to achieve one kilogram of body weight growth. It will be better if the value of the feed cost per gain in livestock fattening is low. Feed conversion and feed ingredient pricing impact feed cost per gain. Even though the feed conversion is low, the price of feed ingredients used is high, so the feed cost per gain will be high or vice versa. Therefore, for the fattening business to be profitable, the farmers should look for livestock that can utilise feed that is consumed properly and look for cheap feed ingredients but has low feed conversion.

## CONCLUSION

According to this study, fattening Balinese bulls in traditional farms resulted in a comparatively high intake of dry matter, crude protein, and organic matter but provided relatively low digestibility and unsatisfactory body weight gain. Following the study results, it can be concluded that fattening Balinese bulls using various types of forages in traditional farms resulted in a relatively high intake of dry matter, crude protein, and organic matter but provided relatively low digestibility and suboptimal body weight gain.

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## References

- Alemneh T, and Mebrate Getabalew. 2019. Factors Influencing the Growth and Development of Meat Animals. *Int J Anim Sci.* 2019; 3(3): 1048. Available at: <https://www.ijmcentral.org/sm-animal-science/ijas-v3-1048.pdf>
- Badarina, I., Jarmuji, D. P Gultom. 2017. Kecernaan ransum sapi Bali dengan konsentrat fermentasi berbasis lumpur sawit dan bahan pakan lokal (*digestibility of bali cattle diet with fermented concentrate based on solid and local feed*). *Agrointek.* 11 (2): 63 – 67.
- Cullison A.E. (1979). *Feed and Feeding.* 2nd Edn., Reston Publishing Company, Reston, Virginia, pp: 12-27.
- Domangue, R.J. 2015. *The Basics of Statistical Design and Analysis of Experiments.* Department of Mathematics and Statistics James Madison University. Available at: [http://educ.jmu.edu/~domangrj/ANOVA\\_Manuscript\\_23Jun2015.pdf](http://educ.jmu.edu/~domangrj/ANOVA_Manuscript_23Jun2015.pdf). Accessed on 8 May 2023
- Handayanta, E., Lutojo dan Kurniasih Nurdiati. 2017. Efisiensi Produksi Sapi Potong Pada Peternakan Rakyat Pada Musim Kemarau Di Daerah Pertanian Lahan Kering Kabupaten Gunungkidul. *Caraka Tani: Journal of Sustainable Agriculture.* 32(1), 49-54 DOI: <http://dx.doi.org/10.20961/carakatani.v32i1.15928>
- Hart, E.H., Sarah R. Christoides, Teri E. Davies, Pauline Rees Stevens, Christopher J. Creevey, Carsten T. Müller, Hilary J. Rogers, & Alison H. Kingston-Smith. 2022. Forage grass growth under future climate change scenarios affects fermentation and ruminant efficiency. *Scientific Reports*, Vol. (2022) 12:4454. <https://doi.org/10.1038/s41598-022-08309-7>
- Kenny, D.A., 2018. C. Fitzsimons, S.M. Waters, M. McGee. 2018. Invited review: Improving feed efficiency of beef cattle – the current state of the art and future challenges. *Animal.* 12 (9), Pages: 1815-1826. DOI: <https://doi.org/10.1017/S1751731118000976>
- Lalman D, and C. Richards. 2017. Nutrient Requirements of Beef Cattle E-974. Available at: <https://extension.okstate.edu/fact-sheets/print-publications/e/nutrient-requirements-of-beef-cattle-e-974.pdf>. Accessed on 26 February 2023.
- Lewis, R.M., and Gerry C. Emmans. 2020. The relationship between feed intake and liveweight in domestic animals. *Journal of Animal Science,* 98

- (4): 1 – 6 Doi: <https://doi.org/10.1093/jas/skaa087>
- Marsetyo, S.Quigley., Damry. 2012. Liveweight gain and feed intake of weaned Bali cattle fed a range of diets in Central Sulawesi, Indonesia. *Animal Production Science*. DOI: <https://doi.org/10.1071/AN11285>
- Mariani, N.P., 2013. Protein and energy requirement for maintenance and growth of Bali cattle. *E-Journal of Animal Science Udayana University [S.I.]*. 2 (1): 1 – 10. Available at: <https://ojs.unud.ac.id/index.php/jas/article/view/7553>
- McLennan, S. 2015. Nutrient requirement tables for Nutrition EDGE manual. Published by: Meat and Livestock Australia Limited Locked Bag 991 NORTH SYDNEY NSW 2059. Available at: [https://www.mla.com.au/contentassets/e1a46b36786b4a3a95546c610a744e7b/b.nbp.0799\\_final\\_report.pdf](https://www.mla.com.au/contentassets/e1a46b36786b4a3a95546c610a744e7b/b.nbp.0799_final_report.pdf)
- McGee, M. (2014) Feed Efficiency in Beef Finishing Systems, Teagasc, Grange Animal & Grassland Research and Innovation Centre, Dunsany, Co. Meath, Ireland. Available at: [https://www.teagasc.ie/media/website/publications/2014/Mark McGEE PAPER.pdf](https://www.teagasc.ie/media/website/publications/2014/Mark%20McGEE%20PAPER.pdf). Accessed on 26 February 2023.
- Muyasaroh, S., I Gede Suparta Budisatria, Kustantinah. 2015. *Income Over Feed Cost* penggemukan sapi oleh kelompok sarjana membangun desa (SMD) di Kabupaten Bantul dan Sleman. *Buletin Peternakan vol. 39 (3): 205-211*. DOI: <https://doi.org/10.21059/buletinpeternak.v39i3.7989>
- Oba, M., and K. Kammes-Main. 2023. Symposium review: Effects of carbohydrate digestion on feed intake and fuel supply. *J. Dairy Sci.* 106:2153–2160. <https://doi.org/10.3168/jds.2022-22420>
- Parish, P. 2018. Beef Cattle Nutrient Requirements. Mississippi State University. Available at: <https://ucanr.edu/sites/nichemarketing/files/341403.pdf>.
- Rosnah, U.S., Yunus, M. 2018. Komposisi Jenis Dan Jumlah Pemberian Pakan Ternak Sapi Bali Penggemukan Pada Kondisi Peternakan Rakyat (*feeds compositions and feeding amount of Bali cattle Fattened on traditional system*). *Jurnal nukleus peternakan*. 5 (1):24 – 30. DOI: <https://doi.org/10.35508/nukleus.v5i1.833>
- Shike, D.W. 2013. Beef Cattle Feed Efficiency. Driftless Region Beef Conference, University of Illinois at Urbana-Champaign. Available at: <https://dr.lib.iastate.edu/server/api/core/bitstreams/dd9ecb91-917e-4167-8c70-f3d638978b57/content>. Accessed 26 February 2023.
- Suryani, N.N., I Wayan Suarna; I Gede Mahardika and Ni Putu Sarini. 2020. Energy And Nitrogen Retention Of Bali Heifers (*Bos sondaicus*) fed diet containing different energy protein Level. *J. Ternak Tropika Vol 21, No 1: 69-76*. DOI: <https://doi.org/10.21776/ub.jtapro.2020.021.01.9>
- Tahuk, P. K., Budhi, S. P. S., & Panjono, B. E. 2016. In vitro characteristics of rumen fermentation of fattening rations with different protein-energy levels fed to Bali cattle. *Pakistan J Nutr*, 15 (10): 897-904. DOI: <https://doi.org/10.3923/pjn.2016.897.904>
- Tahuk, P.K., S.P.S Budhi, Panjono, N. Ngadiyono, R Utomo., C.T.Noviandi., E.Baliarti. 2017. Growth performance of male Bali cattle fattening fed ration with different protein levels in smallholder farms, West Timor, Indonesia. *Asian J. Anim. Sci*, 11 (2): 65 – 73. DOI: 10.3923/ajas.2017.65.73
- Tahuk, P.K., E Baliarti, SPS Budhi, P Panjono.2018. The effect of season on the feed quantity and quality and growth performance of male Bali cattle fattened in smallholder farms. *Buletin Peternakan* 42 (3): 203-209. DOI: <https://doi.org/10.21059/buletinpeternak.v42i3.33058>
- Tahuk PK, Nahak OR, Bira GF (2022). Performance of Male Bali Cattle Fattened by Complete Feed which Fish Meal Containing as a Protein Source. *Adv. Anim. Vet. Sci.* 10(10): 2238-2251. DOI | <http://dx.doi.org/10.17582/journal.aavs/2022/10.10.2238.2251>
- Thulin, S., Hill, M.J., Held, A., Jones, S. and Woodgate, P. (2014) Predicting Levels of Crude Protein, Digestibility, Lignin and Cellulose in Temperate Pastures Using Hyperspectral Image Data. *American Journal of Plant Sciences*, 5, 997-1019. DOI: 10.4236/ajps.2014.57113
- Vickers M. (2019). Feeding growing and finishing cattle for Better Returns. [https://projectblue.blob.core.windows.net/media/Default/Beef%20&%20Lamb/BR\\_Feeding Growing Finishing Cattle-WEB.pdf](https://projectblue.blob.core.windows.net/media/Default/Beef%20&%20Lamb/BR_Feeding Growing Finishing Cattle-WEB.pdf). Accessed on 8 May 2023.
- Webb, M. 2019. Growth promoting hormones in beef production and marketing. Available at: <https://extension.umn.edu/beef-news/growth-promoting-hormones-beef-production-and-marketing>. Accessed 8 May 2023.
- Wilson, H and Kenneth Kalscheur. 2022. Reduced-lignin alfalfa can improve digestibility. Available at: <https://hoards.com/article-31380-reduced-lignin-alfalfa-can-improve-digestibility.html>. Accessed 2 May 2023.
- Yakin, E.A. Nono Ngadiyono Dan Ristianito Utomo. 2013. Pengaruh Substitusi Silase Isi Rumen Sapi Pada Pakan Basal Rumput Dan Konsentrat Terhadap Kinerja Sapi Potong. *Buletin*

- Peternakan.36 (3) : 174-180. DOI: <https://doi.org/10.21059/buletinpeternak.v36i3.1626>
- Yuliaty. 2013. Energy Requirement for Maintenance and Growth of Bali Cattle in East Timor. Available at: <https://espace.curtin.edu.au/bitstream/handle/20.500.11937/2469/>. Accessed 25 April 2023.
- Zhong, H.; Zhou, J.; Abdelrahman, M.; Xu, H.; Wu, Z.; Cui, L.; Ma, Z.; Yang, L.; Li, X. 2021. The Effect of Lignin Composition on Ruminal Fiber Fractions Degradation from Different Roughage Sources in Water Buffalo (*Bubalus bubalis*). Agriculture 2021, 11, 1015: 2 – 15. <https://doi.org/10.3390/agriculture11101015>