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Utilization of Rice Straws as Feed for Beef Cattle during the Dry Season in Merauke Regency, South Papua, Indonesia

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Abstract: Shortage of forages for ruminants was the main challenge faced by farmers, particularly in areas with a longer dry period of approximately 5–6 months, such as Merauke Regency, South Papua Province, Indonesia. Much research has been conducted to study the use of rice straw as feed for beef cattle in other provinces of Indonesia. However, there has been no research in Merauke Regency yet. On the other hand, this regency is central to food crop development, especially rice. Therefore, there are abundant numbers of by-products from rice cultivation that are unutilized, such as rice straws. This study examined the effect of different proportions of fermented rice straw as an alternative source of feed for beef cattle during the dry season. This study was conducted in Merauke Regency during the dry season from July to October 2020. The research design involved fifteen crossbred Ongole beef cattle owned by local farmers. The study employed a completely randomized block design (CRBD) with three treatments and five replications. The research findings indicated that feed treatments significantly influenced dry matter intake (DMI) at a significance level of $P < 0.05$ between treatments P2 and P1, as well as between P3 and P1. However, treatments P2 and P3 exhibited no statistically significant difference ($P > 0.05$). The provision of supplementary feed substantially enhanced the average daily gain (ADG), with significant effects observed between treatments P2 and P1 and between P3 and P1 ($P < 0.05$). Conversely, the effect between treatments P2 and P3 was not statistically significant ($P > 0.05$). The maintenance system with treatment P3 appeared to be more profitable than treatments P2 and P1. On average, treatment P3 yielded a profit of Rp 9,798,333, whereas treatments P2 and P1 yielded Rp 9,143,333 and Rp 8,147,333, respectively. The calculated benefit–cost ratios (BCRs) for treatments P3, P2, and P1 were 1.33, 1.32, and 1.29, respectively. This study applied different proportions of feed intake according to the local specific conditions, which provided a lesson for other regencies with similar local specific contexts, such as Merauke Regency.
Keywords: rice straws; beef cattle; dry season

印度尼西亚南巴布亚马老奇县旱季利用稻草作为肉牛饲料

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摘要: 反刍动物饲料短缺是农民面临的主要挑战，特别是在干旱期较长（约5-6个月）的地区，例如印度尼西亚南巴布亚省马老奇县。印度尼西亚其他省份对稻草用作肉牛饲料的情况进行了大量研究。然而，目前还没有马老奇摄政区的研究。另一方面，这个摄政区对于粮食作物的发展至关重要，尤其是水稻。因此，水稻种植中有大量未利用的副产品，例如稻草。本研究考察了不同比例的发酵稻草作为旱季肉牛替代饲料来源的效果。这项研究是在2020年7月至10月的旱季期间在马老奇县进行的。研究设计涉及当地农民拥有的15头杂交翁戈莱肉牛。该研究采用完全随机区组设计（CRBD），包含三种治疗和五次重复。研究结果表明，饲料处理显着影响干物质摄入量(DMI)，处理磷2和磷1之间以及磷3和磷1之间的显着性水平磷< 0.05。然而，处理P2和P3没有表现出统计学上的显着差异(磷>0.05)。补充饲料的提供显着提高了平均日增重（平均日增重），在处理磷2 和磷1 之间以及磷3 和磷1之间观察到显着效果（磷< 0.05）。相反，处理磷2和磷3之间的效果没有统计学意义（磷>0.05）。处理磷3的维护系统似乎比处理磷2和磷1更有利可图。平均而言，处理磷3产生的利润为9,798,333盾，而处理磷2和磷1分别产生9,143,333盾和8,147,333盾。计算得出的处理磷3、磷2 和磷1的效益成本比(BCR)分别为1.33、1.32和1.29。本研究根据当地具体情况采用不同比例的采食量，为马老奇县等具有类似当地具体情况的地区提供了借鉴。

关键词：稻草； 肉用牛; 旱季

1 Introduction

Merauke Regency is one of the South Papua Province districts, which directly borders the neighboring country, Papua New Guinea (PNG). Merauke is also an area of rice commodity and beef cattle development. Until 2017, there was a new rice field development program in Merauke Regency, which reached as much as 8.915 hectares[18]. Until now, the development of the beef cattle population has reached 38.400 heads[3].

The expansion of the rice field has a positive effect on beef cattle development in Merauke Regency, which is the availability of agricultural by-products, such as rice straw and bran. The agricultural by-product occurs after the harvest time in rice straw, which is not used well by the farmers. Moreover, rice straw is usually burnt in the rice field. The burning has been done because the farmer thinks it will be more comfortable in tillage.

Seasonal change is more precise in Merauke Regency than in other Papua areas, which is indicated by six to seven months of rainy seasons and five to six dry seasons[1]. The dry season is quite long and becomes an obstacle to farmers, especially in cattle feed procurement, which leads to a drastic decrease in body weight. Meanwhile, there are abundant agricultural by-products from the rice plan that can serve as feed reserves or feed banks during the dry season. However, the by-product has low nutrition. Therefore, fermentation or ammonization is a must to increase the nutrition content.

[2] reported that every rice field's hectare can produce fresh rice straw from 12 to 15 tons per hectare per season. After going through the fermentation process, the rice straw shrinks into five to eight tons per hectare and can be sufficient as feed for two or three cows each year. The rice field harvest in the Merauke Regency reaches as much as 57.658.50 hectares[3], which has the high potential to feed 62,940 to 94,410 beef cattle each year.

The beef cattle's potentiality to the land is to produce fertilizer from its manure. Each adult cattle can produce four to five kilograms of fertilizer per day[4].

This study examines the use of rice straw as feed for beef cattle in Merauke Regency during the dry season.

2 Materials and Methods

The study was initiated by a survey in several locations of cattle development in Merauke Regency. The introduced technologies were cattle rearing and rice straw fermentation. Meanwhile, the application of technology consisted of an integrated approach between farmers, extension workers, and scholars. The focus of activity was on agricultural by-product processing, such as rice straw and bran, for cattle feed purposes. To use rice straw as cattle feed, rice straw fermentation with probiotics was performed. The fermentation process used Starbio or Probion as the probiotics (Fig. 1). The installation required a shady building safe from sunrays and rain[5].

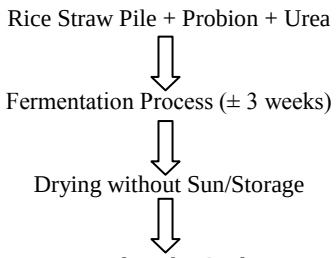

Fig. 1 Fermenting rice straw

The study was conducted collaboratively with the "Mayo Baru" Farmer Group at Harapan Village, Kurik District, Merauke Regency from July to October 2020. The materials and tools used for the study were beef cattle, feed (rice straw and rice bran), "probion" as fermented material, urea, sea salt, bucket, cattle digital scale, hanging scale, and office stationery.

Treatments used fifteen bulls of Ongole Crossbred with similar body weight and age, which were approximately 107–114 kg and 1–1.5 years old, respectively. All the bulls belonged to farmers. Meanwhile, the stall used was the individual type with a feed and drink place. The cattle were given anthelmintics before treatment. The study used a randomized complete block design (RCBD) with three treatments and five replications. The treatments of the study are as follows:

Group I (P1): 100% forage (as control);

Group II (P2): 50% forage + 50% non-fermented rice straw and 1.5% rice bran from BW;

Group III (P3): 50% forage + 50% fermented rice straw and 1.5% rice bran from BW.

The limitations of the application of the three treatments aimed at determining the differences of feeding fermented and non-fermented rice straw to beef cattle. The observation of the body weight was started with the initial body weight (BW) measurement and then followed by monthly weight measurement for three months. Then, the results were analyzed using analysis of variance to determine the difference between the treatments. If there was a significant or a very significant result, the result was then analyzed further with the Duncan multiple range test (DMRT); the economic analysis used RC (revenue-cost) ratio.

The data analyzed covered the technical and economic aspects. The technical aspects included feed consumption, body weight gain (BWG), feed conversion, and feed proximate analysis. Meanwhile, the economic aspect consisted of the production cost and farm revenue during the study period (economical analysis with RC ratio).

3 Results and Discussion

3.1 Local Specific Context

The beef cattle population reached 5,610 heads in 2018 in Kurik District, Merauke Regency. This population became the second largest after Tanah Miring District. The population of beef cattle has the potential to produce organic fertilizer for rice cultivation. Adult beef cattle can produce four to five kilograms of manure per day after the fermentation process[4]. Based on the given information, the population in District Kurik, as much as 5,610 heads, can contribute around 22 to 28 tons of organic fertilizer daily. Utilization of organic fertilizer from cattle manure can help farmers by decreasing the need for inorganic fertilizer. As a result, farmers can save on production costs by using the given resources. The fertilizer contributes as much as 40% of farmers' revenue. The cattle manure can be

transformed into biogas, which can be a fuel alternative, and sludge into a liquid organic fertilizer.

The farmer group of Mayo Baru consisted of thirteen members, with the central business being rice farmers. Beef cattle rearing was a side job. However, the farmers admitted that the contribution of livestock to revenue is higher than that of becoming a rice farmer.

The farmers commonly used a semi-intensive rearing system with minimal management, especially in feed procurement. However, some farmers reared the cattle freely to find their feed, and the others kept the halter attached to the cattle in the farm backyard garden.

The feed was limited by the forage availability, which consisted of two types: wild grass and a small portion of elephant grass from the border around the rice field. There was no additional feed to power up the production, such as rice bran. In contrast, there was an abundance of rice bran on the spot, especially in the vast rice field area. Feeding rice straw happens only during harvest due to lack of facility to keep the rice straw as the feed reserve during the dry season.

The availability became a common problem for farmers during the dry season. The prolonged drought in Merauke Regency affected the availability of forages, leading to feed scarcity in both quality and quantity. However, there was still a vast area of harvesting rice fields that delivered good potential to fight against feed hunger in the area. The vast area of rice fields provided many agricultural by-products. Unfortunately, this potentiality was not well utilized, so the herds could not avoid extreme weight loss during the extreme dry season.

3.2 Feed Consumption

The observations of feed and daily BWG are shown in Tab. 1. In the beginning, not all the cattle wanted to eat the rice straw in both fermented and non-fermented treatment because they were not used to it. However, all of them started to eat the rice straw in the second week of the trial.

Tab. 1 Productivity performance of beef cattle based on three-month treatment (The authors, primary data, 2020)

Description	Treatment		
	P1	P2	P3
Average initial BW (kg)	114.2	108.2	107.8
Average end BW (kg)	135.2	141.0	146.4
Average daily BWG (kg/head/day)	0.23 ± 0.06b	0.36 ± 0.08a	0.43 ± 0.12a
Average DM consumption (kg/head/day)	4.2b	8.4a	8.9a
- Forage	4.2	3.3	3.4
- Rice bran	-	1.6	1.7
- Non-fermented rice straw	-	3.5	-
- Fermented rice straw	-	-	3.8
Feed conversion	19.3a	21.6a	20.4a

Based on Tab. 1, the highest dry matter (DM) consumption of forage occurred at the P1 treatment (control), as much as 4.2 kg/head/day. The highest consumption occurred because the P1 treatment feed was the same as the last feed on the farm. The DM consumption of rice bran during the P2 treatment was 1.6 kg/head/day. The DM consumption of rice bran at P3 was 1.7 kg/head/day. The consumption of DM of forage of non-fermented rice straw or P2 treatment was 3.5 kg/head/day. Simultaneously, the P3 treatment with fermented rice straw was 3.8 kg/head/day. The total DM consumption was as follows: (1) P1 treatment 4.2 kg/head/day; (2) P2 treatment 8.4 kg/head/day; (3) P3 8.9 kg/head/day.

The statistical analysis result showed that the treatment of feed had a significant effect on DM consumption ($P < 0.05$) between P2 and P1 and P3 and P1. However, there were no significant differences between P2 and P1 in terms of DM consumption ($P > 0.05$).

Based on the DM requirement for Ongole crossbred, the P3 treatment already met the need, which was as much as 8.90 kg/day[6]. At the same time, P2 treatment almost met the requirements of Ongole crossbred. The P1 treatment (control), however, was still far from sufficient to meet the minimum requirements of Ongole crossbred. [7] recommended that the DM consumption by adult cows and bulls be at least 6.7–7.2 kg/day, especially for the weight of 315 kg and BWG of 0.2–0.4 kg. Based on this information, the DM of feed in this study was already above the recommended minimum requirement.

The result of this study was slightly lower than that of [8], who reported that DM consumption for Ongole Crossbred concentrates and forages is 10.95 ± 1.03 kg. In contrast, the result was still higher than those of [6] and [9]. [6] reported that the DM consumption by Ongole Crossbred cows was 6.93 ± 1.06 kg/head/day at a

small farmer in the Probolinggo area. [9] noted that the DM consumption by Ongole Crossbred cattle at a small farmer in the Bantul area is 5.31 ± 1.35 kg/head/day.

The low rate of consumption at the farmer stage occurred because of the makeshift feed, which led to low nutrient intake. The difference in the DM consumption probably occurred because of the feed intake composition, palatability rate, age, and body weight.

Ransome consumption was affected by body size, environment, feed condition, and forage consumption. These factors correlated with in vivo digestibility of DM and organic matter[10]. [11] also explained that high digestibility usually leads to high consumption. Ransom DM consumption commonly declined at the inclination toward the consumption of other feed easy to digest.

[12] added that there are two factors affecting feed consumption: (1) feed and (2) livestock. The feed factor consisted of digestibility and palatability. The livestock factors included age, breed, sex, and health condition. [7] said that the palatability of feed is one of many factors that affect feed consumption and cattle's ability to consume the DM inside the feed, which is directly connected with the physical capacity of the stomach and digestion track condition. The value of feed consumption depends on environmental factors and feed ingredients.

3.3 Body Weight Gain in Beef Cattle

The data of daily BWG of beef cattle are shown in Tab. 1. Based on Tab. 1, the highest daily BWG appeared at P3 treatment (50% forage + 50% fermented rice straw and 1.5% rice bran from BW) with 0.43 ± 0.12 kg/head/day. The P2 treatment reached the second-best result (50% forage + 50% non-fermented rice straw and 1.5% rice bran from BW) with 0.36 ± 0.08 kg/head/day. The lowest result was on the P1 treatment (100% forage) with 0.23 ± 0.06 kg/head/day. Based on the results, the additional feed helped to fix the daily BWG in beef cattle. The results showed that the feed treatment significantly affected the daily BWG ($P < 0.05$) for P2 with P1 and P3 with P1. However, there were no significant differences between P2 and P3 ($P > 0.05$).

The drought for quite a long time in Merauke Regency reduced forage availability, which directly reacted to the change in cattle's body weight, especially with a free-range system in the field or the backyard garden. This situation indicated that the integrated farming system of beef cattle with rice farms provided benefits to both the cattle and rice plan. Especially at Merauke Regency, the expansion of the new rice field program reduced the cattle rearing fields. However, there was a positive aspect of the rice field expansion, which was the availability of more agricultural by-products such as rice straw and bran. Each agricultural by-product held immense potential as a feed resource for cattle during the dry season because of the limitation of forage. Meanwhile, the feces of cattle reared inside individual stalls or by a group were useful as organic fertilizers for the rice plan and suppressed the production cost.

The daily BWG description is shown in Fig. 2 and 3. Fig. 2 shows the initial BW and monthly weight measurement for each treatment. The BWG of cattle in the combination of rice straw and rice bran at P2 and P3 treatment was higher than the forage consumption only at P1 treatment. The P2 treatment showed that the average initial BW at P1 was higher than that at P2 and P3. However, P2 and P3 became higher than P1 at the end of the trial.

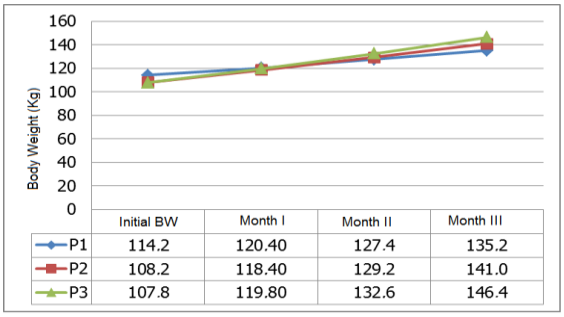

Fig. 2 Line chart of the cattle body weight measurement during the study period

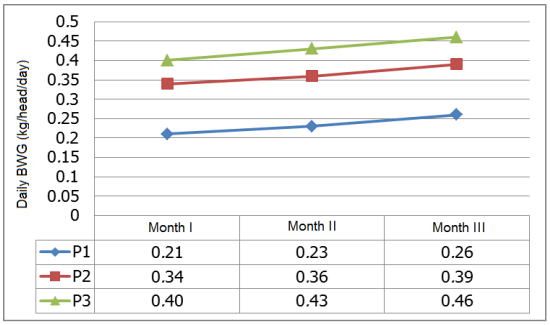

Fig. 3 Line chart of the body weight gain during the study

Fig. 3 shows the average daily BWG for each treatment. The P1 treatment was approximately 0.21–0.26 kg/head/day with a mean of 0.23 kg/head/day. Meanwhile, the P2 treatment had 0.34–0.39 kg/head/day with an average of 0.36 kg/head/day. Finally, the P3 treatment was approximately 0.40–0.46 kg/head/day with an average of 0.43 kg/head/day.

Compared with the P1 treatment (forage 100% or control), the P2 treatment had additional daily BWG of 0.13 kg/head/day, and P3 0.19–

0.20 kg/head/day. The difference between the daily BWGs dramatically affected the sell price value of cattle. During the dry season, the farmer faced hardship because of the declining condition and body weight of the cattle, which led to a much lower selling price. Both quality and quantity of feed extremely affected the daily BWG. Although the cattle had good genetic potential, they could not reach their full potential if they were not supported with feed availability.

The average BWG in this study was lower than that reported by [13], who reported that intensive cattle-rearing can increase the body weight by as much as 0.89 kg/head/day if they pay attention to the feed (concentrate and fermented rice straw), collective stall, and cattle's health condition. In contrast, the current farmer rearing only reached 0.29 kg/head/day. The large gap between the two kinds of rearing occurred probably because the intensive one gave concentrates on the complete nutrient, while the farmer only used rice bran as the additional feed. However, the essence of the study was not only on how to reach high daily BWG but also on using rice straw, which was still not well used. At the end of the study, it will lead to minimizing the production cost and how to become more environmentally friendly. The process will help the environment's recovering since it has no wastes.

3.4 Feed Conversion

Feed conversion is an indicator to measure the efficiency rate of applying ransom to cattle's BWG. In Tab. 1, the highest feed conversion was at P2 with 21.6, then P3 at 20.4. Meanwhile, the lowest value occurred at P1 with 19.3. The statistical result showed that feed treatment did not significantly affect feed conversion ($P > 0.05$). The feed conversion value was relatively higher in this study, which meant that each 1 kg of additional daily BWG required more feed. In summary, the feed consumption was the least efficient.

[14] reported that good feed conversion values were 8.56-13.29. Feed conversion depends on the cattle's condition, digestibility, sex, breed, feed quality, feed quantity, and environmental factors. [15] also stated that the efficiency of feed use is affected by several factors: (1) cattle's capability to digest; (2) adequate nutrition for essential life requirement; (3) growth; (4) body function; (5) type of feed.

However, the feed conversion value in this study was still lower than that reported by [16]. [16] reported that the feed conversion value of basal feed plus supplement (30% energy source and 70% protein) to Bali bull is 39.9 ± 4.5. Fortunately, the study result was still higher than that of [17], who reported Aceh Bull's feed conversion (forage and concentrate) with 4.60 to 9.55. The difference in feed conversion probably depends on the quantity, quality, cattle condition, and environmental factors.

3.5 Beef Cattle Rearing Analysis

The business analysis of livestock rearing is presented in Tab. 2. In Tab. 2, the revenue from the beef cattle business varied between treatments in the 3-month trial. Based on Tab. 2, the lowest revenue occurred at the P1 treatment with 8,147,333 IDR. Meanwhile, the P2 treatment had the second-best revenue with as much as 9,143,333 IDR. The highest revenue came from the P3 treatment with 9,798,333 IDR. The results showed that the rice straw and bran treatment generated higher revenue than the feed treatment consisting only of forage (the previous farmer's pattern). Although it needed higher-cost production, it still helped fix the cattle's price because of the much higher BWG in the cattle.

Tab. 2 Beef cattle farming business analysis during the three months of the study (The authors, primary data, 2020)

Description			P1	P2	P3
I.	Production Cost				
-	Cattle/Broodstock	5 heads x 5,000,000 IDR	25,000,000	25,000,000	25,000,000
-	Feed				
-	Rice bran	5 heads x 2 kg x 90 days x 1,000 IDR	-	900,000	900,000
-	Probion	8 kg x 100,000 IDR			800,000
-	Medicines	2 bottles x 125,000 IDR	250,000	250,000	250,000
-	Worker	30 HOK x 75,000 IDR	2,250,000	2,250,000	2,250,000
-	Stall depreciation	10%/year, or 2.5%/3 month	166,667	166,667	166,667
	Total		27,666,667	28,566,667	29,366,667
II.	Sales				
-	Cattle sale	P1 (5 head x 135.2 kg x 50,000 IDR)	33,800,000		
		P1 (5 head x 141 kg x 50,000 IDR)		35,250,000	
		P1 (5 head x 146.4 kg x 50,000 IDR)			36,600,000
-	Feed Sale	P1: 2,014 kg x 1,000 IDR	2,014,000		
		P2: 2,460 kg x 1,000 IDR		2,460,000	
		P3: 2,565 kg x 1,000 IDR			2,565,000

Continuation of Tab. 2

Total	35,814,000	37,710,000	39,165,000
III. Revenue	8,147,333	9,143,333	9,798,333
R/C	1.29	1.32	1.33

Note: 1 USD = IDR 14,533

The RC value of P1 was 1.29, P2 treatment was 1.32, and P3 was 1.33. The input cost at the P3 treatment had a higher value than that at P1 and P2 because of the additional input into the production of fermented rice straw.

Although the input cost was higher for P2 and P3 than for P1, it still helped the farmer obtain much better revenue. The farmer obtained higher revenue due to better daily weight gain than a non-integrated farming system, which directly led to a better price value. It also provided benefits for farmers since the feces can be transformed into organic fertilizer, which can generate additional revenue.

4 Conclusions

The DM consumption and daily BWG were significantly different at each treatment ($P < 0.05$). The highest DM consumption was at P3 treatment with 8.9 kg/head/day, and the highest daily BWG was at P3 treatment with 0.43 kg/head/day. Economically, beef cattle rearing with the P3 treatment was more profitable than with the P2 and P1 treatments. P1 treatment was the least with 8,147,333 IDR. Meanwhile, P2 treatment had the second-best revenue with as much as 9,143,333 IDR. The highest revenue came from the P3 treatment with 9,798,333 IDR. The R/C value of P1 was 1.29, P2 treatment was 1.32, and P3 was 1.33.

This study has limitations in terms of selecting locations only from one district with the longest dry season in South Papua Province. However, in other provinces, districts can be found with the same dry season characteristics as Merauke District; thus, the results of this research can provide a lesson learned for other locations in order to develop beef cattle farming through the use of rice straw as feed.

References

参 考 文 献

[1] RAUF A W, ATEKAN, JAMIL A, et al. Rice paddy integration study - cows supporting Primatani in Merauke Regency. Papua Agriculture Technology Research Center, 2006.
[2] HARYANTO B, INOUNU I, BUDIARSANA I G M, et al. Rice-livestock integration system. Jakarta: Agriculture Department, Agricultural Research and Development Agency, 2002.
[3] MERAUKE CENTRAL BUREAU OF STATISTICS. *Kurik District in numbers*, 2019.
[4] DIWYANTO K, HARIYANTO B. Crop livestock system to accelerate rice and livestock production. Wartazoa, 2002, 12(1), 1–8.
[5] HARYANTO B, INOUNU I, BUDIARSANA I G M, et al. Technical guidelines for rice-livestock integration (SIPT). Jakarta: Agriculture Department, Agricultural Research and Development Agency, 2003.
[6] PRIARSO Y. Body weight and body size of calves of Generation I and Generation II of Simmental and Ongole breeds from birth to three months of age. Undergraduate thesis. Yogyakarta: Faculty of Animal Husbandry, Gadjah Mada University, 2005.
[7] PARAKKASI A. Nutrition science and ruminant animal feed. Jakarta: University of Indonesia, 1999.
[8] ENDRAWATI E. Performance of Ongole and Simmental cross-breed cows with forage and concentrates, overview of aspects of feed consumption and digestibility. Thesis. Yogyakarta: Gadjah Mada University Postgraduate Program, 2010.
[9] HASBULLAH J. E. Growth and reproduction performance of Simmental cows with Ongole and Ongole breeds in Bantul Regency, Yogyakarta Special Region. Thesis, Faculty of Animal Husbandry, Gadjah Mada University, 2003.
[10] MINSON D J. Forage in ruminant nutrition. San Diego, CA: Academic Press, 1990.
[11] DAVIES Z S, MASON D, BROOKS A E, et al. An automated system for measuring gas production from forage inoculated with rumen fluid and its use in determining the effect of enzymes on grass silage. Animal Feed Science and Technology, 1990, 83, 205–221.
[12] YUDITH T A. Utilization of palm fronds and by-products of the oil palm industry on the growth of Simmental Peranakan cows in the growth phase. Education Department, Faculty of Animal

Husbandry, The University of Northern Sumatra, 2010.
[13] BASUNI R, MULADNO, KUSMANA C, et al. Integration system of paddy-beef cattle in paddy fields. Food Crop Science and Technology, 2010, 5(1).
[14] SIREGAR S B. Ruminant ration. Jakarta: Penebar Swadaya, 1994.
[15] CAMPBELL J R, KENEALY M D, CAMPBELL K L. Animal sciences. 4th ed. New York: McGraw Hill, 2006.
[16] WIDYANINGRUM Y, PAMUNGKAS D, KOTE M, et al. Growth of male Bali cattle in dryland agro-ecosystem of East Nusa Tenggara. In: Proceedings of the National Seminar on Animal and Veterinary Technology, 2013.
[17] USMAN Y, SARI E, FADILLA N. Evaluasi Pertambahan Bobot Badan Sapi Aceh Jantan yang Diberi Imbangan Antara Hijauan dan Konsentrat di Balai Pembibitan Ternak Unggul Indrapuri. Jurnal Agripet, 2013, 13(2), 41–46.
[18] MERAUKE REGENCY FOOD CROPS AGRICULTURE OFFICE. *Annual report,* 2016.

[1] RAUF A W、ATEKAN、JAMIL A 等。稻田一体化研究——奶牛在马老奇摄政区为普里马塔尼提供支持。巴布亚农业技术研究中心，2006。

[2] HARYANTO B、INOUNU I、BUDIARSANA I G M 等人。稻畜一体化系统。雅加达：农业部，农业研究与发展局，2002年。

[3] 马老奇中央统计局。库里克区的数字，2019年。

[4] DIWYANTO K，HARIYANTO B。加速水稻和牲畜生产的作物畜牧系统。瓦尔塔佐阿，2002，12(1)，1-8。

[5] HARYANTO B、INOUNU I、BUDIARSANA I G M 等。稻畜一体化技术指南（SIPT）。雅加达：农业部，农业研究与发展局，2003年。

[6] PRIARSO Y. 西门塔尔牛和翁戈莱牛的第一代和第二代犊牛出生至三个月龄的体重和体型。本科论文。日惹：加札马达大学畜牧学院，2005年。

[7] PARAKKASI A. 营养科学和反刍动物饲料。雅加达：印度尼西亚大学，1999年。

[8] ENDRAWATI E. 翁戈莱和西门塔尔杂交奶牛使用饲料和精料的性能，饲料消耗和消化率方面的概述。论文。日惹：加札马达大学研究生课程，2010年。

[9] HASBULLAH J. E. 日惹特区班图尔摄政区翁戈莱和翁戈莱品种西门塔尔奶牛的生长和繁殖性能。论文，加札马达大学畜牧学院，2003年。

[10] MINSON D J. 反刍动物营养中的饲料。加利福尼亚州圣地亚哥：学术出版社，1990年。

[11] 戴维斯 Z S、梅森 D、布鲁克斯 A E 等。一种自动系统，用于测量接种瘤胃液的饲料的气体产量及其在确定酶对青贮饲料的影响中的应用。动物饲料科学与技术，1990，83，205-221。

[12] YUDITH T A. 利用棕榈叶和油棕工业副产品对西门塔尔土生华人奶牛在生长阶段的生长的影响。北苏门答腊大学畜牧学院教育系，2010年。

[13] BASUNI R、MULADNO、KUSMANA C 等人。稻田稻田肉牛一体化系统。粮食作物科学技术，2010，5(1)。

[14] SIREGAR S B. 反刍动物口粮。雅加达：佩内巴尔·斯瓦达亚，1994年。

[15] 坎贝尔 J R、肯尼利医学博士、坎贝尔 K

L。动物科学。第四版。纽约：麦格劳希尔，2006年。

[16] WIDYANINGRUM Y、PAMUNGKAS D、KOTE M 等。东努沙登加拉旱地农业生态系统中雄性巴厘岛牛的生长。见：2013年全国动物兽医技术研讨会论文集。

[17] USMAN Y、SARI E、FADILLA N. 因德拉普里高级牲畜繁育中心草料和精料之间平衡的雄性亚齐牛体重增加评估。《阿格里佩特杂志》，2013，13(2)，41–46。

[18] 马老奇县粮食作物农业办公室。2016年年度报告。