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Efficiency of Milk Production and Feed Efficiency FH Cross Breed Fed Rice Straw during Dry Season

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Abstract

This study was done to assess the milk efficiency in dairy cows using straw as forage in dry season. Treatments of feed in this study refered to the pattern of feed given by farmers in Cibungbulang smallholder dairy farm with different feed ingredients formula i.e (T1, 59.54% hijauan + 40.46% konsentrat; T2, 26.38% hijauan + 41.42% konsentrat + 32.19% jerami; T3, 28.42% hijauan + 40.22% konsentrat + 31.36% jerami). The variables measured were dry matter intake (DMI), crude protein intake (CPI), total digestible nutrients (TDN), milk yield, milk quality and milk efficiency. Results showed that DMI did not met the requirement of dairy cows except for cows received T1 and T3, while the protein requirements of cows met except for cows received T1 and TDN requirement only met for cows received T2 and T3. The highest milk yield was for cows received T2. Group T2 showed the best feed formula for the dairy cows in Cibungbulang. Efficiency of feed and milk production of all feed formulas were inefficient to increase milk productions.

Keywords: straw; milk production; smallholder dairy farm.

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1. Introduction

In Indonesia, the largest dairy producers are FH crossbreed which spread on smallholder dairy farms in West central and East Java. However, the varying patterns of feeding caused the milk production also varied [1, 15, 3, 6, 25, 28, 11, 26]. The varied patterns and provision of feed affect the met of feed requirements and the quality of feed provided [5] then affects on productivity of dairy cows. In dairy farm, feed has a very important role to increase milk production. Giving of feed must meet the standards requirement for dairy cows both in terms of quality and quantity. However, the quality and feeding fluctuate throughout the year especially in the dry season so that farmers provide less feed to reduce production costs. Scarcity of feed in the dry season causes the type of feed ingredients and feed composition given was always changing and the production of milk produced was lower which then affects the decrease in income of farmers. Therefore, to produce optimal milk production while increasing the farmer's income, it needs quality feed, available in sufficient quantity and cheap by keeping the requirement standard of dairy cows especially in dry season. On smallholder dairy farm, it is anticipated by using agricultural by-products such as rice straw. This study was done to asses the efficiency of milk production and feed efficiency in smallholder dairy farm which use rice straw as feedstuff to meet the requirement of forage in the dry season. Determination of efficiency of milk production is expected to provide information about the best feeding formula of rice straw as forage substitution for increasing milk production.

2. Method

2.1. Time and Place

The study was conducted in November 2015 - February 2016 (dry season) on smallholder dairy farms in Cibungbulang, Kab. Bogor. Analysis of feed samples was caried out on Science and Feed Technology Laboratory and analysis of milk samples was carried out on Laboratory of Animal Production and Technology, Faculty of Animal Husbandry, Bogor Agricultural University.

2.2. Experimental design

This study used 24 lactating FH crossbreed. Feed treatment consist of : T1, 59,54% forage + 40,46% concentrate; T2, 26.38% forage + 41.42% concentrate + 32.19% straw; T3, 28.42% forage + 40.22% concentrate + 31.36% straw. The formula and composition of the feed used in this study refers to the pattern of feeding applied by several dairy farms during the dry season in Cibungbulang (Table 1). The feed samples at each treatment were analyzed using proximate analysis [1] with the results of nutrient content of feed in Table 2.

Table 1: Feed formula of lactating crossbreed FH on Cibungbulang smallholder dairy farm in dry season

Feed formula (%)	T1	T2	T3
Napier grass	57.00	24.32	27.15
Field grass	2.54	2.07	1.27
Cooncentrate	20.65	20.36	14.23
Tofu waste	19.79	21.06	25.99
Straw	0.00	32.19	31.36

Table 2: Nutrien content of feed (% BK) on Cibungbulang smallholder dairy farm in dry season

Treatment	DM	Ash	CP	CF	EE	BeTN	TDN
T1	14.81	9.51	13.62	33.95	2.69	40.22	74.32
T2	19.35	7.53	12.15	32.11	2.35	45.87	70.31
T3	19.67	9.51	13.62	33.95	2.69	40.22	74.32

Source : Proximate analysis of feed carried out on Science and Feed Laboratory, IPB.

DM, Dry matter; CP, Crude Protein; CF, Crude Fiber; EE, Estrak eter; TDN =*Total digestible nutrient*;

% TDN = 92.464 – 3.338(CF) – 6.945(EE) – 0.762(BeTN) + 1.115(CP) + 0.031$(CF)^2$ – 0.133$(EE)^2$ + 0.036(CF)(BeTN) + 0.207(EE)(BeTN) + 0.100 (EE)(CP) – 0.022 $(EE)^2$ (CP) (Hartadi and his colleagues 1986);

T1, 59.54% forage + 40.46% concentrate; T2, 26.38% forage + 41.42% concentrate + 32.19% straw; T3, 28.42% forage + 40.22% concentrate + 31.36% straw.

Forage and straw were given ad libitum but concentrate were not given ad libitum every day. Feed was provided in the morning (06:00 - 08:00 am) and evening (16:00 to 17:30 pm) which the ratio of forage and concentrate was 60: 40%. Daily feed intake were calculated by the difference feed given and the residual feed for 24 hours. The residual of feed were calculated by weighing the feed which unconsumed by the dairy cows on the next day with kg unit. The comparison between dry matter consumption, crude protein and total digestible nutrient (TDN) with nutrient needs of lactating dairy cattle based on livestock weight and Nutrient Requirement of Ruminants in Developing Countries (NRRDC) [7] was performed to determine the adequacy of nutrient intake.

Milk production were measured every morning (04.30-06.30 am) and afternoon (15:00 to 17:00 pm) on each dairy cows. Measurements were done by collecting the milk produced by each dairy cows in the container bucket and weighed using a digital scales then recorded in kilograms. Milk sampling were done every morning and afternoon after milking on each of dairy cows. Milk samples of each dairy cows were taken about 200 ml by homogenizing the milk and then poured into a small container for analysis using milkotester. The measurement results was recorded in units (%) including fat, protein, lactose, non-fat dry matter (SNF). The milk content of milk is calculated by adding BKTL with milk fat. Milk production were corrected into 4% FCM, (0.4 x Milk production) + (15 x Milk production x milk fat) using Gaines method [24].

The calculation of feed efficiency (milk production/DMI) refers to [12]; Efficiency of milk production ((milk productions x 340)/(TDN intake x 1814) x 100%) and Income Over Feed Cost (IOFC) (feed price x milk production) / feed prices) refers to [4].

2.3. Data analysis

The data were analyzed using Independent samples T-test [20].

3. Result

3.1. Dry Matter Intake (DMI)

The DMI of lactation dairy cows showed significantly differences (P <0.01) (Table 3). Lactating dairy cows were fed T2 showed higher DMI of forage and concentrate rather than other groups. Total DMI of lactating dairy cows were fed treatment T2 showed higher than other treatments. The differences of DMI in this study influenced by the content of the feed in each treatment. The content of DMI determine the nutrient intake and the metabolites produced in the rumen i.e acetic acid, butyric, propionate, glucose, free fatty acids, triacylglycerols and amino acids. The butyric acid will be converted to β-hydroxy butyric acid (BHBA). Acetic acid and BHBA were used as a source of energy and fatty acids. Propionic acid were converted into glucose which is partially converted to glycogen and fatty acids and the rest is used to various tissues as energy sources, fatty acid synthesis and glycogen synthesis. Amino acids were used for protein synthesis [13].

Table 3: DMI of feed (kg/h/d) on Cibungbulang smallholder dairy farm in dry season

Variable	T1	T2	T3
DMI of forage (kg/h/d)	3.63 ± 0.41a	7.65 ± 0.47c	5.53 ± 0.75b
DMI of concentrate (kg/h/d)	2.47 ± 0.28a	5.41 ± 0.34c	3.72 ± 0.50b
DMI of feed (kg/h/d)	6.10 ± 0.69a	13.06 ± 0.81c	9.26 ± 0.78b
Body weight (kg)	406.13	483.45	419.30
DMI/BW (%)	1.50	2.70	2.21
NRRDC (kg/h/d)	10.00	10.25	9.89

A different superscript in the same row showed significantly difference (P<0.01);

BW, Body weight; DMI, Dry matter intake; NRRDC, *Nutrient Requirement of Ruminan in Developing Countries*;

T1, 59.54% forage + 40.46% concentrate; T2, 26.38% forage + 41.42% concentrate + 32.19% straw; T3, 28.42% forage + 40.22% concentrate + 31.36% straw.

DMI of feed in present study were higher than [23], 8.8 kg/d; and lower than [27], 15.79 kg/d. Low DMI of feed in present study because high intake of crude fiber so the rate of feed fermentation in the rumen become more slow. [8] states that the presence of structural fiber in feed affecting fullfillment of rumen.

The average DMI of feed in present study ranged from 1.50 to 2.70% per body weight. The value were higher than [23], 2.43 and lower than [27], 3.5%. In present study, only dairy cows were fed T2 met the requirement based on NRRDC [7]. This means that the formula feed on groups T2 with provision rice straw as a forage substitute met the requirement of lactating dairy cows during dry season in Cibungbulang. The difference in DMI of feed in present study was due to differences in feed formula and nutrient content.

3.2. Crude Protein Intake (CPI)

CPI of lactating dairy cows in Cibungbulang showed significantly difference among groups (P <0.01) (Table 4). Lactating dairy cows were fed T2 showed higher CPI than other groups. The high CPI on groups T2 were caused by the high content of feed protein.

The results of present study showed lower values (0.77-1.51 kg/h/d) than [16], 1.85-1.97 kg/h/d and [18], 3.17-3.76 kg/h/d. CPI of feed in present study were met the requirement of lactating dairy cows based on NRRDC [7], except on dairy cows were fed T1. The higher composition of concentrate in feed caused CPI of lactating dairy cows were fulfilled based on NRRDC. The content of protein in present study were good enough to meet the needs of lactation dairy cows. CPI in present study ranged from 0.19 to 0.28% per body weights.

Table 4: CPI of feed (kg/h/d) on Cibungbulang smallholder dairy farm in dry season

Variable	T1	T2	T3
CPI of forage (kg/h/d)	0.40 ± 0.05a	0.65 ± 0.04b	0.41 ± 0.06a
CPI of concentrate (kg/h/d)	0.37 ± 0.04a	0.71 ± 0.04c	0.55 ± 0.07b
CPI of feed (kg/h/d)	0.77 ± 0.09a	1.36 ± 0.08c	0.96 ± 0.13b
Body weight (kg)	0.19	0.28	0.23
CPI/BW (%)	0.91	0.90	0.90
NRRDC (kg/h/d)	0.40 ± 0.05a	0.65 ± 0.04b	0.41 ± 0.06a

A different superscript in the same row showed significantly difference (P<0.01);

BW, Body weight; CPI, Crude protein intake; NRRDC, *Nutrient Requirement of Ruminan in Developing Countries*;

T1, 59.54% forage + 40.46% concentrate; T2, 26.38% forage + 41.42% concentrate + 32.19% straw; T3, 28.42% forage + 40.22% concentrate + 31.36% straw.

3.3. Total Digestible Nutrient (TDN)

Total digestible nutrient (TDN) of lactating dairy cows in Cibungbulang showed significantly difference (P <0.01) (Table 5). Lactating dairy cows were fed T2 showed higher value than other groups. The difference TDN intake in present study caused the different TDN content in each groups. TDN feed in present study ranged from 1.01 to 1.71% per body weight. TDN intake in present study were met the requirement of lactating dairy cows based on NRRDC [7] except on group T1.

3.4. Milk Production and composition

The milk production (kg/h/d) of lactating dairy cows in Cibungbulang showed significantly difference (P <0.01) (Table 6). The highest milk production were shown in group T2. Milk production in present study were higher than [23], 7.4 kg/d and [27], 10.00 kg/d with rice straw substitution. The differences milk production due to differences DMI of feed and nutrient content in each groups. Milk production in present study were positively correlated with DMI (Y = 5.204 + 0.491 x); R = 0.404); CPI (Y = 0.639 + 0.044x; R = 0.383) and TDN intake (Y = 3.512 + 0.295x; R = 0.399). [16] states that the basic necessities and production are determined by nutrient intake. The nutrients were converted into metabolites in the rumen and used for energy, glycogen, triacylglyceride synthesis, fatty acid synthesis and amino acid synthesis in various bodies tissues of dairy cows [13]. In lactating dairy cows, the main metabolite were used for milk synthesis. Milk production is depend on nutritional supplements [14].

Table 5: TDN of feed (kg/h/d) on Cibungbulang smallholder dairy farm in dry season

Variable	T1	T2	T3
TDN of forage (kg/h/d)	2.78 ± 0.32a	4.95 ± 0.31b	3.37 ± 0.46a
TDN of concentrate (kg/h/d)	1.34 ± 0.15a	3.30 ± 0.20c	2.52 ± 0.34b
TDN of feed (kg/h/d)	4.12 ± 0.47a	8.25 ± 0.51c	5.89 ± 0.80b
Body weight (kg)	1.01	1.71	1.40
TDN/BW (%)	5.45	5.75	5.80
NRRDC (kg/h/d)	0.40 ± 0.05a	0.65 ± 0.04b	0.41 ± 0.06a

A different superscript in the same row showed significantly difference (P<0.01);

BW, Body weight; TDN, Total digestible nutrient; NRRDC, *Nutrient Requirement of Ruminan in Developing Countries*; T1, 59.54% forage + 40.46% concentrate; T2, 26.38% forage + 41.42% concentrate + 32.19% straw; T3, 28.42% forage + 40.22% concentrate + 31.36% straw.

Table 6: milk production and comosition (kg/h/d) on Cibungbulang smallholder dairy farm in dry season

Variable	T1	T2	T3
Milk production (kg/h/d)	6.75 ± 3.13a	13.10 ± 3.11b	10.16 ± 2.62ab
Milk production 4% FCM (kg/h/d)	7.13 ± 3.38a	13.01 ± 2.73b	10.00 ± 2.53ab
Milk quality (%) :			
Fat	4.33 ± 0.17	4.01 ± 0.46	3.91 ± 0.34
Protein	3.06 ± 0.07	3.01 ± 0.10	3.19 ± 0.17
Lactosa	4.48 ± 0.10	4.47 ± 0.15	4.74 ± 0.25
Solid non fat (SNF)	8.50 ± 0.19	8.34 ± 0.27	8.84 ± 0.46
Dry matter (DM)	12.83 ± 0.33	12.35 ± 0.64	12.75 ± 0.55
Milk composition (kg/h/d) :			
Fat	0.30 ± 0.14a	0.52 ± 0.10b	0.40 ±0.10ab
Protein	0.21 ± 0.10a	0.39 ± 0.09b	0.32 ± 0.09ab
Lactosa	0.30 ± 0.15a	0.58 ± 0.13b	0.48 ± 0.13ab
Solid non fat (SNF)	0.58 ± 0.27a	1.09 ± 0.25b	0.90 ± 0.24ab
Dry matter (DM)	0.87 ± 0.42a	1.61 ± 0.34b	1.29 ± 0.23ab

A different superscript in the same row showed significantly difference (P<0.01);

T1, 59.54% forage + 40.46% concentrate; T2, 26.38% forage + 41.42% concentrate + 32.19% straw; T3, 28.42% forage + 40.22% concentrate + 31.36% straw.

The differences in 4% FCM caused by DMI of feed and fat content. [19] states that milk production up to 15-20 kg/d will affect the total increase of DMI. The average milk production in Indonesia is 15 L/h/d or equal to 15.42 kg/h/d [9].

The production of fat, protein, lactose, SNF and DM of milk (kg/h/d) showed significantly difference (P <0.01). Milk fat production in groups T2 were higher than other groups. Fat production were influenced by milk production and fat content in milk. Milk fat content in present study were higher than [23], 4.00% and [27], 4.05%. [21] states that milk content is influenced by the ratio of forage and concentrate. The main precursors of milk fat are glucose, acetate, β-hydroxybutyrate acid, triglycerides of chylomikra, and low lipoproteins from the blood. Glucose, triacylglycerol from feedstuffs or formed by rumen bacteria and fatty acids synthesized within the udder gland [10].

Protein production in group T2 were higher than other groups. Protein production were influenced by milk production and protein content in milk. There were no difference in milk protein content in present study with [27], 2.97% and [23], 3.2%. [13] suggests that feed proteins consumed by dairy cows are hydrolyzed into peptides and amino acids by rumen microorganisms and some amino acids will be further transformed into organic acids, ammonia and carbon dioxide. Amino acids were used for protein synthesis or enter the systemic blood and join the amino acids of tissue catabolism then used for protein synthesis by body tissues. In lactating dairy cows, these amino acids are used for milk protein synthesis [10].

Lactose production in group T2 were higher than other groups. Lactose production were influenced by milk production and lactose content in milk. Lactose content in this study did not differ (4.32-4.76%) with [23], 4.50%. Larson [10] states that lactose in milk is largely derived from blood glucose (80%) and galactose that were absorbed by secretory cells from the blood. Lactose were a carbohydrate which synthesized in mammary gland. Lactose content were relatively fixed but lactose production increases as increasing of milk production.

3.5. Efficiency of Milk production and effisiency of feed

The efficiency of milk production in present study did not showed significantly difference (Table 7). The efficiency of milk production in this study ranged from 3.65-4.22.

The feed efficiency in present study did not showed significantly difference (Table 7). The feed efficiency in present study is lower than [11], 1.07-1.16 and [4], 1.51, respectively. The value of feed efficiency in present study illustrates that feed were used inefficient to increase milk production because 1 kg of feed is used to produce 0.12-0.14 kg of milk. Efficient use of nutrients will prevent shortages or excess nutrients intake which then impact on productivity livestock. [17] states that the efficiency of feed in production of dairy cows is an important factor to be considered. If the nutrients are not converted into milk, the food reserves from the body, or the development of a cow's fetus, nutrient will be excreted become the ammonia, methane or nitrous oxide [22].

Income over cost did not showed significantly difference (Table 7). Income over feed cost in present study (1.73-2.78) was higher than the normal range. [12] states that the normal range of income over feed cost were > 1.4. This means economically, all types of feeds are given efficiently. The best economic efficiency value is shown in group T2.

Table 7: Efficiency of milk production on Cibungbulang smallholder dairy farm in dry season

Variable	T1	T2	T3
Feed efficiency	0.14 ± 0.07	0.12 ± 0.03	0.14 ± 0.04
Milk Production efficiency	3.93 ± 1.89	3.65 ± 1.70	4.22 ± 1.31
Feed cost (IDR)	19848.54	23992.14	19794.13
Income Over Feed Cost (IOFC)	1.73 ± 0.80	2.78 ± 0.66	2.61 ± 0.67

A different superscript in the same row showed significantly difference (P<0.01);

T1, 59.54% forage + 40.46% concentrate; T2, 26.38% forage + 41.42% concentrate + 32.19% straw; T3, 28.42% forage + 40.22% concentrate + 31.36% straw.

T4 shows a higher price, IDR 23992.14 and T6 indicates a lower price, IDR 19794.13. The feed price in present study were higher than [11], IDR 1963.3 - 2510.3 and [6], IDR 18803-22229.84. The results showed that the feed price to produce 1 kg of milk will affect the cost of production on smallholder dairy farms. This means that the cheaper feed used for milk production will reduce the cost of production dairy cows and will affect income of farmers. [4] states that how efficiently dairy cows convert feed into milk can affect operational cost of dairy cows. This means that the use of the feed with low price and good quality will affect the profit or loss of dairy farm business.

4. Conclution

Lactating dairy cows were fed T2 (T4, 26.38% forage + 41.42% concentrate + 32.19% straw) showed the best formula with DMI, CPI and TDN intake met the feed requirement based on NRRDC. Efficiency of feed and milk production of all feed formulas were inefficient to increase milk productions.

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