DDGS FEEDING TRIAL ON DAIRY CATTLE IN INDONESIA

DDGS use as a substitute and a supplement to concentrate in dairy nutrition results in significant improvement in milk production

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ABSTRACT

An experiment was undertaken in 2009 to improve milk production by supplementing local feeds with U.S. corn DDGS (*Dried Distiller's Grains with Solubles*). The results indicated that milk production increased by 10% in a farm in Cinagara, West Java and by 30% in a farm in Grati, East Java.

Domestic milk production can only supply 30% of Indonesia's total milk requirement. About 70 percent of the total milk requirement is imported from overseas. One of the main problems facing the dairy industry in Indonesia is low quality of dairy feed. DDGS is a co-product of corn ethanol production containing valuable energy and protein levels amid reasonable price. In 2009, Indonesia is estimated to import about 200,000 metric tons of DDGS mainly used for poultry diets.

This research used DDGS as a supplement and a substitute for the dairy concentrate. The experiment was conducted in two locations:

i) Research in Cinagara, Sukabumi District, West Java, in which 1 kg DDGS was given as a substitute for the concentrate, for comparison the feed given and dairy production was also measured from non-DDGS supplemented animals, and
ii) Research in Grati, Pasuruan District, East Java, in which 1 kg DDGS was given as a supplement on top the concentrate given by farmer, for comparison the feed given and dairy production was also measured from non DDGS supplemented animals.

Twenty dairy cows were used in each location and divided randomly into two comparable groups. The results show that milk production increased by 10% in Cinagara, West Java and by 30% in Grati, East Java. The higher milk production with the inclusion of DDGS was mainly due to the high protein content in DDGS (30%). Economically, the supplementation with 1 kg of DDGS benefited the dairy farmers as the margin of milk production was higher than the cost of inclusion DDGS in the concentrate ration. This project indicates that the milk production and farmers income can increase significantly if DDGS are used in dairy feeds. Results of this project should be disseminated to other dairy farmers in Indonesia.

Key words: *Dairy cattle, milk production, supplement, substitute, DDGS.*

Introduction

Distiller's dried grains with solubles (DDGS) is a co-product produced by "dry mill" ethanol plants as a result of fermenting starch from grain to produce fuel ethanol and carbon dioxide. Increase of ethanol production in USA for the last 10 years has resulted in a higher amount of DDGS available for animal feed. An estimated 35 million ton of DDGS was produced in 2009 and 4.8 million tons were exported to different countries around the world.

Research focusing on feeding DDGS for dairy has been conducted in many universities in USA for the last 20 years. Based on twenty-three studies investigating the inclusion of distiller's grains in dairy cow diets with 96 treatment comparisons, Kalscheur (2005) conducted a meta analyses and reported that in general, distiller's grains are considered to be highly palatable and stimulated feed intake when distiller's grains are included up to 20% of the DM in dairy cow diets (Table 1.). Milk production was not impacted by the form of distiller's grains fed, but there was a curvilinear response to increasing distiller's grains in dairy cow diets (Table 1). Cows fed diets containing 4-30% distiller's grains produced the same amount of milk, approximately 0.4 kg/d more, than cows fed diets containing no distiller's grains. When cows were fed the highest inclusion rate (more than 30%) of distiller's grains, milk yield tended to decrease. It is recognized that distiller's grains quality has changed over this time period.

Table 1. Dry matter intake and milk yield of dairy cows fed increasing levels of distiller's grains as either dried or wet.

Inclusion Level (dry matter-DM)	DM Intake (kg/day)			Milk Production (kg/day)		
	Dry	Wet	All	Dry	Wet	All
0%	23.5^{c}	20.9^{b}	22.2^{b}	33.2	31.4	33.0
4-10%	23.6^{bc}	23.7^{a}	23.7^{a}	33.5	34.0	33.4
10-20%	23.9^{ab}	22.9^{ab}	23.4^{ab}	33.3	34.1	33.2
20-30%	24.2^{a}	21.3^{ab}	22.8^{ab}	33.6	31.6	33.5
> 30%	23.3^{bc}	18.6^{c}	20.9^{c}	32.2	31.6	32.2
SEM	0.8	1.3	0.8	1.5	2.6	1.4

^{a,b,c} *Values within a column followed by a different superscript letter differ ($P < 0.05$).*

In USA, initially DDGS is fed in wet form without drying to the cattle raised in proximity to the ethanol plant. Increasing number of modern ethanol plants have resulted in more DDGS produced in dried form. Feeding trial of DDGS has been conducted in USA using DDGS derived from the older technology that has darker color. Power et al. (1995) reported that feeding darker color of DDGS resulted in a lower milk production compare to DDGS in lighter color.

Distiller's dried grains with solubles (DDGS) is a very good protein source for dairy cows. According to Schingoethe (2004), the protein content in high quality DDGS is typically more than 30% on a dry matter and DDGS contains 10% fat. DDGS is a good source of ruminally undegradable protein (RUP), or by-pass protein and the content was 55%. DDGS is also a very good energy source for dairy cattle with *Total Digestible Nutrient* (TDN) value 77%, NE_{gain} 1.41 Mkal/kg, and $NE_{lactation}$ 2.26 Mkal/kg. This new energy value of DDGS is reported 10-15% higher than that reported by NRC (2001).

Most of the DDGS research involving dairy cattle has been conducted in temperate climates. Chen and Shurson (2004) reported from field feeding trial of DDGS to dairy cows conducted during summer period in Taiwan that inclusion of DDGS 10% in Total Mix Ration (TMR) was able to increase milk production at 0.9 kg/day without affecting feed intake. DDGS can also be fed to growing heifers but the trial is limited; Kalscheur and Garcia (2004) reported that DDGS could be fed to heifers up to 40% in the rations.

Indonesia has been importing DDGS from USA for the last 4 years, but mainly used for poultry feed and fish feed. Currently no DDGS are used for feeding dairy cattle despite that there are 400,000 heads of dairy cattle population in Indonesia. Every year Indonesia also imports more than 500.000 live beef cattle from Australia. DDGS can be a potential feed ingredient for feeding beef in feedlot system. Potential of DDGS for dairy and beef cattle are significant, it is estimated that if 1 kg of DDGS is fed to cattle every day, Indonesia may require 200,000 MT DDGS per year.

Dairy cattle is normally fed green roughage and supplemented by a concentrate comprised of industrial by products such as palm kernel meal, copra meal, wheat pollard, rice bran, cassava waste, molasses, and mineral/vitamin mix. However, the use of DDGS in Indonesia is not known and it would be useful to conduct a feeding trial to dairy cattle in Indonesia.

Materials and Methods

Feeding trial on DDGS was conducted in 2 locations: 1. BBPKH at Cinagara, Sukabumi and 2. Dairy Farm Grati, Pasuruan, East Java on August – November 2009.

Feeding system

(i) At Cinagara, Sukabumi West Java

In West Java, the dairy farm BBPKH Cinagara was selected as they have a complete recording system and availability of the cattle. Total 20 cattle were selected from the cattle having lactation period > 2 months. The cattle were randomly allocated into 2 groups in such a way to have similar production, lactation period

in both groups. Two dietary treatments were used: 1. Control Group was fed the diets currently used in this farm, comprised of elephant grass and concentrate and 2. DDGS Group was fed similar to control group except 1 kg of concentrate was replaced by 1 kg of DDGS. Dietary composition for both groups is presented in Table 2.

Table 2. Daily feed compositions of control and DDGS treatment to substitute 1 kg concentrate at Dairy Farm Cinagara (given *as fed*).

Feed	Control (kg/head/hari)	DDGS substitution (kg/head/day)
Elephant Grass	36	36
Native Grass	4	4
Concentrate	9	8
DDGS	0	1

Elephant and native grass was cut daily from the pasture grown in Cinagara Farm while concentrate was purchased from Dairy Cooperative in Bogor. DDGS was obtained from local trader in Jakarta and was shipped to the farm every month. The ration was given daily while milking was performed twice per day manually at 05:00 and 13:00.

The feeding trial was carried out for 100 days including 2 weeks period of adaptation.

Figure 1. Dairy farm at Cinagara, Sukabumi, West Java: Cattle in the left row for feeding DDGS while right row for control.

(ii) At Grati, Pasuruan, East Java

A dairy farm under supervision of dairy cooperative was selected in Grati, Pasuruan East Java as this farm has complete recording system and facilities to conduct a feeding trial. Total 20 cattle were selected from the cattle having lactation period > 2 months. The cattle were randomly allocated into 2 groups in such a way to have similar production, lactation period in both groups. Two dietary treatments were used: 1. Control Group was fed the diets currently used in this farm; comprise of corn stover, fresh cassava, soybean curd waste and concentrate and 2. DDGS Group was fed similar to control group except 1 kg of DDGS was added on top of the diet. Dietary composition for both groups is presented in Table 3. Amount of concentrate, cassava and soybean curd waste were varied among individual cattle and it would depend on body weight (predicted by length of chest), milk production prior to feeding trial and fat content. The final diet would similar in energy (Total Digestible Nutrient), protein and dry matter intake to meet the requirement as suggested by NRC (1981).

Table 3. Average daily feed composition of control and DDGS treatment to supplement 1 kg concentrate at Dairy Farm Grati (given *as fed*).

Feed	Control (kg/head/day)	DDGS Supplementation (kg/head/day)
Corn stover	9,0	9,0
Fresh soybean curd waste	8.0 (8-8)	9,4 (8-12)
Fresh cassava	8	8 (8-10)
Concentrate	9,8 (9-11)	9,5 (8-13)
DDGS	0	1

Corn stover, cassava and soybean curd waste in fresh form was obtained from surrounding area, while concentrate was purchased from Dairy Cooperative in Pasuruan (Yellow Feed Brand). Amount of concentrate and soybean curd waste was varied among the cattle depending upon milk production and body size. DDGS was obtained from a feedmill in Pasuruan and was shipped to the farm every month. The feed was given two times per day while milking was performed twice per day manually at 09:00 and 15:00. The feeding trial was carried out for 4 months after 30 days period of adaptation. After 30 days of adaptation the feeding amount was adjusted according to body weight and milk production.

Figure 2. Dairy farm at Grati, Pasuruan, East Java: cattle in the left row for feeding DDGS while right row for Control.

Digestibility trial

At the end of the feeding trial, digestibility trials were conducted in each location to measure dry matter, protein and energy digestibility. Grab samples of feces were collected from each individual cattle and analyzed for moisture, protein, gross energy and acid insoluble ash (AIA). AIA was used as internal marker to measure digestibility of the nutrients.

Measurement

Milk production from individual cattle was weighed twice daily, while milk quality (total solid, fat and protein content was measured at end of feeding trial and was compared with milk quality before onset of the trial.

Statistical analyses

Randomized Completely Design was used in each location of the feeding trial using 10 replicated cattle and data was analyzed using SAS 6.12 Proc GLM. Simple economic analyses was performed to measure the economic benefit in using DDGS for dairy cattle based on the current DDGS price, concentrate price and milk price purchased by cooperatives.

Results and Discussion

Dairy Farm at Cinagara

Chemical composition of feed given to dairy cattle at Cinagara farm is presented in Table 4. Value was expressed as wet basis or as is based on the material actually given to animals. The grass had very high moisture content as it was harvested during rainy season. The concentrate contained only 10% protein, which is lower than expected. The composition of concentrate was unknown as it was manufactured by cooperatives. Based on the information collected, the concentrate is composed mainly from locally available ingredients such as cassava waste, poor quality rice bran, copra meal, palm kernel meal, cocoa bean husk, wheat pollard etc. DDGS contained 26.8 % protein which is similar to regular US DDGS imported to Indonesia. Other nutrients including fat, fiber, calcium and phosphorus is acceptable, except for moisture content (14.7%), which considers being higher than usual. High moisture content may result on the deterioration of DDGS during storage due to fungus growing. Normally DDGS from US contain 10% moisture and it is possible that DDGS may pick up moisture during storage at high relative humidity in Sukabumi, however further study is warranted.

Table 4. Chemical composition of feed used at Cinagara (% *as is*).

Feed	Moisture (%)	Protein (%)	Fat (%)	Fiber (%)	Ash (%)	Ca (%)	P (%)	Energy kcal/kg
Elephant Grass	88.9	1,75	0.23	4.01	1.74	<0.01	0.06	614
Concentrate	10.9	10.66	6.80	8.73	8.03	0.04	0.60	3791
DDGS	14.7	26.8	10.29	5.80	4.18	<0.01	0.68	4530

Milk production of dairy cattle fed 1 kg of DDGS to replace 1 kg concentrate during 3 months feeding period is presented in Table 5. Feeding DDGS resulted in significantly higher milk production than the control diet. On average 1.0 L extra milk was produced when DDGS was fed. The improvement in milk production was noticed since the beginning of first month feeding of DDGS. This result was supported by average milk production curve (Figure 3.) that indicated the higher milk production curve. Further regression analyses showed that feeding DDGS was able to increase milk production during 3 months feeding period while control diet resulted in decrease in milk production.

Table 5. Milk production at start and monthly period of dairy cattle fed 1 kg DDGS to substitute concentrate (kg/head/day).

Treatment	At Start	1st Month	2nd Month	3rd Month	Average	SD
Control	8,63	8,64	7,97	8,20	8,48[a]	1,66
DDGS	8,92	9,57	9,63	9,78	9,48 [b]	2,10
Difference	-	0,93	1,66	1,58	1,00	-

Note: *Values within a column followed by a different superscript letter differ (P < 0.05)*; SD = Standard Deviation.

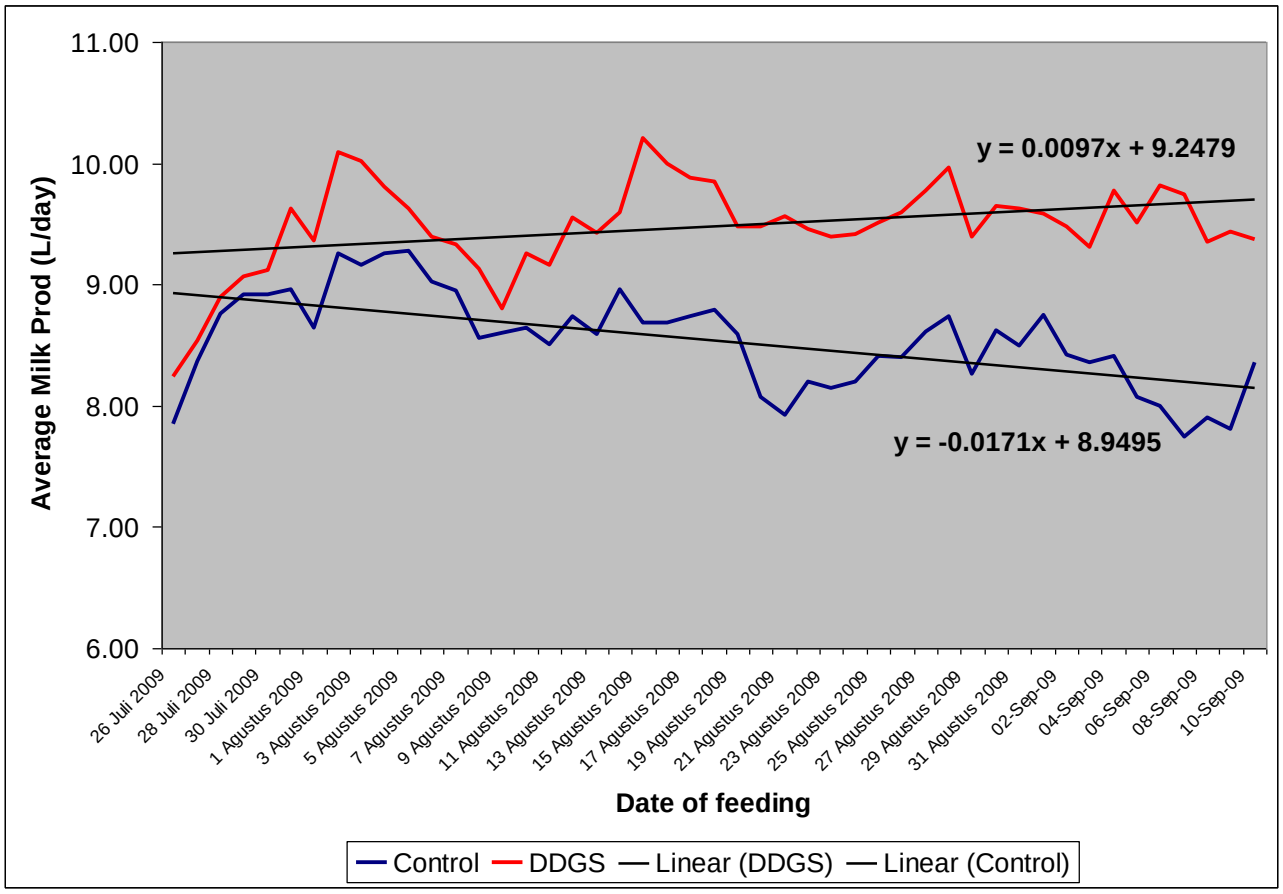

Figure 3. Milk production of dairy cattle fed 1 kg DDGS to substitute concentrate at Cinagara Farm.

Result on the digestibility measurement of the diet with and without DDGS is presented in Table 6. Feeding 1 kg DDGS to replace 1 kg concentrate resulted in significantly higher dry matter, protein and energy digestibility. Increase in protein digestibility from 57.3% to 67.6% is more pronounced compared to energy and dry matter digestibility. Higher protein digestibility in feed containing DDGS may indicate the higher value of protein in DDGS as reported by Schingoethe (2004) that DDGS contained significant amount by pass protein. This may result in higher milk production of dairy cattle in this experiment.

Quality of milk from cattle fed DDGS compared to cattle fed control diet is presented in Table 7. The result indicated that milk quality is not affected by feeding DDGS 1 kg to replace concentrate. In this trial, DDGS inclusion was too low to affect milk quality as Kalscheur (2005) reported that milk protein might be decreased when DDGS inclusion was > 30% in the total mixed diet.

Table 6. Effect of feeding 1 kg DDGS to substitute concentrate on dry matter, protein and energy digestibility (%) of dairy feed at Cinagara.

Treatment	Dry Matter Digestibility (%)	Protein Digestibility (%)	Energy Digestibility (%)
Control	71.3[a]*	57.3[a]	69.6[a]
DDGS	74.6[b]	67.6[b]	73.9[b]
SEM	0.96	2.14	1.10

** Values within a column followed by a different superscript letter differ (P < 0.05).*

Table 7. Milk quality of dairy cattle fed 1 kg DDGS to substitute concentrate.

	Parameter					
Treatment	Fat (%)	SNF (%)	TS (%)	Specific Gravity	Lactose (%)	Protein (%)
Before trial	3,83	7,23	10.86	-	3,83	2,69
Control	3,73	7	10,73	1,024	3,69	2,61
DDGS	3,53	7,34	10,87	1,025	3,86	2,74

Note: SNF = Solid Non Fat; TS = Total Solid

Dairy Farm at Grati

Chemical composition of feed ingredients used in feeding trial conducted at Grati, Pasuruan is presented in Table 8. Corn stover has been considered as source of roughage for dairy and it has crude fiber > 20%. However soybean curd waste that contained protein >20%, also contained higher crude fiber (26%). Cassava is used as soluble carbohydrate in cattle feed therefore contained little protein and fiber. Unlike concentrate in Cinagara trial that contained only 10% protein, concentrate in Grati contained slightly higher protein (13%) but both concentrates had lower protein than standard concentrate that should have protein > 16%. This is one of the reasons that average milk production in Indonesian dairy farms is very low (<8 L/cow/day). DDGS quality in this trial was similar to the quality of DDGS used at Cinagara farm except moisture content of DDGS in Grati was 9.5% which was lower than the DDGS at Cinagara.

Milk production of cattle fed 1 kg DDGS as to supplement concentrate is presented in Table 9. Average milk production from cattle fed DDGS is >3 kg higher than that cattle fed control diet. Increase of milk production was noticed after feeding DDGS for 1 month and continued to stay high till end of feeding

period. Milk production curve is shown in Figure 4 and it is clear that feeding DDGS resulted in higher milk production since it was fed and continue to have high milk production during 4 months period of feeding.

Table 8. Chemical composition of feed used at Grati (% dry matter).

Feed Type	Protein (%)	Fat (%)	Fiber (%)	Ash (%)	Energy kcal/kg
Corn stover	9,57	1,76	21,7	13,9	3420
Fresh soybean curd waste	20,7	5,0	26,5	4,87	3487
Fresh cassava	3,97	1,26	1,14	2,14	3865
Concentrate	13,1	4,87	9,81	9,02	3791
DDGS	30,7	10,2	8,77	6,7	3161

Table 9. Milk production at start and monthly period of dairy cattle fed 1 kg DDGS to supplement concentrate at Grati Farm (kg/head/day).

Treatment	At Start	1st Month	2nd Month	3rd Month	Average	SD
Control	8,96	8,55	8,82	8,57	8,65[a]	1,73
DDGS	9,47	11,87	11,90	11,60	11,79 [b]	1,97
Difference	0,51	2,32	3,08	3,03	3,14	-

Note: *Values within a column followed by a different superscript letter differ ($P < 0.05$)*; SD = Standard Deviation.

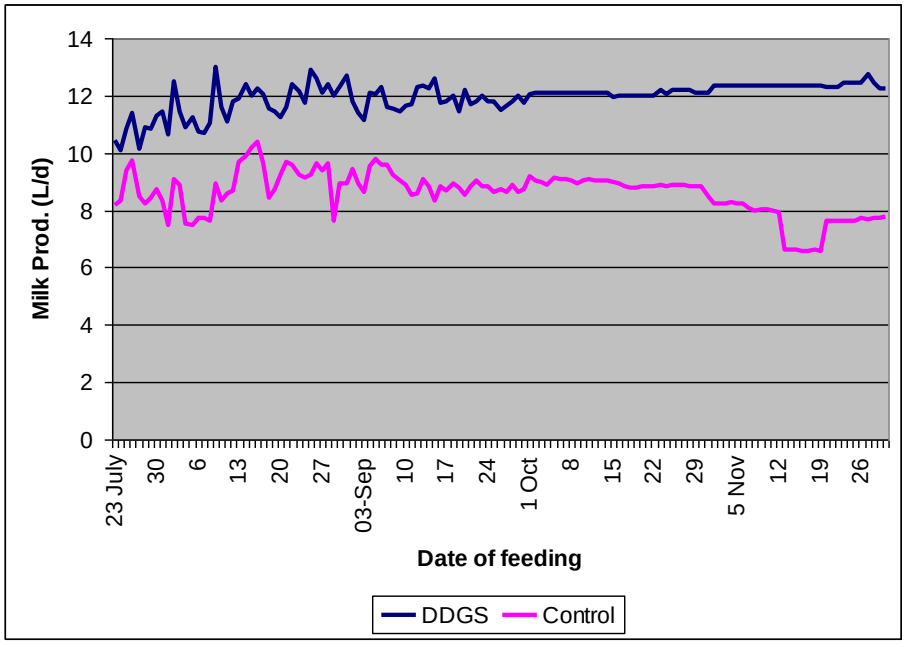

Figure 4. Milk production of dairy cattle fed 1 kg DDGS to supplement concentrate at Grati Farm.

Protein content and density of milk from cattle fed DDGS is presented in Table 10. Protein content is slightly higher in milk of cattle fed DDGS but density is same.

Table 10. Milk protein and density from dairy cattle fed DDGS in Grati.

Treatment	Parameter	
	Density (BJ)	Protein (%)
Control	1,0026	2,65
DDGS	1,0026	2,83

Economic benefits in using DDGS

DDGS was sold at cost Rp 2500/kg or US $ 263/MT while concentrate from cooperative was sold at Rp 1800/kg and milk price was purchased by cooperative at Rp 3200/kg. Simple economic calculation on benefit in using DDGS for dairy cattle in Indonesia is presented in Table 11.

Table 11. Economic benefit in using DDGS 1 kg to substitute or to supplement on top of concentrate for dairy cattle in Indonesia.

Use DDGS 1 kg	**Additional cost (Rp/day)**	**Extra milk produced (Kg/day)**	**Price of milk (Rp/kg)**	**Extra profit (Rp/cow/day)**
Substitute 1 kg concentrate	Rp 2500 – Rp 1800 = Rp 700	1.0	3200	**2500**
Supplement 1 kg concentrate	Rp 2500	3.1	3200	**7420**

When DDGS is used to substitute concentrate at rate 1 kg/head/day, farmer would get extra profit Rp 2,500/cow/day. However when DDGS is used to supplement the feed at 1 kg, farmer would get extra profit at Rp 7,420/cow/day. Higher profit in DDGS supplementation is related with higher milk production compared to DDGS substitution. Increase in milk production was noticed when DDGS used in the diet for dairy but magnitude of the increase would depend upon the quality of feed currently used by the farmers. The concentrate for dairy cattle in Indonesia seemed to be poor quality as shown by very low protein content and relatively higher in crude fiber. DDGS that contain high protein and high by pass protein would be an ideal ingredient for dairy cattle in Indonesia. It was recommended that DDGS should be used at the farm level rather than incorporated as ingredient in concentrate. The farmers would observe a rapid increase in milk production when DDGS is used. For farmers who do not want to spend a higher additional cost because of DDGS usage, it is recommended to replace 1 kg concentrate with DDGS. However for the farmers who want to have higher milk production, supplementation was advised. The level of usage would

depend upon the quality of the feed currently used by the farmers; higher inclusion rate (> 1 kg/cow/day) may produce more extra profit for the farmers.

Conclusion

DDGS usage for dairy cattle diet in Indonesia was able to increase milk production. DDGS usage at 1 kg per day to supplement existing diet would improve > 3kg milk/cow/day while 1 kg DDGS to substitute 1 kg concentrate would increase milk production at 1 kg/cow/day.

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