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# In Situ Digestibility of Cogon Grass (*Imperata cylindrica* L.) in Various Forms and Harvesting Intervals in Rumen-Fistulated Brahman Cattle

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## Abstract

*An experiment was conducted to determine the nutritive value and nutrient digestibility in situ of cogon grass as affected by harvesting intervals in fresh and silage forms. The experiment was set up in a completely randomized design with a 2 x 5 factorial treatment design: factor A with two forms of cogon grass (soilage and silage), and factor B with five harvesting intervals after the last cutting (20, 25, 30, 35 and 40 days). Nutrient digestibility was determined by incubating ground samples of cogon grass soilage and silage in rumen-fistulated Brahman bull for 24 hours. Results revealed that cogon grass was best utilized in terms of the in situ digestibility of organic matter (OM) and neutral detergent fiber (NDF) at 20-day old after the last cutting and in silage form. Digestibility of dry matter (DM), OM and NDF of cogon grass in silage form were high at 25-30 days harvesting interval but these were significantly lower than that of 20 days interval. Therefore, the silage form of cogon grass is superior over fresh form, and the best utilization of cogon grass as feed is at 20 days after the last cutting to capitalize on high digestibility.*

***Keywords****:* in situ digestibility, harvesting interval, rumen-fistulated, cogon grass and various forms

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## 1. Introduction

Cogon grass (*Imperata cylindrica* L.) grows all around in the Philippines. It is known for its massive spread over large areas and is readily available all year-round. This species is traditionally used as roofing material, less often as feed for ruminants during periods of drought (Samson and Capistrano, 1982). Its use as animal feed could be limited because of low digestibility if grazed or harvested at a stage when its cell wall becomes highly lignified, and consequently, low voluntary intake. However, the grass can be maintained at a stage of fine leaves through frequent burning, grazing or cutting. Its low digestibility, low protein content and low herbage production in the dry season limit animal production compared with many other tropical grasses (Yunus *et al.*, 2000).

The performance of ruminant animals, which is dependent on the native pasture, is seriously impaired in drought. The quality is associated with the fibrous and lignified nature of the pasture that limits intake, digestibility and utilization (Olafadehan and Adewumi, 2009). The problem during summer season is that feed and feeding have been recognized as a limiting factor to a successful ruminant production due to poor quality and quantity feeds available for animals. This eventually results to a drop in animal performance in terms of growth, work, maintenance, production and reproduction (Darrag, 1995).

There is a seasonal variation in the availability of natural pasture. Pasture tends to be more succulent, highly nutritious and more abundant in the rainy season (around May to November) as opposed to the dry season (around November to April), where they become fibrous, scarce and devoid of most essential nutrients such as protein, energy, minerals and vitamins. These nutrients are required in increasing the rumen microbial fermentation that results into production of volatile fatty acid and performances of the host animal in the area of maintenance, production and reproduction (Sowande, 2004; Lamidi, 2009).

Forage preservation through ensiling is a way of ensuring the continuity in ruminant feed availability. It ensures sustainability of ruminant animal at the crucial period during dry season (Aina, 2012). One potential feed for ensiling is cogon grass because it is readily available year-round. However, improving the nutrient content and digestibility of cogon grass through ensiling at proper harvesting age should be verified and properly documented. Hence, this study was aimed at determining the optimum harvesting age of cogon grass in terms of soilage and silage forms. It identified the nutritive value of the grass at varying harvesting intervals in silage or soilage forms and compared nutrient in situ digestibility of cogon grass as affected by harvesting intervals and silage and soilage forms.

## 2. Methodology

### *2.1 Preparation of Experimental Animals and Diets*

A rumen-fistulated Brahman bull was used in the study. The cogon grass was fed in fresh or silage forms. Freshly cut cogon was wilted to 60-75% dry matter (DM) and chopped to 2-3 cm long. Urea-molasses was used as silage additive to the cogon grass at 2.1% of silage mass with molasses added at five times greater than that of urea (Ubod and Bestil, 2018a). The silage material was compacted and the air was withdrawn from the plastic silage bags that were then stored at room temperature of about 27-30 °C inside a 200-L plastic drums with clamp lid, and harvested after 21 days.

The experiment was set up in a completely randomized design (CRD) with three replicates, having a 2 x 5 factorial treatment design, as follows:

Factor A (Forms)

$A_1$ - Cogon grass silage
$A_2$ - Cogon grass soilage

Factor B (Harvesting Interval)

$B_1$ - Cogon (20 days after last cutting)
$B_2$ - Cogon (25 days after last cutting)
$B_3$ - Cogon (30 days after last cutting)
$B_4$ - Cogon (35 days after last cutting)
$B_5$ - Cogon (40 days after last cutting)

### *2.2 In Situ Digestibility Trial*

The nylon bags (5 x 10 cm, pore size of 53 microns) were oven dried at 65 °C for 30 min, and approximately 5 g of feed samples were placed for rumen incubation (Osuji *et al*., 1993). All bags were placed inside the lingerie bag with stainless steel weights to prevent the nylon bags from floating on the top of the liquid phase of the rumen digesta which would give very variable degradation rates (Preston, 1986).

Days one to eight covered the adjustment period (100% of treatment diets). This is the period to clear previously fed diets from the digestive tract and establish *ad libitum* (free choice) intake level of the treatment diets by giving 15 to 20% allowance of the day's offering based on previous day's voluntary intake. Diet composition was 70% basal Napier grass and 30% of test diets equally divided among them. From ninth to 12$^{th}$ day, the reduction of feed offered to 50-60% was done in order to accommodate the nylon bags with feed samples. The incubation period of 24 hours (h) was employed on the 13$^{th}$ day. Then, the nylon bags were harvested, washed thoroughly, and dried.

The samples were washed immediately after removal from the rumen under running water for 30 min while rubbing gently between the thumb and fingers until the water ran clear. The bags were then oven-dried at 60 °C for 48 h, and the dry matter (DM) degradation was calculated using Formula 1.

$$DMD\ (\%) = \frac{(W1 - W2)}{(W1)} \times 100 \tag{1}$$

where:

*W1* = weight of dried sample before incubation
*W2* = weight of dried sample after incubation

The organic matter (OM) degradation (%) was calculated using Formula 2.

$$OMD\ (\%) = \frac{OMW1 - OMW2}{OMW1} \times 100 \tag{2}$$

where:

*OMW1* = weight of dried sample before incubation × OM (%) before incubation
*OMW2* = weight of dried sample after incubation × OM (%) after incubation

The neutral detergent fiber (NDF) degradation (%) was calculated as follows:

$$NDFD\ (\%) = \frac{(WNDF1 - WNDF2)}{(WNDF1)} \times 100 \qquad (3)$$

where:

*WNDF1* = weight of dried sample before incubation × NDF (%) before incubation

*WNDF2* = weight of dried sample after incubation × NDF (%) after incubation

### *2.7 Statistical Analysis*

Data were analyzed using one-way analysis of variance (ANOVA) and comparison of treatment means was done by least significant difference (LSD) test using the Statistical Tool for Agricultural Research (STAR) version 2.0.1. Statistix version 10.0 was utilized for the analysis of the interaction among factors.

## 3. Results and Discussion

### *3.1 Dry Matter Digestibility*

Dry matter digestibility is the proportion of the dry matter in the feed that is digested by the animal. As shown in Table 1, there were no significant differences in terms of forms of diet. This means that soilage and silage cogon grass had a comparable effect on the dry matter digestibility. However, highly significant differences ($p < 0.01$) were noted in terms of the harvesting interval. Result also showed that in situ digestibility of cogon grasses cut at 20 days had the highest DMD. Cutting at 25 days was significantly different from 20 days although it showed a higher DMD too. Cutting at 30 and 35 days had a comparable effect while cutting at 40 days interval had a highly significant difference from other treatments.

Harvesting stage (maturity) is an important factor affecting the degradability of cogon grass. The cogon's DM degradability was lowest in its most mature form because its degradability decreased by maturity. With increasing maturity, plants – having a high content of cell wall – take the place of fresh plants that have high water content. Its use as animal feed could then be limited due to low digestibility if grazed or harvested at a stage when its cell wall becomes highly lignified (Karayilanli and Ayhan, 2016).

Table 1. Digestibility of dry matter (DMD), organic matter (OMD), and neutral detergent fiber (NDFD) of cogon at varying harvesting intervals in fresh and silage forms

| Treatments | DMD (%) | OMD (%) | NDFD (%) |
|---|---|---|---|
| Factor A (Diet form) | | | |
| $A_1$ - Cogon Silage | 30.62 | 73.86$^{a}$ | 83.27$^{a}$ |
| $A_2$ - Cogon Soilage | 31.63 | 64.29$^{b}$ | 62.13$^{b}$ |
| P-value | 0.0792$^{ns}$ | 0.0024** | 0.0001** |
| Factor B (Harvesting interval) | | | |
| $B_1$ - Cogon (20 days) | 39.38$^{a}$ | 77.05$^{a}$ | 80.96$^{a}$ |
| $B_2$ - Cogon (25 days) | 34.99$^{b}$ | 66.71$^{b}$ | 77.74$^{b}$ |
| $B_3$ - Cogon (30 days) | 26.02$^{d}$ | 77.93$^{a}$ | 73.04$^{c}$ |
| $B_4$ - Cogon (35 days) | 27.10$^{cd}$ | 61.21$^{b}$ | 68.06$^{d}$ |
| $B_5$ - Cogon (40 days) | 28.11$^{c}$ | 62.47$^{b}$ | 63.72$^{e}$ |
| P-value | 0.0001** | 0.001** | 0.0001** |
| Interaction Factor A x B | | | |
| $A_1B_1$ - Cogon Silage (20 days) | 40.10$^{a}$ | 98.12$^{a}$ | 88.93$^{a}$ |
| $A_1B_2$ - Cogon Silage (25 days) | 33.04$^{c}$ | 70.49$^{bcd}$ | 85.23$^{b}$ |
| $A_1B_3$ - Cogon Silage (30 days) | 27.99$^{d}$ | 83.32$^{b}$ | 85.35$^{b}$ |
| $A_1B_4$ - Cogon Silage (35 days) | 24.10$^{e}$ | 59.63$^{de}$ | 80.90$^{c}$ |
| $A_1B_5$ - Cogon Silage (40 days) | 27.84$^{d}$ | 57.75$^{de}$ | 75.96$^{d}$ |
| $A_2B_1$ - Cogon Soilage (20 days) | 38.67$^{b}$ | 55.98$^{e}$ | 72.98$^{e}$ |
| $A_2B_2$ - Cogon Soilage (25 days) | 36.94$^{b}$ | 62.93$^{cde}$ | 70.26$^{f}$ |
| $A_2B_3$ - Cogon Soilage (30 days) | 26.22$^{de}$ | 72.54$^{bc}$ | 60.73$^{g}$ |
| $A_2B_4$ - Cogon Soilage (35 days) | 27.94$^{d}$ | 62.79$^{cde}$ | 55.21$^{h}$ |
| $A_2B_5$ - Cogon Soilage (40 days) | 28.39$^{d}$ | 67.18$^{cde}$ | 51.47$^{i}$ |
| P-value | 0.006** | 0.0001** | 0.0001** |
| CV (%) | 4.84 | 10.95 | 1.85 |

Means within column with dissimilar letter superscripts are significantly different ($p < 0.05$).

Data also showed a highly significant interaction between the two factors. Dry matter digestibility was highest in cogon silage at 20 days cutting interval. This was followed by cogon soilage cut at 20 days interval which was comparable with or not significantly different from soilage cut at 25 days interval. Dry matter digestibility was comparable between cogon silage and soilage cut at 25 days interval, while cogon silage, and soilage cut at 30 days and soilage cut at 40 days had comparable effects. On the other hand, cogon silage and soilage cut at 35 days had a comparable effect on the DMD. The results suggest that the type of treatment and harvesting interval had significantly affected each other in terms of dry matter digestibility. However, it was noted that the type of preparation in soilage and silage forms and cutting intervals had a comparable effect.

The high DMD of grass-based silage was due to the use of chemical additives which can increase intake and digestibility of silages. Urea as an additive contains between 42 and 45% of nitrogen commonly used in fodder ammonization, as a source of non-protein nitrogen, utilized in reducing the fibrous portion of forage (NDF), favored the partial solubilization of hemicelluloses, and influenced the increase in intake and digestibility of silage (de Oliveira *et al*., 2016).

It was noted that reduction of dry matter digestibility of grass silages after a day of exposure to rumen microorganisms compared with soilage was due to the fermentation process caused by bacteria during the ensiling. Digestibility of a particular grass-based silage usually declines after it undergoes in situ digestibility due to the addition of particular silage additives, partial degradation of the nutrients present in the forage used during ensiling and fermentation processes of the silage.

### *3.2 Organic Matter Digestibility*

Organic matter digestibility is defined as the proportion of organic matter in the feed that is apparently digested in the total ruminant digestive tract. Organic matter digestibility can be used to measure the energy available and to estimate the protein microbial synthesis in the rumen (Anam *et al*., 2017).

Data show a highly significant difference ($p < 0.001$) between forms of diet in terms of OM digestibility (Table 1). Urea-ensiled cogon had a higher OMD compared with cogon soilage. The use of additives may stimulate the intake and improve digestibility of silages. The use of urea for instance, as a silage additive may provide additional nitrogen that improves digestibility. (Egan and Doyle, 1985).

In terms of harvesting interval, a highly significant difference also existed between the harvesting intervals. Cogon cut at 20 and 30 days had the highest OMD and had a comparable effect while cogon cut at 25, 35 and 40 days was not significantly different from each other. A 45-day cutting interval is recommended for most improved grasses; hence, the comparable effects in the OMD.

Data also showed a highly significant difference between the two factors, with cogon silage cut at 20 days having the highest value. Cogon grass silage cut at 25 and both cogon silage and soilage cut at 30 days had a comparable effect. Cogon soilage cut at 25 and 30 days was not significantly different from cogon soilage cut at 40 days. The data also showed that cogon silage cut at 25 and 35 days was comparable with soilage cut at 25, 35 and 40 days. Moreover, cogon cut at 35 and 40 days was comparable with soilage cut at 20, 25 and 40 days.

Due to the addition of urea molasses in cogon silage, higher OMD values for cogon that were harvested earlier compared to other treatments were observed.

### *3.3 Neutral Detergent Fiber Digestibility*

As shown in Table 1, highly significant differences were observed in terms of forms of diet, the harvesting interval and the interaction between the two factors.

Neutral detergent fiber digestibility is a good indicator of fiber contents in forages. In vitro NDF digestibility gives more accurate estimates of total digestible nutrients (TDN), net energy (NE), and feed intake potential compared with in situ NDF digestibility (Spanghero *et al*., 2010). In general, increased NDF digestibility would result in higher digestible energy and forage intakes. By including NDF digestibility parameter, ration balancing can be more precise resulting in more predictable production.

Results further showed a highly significant difference between cogon silage and soilage forms in terms of NDF digestibility. This means that urea-molasses ensiled cogon had a higher NDF digestibility compared with cogon soilage (Ubod and Bestil, 2018b).

In terms of harvesting interval, significant differences in digestibility were observed with cogon cut at 20 days interval having the highest value. This was followed by descending order of cutting interval, at 25, 30, 35 and 40 days cutting interval having the least value.

A highly significant difference was also observed between the interaction of the two factors with urea-ensiled cogon having the highest value, followed by silage cut at 25 and 30 days interval. Significant differences were noted between ensiled cogon cut at 35 and 40 days, cogon soilage cut at 20, 25, 30, 35 and 40 days interval.

It was noted that NDF digestibility values were higher in shorter time of cutting and decreased when cutting interval was longer. The reason for this is that maturity has the greatest influence on NDF digestibility. As forage matures, NDF digestibility can decline more than 40 percentage units (percent of NDFD). The decline in NDF digestibility in grasses and small grain silages is particularly dramatic with advancing maturity. In general, when grasses and small grain forages are in the vegetative stage, NDF digestibility is very high (>70% of NDFD). However, when stem elongation occurs in grasses and small grain forages, NDF digestibility declines at a relatively fast rate (Hoffman *et al*., 2003). With advancing maturity, plants develop xylem tissue for water transport, accumulate cellulose and other complex carbohydrates, and these tissues bound together by a process known as lignification. In particular, lignin in plant cell walls is more difficult for rumen bacteria to digest than cellulose or hemicellulose. As maturity proceeds, leaf-to-stem ratio declines and as a result, NDF digestibility declines because a greater portion of the total NDF is NDF associated with stem tissue (Doo, 2012).

## 4. Conclusion and Recommendation

The experiment on in situ digestibility of cogon grass implies that its utilization as ruminant feed is maximized when harvested at 20 days after the last cutting. Making the grass into silage form can stabilize on-farm feed supply from longer storage. It did not only make it highly digestible because of partial breakdown during anaerobic fermentation, but also improved nutritive value by way of fortification with highly nutritious additives.

Based on the results, the silage form of cogon grass was superior over that of soilage form; therefore, it is highly recommended. The best age to harvest was at 20 days after the last cutting. Silage making has become consequential to store the cogon grass harvested as early as 20 days after the last cutting if one wants to maximize digestibility. Therefore, cogon grass is better utilized at 20 days of age after the last cutting and in silage form in terms of the digestibilities of organic matter and neutral detergent fiber. Digestibilities of cogon grass in silage form were still high at 25-30 days harvesting interval but significantly lower than 20 days interval. The soilage form was inferior in digestibility compared with the silage form even at 20 days harvesting interval, and also when harvested at longer intervals.

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