

PREPARATION AND PRESERVATION OF MAIZE STALK FODDER

M. A. HOQUE¹, M. I. HOSSAIN², M. M. UDDIN³ AND M. A. ISLAM⁴

Abstract

Shortage of feed supply of the cattle during the dry season or flood period is an important issue which could be partially met by maize stalk. An experiment was conducted to prepare maize stalk fodder for cattle. The BARI chopper was improved for chopping maize stalk (MS) in smaller size (7-8mm) by adding blades and make the chopper safe by adding casing. The capacity of the BARI chopper was 745 and 425 kg/h with fresh and dried maize stalk, respectively. Total chopping cost per hour was Taka 0.23 per kg. The chopped maize stalk in both fresh and dried conditions with different combinations were served to the cattle and found that smaller sized chopped piece of both dried and fresh maize stalk could be feed in both raw and mixing with salt, wheat bran and water with little molasses. Maize stalk block also prepared with different combinations and found that block made by liquid *Gur* was better in both physically and cattle likeness. Total cost of block per kg was Tk. 13.85, 31.35, 28.85 and 36.35 for MS block 1, MS block 2, MS block 3 and MS block 4, respectively. Chopped and dried maize stalk were preserved in polybag, open drum and store room were liked by the cattle up to three months of the storage. Flatten and dried maize stalk were not liked by the cattle due to their long size and hardness.

Keywords: Maize stalk, Fodder, BARI Chopper, Capacity, Storage

Introduction

Fodder refers particularly to food given to the animals (including plants cut and carried to them), rather than that which they forage for themselves (called forage). Fodder includes hay, straw, silage, compressed and pelleted feeds, oils and mixed rations, and sprouted grains and legumes (such as bean sprouts, fresh malt, or spent malt). Most animal feed is from plants, but some manufacturers add ingredients to processed feeds that are of animal origin. The traditional feeding system for dairy cattle is based on the use of rice straw, natural grasses supplemented with a little or no concentrates. Rice straw is the main roughage for dairy cows, which is low in nutritive value and palatability but it contributes 90% of the roughage feed to animals (Khan *et al.*, 2009). The quantity and quality of fodder available from natural pasture shows seasonal fluctuation. There is an acute shortage of feed supply during the dry season and the available feed during this period is of very poor quality (Khan *et al.*, 2009). The various types of fodder available in

¹Senior Scientific Officer, FMP Engineering Division, Bangladesh Agricultural Research Institute (BARI), Gazipur-1701, ^{2&4}Ex Director General, Bangladesh Wheat and Maize Research Institute (BWMRI), Dinajpur, ³Ex Director (Research) BARI, Gazipur-1701, Bangladesh.

Bangladesh a forage grass, green grass, dry corn straw, wheat stalk etc. All of these fodders are chopped into small pieces to mix it together as it prevents animals from rejecting any part of their food. Cereal milling by-products, grains and oilcakes are the three major types of ingredients constitute concentrate feed in the country. Methane, a major component of greenhouse gas, produced in the rumen at the expense of up to 15% of the dietary digestible energy when it lacks supplementation of protein and soluble carbohydrate. It may be reduced up to 30% when rice straw diet is supplemented with urea and molasses (Huque and Chowdhury 1997). Introduction of densified complete feed block can improve nutritive value instead of poor quality and bulky roughages (Salem and Nefzaoui, 2003). The densified complete feed block technology offers a variety of benefits to the farmers and the feed manufacturers (Walli, 2011; FAO, 2012). Thus, molasses in addition to its contribution to farm animal production also can help mitigation of environment pollution. Promma *et al.* (1985) demonstrated that dairy cows fed with urea-treated rice straw has similar milk yield that of cows fed with fresh grass, and intake of the cows fed urea treated rice had a higher milk fat content and net income as compared with the milk produced by cows fed untreated straw. Now a days, maize of different varieties is widely cultivated in different areas of the country, after harvesting grain the remaining stalks can fed after processing (Jamee *et al.*, 2019). Nutrient composition of corn stover on dried and fresh condition are dry matter 92.9 and 28.9%, Crude protein 3.7 and 6.9%, crude fibre 42.4 and 30.1%, lignin 8.4 and 4.8%, ether extract 0.6 and 1.2%, ash 6.6 and 6.7%, total sugars 17.9 and 18.1%, gross energy 92.9 and 28.9 MJ/kg, calcium 2.9 and 3.7 g/kg, phosphorus 0.7 and 2.0 g/kg, potassium 13.6 and 18.7 g/kg, respectively (Bhandari and Bahadur, 2019).

The main component of the operating cost of dairy farming is the feed cost. Diversification and production of quality feeds and fodders are important for achieving economically sustainable animal production systems. Dual purpose crop introduction in the existing cultivation system potential of plantation crops, in a tropical country like Bangladesh, as animal feeds may be explored (Huque and Sarker, 2014). The primary concern with feeding corn stalks to dairy cattle is the physical nature of the stalks. Dairy cattle fodder (especially maize stalk) needs to be chopped prior to feeding. Therefore, this research was undertaken to improve the BARI chopper for effective size of maize stalk, to determine suitable mixture of molasses and stalk pieces and to find out the storability of maize stalk feed.

Materials and Methods

A straw chopper was available at Farm Machinery and Postharvest Process Engineering Division, Bangladesh Agricultural Research Institute, Gazipur. This chopper was suitable for chopping rice straw. The chopper was modified for chopping maize stalk in small pieces (Figure 1). The number of blades, feeding

tray and power transmission systems were modified during 2017–18. The description of different parts of the chopper are described below:

- 1) Feeding tray: A tray was made of sheet metal. The length of the tray was revised to feed the maize stalk and store. The tray dimension was 500x180x 16mm.
- 2) Feeding sprocket: There were two oppositely rotating feeding sprockets with 75 mm diameter and 180 mm length.
- 3) Cutting blade: Cutting blades were attached in 710 mm diameter wheel made of MS rod. There were two blades (300mm X 100 mm) which was made of high carbon steel settled on blade base (340 mm x 120 x 20 mm). Additional two blades with same dimension were added with it.
- 4) Blade casing: The blades were covered with a casing made of sheet metal. It was a round box having 900 mm diameter and 160 mm width. It increases safety of users. The casing was not available in previous models.
- 5) Delivery chute: The chopped maize stalk was delivered with a chute. The dimension of the chute was 360 x 280 x 120 mm where top side was open.
- 6) Frame: The main frame was carrying all load of the machine. The hopper, blades with casing and delivery chute was attached with it. Dimension was 1550 x 570 x 640 mm. But, the overall dimension was 1550 x 1380 x 1270 mm.

The chopper was tested with fresh and dried maize stalks. Two different sizes of stalks were feed the cows to evaluate their interest in eating. The chopped stalks were also served to the cow with different recipe.



Fig. 1. Operation of BARI chopper for chopping maize stalk

To prepare alternative animal feed the maize stalks were formulated to cubic silage like cake. Different silage blocks were prepared with various ratio of maize stalk and binding materials during 2017-18. The maize variety was BARI Hybrid

Maize-9. The maize stalk was dried at 7.5% MC. The binding materials were molasses, sugar, liquid and solid Gur. For all combinations, the binding material were heated for 15-20 minute up to the sticky phase come. About 250ml water was added with 1 kg liquid or solid Gur before heating. Then chopped maize stalks were mixed with binding materials with 1:1 by weight ratio. Then keep them to be cool for 5 minutes and after then the mixture was inserted and pressed to a 200 mm X 100 mm cubic frame to give a shape. The following combinations were tried: i) Block 1= Molasses+ maize stalk, ii) Block 2= Sugar + maize stalk, iii) Block 3= Liquid Gur + maize stalk and iv) Block 4= Solid Gur + maize stalk. Physical appearance of the blocks was evaluated. The developed blocks were feed to the cattle and their liking behavior were observed.

Dried and chopped maize stalk were preserved with four different forms. Those forms were: i) Form 1= Chopped (7-8mm) and dried maize stalk preserved in polybag, ii) Form 2= Chopped (7-8mm) and dried maize stalk preserved in open floor , iii) Form 3= Chopped (7-8mm) and iv) dried maize stalk preserved in store room and iv) Form 4= Flatten (0.75-1.25mm) and dried maize stalk preserved in store room. The liking behavior of cattle to eat dried maize stalk in different forms were studied with randomly selected 15 cattle having 130-145kg body weight. Storability of those forms were evaluated in terms of weight loss, physical appearance and fungus attack. Weight loss was calculated periodically. Physical appearance and fungus attack were observed periodically by investigators..

Results and Discussion

Performance of chopper for different types of maize stalk (MS) is shown in Table 1. Average of 20 chopped piece of maize stalk was 18.45 mm and 7.10 mm for fresh stalk with 2 and 4 blades respectively. Again, chopped piece of dried maize stalk was 18.85 mm and 7.12 mm for fresh stalk with 2 and 4 blades, respectively. Fresh copped size was little small as they were shrunk by losing moisture before taking measurement. Capacity of the chopper was more for chopping fresh stalk than the dried stalk. Similarly, Capacity of bigger size chopping was little more than smaller size though the blade shaft rpm was similar. It was happened due to operator's scope to push more length before coming the next blade to cut the stalk. Average capacity of the chopper was 744 kg/h and 700 kg/h for chopping fresh maize stalk with bigger and smaller size respectively. On the other hand, for dried stalk chopping with 2 and 4 blades the capacity of the chopper was 425 and 372 kg/h, respectively.

Table 1. Performance of chopper for different types of maize stalk (MS)

State of MS	Average Size, mm	Rep.	No of Blade	RPM of Engine	RPM of Blade shaft	Feeding amount (kg)	Time (min)	Capacity (kg/h)	Average capacity (kg/h)
Fresh	18.45	1	02	2000	212	50	4.00	750	744
		2	02	2017	214	48	4.10	702	
		3	02	2011	213	52	4.00	780	
	7.10	1	04	2000	212	48	4.00	720	700
		2	04	2015	214	45	4.00	675	
		3	04	2010	213	47	4.00	705	
Dried	18.85	1	02	2000	211	27	4.05	405	425
		2	02	2011	212	28	4.00	420	
		3	02	2010	213	30	4.00	450	
	7.12	1	04	2000	212	25	4.00	375	372
		2	04	2015	214	24	4.00	360	
		3	04	2010	213	26	4.10	380	

Chopped maize stalks were feed to cattle to check the likeness. Feeding likeness of different combinations of maize stalk (MS) is shown in Table 2. Small pieces (both fresh and dried) were liked much by the cattle than the bigger chopped maize stalk. The dried maize stalk with bigger size was disliked by the cattle. The likeness increased when the chopped maize stalks were served with salt and water. However, the cattle finished quickly showing their more demand when chopped maize stalks were served with salt, wheat bran and water mixing with some molasses.

The chopped dried maize stalks were made block with different combination of binding materials (combination in methodology). Physical appearance of different maize stalk (MS) blocks is shown in Table 3. Maize stalk block 3 was physically better in terms of appearance, smell, oil stickiness and compactness than others. . Maize stalk block 1 was physically worst. Santhiralingam and Sinniah (2018) were also prepared block with different agricultural waste.

Prepared all blocks were served to cattle with different combinations. Feeding likeness of different combinations of maize stalk (MS) blocks were shown in Table 4. Maize stalk block 1 was disliked by the cattle due to bad smell. Other blocks were liked. But when blocks were feed mixing with salt, and water, the cattle liked much. Use of chopped maize stocks as fodder also suggested by Surla and Krishna (2021).

Table 2. Feeding likeness of different combinations of maize stalk (MS)

Treatment	Feeding Rank			
	Like much	Like	Moderate	Dislike
Fresh MS size 15-20 mm			√	
Fresh MS size 7-8mm	√			
Dried MS size 15-20 mm				√
Dried MS size 7-8 mm		√		
Fresh MS size 15-20 mm + Salt+ Water			√	
Fresh MS size 7-8 mm + Salt+ Water	√			
Dried MS size 15-20 mm + Salt + Water		√		
Dried MS size 7-8 mm + Salt + Water	√			
Fresh MS size 15-20 mm + Salt+ Wheat Bran + Water + Molasses		√		
Fresh MS size 7-8 mm + Salt+ Wheat Bran + Water + Molasses	√			
Dried MS size 15-20 mm + Salt + Wheat Brun + Water + Molasses		√		
Dried MS size 7-8 mm + Salt+ Wheat Bran + Water + Molasses	√			

Table 3. Physical appearance of different maize stalk (MS) blocks

	MS Block 1	MS Block 2	MS Block 3	MS Block 4
Appearance	Not block	Partial block	Good block	Moderate block
Smell	Bad	Acceptable	Good	Good
Oil stickiness	Oily	Oily	Non-sticky	Non-sticky
Compactness	Bad	Partial	Very Good	Good

Table 4. Feeding likeness of different combinations of maize stalk (MS) blocks

Treatment	Feeding Rank			
	Like much	Like	Moderate	Dislike
MS Block 1				√
MS Block 2		√		
MS Block 3		√		
MS Block 4		√		

Cost analysis of BARI Chopper is shown in Table 5. Price of the BARI chopper was Tk. 50000. All fixed cost (Tk. 7.75 /h) and variable costs (Tk. 120 /h) were considered for this analysis with average capacity of both dried and fresh stalk chopping. Total chopping cost per hour was Tk. 0.23 . Preparation cost of different blocks were also calculated (Table 6). Total cost of block per kg was Tk. 13.85, 31.35, 28.85 and 36.35 for MS block 1, MS block 2, MS block 3 and MS block 4, respectively. Considering feeding likeness, Physical appearance and cost, MS block 3 (As shown in Fig 3) is an advisable option as alternate dry feed for cattle.

Table 5. Cost analysis of BARI Chopper

Sl. No.	Items	Fixed cost(Tk.)
1	Price (P), Tk.	50000
2	Salvage value (S), Tk. (10% of P)	5000
3	Working life (L), yr	10
4	Average annual use (Au), h/ yr	1200
5	<i>Fixed Cost</i>	
	i) Annual depreciation, $D=(P-S)/L$	4500
	ii) Interest on investment, $I=(P+S)/2*I$, where rate of interest is 12%	3300
	iii) Tax and insurance, $T=3\%$ of P	1500
	iv) Total fixed cost (D+I+T), Tk./ yr	9300
	v) <i>Total fixed cost, Tk./h</i>	7.75
6	<i>Variable cost</i>	
	a) No. of labour , Tk./h (1day-hour=400 taka)	50
	b) Fuel for chopping (Tk./h)	70
	c) Repair and maintenance cost (Tk./h)	1.46
	Total operating cost (Tk./h)	121.46
7	<i>Total cost (4+5)(Tk./h)</i>	129.21
8	<i>Total chopping cost, Tk./kg (Average Capacity 560 kg/h)</i>	0.23

Table 6. Preparation cost of different blocks

	MS Block 1	MS Block 2	MS Block 3	MS Block 4
Price of MS (Tk./kg)	0.50	0.50	0.50	0.50
Cost for MS chopping(Tk./kg)	0.21	0.21	0.21	0.21
Price of binding material (Tk./kg)	25	60	55	70
Labour (Tk./kg)	2	2	2	2
Total cost of block (Tk./kg)	13.85	31.35	28.85	36.35
Total cost of block (Tk./ton)	13850	31350	28850	36350



a) Block



b) Feeding blocks



c) Maize stalk fodder



d) Flatten stock



e) Dried maize stock

Fig. 3. Pictorial views of different forms of maize stalk fodder

Storability of dried maize stalk (MS) and Block is shown in Table 7. All forms of dried maize stalk and selected block were good in all storage systems up to three months except some colour change in the samples those were stored in open floor and store room. Feeding likeness of different forms of dried maize stalk (MS) are shown in Table 8. Chopped (7-8mm) and dried maize stalk were preserved in polybag, open drum and store room were liked by the cattle up to three months of the storage. Flatten and dried maize stalk were not liked by the cattle due to their long size. It may again feed after chopping but chopping in this stage was hard. Flatten sample took more space to store than the chopped sample.

Table 7. Storability of dried maize stalk (MS) and Block

Treatment	Initial			After 1 month			After 2 months			After 3 months		
	W (Kg)	A.	SP	W (Kg)	A.	SP	W (kg)	A.	SP	W (kg)	A.	SP
Form 1	2.25	B	Nil	2.25	B	Nil	2.25	B	Nil	2.25	B	Nil
Form 2	5.00	B	Nil	5.00	B	Nil	5.15	FB	Nil	5.20	FB	Nil
Form 3	5.00	B	Nil	5.00	B	Nil	5.05	B	Nil	5.10	FB	Nil
Form 4	5.00	B	Nil	5.00	B	Nil	5.10	FB	Nil	5.15	FB	Nil

W=Weight, A. =Appearance and SP= Spoilage, B=Brown, FB=Fate Brown,

Table 8. Feeding likeness of different forms of dried maize stalk (MS)

Treatment	Feeding Rank		
	Like	Moderate	Dislike
Form 1= Chopped (7-8mm) and dried maize stalk preserved in polybag	√		
Form 2= Chopped (7-8mm) and dried maize stalk preserved in open floor	√		
Form 3= Chopped (7-8mm) and dried maize stalk preserved in store room	√		
Form 4= Flatten (0.75-1.25mm) and dried maize stalk preserved in store room			√

Conclusion

Increasing maize production can open a new era of using maize stock as fodder for cattle. Maize stalk could be served by chopping in 7-8 mm size with BARI chopper and stored after dry in air tied bags. The chopped maize stalk could be feed either in fresh or dried conditions. The maize stalk block made with liquid gur (molasses) also could be prepared and feed to the cattle as an alternative fodder. Thus, the

maize stalk could be stored in different form for cattle which can be feed the cattle to meet the demand during disasters. However, a detail feeding trial is required to evaluate the cattle growth rate and feed conversion efficiency of maize stack and to select the best feed block.

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