International Journal of Sciences: Basic and Applied Research (IJSBAR)

ISSN 2307-4531
(Print & Online)

http://gssrr.org/index.php?journal=JournalOfBasicAndApplied

Feeding Dairy Cows with Maize Silage and its Effect in Milk Production and Milk Quality in Hai District

Mkani David Waziri[a*], Peniel Uliwa[b]

[a,b]*Match Maker Associates Limited (MMA), P.O. Box 12257, Arusha, Tanzania*

[a]*Email: mkaniwaziri@yahoo.com* , [b]*Email: peniel@matchmakergroup.com*

Abstract

A feeding experiment involving 16 lactating improved dairy cows was conducted to test the hypothesis that feeding maize silage (at 25% and 50% inclusion level to (4±3) kg maize stover + green forages and (3±1) concentrates) fed/cow/day based on individual dairy cow requirements would increase milk yield and improve milk composition. The experiment comprised three sequential periods that differed only in the way maize silage was offered to cows (farmers practice without maize silage in the diet, 25% and 50% maize silage in the diets fed in the morning and evening). Intake of individual cows was measured using spring balance (50kg). Compared with farmers practice experiment period, milk yield and milk protein for 25% and 50% inclusion levels of maize silage fed to dairy cows increased significantly ($p<0.0001$) respectively. There was an average increase in milk production by 50% from 10 to 15 litres per day during the experiment. Neither milk fat content nor milk solid yield was affected ($p>0.05$) by treatment. The increase in milk yield and milk protein content was presumably associated with an improved diet nutrient balance in the 25% and 50% MS diets fed to dairy cows. In this study, higher-producing dairy cows compensated for their higher requirements by increasing intake of maize silage, rather than pasture, as the former was the less restricted feed on offer. This highlights the importance of offering maize silage to dairy cows with other feeds (maize stover and greed forages) in order to enable high-producing cows in the herd to attain their higher intake requirements. In conclusion, under the conditions of the present study, feeding concentrates to cows based on individual cow requirements increased milk solids yield at no extra cost.

Keywords: Maize; Silage; Feeding; Cows; Milk.

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* Corresponding author.

1. Introduction

Dairy production is one of the largest agricultural activity practiced by many smallholder farmers in Hai District in Kilimanjaro Region. Dairy prays an important role in food security, employment creation, income generation, and enhances the living condition of many dairy farmers, traders and processors and all participants in the entirely milk supply chain in the district and region at large [4,7]. Hai District produces the high amount of milk due to its higher population of dairy cows as compared to other districts in Tanzania [3]. However, like in other areas, dairy production in Hai District is aggravated by low dairy feed resources mostly experienced in the dry season of the year, low genetically potential dairy cows, and unreliable markets for raw and processed milk products [3]. This study which was funded and supervised by DAIRYPROFIT Project, therefore, conducted on-farm in Hai District to take advantage of having a good land for producing maize for making silage and use it as an alternative feed stuff for feeding dairy cows into smallholding dairy farming systems in the area so as to improve the efficiency of dairy production in dry season months where feed shortage is vibrant and enormously reduce milk production to cows henceforth slows equitable distribution of income to many dairy household farmers and inhibit poverty alleviation in Hai District as in line with the Tanzania vision 2025 [5]. The overall objective of this study was to assess the effect of maize silage feeding on improved dairy cows and how it could improve the milk quality and quantity through the whole time of experiment in Hai District. Either some specific parameters were set to come up with concrete results as follows: -

i. To assess quality parameters (dry matter content, and crude protein of maize silage) that was to be used in feeding dairy cows during the experiment.
ii. Assess dairy cows' milk yield before and after the experimental periods.
iii. Assess the milk composition of dairy cows' before and after experiment periods.

2. Materials and Methods

2.1. Site location

The study was conducted in Hai District from October to December 2019. The district is located between latitude 30 to 40 south and longitude 340 to 350 east. The elevation of the district is between 1000m to 2000m above sea level. Hai District has an area of about 4600sq km, of which 90,000 ha is arable land. The climate ranges from semi–arid to sub–humid with an annual rainfall of between 800 – 1000mm. There are two main rainy season, the long rainy season extends from about March to mid-May and the short rainy period from November to December.

2.2. Animals and treatments

The study adopted a completely randomized design (CRD). The host farms owned at least one or two milking cows, kept under zero grazing system from six cooperatives of Nkwarungo, Nure, Mamba, Ng'uni, Marukeni, Chawamando, Nronga and Kalali were selected to represent other cooperatives. The selected cows were of those with the following criteria: Lactating cows of between one to two months at the time of experiment, number of calving was two, and the cow used was the improved dairy breed. The maize silage which were used in the

experiments obtained from youth groups of MKAF – Siha District, VIWANKUU and KIVIWAMA in Hai District in Kilimanjaro Region. The groups have been trained by DAIRYPROFIT Project and have invested themselves in the business of making and selling maize silage to dairy farmers in Kilimanjaro Region.

2.3. Quality parameters of maize silage used during the experiment

Sample of maize silage (500g) were carried for analytical laboratory processes at the Sokoine University of Agriculture for organoleptic test and pH determination, the other samples were analysed for chemical composition Dry matter (DM), Crude protein (CP), Neutral detergent fibre and in-vitro dry matter digestibility.

2.4. Monitoring of the study

Frequent farm visits, twice in a month were conducted by scientists from Innovate Company Limited while weekly visits were conducted by the dairy specialist from the Kilimanjaro Dairy Cooperative Joint Enterprise in Hai District. Farm and dairy evaluation sheets were used to record date and data all the time of experiment.

2.5. Estimation of feed offered to dairy cows

Quantities of maize silage offered and other feed stuffs (forage and supplementation) was measured and estimated at every week of the experiment. The simple weighing balance (50 Kgs) was applied in measuring livestock feeds at each farm household involved in the experiment.

2.6. Experiment feeds

Treatments corresponded to the following experimental diets:

1. Maize stover + Green forages + Concentrates
2. 25% Maize Silage + Maize stover + Green forages + Concentrates
3. 50% Maize Silage + Maize stover + Green forages + Concentrates

2.7. Data collection

Milk yield was recorded daily for the morning and evening every day for three weeks before the start of experiment and four weeks during the actual experiment. Milk samples were stored in a cold room until analysed in Laboratory at the Sokoine University of Agriculture in Morogoro Region. Milk samples (50 ml/individual cows) was taken for analytical laboratory processes. Milk compositions (fat, protein, density, water content, and pH) were analysed using FIL-IDF procedure by Milk Scan for all samples of milk collected from each individual milking cow under the experiment.

2.8. Statistical analysis

Analysis of data was conducted by using the Statistical Analysis System (SAS, 1999) Computer programme. Descriptive statistics were used to draw graphs in Microsoft excel.

2.9. Limitations of the study

The study required intensive engagement with dairy farmers. One of the main limitations of this study was inadequate knowledge and commitment of some of the dairy farmers during data collection. Consequently, researchers had to ensure that during critical data collection at farmer level they were present which was time consuming, but was crucial for accuracy and authenticity of data. Due to this intensive approach, only a relatively small sample size of dairy cows in the district was used for this experimental protocol. Despite these limitations, the author strongly believes this paper has generated sound basis for the findings that are shared in this study.

3. Results and Discussion

3.1. Nutritive values of maize silage

Nutritive values of maize silage used in this experiment was higher (8.5% CP) than (6.44% CP) that reported by [6] and equal to 8.75% CP reported by [1] in his study conducted on Evaluation of rations supplemented with fibrolytic enzyme on dairy cow's performance. The quality of silage was due to its low pH 3.5 – 4.2 and from well preserved sources, these levels helped to maintain optimal digestion and avoid acidosis.

Table 1: Nutritive Composition of Maize silage used during the experiment

	Tube inoculant MS	**Tube Molasses MS**	**Surface Inoculant MS**	**Surface Molasses MS**	**SEM**
DM %	23.90	25.66	22.66	24.85	24.75
CP %	7.63	8.08	9.77	8.71	8.55
NDF %	48.06	47.32	47.76	48.66	47.95
IVOMD %	48.52	49.37	48.36	46.91	48.29
IVDMD %	53.93	54.32	53.11	48.82	52.54
MJME/kgDM	10.3	10.4	10.6	10.5	10.4

MS = Maize Silage

3.2. Dry Matter Feed Intake

The study observed a high amount of feed wastage averaged 6kg per day/cow through farmers practice in Hai district. The reason for high wastage (refusal) of feed was due to high amount of feed stuffs offered to dairy cows per day without considering weighty of the cow and its production yield of milk of per day. Likewise, feeding of unprocessed feeds stuffs reported to be a challenging factor to feeding dairy cows in Hai District, hence reduced chewing ability and digestibility of dairy cow. Feeding of unprocessed feed stuffs to cows was because of limited knowledge and skills on dairy cows feed technology practices. The study similarly observed inadequate of extension services to dairy farmers, hence dairy farmers were practicing their own way preparation and feeding of dairies which resulted to producing low milk outputs and experienced low income through selling milk. However, the results of milk obtained during the study period in Hai District collected during early rain season where the area was marked with favourable regrowth of pastures for dairy cows. This affected positively milk production level in dairy cows compared to the dry season where, normally dairy cows are succumbed with negative energy and protein balance hence low production and productivity in dairy cows

and this prevails greatly in July – October. High dry matter intake of feed ($p<0.0001$) revealed at both 25% and 50% maize silage feeding levels (Table 2). The high intake was relatively higher during 25% MS and 50% MS due to high organic matter digestibility and palatability of maize silage diets offered to dairy cows during the experiments.

Table 2: Dairy dry matter feed intake of dairy cows (LS means and SEM)

	DM Intake before experiment	**DM intake at 25% MS**	**DM Intake at 50% MS**	**SEM**	***p***
DM Intake %	24.87	27.87	29.19	3.43	0.0001
Refusal %	6.31	0.36	0.82	0.57	0.0001

p=0.0001 Shows strong evidence of tested technology.

3.3. Milk yield and composition

The experiment revealed a significant increase in milk yields ($P<0.0001$) with 25% and 50% maize silage inclusion levels in the diets compared to the control diet which comprised of maize stover, green forages and concentrates (Table 3). The lowest milk production per individual farm was 5 and the highest was 10 litres/day before the experiment, where at the end of the experiment milk yield increased by 50% for the lowest dairy cow. The increase in milk yield could have been a result of the relatively higher intake of digestible CP of the two silages as well as the processed silage at harvesting time that influenced high intake of dry matter. Also, there was a slightly difference increase in milk yield between maize silage fed at 25% and 50%. Milk protein contents was higher ($P<0.0001$) at both levels of 25% and 50% diets offered to dairy cows during the experimental period. The study observed insignificant changes in total milk solid for control and experimental diets at all levels of inclusion. The same results was observed on fat compositions, the diets had no effect ($P>0.05$), the control feed and experimental diets produced the same results on butterfat milk contents. The relatively higher fibre contents in the control diet and the level of grain in maize silage used in experimental diets (25% and 50%) could be the source of this results. Inclusion of an additional fibre source may increase milk solids production as reported by [2]. And this situation is more likely with crops (maize) that have a high cob: Stover ratio.

Table 3: Mean effect of different levels of Maize Silage on milk yield and quality

	Control feed (Before Experiment)	**Maize Silage at (25%) level**	**Maize Silage at (50%) level**	**SEM**	***P***
Milk yield (Lt/day)	10.27	11.28	12.92	4.16	0.0001
Milk Composition					
Total Solid (%)	12.37	12.43	12.41	0.43	0.0056
Protein (%)	2.89	3.54	3.63	0.35	0.0001
Fat (%)	3.83	3.95	3.87	0.57	0.5203

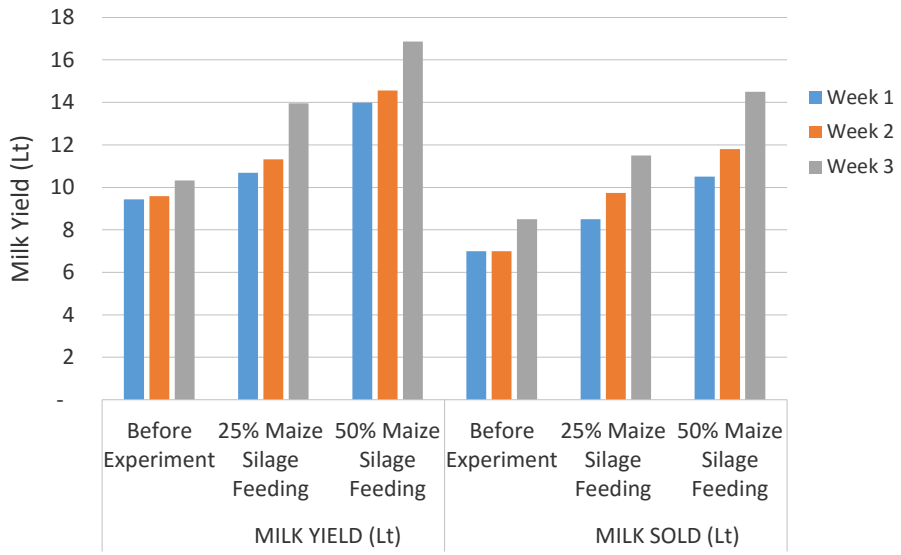

Figure 1: The trend of milk production and milk sold during the experiment of feeding maize silage for improved dairy cows

Figure 2: A well preserved surface maize silage being taken for feeding dairy cows in Hai District

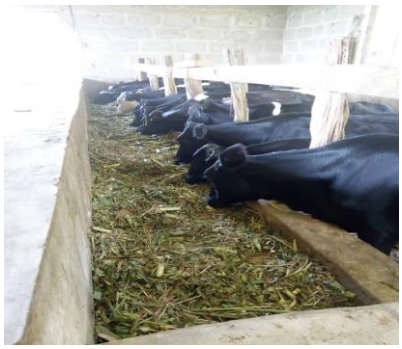

Figure 3: Dairy cows feeding on maize silage

3.4. Revenue obtained from selling of milk produced

The highest sell and gross margin of milk per litre strongly represented by ($p<0.0001$) attained during 25% and 50% maize silage feeding experiment compared to farmer's practices (Table 4). The cost of production of milk per litre was low during the experiment period, this was associated by high milk yield produced per cow after feeding of maize silage hence enabled farmers to earn a substantial profit compared to the sale of milk during farmers' practices. The low cost of producing a litre of milk per cows in 25% and 50% maize silage feeding was attributed to the fact that the dairy cows consumed the least amount of feed and produces highest quality of milk. For dairy keepers to be able to fetch profit from dairy business they must produce at least 10 litres of milk per day, see example of simple calculations on cost of milk production for low (5litres) and ten (10litres) in two different farms (Table 5). The small amount of milk produced per cow/per litre in a day, the expensive it becomes for producing a litre of milk per cow. For dairy farmers to be able to realise profit from selling of milk they are supposed to apply nutritive feed stuffs for feeding dairy cows so that they can produce conferring to their genetically potentials. High production of milk considering the quality and quantity will attract more

investors in the dairy subsector to invest in the sector through installation of collection centres, establishing of simple dairy processing industries, as of the fact that milk is bulky and highly perishable, therefore, milk processing is prerequisite to milk marketing. Through processing fluid milk will be transformed into high value products. This will improve the quality of milk and be able to serve the market with a wide range of products. Processing will bring more improvement in milk and milk by-products utilisation henceforth create suitable and sustainable milk market value chain for dairy farmers in Hai District.

Table 4: Dairy milk sold during farmer's practices and maize silage feeding experiments (LS means and SEM)

	Milk sold before experiment	**Milk sold at 25% MS**	**Milk sold at 50% MS**	**SEM**	***p***
Milk yield (Lt/day)	10.65	11.28	12.92	4.33	0.0001

Table 5: Example; of cost of milk production in two farms (A and B) producing in different levels 5 and 10 litres/day (in 30days)

Variable dairy activities	**Unit**	**Simple calculations on cost of feeds (TSH)/Month (A)**	**Milk Yield/Month (B)**	**Price of milk /litre (C)**	**Total revenue D (B*C)**	**Net profit E (D-A)**
1 Sack of cut & carry forage	35kg	(1000*30) =30,000	(5*30) =150	800	120,000	4,800
Concentrate	2kg	(2*350) *30=21,000				
Maize stover	8kg	(8*80) *30 = 19,200				
Labour charges	1500Tsh	1500*30 = 45,000				
	Total	**115,200**				

Variable dairy activities	**Unit**	**Simple calculations on cost of feeds (TSH)/ Month (A)**	**Milk Yield/Month (B)**	**Price of milk /litre (C)**	**Total revenue D (B*C)**	**Net profit E (D-A)**
1 Sack of cut & carry forage	35kg	(1000*30) =30,000	(10*30) =300	800	240,000	80,400
Concentrate	2kg	(2*350) *30=21,000				
Maize stover	4kg	(4*80) *30 = 9,600				
Maize silage	6kg	(6*300) *30 =54,000				
Labour charges	1500Tsh	1500*30 = 45,000				
	Total	**159,600**				

Estimated cost of producing milk in farm A (Variable cost without considering other factors of production)

Estimated Cost of producing milk in farm B (Variable cost without considering other factors of production)

4. Conclusions and recommendations

The on-farm experiment study performed on utilisation of maize silage as supplemental diets mixed with other

fodder grasses during the dry season of the year for maximizing milk yields and milk quality realised that, maize silage provides a low cost source of energy in the form of starch and fibre which accolades well for sustainable dairy production. For dairy keepers adapting to feeding their animals with maize silage will assure them of producing efficient milk throughout the year, break the feed barrier, reduce cost of production and assist them to create a sustainable avenue for earning more income through selling of milk. It is highly recommended to improve the protein content of the forage grasses by establishing forage plots/garden well intercropped of leguminous plant feeds to boost the protein contents of the feed mixtures. This will help farmers to move from cut and carry feeding systems and be able to harvest fodder at finest stage and attain the highest nutritive quality feed that will be used by dairy cows all the year. The dairy farmers should stop the tendency of selling milk directly and in small quantities, to avoid a creation of diseconomies of scale. The available cooperative models should be capacitated with improved technologies in handling and processing milk and improve their infrastructures. Dairy farmers should endeavour on getting improved and suitable genetically potential dairy cows to be able to produce sufficient milk and reduced cost of production of milk per litre per cow and this will be echoed through earning of income over selling of milk.

Acknowledgements

This work is supported by European Union (EU) under the European Development Fund managed by Technical Centre for Agricultural and Rural Cooperation (CTA).

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