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Effect of legume type and nitrogen source on milk yield among dairy cows fed maize (Zea mays) stover treated with groundnut (Arachis hypogea) and soybean (Glycine max) stover

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Abstract

The main objective of the study was to develop technology for improving utilization of abundant quantities of under-utilized crop residues and leguminous plants during the dry season to mitigate effects of dry season on milk yield. The study was set up to test practical ways of upgrading low quality roughage and their effect on milk yield. A 22 factorial experiment within a Completely Randomised Design (CRD) was used. The study involved improving the quality of maize stover using urea fertilizer (UF), chopped groundnut (cGS) and soybean (cSS) stover, mineralized groundnut (mGS) and mineralized soybean (mSS) solution as sources of nitrogen. Research findings revealed superiority of UET over both groundnut and soybean stover in improving the quality of maize stover. Across legume types, groundnut stover had a higher positive effect on improving the quality of maize stover in terms of milk yield. Within legume stover type mGS showed superior milk yield values than cGS. The reverse was true for soybean stover. The study indicated the effect of improving maize stover with cSS on milk yield was higher than that of mSS in improving the quality of maize stover. It was generally observed that the use of mineralization of legume stover in improving the quality of maize stover is more effective than chopping. Pooled result of effect of mineralised groundnut and soybean stover on milk yield was significantly ($p<0.05$) higher than that of the chopped forms for the same legume stover. When evaluated across legume type the effect of legume type on milk yield did not differ significantly ($p>0.05$) for both processing methods.

Keywords: Maize; Groundnut; Soybean; Stover; Nitrogen; Milk

1. Introduction

In recent decades, developing countries have increased their share in global dairy production. This growth is mostly the result of an increase in numbers of milk producing animals rather than a rise in productivity per head. In many developing countries, dairy productivity is constrained by poor-quality feed resources, diseases, limited access to markets and services (e.g., health, credit and training) and dairy animals' low genetic potential for milk production. Unlike developed countries, many developing countries have hot and/or humid climates that are unfavourable for dairying (FAO, 2012) [1].

Dairy industry in Zambia is very small and demand for milk far outweighs supply. The dairy sector in Zambia is a viable industry that could contribute to poverty reduction especially in rural areas. However, over the years this sector has been unable to supply the much needed milk with only an annual supply of about 125 million litres. There is a shortfall of about 25% in the market (Hemen and Tony, 2015) [2]. Pandey and Voskuil (2011) pointed out that the recommended annual consumption of milk by the WHO and FAO report is in the range of 200 million litres per year [3]. According to

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Aregheore (2010) dairy intake of milk in Zambia stands at less than 40 million litres. The same report indicated that the dairy industry is not well organized. The dairy herd is estimated at 1 – 2% of total national herd of cattle (i. e 500,000) [4].

Dairy production is relatively small in relation to the large domestic market for dairy products. Aregheore (2010) indicated that in 1982 there were about 600,000 small-scale milk producers (traditional dairy sub-sector) and about 100 large-scale commercial producers (modern dairy sub-sector). The 600,000 small-scale producers provide for on-farm domestic consumption and the estimated production from this sub-sector in 1982 was 28 million litres [4]. The 100 large-scale dairy farms, including 11 state farms were estimated to have produced about 10.5 million litres during the same period (Pandey and Voskuil, 2011) [2].

1.1. Seasonal Changes and its Impact on Feed Resources

In different regions of the world dairy cattle milk yields differ due to many factors such as environment, season, nutrition and difference in genetic makeup of animals (Rhone, 2008) [5]. Milk yield and reproductive performance play major roles in determining the profitability of a dairy herd (Toghiani, 2012) [6]. It has been observed that the milk production by smallholder dairy farmers during the dry season is significantly reduced. During that period, which might last up to six months per year, the quantity of milk, which the average farmer is able to sell and deliver, is reduced by 35%- 60%. This means that the income of those farmers is also reduced considerably during that period. However, it is also observed that in many cases the milk production and the delivery of milk by commercial and progressive smallholder dairy farmers is hardly affected The milk delivery from about 160 farmers at a Smallholder Dairy Farmers Association (SDFA) is reduced in the period April – October, while the delivery of milk by a commercial farmer is rather consistent during the year (Pandey and Voskuil, 2011) [3].

1.2. Environmental, Seasonal and Physiological Factors affecting Milk Quantity

It has long been known that season of the year has major impacts on dairy animal performance measures including growth, reproduction, and lactation. Epaphras, Karimuribo and Msellem (2011) reported that the critical period, in terms of daily milk production in Tanzania, was from December through February, a period of high ambient temperature and low rainfall. During this period production dropped to as low as 6.1 and 205 litres/day per cow and farm, respectively. However, these workers observed that there was no significant difference between average daily milk production between dry and wet seasons [7].

The relevance of forage production and its utilisation in farming systems rests primarily in its applicability and potential to service the need and aspirations of the integrated small-scale livestock farmers. Forage has been and will continue to be an important resource base for feeding dairy animals in the Southeast Asian region. As a matter of fact, smallholder dairy farmers only own a small number (112) of animals, and therefore, adoption of any new technology involves a risk factor whether in economic outlay or management. A systematic critical appraisal of the establishment and management methods of improved pasture and fodder species is probably relevant in the promotion for better development and utilisation of the crop by dairy cattle in the small-scale farming systems (Mohd et al, 2013) [8]. Supply of adequate nutrients is crucial for optimum milk production without jeopardizing the reproduction capacity of dairy animals. However, tropical feed resources are of low quality and demand appropriate supplementation to boost milk production from improved dairy genotypes (Mosimanyana and Kiflewahid, 2012) [9]. It was reported by Mosimanyana and Kiflewahid (2012) that cereal crop residues are available to all farmers and since they are low in crude protein content there is a need to supplement them with high protein legumes (Cowpeas) and fodder crops (lablab) or locally produced milling by-products (moroko). The feeding systems based on natural grazing (summer) and feeding of conserved crop residues (winter) are the most practical [9].

1.3. Problem Statement

It has been observed that milk yield among small holder dairy farmers has been erratic over the years especially during periods of drought. The effect of supplementation of maize stover with legume stovers on milk yield has not been evaluated. It is against this background that a research project was carried out at Batoka Livestock Research Station in Zambia. The research was designed to:

To assess the effect of improving the quality of maize stover using groundnut and soybean stover on milk yield in dairy cows.

2. Materials and methods

2.1. Research site

The research was conducted in the Southern Province of Zambia. The province lies at an altitude range of 400- 1400 metres above sea level. It has a mean annual temperature ranging from 14°C to 28°C. It receives an annual rainfall of 700 mm to 1000 mm. The soil type ranges from clay to sandy loam (Ministry of Agriculture, 2013) [10].

2.2. Methodology

2.2.1. Study 1: Treatment with urea

Dry maize stover was chopped using a shredder machine and treated using the Urea-Ensiling Technique (UET) before being offered to the cows. The standard method of urea treatment used in other developing countries which involves the making of a solution of urea using four kilograms (4 kg) urea fertilizer feed grade (46%N) into sixty (60) litres of water and mixing this with one hundred kilograms (100 kg) of stover was used. Pits were dug on raised ground for the purpose of the UET. The stover were chopped into 3-5 cm pieces, mixed with the urea solution using a watering can and buried into the pit. Polythene plastic sheets and compacting were used to ensure an air-tight environment. The stover and straw were ready to be fed to cows after 21 days (3 weeks urea incubation period). Three kilograms (3 kg) of the feed was given to each cow per day in a 2^2 factorial experiment in a Complete Randomised Design (CRD). UET was taken as novel therapy or positive control and compared with the test therapies.

2.2.2. Study 2: Treatment with legume stover

The quality of maize stover was improved using mineralised and chopped legume stover [Groundnuts (*Arachis hypogea*) and Soybean (*Glycine max*)]. These feeds constituted test therapies. The feed ingredients (maize and legume stover) were all procured from local farmers. Three kilograms (3 kg) of the feed was given to each cow per day in a 2^2 factorial experiment in a Complete Randomised Design (CRD). Four rations were prepared on the basis of cereal type, legume type, source of nitrogen and method of processing of legumes as follows:

- Maize stover + mineralized Groundnut stover solution
- Maize stover + chopped Groundnut stover
- Maize stover + mineralized Soybean stover solution
- Maize stover + chopped Soybean stover

A similar number of animals fed on commercial diet (dairy meal) were used as positive control. Additionally, another similar number of animals that just graze normally (no supplementation) were used as negative control. Test diets were formulated such that they were iso – nitrogenous (same CP) and iso – energetic (same GE or ME). To ensure that the diets were iso-nitrogenous and iso-energetic, samples of cereal and legume stover were analysed for their GE and nitrogen content respectively before rations were compounded. Quantities of cereal and legumes (maize, groundnut and soybean stover) used were computed by simple proportion to equate the energy and nitrogen content in each feed based on the results of the proximate analysis. This was important for the data to be valid and reliable, hence, the conclusions and recommendations.

2.2.3. Mineralization of legume stover

Dry groundnut and soybean stover were tied into bundles each weighing five kilograms (5 kg). Three (3) bundles of groundnut stover bundles were completely immersed in 100 litres of water in a plastic drum of 210 litre capacity. The drum was covered with a tight lid. Another three (3) bundles of soybean stover were treated in a similar manner in another drum. The set up was left for five days to allow for mineralization to take place. A preliminary proximate analysis of samples revealed that a period of five (5) days was the optimum for mineralisation to be effective.

2.2.4. Ration formulation

Rations were prepared using the BLP 88 computer programme (1987) [11] to meet the nutrient requirements of dairy animals (NRC, 2001) [12]. Amounts generated from the ration formulation programme were measured using a scale and mixed by rolling and turning several times on polythene plastics spread on concrete floor using a garden fork in order to ensure consistence in the composition.

Two (2) types of rations were compounded-one comprising chopped cereal stover and chopped legumes while the other comprised chopped cereal stover and mineralized legume solutions. The mineralised legume solutions were sprayed on the measured quantities of chopped maize stover using a watering can and then turned several times using a garden fork on a concrete floor. To help bind the chopped (ground) legume stover to maize stover as well as to improve palatability molasses solution was sprinkled and mixed with all types of rations at compounding. All other ingredients were the same for the rations but only differed in the source of protein and processing method used. Feeds were then packed in 25 kg plastic bags in readiness for delivery to the milking parlour where feeding was carried out.

2.2.5. Feeding trials

The feeding trials involved twelve (12) lactating dairy cows in their second parity arranged in a 2^2 factorial experiment within a Complete Randomized Design (CRD). The experimental units (dairy cows) were randomly selected using simple random numbers from the herd available at Batoka Livestock Trust Research Centre (BLTRC). Treatments (rations) were randomly allocated to experimental units (dairy cows) by picking lots using animal identities (Ear-tags and feed type) written on pieces of paper and placed in two separate urns (boxes). An adaptation period of five (5) days was allowed for each feed before data was recorded.

The feeding trial commenced by determining of the optimum quantity of feed to be given to each animal. Quantities of four kilograms (4 kg), three kilograms (3 kg), two kilograms (2 kg) and one kilogram (1 kg) were tried over a period of seven (7) days. During the trial one kilogram (1 kg) of feed was found to be the appropriate quantity of feeding to appetite during supplementation since rejected quantities were much less.

The experimental cows were allowed to graze from seven (7) to twelve (12) hours and then brought to the milking parlour for milking each day. Each animal was offered one (1 kg) of the ration being administered at a given time (control or test therapy). The control or test treatments were supplements to the free grazing during times of feed shortage. The parameter used to test the effect of the treatments was milk yield. An adaptation period of seven (7) days was allowed for each feed before data was recorded.

2.2.6. Statistical model

$$Y_i=\mu +R_i + b(x) + \varepsilon_i$$

Where Y_i= observed milk yield on individual cow of a given i^{th} legume type.
μ=overall mean
R_i=effect of the i^{th} legume type
b(x)=b is the regression coefficient for initial milk yield used as a covariate
ε_i=random error component

2.2.7. Research design and data collection

The twelve (12) dairy cows were arranged in a 2^2 factorial experiment in a Complete Randomized Design (CRD). Daily milk yield was recorded on individual score cards identified by animal identity numbers from June 12, 2017 through November 09, 2017.

2.2.8. Statistical analysis

Data was analysed using the Statistical Analysis System on the General Linear Model computer. Treatment means were compared using the F-test.

3. Results

Figure 1 below, shows the trends of daily milk yield from cows fed on the improved maize stover using feeding grade urea, mineralized groundnut stover solution, mineralized soybean stover solution, chopped groundnut stover and chopped soybean stover during the feeding period.

Milk yield was highest for animals fed on maize stover treated with Urea Ensiling and lowest for maize stover improved by addition of chopped soybean stover (Fig. 1 and 2).

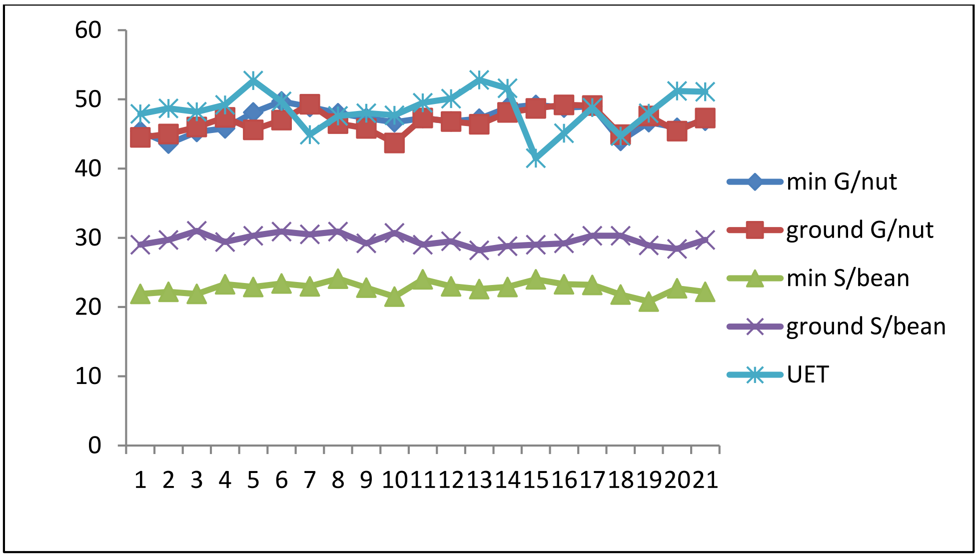

Figure 1 Milk yield response of cows to rations during the feeding trial

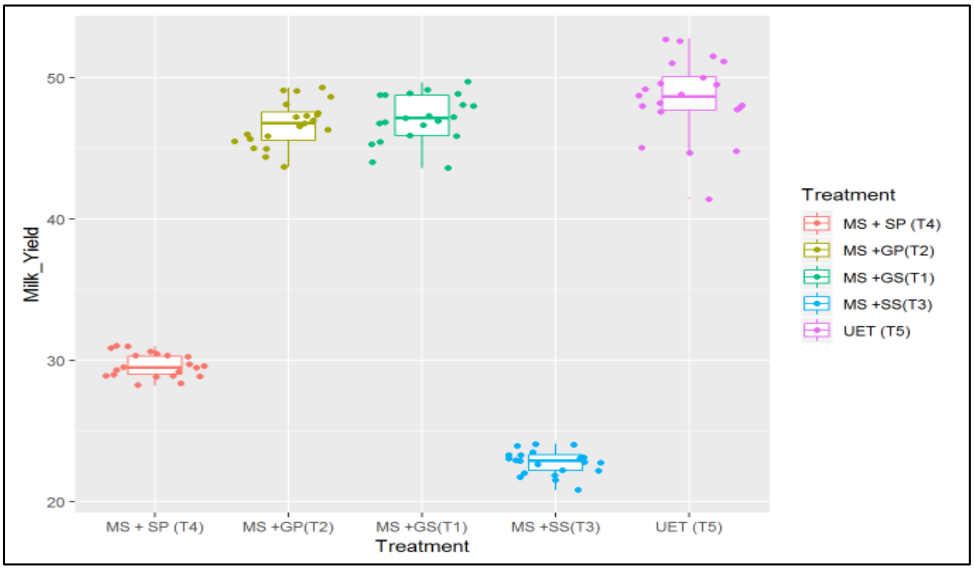

Figure 2 Distribution of milk yield by treatment

Table 1 Effect of Groundnut Stover Processing Method on Milk Yield (ltrs)

Treatment	Replication						Total (Y)	Mean ($\bar{y}$)	SD	SEM
Mineralized G/nut solution	1.8	9.1	11.2	7.6	11.5	6.1	47.3	7.88		1.0
Chopped G/nut stover	9.9	14.3	7.1	5.2	6.7	3.6	46.8	7.80	±3.5	
							ΣY=94.1	$\bar{\bar{Y}}$ =7.84		

Average milk yield for cows fed maize stover treated with mineralized groundnut stover solution and chopped groundnut stover were 7.88ltrs (s.e=1.0) and 7.80ltrs (s.e=1.0) respectively (Table 1). Across processing method the effect of groundnut stover on milk yield did not differ significantly (p>0.05) (Table 2). A similar trend was reflected in the milk yield of cows fed on mineralized and chopped soybean stover (Tables 3 and 4). The effect of method of processing on milk yield in groundnut showed variance estimate of 0.8ltrs and residual of 12.25 ltrs.

Table 2 Analysis of Variance for Effect of Mineralization and Grinding of Groundnut Stovers on Milk Yield (ltrs)

Source of variation	df	Sum of squares	Mean square	Fcal	Ftab
Total	11	138.6			
Treatment	1	0.02	0.02	0.001	4.96
Error	10	138.6	13.9		

CV=44.6%

Table 3 Effect of Soybean Stover Processing Method on Milk Yield (ltrs)

<table>
<tr><th>Treatment</th><th colspan="5">Replication</th><th>Total
(Y)</th><th>Mean
($\bar{Y}$)</th><th>SD</th><th>SEM</th></tr>
<tr><td>Mineralized S/bean solution</td><td>4.6</td><td>1.4</td><td>8.8</td><td>3.4</td><td>4.5</td><td>22.7</td><td>4.54</td><td></td><td rowspan="3">0.98</td></tr>
<tr><td>Chopped S/bean powder</td><td>8.0</td><td>11.2</td><td>4.8</td><td>2.5</td><td>3.1</td><td>29.6</td><td>5.92</td><td>±3.11</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td>ΣY=52.3</td><td>$\bar{Y}$ =5.23</td><td></td></tr>
</table>

Table 4 Analysis of Variance for Effect of Mineralization and Grinding of Soybean Stover on Milk Yield (ltrs)

Source of variation	df	Sum of squares	Mean square	F_{cal}	F_{tab}
Total	9	83.69			
Treatment	1	4.79	4.79	0.48	5.32
Error	8	78.9	9.86		

CV=59.5%

Comparison of effect of legume stover type on milk yield is shown in tables 5, 6, 7 and 8. The effect of improving maize stover using mineralized groundnut stover and mineralized Soybean stover showed numerical milk yield values of 7.88 ltrs (s.e=0.4) and 4.54 ltrs (s.e=0.4) respectively (Table 5). The study revealed a variance estimate of 1.69ltrs and residual of 3.34ltrs for mineralization of the legume types. The effect of mineralization of the two types of stover on milk yield did not differ significantly (p>0.05) (Table 6). The variance estimate and residual for effect of method of processing on milk yield in Soybean were 9.67 ltrs and 1.38 ltrs respectively.

An evaluation of effect of treatment of maize stover with chopped groundnut and soybean stover on milk yield revealed higher (7.8 ltrs, s.e=1.1) numerical value for cows fed on chopped groundnuts compared to that of milk yield (5.9 ltrs, s.e=1.1) from cows fed on maize stover treated with chopped soybean stover (Table 8). Similarly, the mean milk yields for chopped legume inclusions did not differ significantly (p>0.05) (Table 8). The magnitude for variance estimate was 12.96 ltrs while that of the residual was observed to be 1.9 ltrs.

However, when the effect of pooled mineralized legume stover solution and pooled chopped legume stover on milk yield were compared the mean effect of pooled mineralised legume stover solution was numerically higher (7.7 ltrs, s.e=0.9) than that of the effect of pooled chopped legume stover (5.8 ltrs, s.e=0.9) (Table 9). The mean milk yield for the effect of mineralized legume stover solution and chopped legume stover differed significantly (p<0.05) (Table 10). The variance estimate and residual for pooled effect of processing method on milk yield was 10.89 ltrs and 1.9 ltrs respectively.

Table 5 Effect of Mineralized Groundnut and Soybean Stover on Milk Yield (ltrs)

Treatment	Replication						Total (Y)	Mean ($\bar{Y}$)	SD	SEM
Mineralized G/nut solution	1.8	9.1	11.2	7.6	11.5	6.1	47.3	7.88		0.4
Mineralized S/bean stover	4.6	1.4	8.8	3.4	4.5	-	22.7	4.54	±1.3	
							ΣY=70 Y	$\bar{\bar{Y}}$ =6.2		

Table 6 Analysis of Variance for Effect of Mineralized Groundnut and Soybean Stover on Milk Yield (ltrs)

Source of variation	Df	Sum of squares	Mean square	F_{cal}	F_{tab}
Total	10	125.6			
Treatment	1	30.46	30.46	2.88	5.12
Error	9	95.14	10.57		

CV=20.9%

Table 7 Effect of Chopped Groundnut and Soybean Stover on Milk Yield (ltrs)

Treatment	Replication						Total(Y)	Mean ($\bar{Y}$)	SD	SEM
Chopped G/nut powder	9.9	14.3	7.1	5.2	6.7	3.6	46.8	7.8		1.1
Chopped S/bean powder	8.0	11.2	4.8	2.5	3.1	-	29.6	5.9	±3.6	
							ΣY=76.4	$\bar{\bar{Y}}$=6.9		

Table 8 Analysis of Variance for Effect of Choppinng Groundnut and Soybean Stover on Milk Yield (ltrs)

Source of variation	Df	Sum of squares	Mean square	F_{cal}	F_{tab}
Total	10	135.5			
Treatment	1	9.67	9.67	0.69	5.12
Error	9	125.83	13.98		

Table 9 Effect of Pooled Mineralised Legumes Vs Pooled Ground Legumes on Milk Yield (ltrs)

Treatment	Replication						Total (Y)	Mean ($\bar{Y}$)	SD	SEM
Mineralization	9.0	12.8	6.0	3.9	4.9	1.8	46.3	7.7		0.9
Chopping	3.2	5.3	10.0	5.5	8.0	3.1	35.0	5.8	±3.3	
							ΣY=81.3	$\bar{\bar{Y}}$ =6.8		

Table 10 Analysis of Variance for Effect of Processing Method of Legume Stover on Milk Yield (ltrs)

Source of variation	Df	Sum of squares	Mean square	F_{cal}	F_{tab}
Total	11	14.69			
Treatment	1	10.65	10.65	26.36	4.96
Error	10	4.04	0.404		

CV=48.5%

Table 11 and 13 shows the comparison of the effect of the control (UET) on milk yield used by many smallholder dairy farmers for supplementation against the test therapies of this study (i.e mineralised groundnut and Soybean stover solution, chopped groundnut and Soybean stover). Numerically, the effect of the Urea Ensiling Treatment (UET) was superior (8.0 ltrs, s.e=0.64) to all the test therapies. The mean milk yields for UET and the test therapies differed significantly ($p<0.05$).

Table 11 Effect of Maize Stover Quality Improvement on Milk Yield (Ltrs)

Treatment	Replication						Total(Y)	Mean ($\bar{Y}$)	SD	SEM
Mineralized G/nut	1.8	9.1	11.2	7.6	11.5	6.1	47.3	7.88		
Chopped G/nut	9.9	14.3	7.1	5.2	6.7	3.6	46.8	7.80		
Mineralized S/bean	4.6	1.4	8.8	3.4	4.5	-	22.7	4.54	±3.36	0.64
Chopped S/bean	8.0	11.2	4.8	2.5	3.1	-	29.6	5.92		
UET	9.3	8.2	8.9	3.2	10.6	8.0	48.2	8.00		
							ΣY=194.6	$\bar{\bar{Y}}$ =6.82		

Table 12 Effect of Feed Type on Milk Yield

Milk Yield (ltrs)			
Level of Treatment	**N**	**Mean**	**Std Dev**
1	6	7.88333333	3.62845238
2	6	7.80200000	4.57484062
3	5	4.54000000	2.70702789
4	5	5.92000000	3.64376179
5	6	8.03333333	2.54296415

1.=Maize Stover + Chopped Groundnut stover, 2= Maize Stover + Mineralized Groundnut Stover Solution, 3= Maize Stover + Mineralised Soybean Stover Solution, 4=Maize Stover + Chopped Soybean Stover, 5= Maize Stover + Urea Solution

Table 13 Analysis of Variance for Effect of Legume Stover and Urea Fertilizer on Milk Yield (ltrs)

Source of variation	Df	Sum of squares	Mean square	F_{cal}	F_{tab}
Total	27	304.30			
Treatment	4	50.91	12.74	1.16	4.43
Error	23	253.35	11.02		

CV=49.27

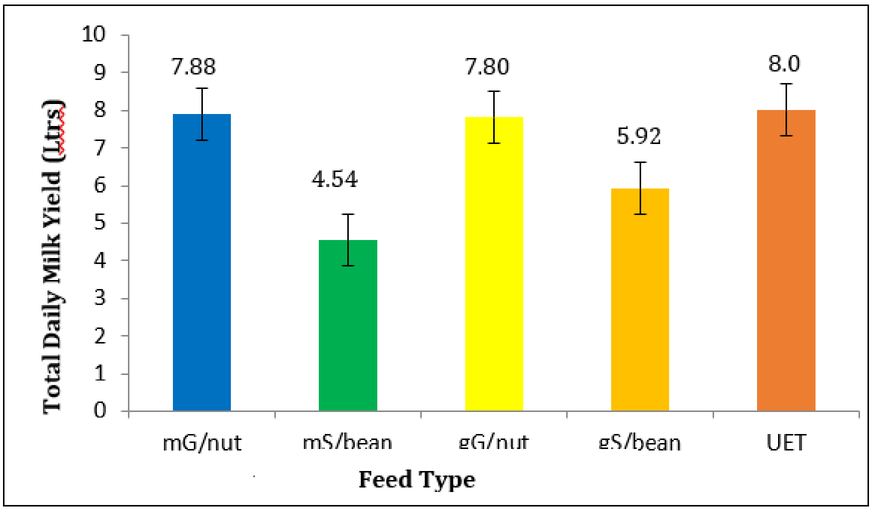

Figure 3 Effect of feed type on average daily milk yield

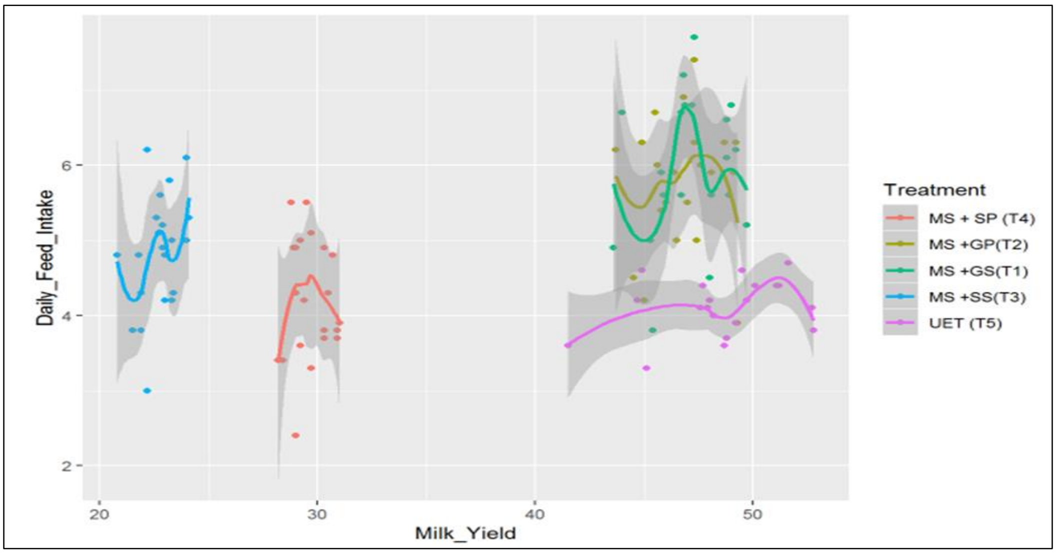

Figure 4 Relationship between Daily Feed Intake and Milk Yield

Table 14 Effect of Treatment and Processing Method on DMY (ltrs/day)

Source of Variation	n	LS means	Stderr
Treatment			
Maize Maize stover + mineralised Groundnut solution	6	7.88^{a}	0.37
Maiz Maize stover + chopped Groundnut stover	5	7.80^{a}	0.35
Maize s Maize stover + mineralised Soybean solution	5	4.54^{a}	0.19
Maize S Maize stover + chopped Soybean stover	6	5.92^{a}	0.19
Urea U Urea Ensiling Treatment of Maize stover	6	8.00^{a}	0.61

^{abc}Means with different superscripts are significantly different (p<0.05)
ADMY = Average Daily Milk Yield, n= number of dairy cows, CV=49.27

The gg-plot in Figure 4 shows that though improving quality of maize stover with Urea Ensilage Treatment resulted in low feed intake it had the highest milk yield. This implies that high feed intake does not necessarily translate into high milk yield. The quality or nutritive value of the feed is the most important factor in determining milk yield. The low feed intake observed in Urea Ensilage treated maize stover can be attributed to the effect of ammonia which lowers the palatability of stover.

3.1. Milk Records from Batoka Bulking Centre for Fourteen (14) Selected Farms Before and During Technology Transfer

Table 15 Av. Milk Yield per cow from Fourteen (14) Selected Farms for Dry Season during Technology Transfer

Farm ID	Sex	Total Monthly Milk Yield (Ltrs)						Total	# of milking Cows	Av./Cow
		Jun 2018	Jul 2018	Aug 2018	Sept 2018	Oct 2018	Nov 2018			
1	M	475.0	433.0	300.3	201.1	113.0	98.5	1,620.9	8	202.6
2	M	486.1	359.2	345.0	290.0	182.0	89.8	1,752.1	10	175.2
3	M	160.7	178.0	165.4	82.3	47.6	36.7	670.7	5	134.1
4	M	100.2	76.6	92.3	68.9	28.5	29.3	395.8	4	98.95
5	F	143.5	89.9	56.6	50.4	20.7	25.8	386.9	5	77.38
6	M	182.9	191.5	153.1	104.8	79.1	57.2	768.6	6	128.1
7	M	131.2	122.0	102.9	110.0	67.0	70.0	603.1	7	86.20
8	M	168.1	160.3	151.0	124.7	88.4	79.4	771.9	5	154.38
9	M	79.5	74.7	81.7	83.2	73.0	68.5	460.6	6	76.8
10	M	325.0	290.4	104.7	89.9	39.0	34.9	883.9	7	126.3
11	M	384.4	378.9	303.5	205.7	107.2	89.7	1,469.4	7	209.9
12	M	76.7	45.2	40.6	38.2	41.7	44.2	286.6	3	95.53
13	M	367.9	294.0	301.0	257.0	185.8	154.3	1,560.0	10	156.0
14	F	113.8	139.6	125.2	100.5	59.0	66.0	604.1	5	120.82
Monthly Totals		3,195	2,833.3	2,323.3	1,807	1,132	944.3	12,235		
Monthly Av./Farm		228.2	202.4	166.0	129.1	80.9	67.5	873.9		
Av. Daily Milk Yield/Farm		7.6	6.75	5.53	4.30	2.69	2.25	29.13		
Av. Daily Milk Yield /Farm/Cow										4.64

Table 16 Milk yields (ltrs) before and during Technology Transfer among Smallholder Dairy Farms in Batoka

Treatment	Replication						Total (Y)	Mean ($\bar{y}$)	SD	SEM
Before Technology Transfer	205	178	132	84	71	53	723	121		17.80
During Technology Transfer	228	202	166	129	81	68	874	146	±62	
							ΣY=1597	$\bar{\bar{Y}}$ =134		

Mean monthly milk yield before and during technology transfer were compared for a period of six (6) months (Table 16). Average monthly milk yield during the transfer of technology (i.e maize stover treated with mineralised and chopped groundnut and soybean legumes) was higher (146 ltrs, s.e=17.80) than that (121 ltrs, s.e=17.8) for the period before introduction of technology (Table 13). The average monthly milk yield for the period of technology transfer did not differ significantly (p>0.05) from that for the period before technology transfer (Table 17). Milk yield before and during technology transfer showed variance estimates of 3844 ltrs and residuals of 25 ltrs.

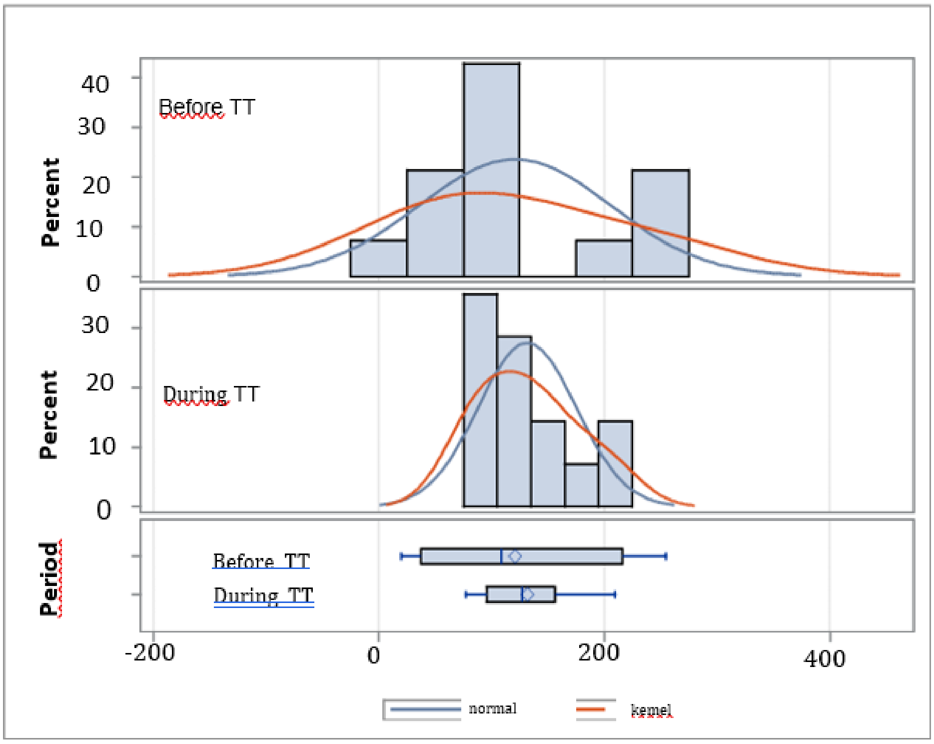

Figure 5 Performance of farms in milk yield before and after technology transfer

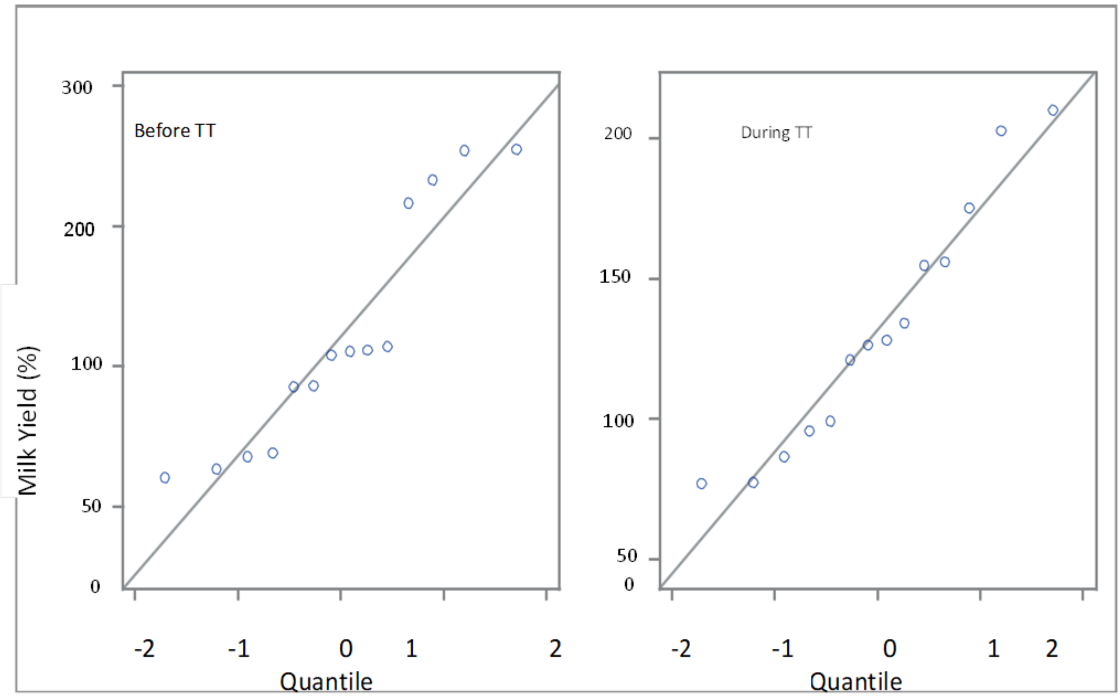

Figure 6. Q-Q Plot for Milk Distribution before and during technology transfer

Table 17 Analysis of Variance for Effect of Season on Milk Yield (ltrs) among Smallholder Dairy Farms

Source of variation	df	Sum of squares	Mean square	F_{cal}	F_{tab}
Total	11	41,655			
Treatment	1	1,880.2	1,880.2	0.47	4.96
Error	10	39,774.8	3,977.5		

CV=46%

4. Discussion

4.1. Effect of legume type on milk yield

The milk yield differences recorded among the experimental groups were certainly related to the diets' nutrient contents, in particular the protein and energy content which were higher in groundnut based diets and UET and lower in soybean based diets (Table 11). We can also explain these differences by several factors such as the biological variations among experimental units.

Results of the current study are in agreement with those of Munthali et al., (2014) who reported that supplementing water-treated stover with urea-molasses block, or treating the stover with urea, were sufficient to support maintenance plus small live-weight gains in cattle. Supplementing urea-treated stover with a suitable source of energy (such as starch, as in maize bran) promoted high live-weight gains and milk yield [13].

When evaluated within legume type the effect of processing method on milk yield did not differ significantly (p>0.05) for both legumes. However, processing methods differed numerically with mineralised groundnut stover solution showing a higher effect (7.88 ltrs, se=1.0) than chopped groundnut stover (7.80 ltrs, se=1.0). Conversely, the effect of mineralization of soybean stover was lower (4.54 ltrs, se=0.98) than that of chopped soybean stover (5.92 ltrs, se=0.98).

When evaluated across legume type the effect of legume type on milk yield did not differ significantly (p>0.05) for both processing methods. Similarly, values differed numerically with mineralised groundnut stover solution showing higher value (7.88 ltrs, se=0.4) than mineralised soybean stover solution (4.54 ltrs, se=0.4). A similar trend was observed in the use of chopped samples, with values of 7.80 ltrs (se=1.1) for groundnut stover and 5.90 ltrs (se=1.1) for soybean stover.

4.2. Effect of stover processing method on milk yield

When evaluated within feeds differences in milk yield were observed between processing methods. Milk yield was higher (7.88 ltrs, se=0.64) for cows fed on maize stover treated with mineralised groundnut stover solution than that for cows fed on maize stover treated with chopped groundnut stover (7.80 ltrs, se=0.64). The opposite was true in the case of treating maize stover with soybean legume stover. Milk yield was higher (5.92 ltrs, se=0.64) for cows fed on maize stover treated with chopped soybean stover than that from cows fed on maize stover treated with mineralised soybean stover solution (4.54 ltrs, se=0.64). This demonstrates that mineralization is poor in soybean stover due to higher degree of lignification compared to groundnut stover. However, cows fed on urea treated maize stover had higher (8.0 ltrs, se=0.64) milk yield than those treated with either of the two legume stover types (Table 11, Fig. 3). Averaging results of effect of processing methods in both legume types revealed higher effect of mineralization (7.7 ltrs, se=0.9) than chopping (5.8 ltrs, se=0.9) (Table 9).

5. Conclusion

The study has demonstrated that when the quality of maize stover is improved using legume stover with high nitrogen content milk yield is higher. When evaluated across feeds the study has indicated that milk yield was highest for maize stover treated with urea seconded by that from animals fed on mineralized groundnut stover solution.

Findings of the research have shown that groundnut stover can be used to improve the quality of maize stover in order to mitigate the decline in milk yield during the dry season among smallholder dairy farmers. The stover is cheap and easily available and can replace the use of urea which is more expensive and is not easily accessible to most smallholder farmers.

Compliance with ethical standards

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Disclosure of conflict of interest

As authors we declare that we have no competing interests. There is no conflict of interest regarding the publication of this article.

Statement of ethical approval

The use of dairy animals in this research was approved by the Animal Rights and Ethical Committee of the Livestock Research Trust of the Golden Valley Agricultural Research.

Statement of informed consent

Informed consent was obtained from all individual participants included in the study.

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