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Effect of Maize Stover Silage based Total Mixed Ration on Milk Yield and Composition of Cross Breed (Boran X Friesian) Dairy Cow

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ይህ ጥናት የተካሄደው በ2011 ዓ.ም በሆለታ ግብርና ምርምር ማዕከል ነበር። የጥናቱ ዋና ዓላማ የበቆሎ ገፈራን ከተለያዩ የኢንዱስትሪ ተረፈ ምርቶች ማለትም ፋግሎ፣ ፉርሽካ፣ ጥጥ ፍሬ፣ ሞላሰስ እና ጨውን በማዋሀድ በታላቢ የወተት ላሞች የወተት ምርት እና ተዋፅዖዎች (ለምሳሌ የቅባት፣ የገንቢ እና የማዕድናት ንጥረ-ነገሮች) ላይ የሚያሳድረውን ተፅዕኖ ማጥናት ነበር። ለዚህ ሙከራም በቆሎን በመዝራትና በእሸት ደረጃው በማጭድ፡ በቆሎውን እና አገዳውን በመለያየት በቆሎውን በፀሀይ በማድረቅ እና ርጥብ የበቆሎ አገዳውን በመፍጭት (ከ5-10 ሳ.ሜ) መከራው ተጀመረ። አንድ እጅ የተፈጨ የበቆሎ አገዳን (ከ5-10 ሳ.ሜ) ከሶስት እጅ ሞላሰስ እና ውሃ ጋር በማዋሀድ ለተከታታይ 45 ቀናት በጉድጓድ በመቅበር የበቆሎ አገዳ ገፈራ ተዘጋጀ። ከዚህም በመቀጠል የተለያየ መጠን ያለው የበቆሎ አገዳ ገፈራ እና ኢንዱስትሪ ተረፈ ምርቶች በማዋሀድ ውህድ የእንስሳት መኖ ተዘጋጅቷል። ለዚህ ምርምር 1ኛ፡ የተፈጥሮ ድርቆሽ እና የኢንዱስትሪ ተረፈ ምርቶች(0.5 ኪ.ግ ለ1 ሊትር ወተት ምርት) ` 2ኛ፡- 70 እጅ የበቆሎ አገዳ ገፈራን ከ30 እጅ የኢንዱስትሪ ተረፈ ምርቶች 3ኛ፡ 60 እጅ የበቆሎ አገዳ ገፈራን ከ40 እጅ ከኢንዱስትሪ ተረፈ ምርቶች እና 4ኛ፡ 50 እጅ የበቆሎ አገዳ ገፈራን ከ50 እጅ ከኢንዱስትሪ ተረፈ ምርቶች ጋር በማዋሀድ ለታላቢ ላሞች ለተከታታይ አንድ መቶ (100) ቀናት በመመገብ በወተት ምርት እና ተዋፅዖዎች ላይ ያለውን ተፅዕኖ ማየት የተቻለ ሲሆን አራተኛው አማራጭ (50 እጅ የበቆሎ አገዳ ገፈራን ከ50 እጅ ከኢንዱስትሪ ተረፈ ምርቶች ጋር በማዋሀድ ለታላቢ ላሞች መመገብ) የተሻለ የወተት ምርት ማግኘት የተቻለ ሲሆን በሶስቱም የአመጋገብ አማራጮች ላይ የተጋነነ የወተት ተዋፅዖዎች ልዩነት አልታየም።

Abstract

This study was conducted at Holetta agricultural research center, Ethiopia with the major objectives to evaluate the effect of silage made from late maturing dual purpose maize crop on intake digestibility, milk yield and composition of dairy cows. A total of eight mid lactating F1 (Boran X Friesian) dairy cows with similar milk yield (9.1 ± 0.91 kg/d) but differing in parity (ranges one to four) were selected and randomly assigned in to one of the four dietary treatments (T1=Natural pasture hay ad libitum + 0.5 kg concentrate mixture (CM) per liter of milk production; T2=TMR-1 (70% MSS: 30% CM) ;T3=TMR -2(60% MSS: 40% CM) and T4=TMR-3 (50% MSS: 50% CM) in a double 4X4 Latin square design. The cows fed T1 and T4 diet had similar DM, OM and NDF intakes (P>0.05) which is

significantly higher over cows receiving the remaining treatments (P<0.05). On the other hand CP was significantly higher (P<0.05) inT4 while the ADF intake was significantly higher (P<0.05) in T1 compared to the other treatments. In addition to this, dietary treatments varied (P<0.001) in terms of their apparent DM, OM and CP digestibility, with cows on T3 showed considerably higher (P<0.05) digestibility for DM, OM and CP than cows on the control diet. Similarly T4 had shown higher CP digestibility (P<0.05) compared to the control group. However, the NDF and ADF digestibility were not affected by dietary treatments. Silage based total mixed ration improved daily milk yield with the higher (P<0.01) milk being recorded for cows receiving T4 (10.2 litter/day). Dietary treatment had no effect (P>0.05) on milk composition. Feeding maize stover silage harvested at late maturity to crossbred cows resulted better daily milk yield; however, further study is required on the economics aspect before the diet is recommended for wider use under field conditions in Ethiopia.

Keywords: cow, digestibility, intake, milk, silage

Introduction

A key factor limiting competitive access to markets, income and enhanced nutrition of smallholder producers is low dairy cattle productivity. Feed scarcity is the common constraint to increasing livestock in general and dairy productivity in particular as the pressure on land for food crops may limit the specialized production of fodder in systems where farmers prefer to spread risk across multiple enterprises and reduces the availability of grazing glands. This means that a significant proportion of the feed produced on farm needs to come from the crops that produce food for human consumption. In surveys conducted in Ethiopia's maize belt in 2003, it was found that maize contributes with about 60% of the feed produced on farm. In Ethiopia, maize is planted on more than 2.4 million ha (CSA, 2018/19) and is the food staple for several million families, the majority of whom also rear dairy cattle and other livestock species (Thorne *et al*., 2002). The crop has a relatively stable yield, high energy content, good ensiling characteristics, and inclusion of maize silages in the total ration of dairy cows can increase feed intake, milk yield and milk protein content (O'Mara *et al.*, 1998; Phipps *et al.*, 2000). Whole crop maize silage is a major forage component in the ration of dairy cows, under most dietary regimes elsewhere outside Ethiopia. However, associated to land scarcity for cereal food grain production, the use of whole crop maize silage for dairy cattle feeding under local conditions is only limited to some government organizations (universities and research institution). As part of a solution to the problem a research project has been planned to use the green maize stover for silage making at some later stage of grain maturity (i.e. after the grain was being harvested at dough stage with the assumption that the remaining grain moisture removed with sun drying for proper storage and use as a grain for human consumption). Nutritionally, it is well-documented that an increased maturity at harvest results in an increased grain filling for human

consumption, starch-to-NDF ratio and increased fraction of rumen by-pass starch in maize silages (Bal *et al.,* 2000; Phipps *et al.,* 2000). Therefore, inclusion of maize silage which is harvested at a more mature stage (>350 g DM/kg fresh weight, dough stage) in the diet of dairy cows could be an option to increase the supply of starch and rumen by-pass starch. Moreover, a recent study indicated that maize silage harvesting at dough stage of the grain results in higher yields of dry matter, starch and energy (Zom *et al.,* 2012). Therefore, increasing maturity may also contribute to an increased self-sufficiency rate for feed and hence reduce the farm purchases of feeds and forage, and the food-for-feed competition. This research study being an innovative approach was proposed to evaluate and thereby improve the potential contribution of maize as food–feed to the livelihoods of dairy producers at farm level in Ethiopia.

Materials and Methods

Study site

The study was carried out at Holetta agricultural research center, Ethiopia. The center is located at 9^{o} 03'28.82" E latitude and 38^{o} 30'17.59" E longitude at an elevation of 2,400 m above sea level. The mean annual temperature and rainfall during the study were 18^{o}C and 1225mm, respectively.

Animal selection and management

A total of eight F1 (Boran X Friesian) mid lactating cross breed dairy cows with different parity (range one to four) but yielding more or less similar initial daily milk (9.1 ± 0.91 kg) were selected from the total milking herd available on-station. Experimental cows were randomly assigned to one of the four dietary treatments using a double 4×4 Latin square design consisting of four periods with each having 15 days of feed adaptations and 10 days of data measurement. The experiment has taken a total of 100 days (from March 1 to June 10, 2019). The cows were de-wormed against internal parasites prior to the beginning of the experiment. They were handled individually in a well-ventilated house at Holeta dairy animal's barn. The house had appropriate drainage slope, gutter for urine removal and individual feeding troughs.

Experimental feed preparations and feeding management

Maize was planted for dual purpose (food-feed) on station following recommended planting and agronomic practices. Harvesting was made at some stage of grain maturity (dough stage) when residual moisture and soluble sugar is left for silage fermentation and after the cobs have been already removed for use as food for human consumption later on after removing the moisture of the grain using solar heat. The partially green maize stover (25% DM) was then subjected to

chopping (10-15 cm in length) and ensiled in the presence of molasses additive added at the rate of 3% on DM basis. Silage was kept under the silo for 45 days during the dry season (from December 15 /2018 to January 30/2019) until the start of the feeding trial. Natural pasture hay for the control group and maize stover silage based total mixed ration for the TMR groups were offered *ad-libitum* while the concentrate mix for the control group was offered twice a day during the morning and milking times (6.00AM and 2:00PM). Feed offer per each dietary treatment was periodically subjected to revision with changes in milk production. Water was provided free of any choice. The daily amount of the feed consumed and refused per each cow was recorded to calculate feed and nutrient intake of individual animals.

Table 1: Proportion of feed ingredients in the dietary treatments (DM basis)

Feed	Treatment			
	T1	T2	T3	T4
Hay	60	0	0	0
Maize stover silage (MSS)	0	70	60	50
Wheat bran	17.6	13.2	17.6	22
Cotton seed cake	7.2	5.4	7.2	9
Noug seed cake	4.8	3.6	4.8	6
Molasses	10	7.5	10	12.5
Salt	0.4	0.4	0.4	0.4

The treatments were:- *T1 = natural pasture hay ad libitum + 0.5 kg concentrate mixture (CM) /liter of milk; T2= TMR (70% MS: 30% CM), T3 = TMR (60% MS: 40% CM), T4 = TMR (50% MS: 50% CM)*

Digestibility trial

At the end of every period, faces was collected and total daily weight was taken from individual cows for 7 consecutive days based on appropriate collection procedure. To avoid cross contaminations with urine farm personnel were assigned around the clock to scoop the fresh faces and wash the floor with high pressure tap water coming through plastic hose. Representative samples (1% of the daily collected feaces weight on fresh matter basis) were taken in the morning (8:00 Am) before fresh feed was being offered to the animals and stored in deep freezer (-20^{o}C) until ready for subsequent lab analysis.

Laboratory analysis

Maize stover silage, TMR feed and fecal samples were dried at 55 ^{o}C for 48 h, ground using a Wiley mill to pass a 1-mm sieve size. Feed and fecal samples were analyzed for N (Kjeldahl method; AOAC, 1990), DM, Ash (AOAC, 1990), ADF, permanganate lignin and NDF (Van Soest and Robertson, 1985), *in vitro* dry matter digestibility (two stage procedures of Tilley and Terry, 1963), metabolizable energy was calculated by ME (MJ/kg) = 0.16* *in vitro* organic matter digestibility (McDonald *et al*., 2002).

Milking and milk composition analysis

Cows were hand-milked twice a day at 6:00 AM and 6:00 PM in a milking house. The amount of milk produced from each cow at every feeding period was measured by using graduated glass cylinder. During the last 5 days of each period, milk aliquot sample from the morning and evening milking was taken for each individual cow. Milk was sampled in pre-labelled 50 ml plastic vials. An auto-scan milk analyzer (milko-scan 133R) was used to determine fat, protein, total solids and lactose.

Statistical analysis

All data were analyzed with R software version 3.5.2 (R Core Team.2018).The effects of treatment and periods were fixed and the effect of parity was random. Tukey's test was used to compare least square means and response criteria were declared different if $P<0.05$. The standard errors (S.E.) reported in the tables are for differences of least square means.

Response variables were analyzed using the statistical model:-

$$Y_{hijk}= \mu +S_{h+} C_{i}+P_{j +} T_{k} +E_{hijk},$$

Where, Yhijk is the dependent variable (intake, milk yield& composition), μ = overall mean, S_{h} = Square effects, C_{i}= cow effect (parity) (i=1-4), P_{j} = effect of period (j=1-4), Tk= effect of treatment (diet) (k=1-4), Eijk= experimental error

Results and Discussion

Chemical composition of feeds

The mean chemical composition of dietary treatments, concentrate mixture and feed ingredients is presented in Table (2). The two basal diets (natural pasture hay and MSS) had more or less comparable ash, CP, lignin and ME contents; they exhibited larger variations in terms of their ADF and in-vitro digestibility values. The green maize stover silage had close to 7 percent unit less ADF and slightly greater than 10 percent unit digestible organic matter over the natural pasture hay. Among supplemental feed ingredients and the concentrate mix, the two protein sources (Cotton seed cake &Noug seed cake noted to have the highest CP and the lowest digestible organic matter compared to the energy source (wheat bran). Exceptionally, Noug seed cake was found to be rich in its ash and permanent lignin contents than the remaining protein and energy supplemental feeds. Other than that mentioned earlier, all supplemental feed ingredients and the concentrate diet resemble to one another for most nutritional parameters under consideration. Greater variations were observed for only DM content of the diets considered under the TMR based dietary treatments. Thus while DM contents of the TMR

diets increased with reduction in the level of MSS in the total diets. The mean CP and *Invitro* organic matter digestibility contents of concentrate feeds and maize stover silage in the present study is comparable with the report of Habtie et al. (2020). The use of maize stover silage as roughage source in total mixed ration improves the crude protein and metabolizable energy contents of the diet. The current finding is consistence with the study of Rajamma (2014), Buddanoi1 *et al.*, (2017) and Habte *et al.,* (2020) who reported maize stover use as roughage source in TMR could increase nutritive value of the diet.

Table 2:- Chemical composition of feed ingredients and total mixed ration (% DM basis)

	DM	Ash	CP	NDF	ADF	Lignin	IVOMD	ME (MJ/kgDM)
Hay	92.12	6.72	6.15	63.24	42.89	8.10	50.41	8.07
MSS	35.89	7.21	6.41	63.03	35.67	7.65	60.56	9.70
Wheat bran	89.89	5.34	16.56	48.03	22.89	4.43	69.89	11.18
Cotton seed cake	91.20	5.80	27.00	43.70	23.90	5.30	62.90	10.10
Noug seed cake	90.89	9.10	30.30	42.35	20.19	8.50	65.40	10.50
TMR-1	52.62	8.54	10.76	63.53	26.82	4.68	61.98	9.92
TMR-2	56.95	7.87	11.85	61.47	25.95	5.19	62.34	10.01
TMR-3	62.07	8.12	12.79	64.15	24.65	5.28	62.89	10.08

MSS=Maize stover silage, DM=Dry matter, OM=Organic matter, CP=Crude protein, NDF= Neutral detergent fiber, ADF= Acid detergent fiber, IVOMD=Invitro organic matter digestibility, ME =Metabolizable energy, TMR=Total mixed ration, TMR1 (70% MSS: 30% CM), TMR2 (60% MS: 40% CM) and TMR3 (50% MS: 50% CM)

Dry matter and nutrient intake

There was significant ($P<0.001$) difference in mean daily total DM and nutrient intakes among experimental cows (Table 3). Among cows receiving the silage based diet, substantially higher feed and nutrient intakes ($P<0.05$) was recorded for cows receiving the MSS at half their total daily feed requirement (T4).Cows kept on T4 consumed comparable quantities of daily feed DM, OM and NDF; higher CP but lower ADF than cows on the control diet (T1). In agreement to the current finding, inclusion of green maize silages made from lately harvested dual purpose maize crop in the total ration of dairy cows noted to have increased feed intake O'Mara et al. (1998) and Phipps et al.(2000).The lower DM, OM, CP, ADF and NDF intake observed in T2 (70% maize stover silage and 30% concentrate mix based TMR) and T3 (60% maize stover silage and 40% concentrate mix based TMR) are related to the fermentation effect of maize stover silage in the total mixed ration on the intake in T2 and T3. This finding is consistent with the study of Juliana *et al.,* (2016) who reported the end-product of silage fermentation can affect the intake and influence animal performance, since some organic acids negatively influence the intake. The higher DM, OM and CP intake in T1 and T4 was due to the higher DM, OM and CP concentration in the diets.

Table 3: Average dry matter and nutrient intake of Boran-Friesian cross breed dairy cows

Intake (kg/day/cow)	T1	T2	T3	T4	SEM	P value
Natural pasture hay	7.76	-	-	-	-	
Concentrate	4.34	-	-	-	-	
Total DM	12.11^{a}	10.76^{b}	11.09^{b}	12.29^{a}	0.22	0.0000
OM	11.13^{a}	9.84^{c}	10.25^{b}	11.18^{a}	0.20	0.0000
CP	1.45^{b}	1.16^{d}	1.27^{c}	1.52^{a}	0.03	0.0000
NDF	8.60^{a}	6.84^{c}	7.93^{b}	7.88^{a}	0.15	0.0000
ADF	3.63^{a}	2.89^{c}	2.88^{c}	3.03^{b}	0.10	0.0000

Means in each row with different letters have a significance difference at (P<0.0000), SEM=standard error of mean, DM= Dry matter, OM= Organic matter, CP= Crude protein, NDF= Neutral detergent fiber, ADF= Acid detergent fiber, T1 = Natural pasture hay ad libitum + 0.5 kg concentrate mixture(CM) /liter of milk, T2= TMR1 (70% MSS: 30% CM), T3 = TMR2 (60% MSS: 40% CM) and T4 = TMR3 (50% MSS: 50% CM)

Apparent DM and nutrient digestibility

The mean apparent dry matter and nutrient digestibility of cows fed the control and diets with different levels of silage is presented in Table (4).The DM, OM and CP apparent digestibility were significantly (P<0.05) affected by dietary treatments. Considerably higher (P<0.001) DM, OM and CP digestibility was observed for cows receiving dietary T3 than T1. However, the NDF and ADF digestibility were not significantly affected by diet. The higher DM, OM and CP apparent digestibility in the maize stover silage based total mixed ration groups (T2, T3 and T4) observed in the present study is in agreement with the finding of Habte *et al.,* (2020) and Rajamma (2014) who suggested that utilization of green maize stover silage made from maize crop harvested at late grain maturity could increase nutritive value and digestibility of the feed.

Table 4: Apparent dry matter and nutrient digestibility of cows fed different diet.

Apparent digestibility (%)	T1	T2	T3	T4	SEM	P value
DM	60.64^{b}	67.31^{ab}	71.04^{a}	68.03^{ab}	3.01	0.05
OM	59.26^{b}	65.47^{ab}	69.33^{a}	65.81^{ab}	3.07	0.05
CP	62.76^{b}	68.21^{ab}	71.94^{a}	72.50^{a}	2.74	0.05
NDF	68.36	72.46	72.53	74.61	1.77	0.26
ADF	48.95	58.96	55.37	61.37	1.79	0.33

Means in each row with different letters have a significance difference at (P<0.05), SEM=standard error of mean, DM= Dry matter, OM= Organic matter, CP= Crude protein, NDF= Neutral detergent fiber, ADF= Acid detergent fiber, T1 = Natural pasture hay ad libitum + 0.5 kg concentrate mixture (CM) /liter of milk; T2= TMR1 (70% MSS: 30% CM), T3 = TMR2 (60% MSS: 40% CM) and T4 = TMR3 (50% MSS: 50% CM)

Milk production and composition

The mean daily milk yield and composition of experimental cows fed with the different dietary treatments is presented in Table 5. Daily milk yield of the cow was significantly affected (P<0.01) by the dietary treatments with cows receiving the silage based TMR diet producing better daily milk than cows on the control diet. In general, cows maintained on dietary T4 produced an extra daily milk yield

of 1.33, 0.66 and 0.63 kg over those cows receiving dietary T1, T2 and T3 ($P<0.05$) respectively. But cows on the different dietary treatment didn't responded to changes in dietary formulations ($P>0.05$). Similar to the present findings, inclusion of green maize silages made from lately harvested dual purpose maize crop in the total ration of dairy cows noted to have also increased feed intake and milk yield (O'Mara *et al.,* 1998; Phipps et al. (2000). Although the milk composition of cows in the present study were not affected by dietary treatments, previous studies indicated that milk protein increased as a consequence of increased CP concentration in the diet (Sutton *et al.,* 1996; O'Mara *et al.,* 1998 and Phipps *et al.,* 2000).

Table 5: Milk production and composition of cows fed maize stover based total mixed ration and conventional feeding of natural pasture hay and concentrate mixture

Parameter (kg/day)	T1	T2	T3	T4	SEM	Pval
Milk yield	8.79^{c}	9.46^{b}	9.49^{b}	10.12^{a}	0.65	0.007
Fat yield	0.21	0.21	0.23	0.22	0.02	0.8
Protein yield	0.29	0.25	0.26	0.31	0.02	0.08
Lactose yield	0.45	0.38	0.40	0.48	0.03	0.10
Milk composition (g/kg)						
Fat	25.3	26.1	27.3	24.4	0.14	0.26
Protein	30.9	31.1	30.8	31.3	0.03	0.41
Lactose	48.1	48.4	48.0	48.8	0.04	0.30
Ash	7.2	7.2	7.1	7.3	0.01	0.10
SNF	87.0	88.1	87.3	88.8	0.08	0.17

Means in each row with different letters have a significance difference at ($P<0.007$), SEM=standard error of mean, SNF=Solid non-fat, T1 = Natural pasture hay ad libitum + 0.5 kg concentrate mixture (CM) /liter of milk, T2= TMR1 (70% MSS: 30% CM), T3 = TMR2 (60% MSS: 40% CM), T4 = TMR3 (50% MSS: 50% CM)

Conclusion

This study demonstrate that maize stover silage based TMR had shown better feeding value based on biological responses compared to the conventional feeding for lactating crossbred dairy cows. The findings of this study revealed that, TMR with 50% maize stover silage and 50% concentrate mixture had higher milk yield (10.12 kg), which is superior to the other treatments. Thus, TMR with 50% maize stover silage and 50% concentrate mixture can be a promising option to conventional supplementation for crossbred cows and for recommendation, the economic visibility needs to be verified with further study.

References

AOAC. 1990. Official Methods of Analysis. 15th Edition. Arlington, Virginia, USA. pp. 12-98.

Bal MA, Shaver RD, Jirovec AG, Shinners KJ and Coors JG. 2000. Crop processing and choplength of corn silage: Effects on intake, digestion, and milk production by dairy cows. J.Dairy Sci.83, 1264-1273.

Buddanoil R, Abrar A and Wachirapakorn1 C. 2017. Effect of Maize Stover in Fermented Total Mixed Ration on Nutritive Value and Digestibility Quality in Vitro. Jurnal Peternakan Sriwijaya. Vol. 6, No. 1, June 2017, pp.44-51.

CSA (Central Statistical Agency), 2018/19.The federal democratic republic of Ethiopia central statistical agency agricultural sample survey 2018/19 (2011 E.C.).Volume I. Report on area and production of major crops. Statistical bullet in 589. Addis Ababa, Ethiopia.

Habte Abebaye, Ashenafi Mengistu, Berhan Tamir, Getnet Assefa and Fekede Feyissa. 2020.Effect of maize silage and concentrates fed separately or as total mixed ration (TMR) on milk yield of Jersey cows.Livestock Research for Rural Development.32 (2).

Juliana Silva de Oliveira, Edson Mauro Santos and Ana Paula Maia dos Santos. 2016.Intake and Digestibility of Silages. Open scince pp. 102-121.

Lacto scan Milk Analyzer. 2016. Operational manual.4, Narodni Buditeli str. 8900, Nova Zagora, Bulgaria. 79p.

McDonald PR, Edwards A, Greenhalgh TFD, and Morgan CA. 2002.Evaluation of feeds. Animals Nutrition 5th edition. pp. 221-228.

O'Mara FP, Fitzgerald JJ, Murphy JJ, and Rath M. 1998. The effect on milk production of replacing grass silage with maize silage in the diet of dairy cows. Livest.Prod.Sci.55, 79-87.

Phipps RH, Sutton JD, Beever DE, and Jones AK. 2000. The effect of crop maturity on the nutritional value of maize silage for lactating dairy cows. Food intake and milk production.Anim.Sci.71, 401-409.

Rajamma K, Kumar DS, Rao ER, and Nath DN. 2014. Effect of feeding total mixed ration ssupplemented with or without exogenous fibrolytic enzymes on rumen degradation kinetics inbuffalo bulls. *International Journal of Veterinary Science.* 3(4): 236-239.

R Core Team. 2018. R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria.

Sutton JD, Aston K, Beever DE, and Dhanoas MS. 1996. Milk production from silage based diets: Effects of high-protein concentrates for lactating heifers and cows on intake, milk production and milk nitrogen fractions. Animal Sci., 62:207–215.

Tilley JMA and Terry RA. 1963. A two stage method for the in vitro digestion of forage crops. Journal Britannia Grassland Society.18: 104-111.

Thorne PJ, Thornton PK, Kruska R, Reynolds L, Waddington SR, Rutherford AS, and Othero AN. 2002. Maize as food, feed and fertilizer in intensifying crop- livestocksystems in East and southern Africa: An ex ante impact assessment of technology interventions to improve smallholder welfare. ILRI Impact Assessment Series 11. International Livestock Research Institute, Nairobi, Kenya, 123 p.

Van Soest PJ and Robertson JB.1985.Analysis of Forages and Fibrous Foods a Laboratory Manual for Animal Science. Cornell University, Ithaca, NY.

Zom RLG, Bannink A, Goselink RMA. 2012. Effect of increased maturity of silage maize at harvest on conservation, dairy cow performance and methane emission. Wageningen UR Livestock Research, Wageningen, the Nederland's.