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Research Paper

Benefit of feeding *Urochloa* hybrid cultivar 'Cobra' on milk production in Tanzania

Beneficio de alimentar con el cultivar híbrido de Urochloa *'Cobra' en la producción de leche en Tanzania*

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Abstract

Animal genetics, management, diseases, feeds and environment affect milk production in cattle. Feed is the most important and when addressed, cattle show immediate responses. In sub-Saharan Africa, livestock productivity is low largely due to use of low-quality crop residues and natural pastures, often poor in key nutrients for animal performance. In an 8-week on-farm feeding trial with farmers' participation, milk production under farmers' practice (FP) was compared with the use of improved *Urochloa* hybrid cultivar 'Cobra' hay (Cobra hay) as an intervention (IN). A crossover design with each cow undergoing FP and IN phases was used. For the initial 2 weeks, the experiment followed FP before shifting to 50-50 FP/IN in week 3 and 100 % IN in week 4 and 5, followed by 50-50 FP/IN in week six and 100 % FP in week 7 and 8. Milk production increased by 15 % under IN and was associated with better feed utilization efficiency of 2 kg DM Cobra hay/L of milk. The use of Cobra hay has potential to increase dairy productivity in Tanzania and other similar tropical ecologies and contexts in sub-Saharan Africa.

Keywords: Dairy, feeding trial, feed utilization efficiency.

Resumen

La genética animal, el manejo, las enfermedades, la alimentación y el medio ambiente afectan la producción de leche en el ganado. La alimentación es lo más importante y cuando se aborda, el ganado muestra respuestas inmediatas. En el África subsahariana, la productividad ganadera es baja en gran parte debido al uso de residuos de cultivos de baja calidad y pasturas naturalizadas, a menudo pobres en nutrientes clave para el rendimiento animal. En una prueba de alimentación de 8 semanas en finca con la participación de los productores, la producción de leche bajo la práctica tradicional (FP) se comparó con el uso de heno del cultivar mejorado *Urochloa* híbrido 'Cobra' como una intervención (IN). Se utilizó un diseño cruzado (crossover) con cada vaca pasando por las fases FP e IN. Durante las 2 semanas iniciales, el experimento utilizó FP antes de cambiar a 50-50 FP/IN en la semana 3 y 100 % IN en las semanas 4 y 5, seguido de 50-50 FP/IN en la semana seis y 100 % FP en la semana 7 y 8. La producción de leche aumentó un 15 % bajo IN y se asoció con una mejor eficiencia de utilización de 2 kg de MS de heno de pasto Cobra/L de leche. El uso de heno de pasto 'Cobra' tiene potencial para aumentar la productividad lechera en Tanzania y en otras ecologías y contextos tropicales similares en el África subsahariana.

Palabras clave: Eficiencia de utilización de forrajes, lechería, prueba de alimentación.

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Introduction

Sub-Saharan African livestock productivity is low (Nin et al. 2007). The increasing demand for animal source foods driven by human population growth and dietary change exerts pressure on livestock feed supply. For example, per capita milk consumption in Tanzania is increasing and projected to reach 55–100 L/person/yr by 2022 (IFAD 2016). Given that arable land is scarce (Jayne et al. 2014), forage production competes with food crops and there is limited or no land for agricultural expansion, more efficient use of available land becomes key in responding to the increasing demand for livestock products.

Low availability of quality livestock feeds has resulted in use of crop residues and limited locally produced and poorly formulated concentrate feeds for livestock production. Crop residues provide a limited supply of required nutrients for animal maintenance, growth, reproduction and production (FAO 2018). This leads to low milk and meat production, contributing to high emissions of methane gas per unit of product, associated with global warming (Makkar 2016). Long calving intervals and low lactation yields characterize livestock on most smallholder mixed farms in Tanzania and East African countries (Kanuya et al. 2000). Although animal productivity can be limited by genetics and management, feeding is the single most important component that accounts for 70 % of the costs in dairy production (Makkar 2016; Odero-Waitituh 2017) and, if well addressed, results in positive impact more quickly.

In a recent assessment of livestock feeds in Tanzania, the estimated requirement for livestock feed is >172 million t/yr, of which 70 % are roughage based (FAO and IGAD 2019). Roughages include Rhodes grass (*Chloris gayana*), buffel grass (*Cenchrus ciliaris*), Napier grass (*Cenchrus purpureus*), Guatemala grass (*Tripsacum andersonii*) and natural pastures. There is also localized evidence of livestock roughage shortages in Tanzania, including in high potential areas. Mwendia et al. (2019) reported farmers' experience in the southern highlands, where forage availability drops by about 50 % for more than 6 months in a year, with implications of underfeeding livestock. Low forage cultivation in Tanzania (Maleko et al. 2018a; 2018b) further constrains roughage availability. Use of appropriate forages is paramount for improved livestock productivity. Use of forage-based roughages is preferred to grain-based diets (Scaglia et al. 2014), which not only compete with human food but are more expensive (Makkar 2016).

While there are many forages that could fit in dairy systems in Tanzania (Cook et al. 2020), *Urochloa* has recently received attention for its potential to increase livestock productivity (Mutimura et al. 2016; Cheruiyot et al. 2018; Mwendia et al. 2021b). *Urochloa* breeding and cultivar selection has produced hybrids with increased dry matter production and quality, e.g. *Urochloa* hybrid cultivar 'Cayman' and *Urochloa* cultivar 'Basilisk' (Mwendia et al. 2021a). In Latin America, *Urochloa* contributes significantly to beef production under extensive systems (Jank et al. 2014). The Consultative Group for International Agricultural Research (CGIAR) estimates that grasses cover 12 million ha in Latin America (Fuglie et. 2021). In eastern Africa, *Urochloa* is also gaining attention by livestock producers and livestock scientists due to its potential in smallholder agricultural systems (Schiek et al. 2018).

Urochloa hybrids have been estimated to have the potential to increase milk production by 15–40 % in eastern Africa (Schiek et al. 2018). CIAT (2003) reported that cows fed on *Urochloa* hybrid 'Mulato II' produced 11 % more milk during the dry season and 23 % more during the rainy season compared with those fed on *Urochloa* cultivars 'Basilisk' and 'Xaraes'. Muinga et al. (2016) found that cows fed on *Urochloa* cultivars produced 15–40 % more milk compared to those fed with normal farmers' practice in Kenya. These findings support the need to improve use of *Urochloa* species for improving livestock productivity. This on-farm participatory trial was designed to investigate the effects of *Urochloa* hybrid cultivar 'Cobra' hay (Cobra hay) on milk production in Njombe district, located in Njombe region in the Southern highlands of Tanzania. We chose to demonstrate improved feeding and its impact on productivity on-farm with farmers' participation with the aim to encourage use of this improved cultivated forage. We postulated that the use of improved Cobra hay would increase milk production and forage use efficiency.

Materials and Methods

Selection of farmers, trial cows and feed

Six farmers each with 1 crossbred cow in early lactation (2–3 months after parturition) and in between 2nd to 4th calving were selected in Njombe district in February 2019. Njombe receives bimodal rainfall, mid-February to end of May in the long rainfall season and mid- November to mid-January in the short rainfall season (NASA, 2021). The crossbred cows were from either Friesian, Ayrshire or Jersey and were fully stall-fed to allow measurement of dry matter intake. As a preliminary requirement, the

Internal Review Board (IRB) of Alliance of Bioversity and CIAT scrutinized the process and consent was given to do the work.

Cobra hay was selected as a representative of an improved forage grass hybrid with better forage quality traits when harvested at the right growth stage. It is leafy, with high crude protein and good digestibility (Mwendia et al. 2021b). Cobra is a hybrid of *Urochloa ruziziensis* x *U. decumbens* x *U. brizantha* and is a released forage in Latin America and Kenya and is in the process of registration in other East African countries.

Considering a daily dry matter (DM) intake of 15 kg/cow/day, we estimated that 420 kg DM would be enough to feed a mature cow of about 400 kg live weight for 4 weeks. Using Cobra mean dry matter yields [3 t DM/ha/cut (Cook et al. 2020)], we estimated that 0.14 ha land was required to produce 420 kg DM of Cobra hay. To have sufficient feed if the season has unfavorable weather conditions, the land size was increased to 0.2 ha. Selected farmers were assisted to establish 0.2 ha of Cobra ready for feeding by June 2019. The annual mean temperature is 18 °C while rainfall ranges from 2,700– 4,000 mm. The grass was established in March 2019 when the long rainfall season had set in to provide adequate soil moisture. Recommended agronomic practices were observed in establishing the grass including land preparation (fine soil tilth), seed-rate (6 kg/ha), soil fertilization (26 kg P/ ha) and maintaining the fields weed-free (Cook et al. 2020).

Farmers' practice and intervention feeding in trial design

Farmers fed a mix of roughages that were available in their locality. The roughages included fresh feed harvested at different growth stages, as well as crop residues obtained after crop harvest. All roughage offered was measured with a spring balance (KERN CH 50K50 with 10 g precision) and the weights of offered roughages and their refusals recorded on a daily basis. The initial plan to weigh the different proportions offered under farmers' practice (FP) was logistically too difficult due to farmer time constraints. The difference between offered roughages and refusals constituted the daily feed intake. Under 100 % intervention feeding (IN) in weeks 4 and 5, lactating cows were offered Cobra hay daily (Table 1). To gauge the selected cow daily dry matter requirements, heart girth was measured, converted to live weight, and subsequently the daily dry matter requirement was estimated at 3 % of the body live weight (Lukuyu et al. 2012).

The feeding trial was done as a crossover design with a lactating cow as the experimental unit and each cow acting as its control to mitigate against the genetic variation in the selected cows. In practice each cow underwent feeding phases under FP as well as under IN. The selected cows were monitored for 2 weeks under FP before transitioning to a week of 50 % FP and 50 % intervention feeding (IN), followed by 2 weeks on IN at 100 % followed by a return to the 50 % each FP and IN feeding for 1 week, before finishing off with another 2 weeks of feeding under FP. This resulted in each of the cows receiving a phase of IN preceded by FP and followed by FP. The crossover design made it possible to randomize for any of the 3 cows having FP→IN and the other 3 IN→FP arrangement and avoid bias (Mills et al 2009).

The cows were offered the estimated feed weight (as-fed) to meet the dry matter requirements on a daily basis (Table 1) under 100 % IN feeding. Cobra hay was fed to each cow 5-6 times per day until the cow was observed not to take any more and the total weight fed for the day was recorded. Throughout the 100 % IN, 14 –25 kg DM/d was made available (Table 1). During the 50:50 % transition phases, the farmers gave half of what they were giving under FP and following that, the other half of the daily feed was given as Cobra hay, about 7 kg. This phase was to allow the cows to acclimatize to Cobra hay before being fed 100 % Cobra hay in Week 4 and 5. Throughout the experiment, the cows had access to clean drinking water *ad libitum*.

Table 1. Experimental cows' attributes used to estimate daily dry matter requirements.

Farm	CHGL[1]	ELW[2]	EDDMR[3]	IFFWA[4]
1	172	420	12.6	22.9
2	153	285	8.6	14.2
3	173	427	12.8	25.3
4	169	399	12.0	24.5
5	168	392	11.8	25.1
6	176	451	13.5	22.0

[1]CHGL= Cow heart girth length (cm)
[2]ELW=Estimated live weight (kg)
[3]EDDMR= Estimated daily dry matter requirement (kg)
[4]IFFWA= Intervention feeding forage weight (kg) as-fed

Data collection

To address the intensive data collection, farmers who offered their cows for trials and frontline livestock extension officers were first sensitized on the breadth and expectations of the study including the care required during data collection. Specifically, we developed and printed weekly data sheets. Each sheet had cells to enter daily data on the type and weight of forage offered (kg), the forage refusals (kg) and morning and evening milk yields (L). Milk was measured with a graduated cylinder. Farmers and extension officers were trained in use of the data sheet until they understood it. Each farmer took records of feeds and milk production on the data sheets and extension officers assisted during the start of the experiment and moved around confirming no farmer had difficulties.

Forage nutritional analysis

In addition to feed weights and milk yields, a sample of approximately 400g of each forage type was taken each week for laboratory quality analysis and processed at Mpwapwa Tanzania Livestock Research Institute (TALIRI) in Dodoma. Samples of forages collected were oven dried to constant weight at 65°C for 48 hand ground to pass 1 mm sieve and packed in ziplock bags labeled accordingly by farm and forage species. The samples were then sent to the International Livestock Research Institute (ILRI) laboratory in Addis Ababa, Ethiopia, for analysis. Analysis was done using Near Infrared Spectroscopy (NIRS) calibrated for tropical forages. Nutritional parameters included dry matter, ash, crude protein, neutral detergent fiber, acid detergent fiber, acid detergent lignin, metabolizable energy and in vitro organic matter digestibility.

Data analyses

Data analyses were performed using GenStat statistical software version 18 by pooling data for feed intake, feed refusal, morning, and evening milk production from the six cows. Analysis of Variance following an unbalanced design was applied because the FP phase was 4 weeks while IN feeding and the 50:50 phase took 2 weeks each. Least significant difference (lsd) separated the means and were significantly different at $P<0.05$.

Results

Feeds and feed quality

Under FP, an array of forages was offered to the lactating cows (Table 2). This included a mix of crop residues from maize stovers (*Zea mays*), beans haulms (*Phaseololus vulgaris*) and banana stems (*Musa* spp). Common forage crops included buffel grass (*Cenchrus ciliaris*), Napier grass (*Cenchrus purpureus*), Rhodes grass (*Chloris gayana)*, Guatemala grass (*Tripsacum andersonii*), star grass (*Cynodon dactylon*) and to a limited extent leucaena (*Leucaena leucocephala*) and Desmodium (*Desmodium intortum*) forage legumes and sorghum (*Sorghum bicolor*). All the 6 farms fed Rhodes grass and natural pastures, 4 fed star grass, Guatemala grass, maize thinnings/stovers and bean haulms. Four farms offered Napier grass while 2 farms gave banana leaves. Buffel grass, pearl millet (*Pennisetum glaucum*), leucaena leaves and Setaria (*Setaria sphacelata*) were observed in one farm each.

Table 2. Forages offered to cows under FP during feeding trial in Njombe District, Tanzania

Farm	Forages offered under FP
1	Rhodes grass, maize thinnings, Guatemala grass, Desmodium, Napier grass, star grass, banana leaves and mixed natural pastures.
2	Rhodes grass, Guatemala grass, Napier grass, star grass, bean haulms, pearl millet leaves and mixed natural pastures.
3	Rhodes grass, maize stover, Setaria, bean haulms and mixed natural pastures.
4	Rhodes grass, maize stover, star grass, *Desmodium intortum*, Napier grass, bean haulms, leucaena, Guatemala grass, sorghum, buffel grass and mixed natural pastures.
5	Rhodes grass, maize stover and mixed natural pastures.
6	Rhodes grass, bean haulms, star grass, banana leaves, Napier grass, Guatemala grass and mixed natural pastures.

Following forage nutritional analysis, differences in feed quality across farms were observed in ash, crude protein (CP), neutral detergent fiber (NDF) acid detergent fiber (ADF), metabolizable energy (ME) and in vitro organic matter digestibility (IVOMD) (Table 3).

Milk yields

The six cows significantly increased their milk yields under IN feeding compared to FP except in Farm 5 (Figure 1). The increase ranged from 1.2–21 %. The milk yields among cows were in the order Farm 1>Farm 3≈Farm 4>Farm 6>Farm 2>Farm 5 (Figure 1).

Table 3. Nutritional value of feeds offered under FP and IN during 8-week experimental period in Njombe District, Tanzania

Farm	Feed type	DM (%)	Ash (%)	CP (%)	NDF (%)	ADF (%)	ADL (%)	ME (MJ/kg)	IVOMD (%)
1	Cobra hay	93.9	15.6	9.8	64.9	36.5	8.0	7.0	50.7
	Rhodes grass	93.9	10.8	8.2	73.7	46.7	8.6	6.7	46.9
	Star grass	93.7	7.7	8.2	75.6	49.1	10.7	6.3	43.5
	Desmodium	92.9	8.0	10.8	56.9	50.9	16.2	6.8	47.9
	Banana Leaves	94.1	16.3	13.8	49.3	38.6	10.9	6.7	49.8
	Mixed natural pastures	93.7	9.6	7.4	73.2	47.2	9.4	6.6	45.4
	Buffel grass	93.9	12.3	8.6	71.6	44.4	8.1	6.6	47.4
	Guatemala grass	94.0	11.7	11.9	67.2	43.6	8.5	7.0	50.1
	Maize thinnings	93.6	13.6	12.2	64.7	37.8	8.9	7.0	50.0
2	Cobra hay	92.5	8.3	10.4	41.3	20.8	4.9	8.5	58.2
	Rhodes grass	93.7	8.2	6.0	76.8	49.8	9.2	6.5	44.4
	Star grass	93.4	8.0	8.1	67.6	41.5	9.0	6.9	47.5
	Napier grass	93.9	11.0	7.8	72.1	46.3	8.6	6.6	46.4
	Bean haulms	93.1	7.1	5.9	73.1	53.6	12	6.8	46.1
	Pearl millet	93.6	9.6	8.0	69.8	44.5	8.0	7.0	48.8
	Guatemala grass	94.1	12.1	12.2	67.4	43.1	7.8	7.2	51.2
	Mixed natural pastures	93.6	9.2	6.3	74.2	44.9	7.8	6.8	47.0
3	Cobra hay	93.5	12.4	7.8	63.2	35.8	8.1	7.0	49.3
	Setaria	93.8	13.5	11.7	63.8	38.6	6.1	7.4	53.4
	Rhodes grass	94.0	9.9	6.6	75.7	47.6	8.4	6.5	45.1
	Bean haulms	92.5	7.3	11.1	51.5	38.1	8.8	8.1	56.4
	Mixed natural pastures	93.8	9.5	8.4	72.2	46.7	10.5	6.5	45.0
	Maize stover	93.8	13.7	15.5	56.7	34.5	8.0	7.6	55.8
4	Cobra hay	93.8	13.9	7.3	68.7	40.3	8.8	6.6	47.1
	Buffel grass	93.9	11.0	6.8	75.3	46.1	7.8	6.7	47.1
	Rhodes grass	93.5	8.5	10.0	59.4	35.7	7.5	7.6	52.7
	Star grass	93.2	8.0	9.8	62.6	41.9	9.9	7.1	49.1
	Desmodium	93.1	11.2	13.0	51.5	51.1	16.6	7.1	52.8
	Leucaena	92.4	13.2	19.1	29.9	41.7	20.2	8.1	59.7
	Napier grass	93.5	9.3	7.5	65.3	40.6	7.8	7.1	49.0
	Bean haulms	92.3	8.2	11.6	29.8	16.7	5.5	8.6	59.2
	Sorghum	93.6	8.1	7.1	74.9	46.1	8.1	6.6	45.0
	Guatemala grass	94.0	9.6	6.7	76.7	50.6	8.6	6.4	44.7
	Mixed natural pastures	93.8	9.5	8.8	72.9	45.7	8.5	6.8	47.6
	Maize thinnings	93.1	9.2	8.9	59	33.9	6.9	7.5	51.9
5	Cobra hay	94.1	12.4	10.5	70.2	41.5	7.1	6.9	48.9
	Rhodes grass	93.5	9.7	11.6	58.6	35.5	7.0	7.3	51.2
	Maize stover	93.2	6.2	3.5	81.0	43.1	6.6	6.9	45.8
	Mixed natural pastures	94.0	10.8	9.0	75.4	46	8.8	6.5	45.5
6	Cobra hay	93.9	12.4	6.4	70.1	42.8	8.0	6.8	47.6
	Rhodes grass	93.9	8.2	6.8	77.9	51.1	9.8	6.2	42.8
	Star grass	93.8	8.3	6.6	76.5	50.3	10.5	6.3	43.4
	Banana leaves	93.5	12.9	9.0	59.4	42.6	10.4	7.0	49.5
	Napier grass	93.9	7.2	5.3	82.1	51.6	10.1	6.1	41.3
	Bean haulms	92.7	6.3	5.2	68.6	54.3	10.2	7.8	52.5
	Guatemala grass	93.9	9.3	7.3	74.4	49.4	8.6	6.5	45.5
	Mixed natural pastures	93.6	8.8	8.2	71.9	47.8	9.6	6.7	46.4
Overall Means	IN	93.6	12.5	8.7	63.0	36.2	7.5	7.1	50.3

Pooling data across the farms under FP, daily feed intake per cow averaged 38.2 kg as fed (Table 4). When the cows crossed to 50:50 (FP: IN) intake dropped by 26 % followed by a further drop of 24 % when the IN was fed, representing a total drop of 50 % comparing FP and IN. The feed intake values returned significant differences (P< 0.001) among them with FP registering the highest value. Subsequently, morning milk production was of the order FP < FP: IN < IN with values of 5 < 5.4 < 5.7 L /cow/d respectively. The milk yield under IN was significantly higher (P = 0.009) than the yields under FP. Evening milk yields followed the same order as that of the morning (Table 3) except that the values were lower. Feed use efficiency was greater when Cobra hay was used compared to FP where 2 kg DM contributed to a L of milk unlike 4.5 kg DM/L under FP (Table 3). The quality of FP feeds compared to IN (Table 3) was lower in terms of ash, neutral detergent fiber, acid detergent fiber, acid detergent lignin, metabolizable energy and in vitro organic matter digestibility.

Milk yields over the 8-week experimental period (Figure 2) started at a weekly average of 8.8 L milk/d (morning + evening) during the initial 2 weeks under FP and increased by 6.8 % in week 3 with 50:50 feeding before peaking at 10.1 L milk/d (15 % increase) when the cows were fed IN. On reverting to 50:50 feeding at week 6 the production remained at 10.1 L milk/d but when completely reverted to FP in week 7 and 8, production dropped by 2.6 % and 15.2 % respectively.

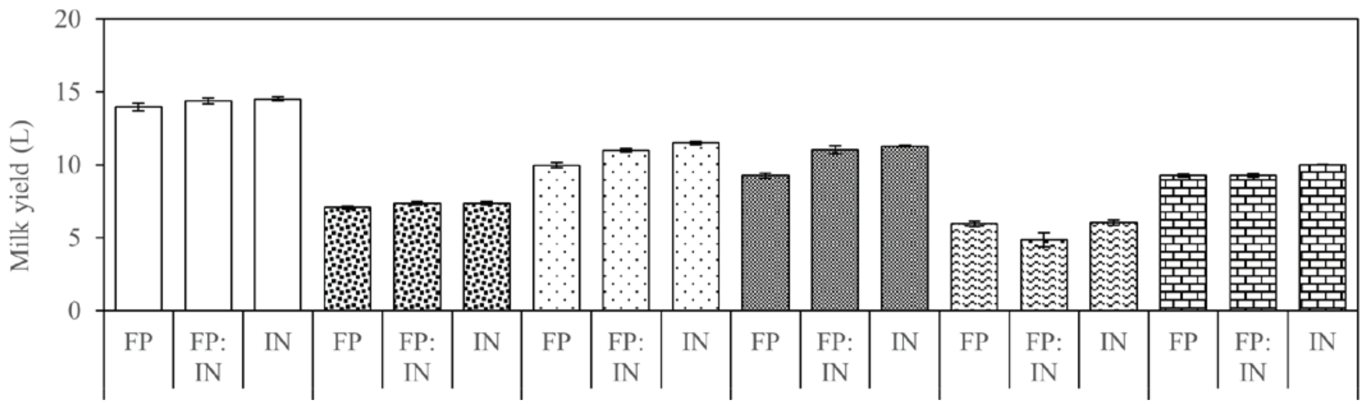

Figure 1. Mean (± se) of milk production (liters) for six lactating cows under either farmers' practice (FP), 50:50 of FP and intervention (FP:IN) and intervention alone (IN) in Njombe district, Tanzania.

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Table 4. Effects of FP and IN on feed intake and milk yields from experimental cows in Njombe district, Tanzania.

Parameter	Farmer's practice (FP)	Intervention alone (IN)	FP: IN	P value	Lsd
Feed intake (kg)	38.2	19.0	28.3	<0.001	4.099`
Morning milk production (L)	5.0	5.7	5.4	0.009	0.525
Evening milk productio (L)	4.1	4.5	4.4	0.038	0.372
Feed utilization efficiency (kg DM/L)	4.5	2.0	3.2	<0.001	0.481

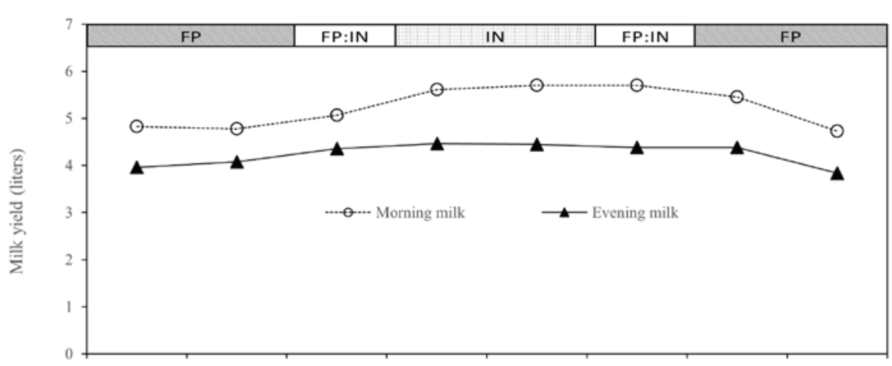

Figure 2. Average morning and evening milk production from six experimental cows over 8-week trial period in Njombe distrct, Tanzania. The performance was measured over 3 phases of farmers' practice (FP), 50:50 of FP and intervention (FP:IN) and intervention alone (IN). Each data point on the lines is an average of 7-daily measurements per cow and for the six cows.

Discussion

In livestock production, feed intake is key for maintenance, growth and reproduction. FP comprised a mix of crop residues, natural pastures and cultivated forages across the 6 farms. Crop residues are characterized by low digestibility, energy and crude protein content (Methu et al. 2001) as observed by use of maize stovers in Farm 5 (Table 3) thus limiting cow performance. Although quality of grasses depends on stage of growth, young grasses being more nutritious, natural pastures are of relatively lower quality than cultivated forages (Gietema 2005). In the 6 farms, natural grasses had lower digestibility, energy and crude protein compared to the grown fodder grasses (Table 3). However, there was variation of nutritional parameters in feed samples of the same species from different farms, most likely influenced by farm management e.g. soil fertility and possible harvest at different stages of growth among the farms. Cows in the study ingested more feed under FP than IN. The lower Cobra hay intake compared to FP (Table 4) during IN phase did not depress milk production and meant no abrupt changes in feed type. Often abrupt changes in feed types, like the use of different roughage sources as observed under FP, lower the microbial activity in the rumen and consistency in feeding is of utmost importance in rumen adaptation (Humer et al. 2018).

The increase in milk yields from feeding Cobra hay demonstrates its potential in supporting milk production, despite the genetic differences that may exist in the cows involved (Figure 1). The benefit most likely can be attributed to better quality of Cobra hay than feeds offered under FP (Table 3). Milk yield increased with feeding Cobra hay despite reduced feed-intake compared to FP most likely benefiting from the greater nutritive profile compared to fodder types under FP. To produce milk under FP required 4.5 kg feed/L and 2.0 kg Cobra hay/L under IN (Table 4). Where lower yield of quality forage is realized per unit of land, compared to unimproved forages, it does not therefore necessarily translate into an increased land requirement for more forage production. This is a key benefit of using improved forages for improving livestock productivity. Farmers take a lot of time cutting and carrying natural pastures (Paul et al. 2017) and growing improved forages with lower DM requirements would save on time for other important activities.

The increase in milk production (Figure 1, 2 and Table 4) by changing to Cobra hay confirms the potential to increase productivity even with the current crossbred cows, whose productivity potential is underutilized due to poor feeding (Swai et al. 2014; Maleko et al. 2018a). Tanzania's low national average lactation of 2,000 L/cow/yr (CSIRO 2021) could be increased to 2,300 L/cow/yr with Cobra hay intervention. Assuming half of the estimated 239,237 improved dairy animals in Tanzania are in lactation in a year, this would translate to about 35.8 million L milk/y (CSIRO 2021) and contribute to the projected growth of per capita milk consumption (IFAD 2016).

Use of Rhodes grass and Napier grass, both of which are forage grasses under FP in this study, indicate farmers' awareness about growing forages on farm. In addition to Napier grass's relatively low crude protein content 5.3–7.8 % (Table 3), its cultivation is currently negatively affected by smut and stunt diseases (Mwendia et al. 2007; Obura et al. 2009). Rhodes grass is also low in crude protein. Gietema (2005) reports figures as low as 2.3 %, although the figures of 6.0–11.6% we obtained in this study are much higher, implying farmers are using the grass at much younger growth stages. This implies farmers are knowledgeable about forage cultivation and could benefit from use of better forage crops. Livestock extension assistance, access and affordability of seeds of better forages are paramount for adoption to increase and realize the benefits of improved forages.

Conclusions

The study provided emperical evidence on the potential of Cobra hay to increase milk production in Tanzania, owing to its desirable attributes, including nutrient content, high digestibility and high feed utilization efficiency. Cows required more than double the amount of feed under FP compared to use of Cobra hay. Involving farmers in forage feeding trials may contribute to changing their perception about the need for improved forages for increased productivity. However, for farmers to adopt improved forage technologies, access to affordable seeds/planting materials is key.

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