Working with smallholder dairy producers on feeding dairy cattle in western Kenya

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December 2020

Summary

We worked with selected dairy farmers in Western Kenya counties (Bungoma, Busia, Kakamega) on feeding lactating cattle and monitored milk output. Two feeding phases comprised, following farmer own practice on what they normally do on daily basis, and two, introduced forages not normally used in the area namely *Panicum* Maasai and Brachiaria Mulato II. Under either case, we observed milk production (liters). Generally, there was a mix of some animals increasing milk production and a drop in others. The animals increased milk production by up to 9.5% when the two introduced grasses were compared to farmers practice. However, *Panicum* Maasai has greater increase in production of up to 31% while Mulato II on its own did not register milk increase with the animals used and is worth investigating more. Use of improved forages for increased livestock productivity require concerted effort on promotion and awareness creation while ensuring availability of seeds/planting materials is adequate to reach adoption at scale.

Introduction

Livestock productivity has remained low in sub-Saharan Africa (SSA) compared to the rest of the world (Otte and Knips 2005) albeit the various benefits livestock contributes especially in the smallholder mixed cropping systems. Largely, livestock more so smallholder dairy provide household nutrition, incomes and manure utilized to fertilizer other food crops. Additionally, livestock caters as source of wealth, and acts as an insurance against unforeseen incidences that require cash often mitigated by livestock sale (Bebe et al. 2003). While there are several areas that affect livestock productivity including, breeds, management, health and feeds; feeds and feeding alone takes up to 70 percent (Odero-Waitituh 2017) of costs associated with milk production signifying the importance of addressing livestock feeds.

The roughages that form the basal diet of cattle essentially should contain nutrients key for the body maintenance, growth, production and reproduction (Lukuyu, et al 2012). Largely, livestock production in SSA relies on natural and unimproved pasture and forages often low in nutrients (Manaye et al. 2009) and one of the reasons for the low productivity. Improved forages through selection and breeding exist and that have proved increased livestock production. For example, Mwendia et al 2017 while using fodder oat (*Avena sativa*) and vetch (*Vicia villosa*) reported milk increase of 21% under smallholder dairy context in tropical Kenya. Similarly, and in more temperate environment, use of festulolium bred for high water soluble carbohydrates increase milk and meat (Humphreys et al. 2014a). The growing human population in the region and increasing per capita milk consumption (Auma et al 2017) implores the need to improve livestock production.

Largely, farmers do not plan feeding for their dairy cattle. Animals are usually fed on what is available, with fluctuations especially during dry seasons, despite availability of improved grasses with potential to increase productivity. Conventional approaches to testing planted forages end at the agronomy level, and rarely taken through animal feeding trials for empirical evidence of potential improvement. On-station, trials are not only expensive but also disconnected from farmer practice that are essentially targeted to change for the better. Therefore, the objectives of this trial are to (1.) Test productivity gains from use of *Brachiaria and Panicum* improved grass cultivars by growing on farm and feeding on farm (2.) Conduct trials *in situ* on farm to allow farmers first-hand experience of potential benefits.

Approach

Design: The trial design employed crossover where the experimental unit (lactating cow) where we trialed under farmers practice (FP) then transferred to experimental feeding intervention (IN) before reverting to FP. The treatments details are stipulated in Table 2. In Kenya, we conducted the research in three county sites (Kakamega, Bungoma, and Busia) using Brachiaria hybrid (Mulato II) and a Panicum (Maasai). Because of the complexity of animal trials and especially in an on-farm participatory set up, where breeds may be different e.g. local, crosses etc. comparisons fist made within animals and each animal acting as its own control. The main comparison will be to compare test forages (intervention- IN) with conventional farmer practice (FP).

Sample size: To estimate the number of cows required for the trial the following equation, using fixed mean as farmer usual practice, was used.

$$n = \frac{\left(Z_{\frac{\alpha}{2}} + Z_{\beta}\right)^2}{d^2} \quad \sigma^2$$

Where:

n- Number of a cows required in the trial

d - Acceptable margin of error (i.e. mean ± confidence interval) or in this case the difference that would be recognised to be a significant productivity increase. This is expressed as a proportion of the mean, in this case 1.22 (i.e. 22% increase) obtained from contacting farmers in the area on expected milk increase with proper feeding compared to farmer practice.

σ^2 - Variance of the estimated mean assumed to be equal for each sample. This is also expressed as a proportion of the mean and estimated from expert knowledge is likely to be 1 (i.e. equal to the mean)

$Z_{\alpha/2}$ - is the significance level (5%), with a Z-value of 1.96.

Z_b - I**s** the power of the test to identify a significant difference i.e. 'chance' of this occurring. Eighty percent is a commonly used value for power of the test providing a Z-value of 0.84.

Therefore, the n equals $[(1.96 + 0.84)^2 \times 1^2] / 1.22^2 = 5.26$ animals needed per forage (rounded to 6)

Measurements: After selecting animals (described below), we monitored the animals under FP for 2 weeks and measuring feed intake, and milk production. To capture these, we undertook the following: On a daily basis recorded the type of feeds and quantities (kg) given to the animals and refusals (kg) in the morning of the next day. Daily milk yield in both the morning and evening milking measured with a graduated container (liters). After the initial two week period, test forage (IN) followed by 100% IN at week 3 before getting back to FP at week 4 and 5. For IN herbage we estimated at 3% DM of the live body weight (≈300 kg) for local zebu equivalent to 9 kg DM/day. During IN, forage quantities fed as well as the milk production were quantified as in FP. Therefore, the total experimental period is five weeks (Table 1). Clean drinking water was available throughout the experiment. Where supplementation and mineral licks were offered under FP, the same regime was maintained during IN, such that the only difference between FP and IN was the roughage source.

Table 1. Activities weekly schedule

Activity	1	2	3	4	5
Farmer practice monitoring (FP)					
Weighing feed and forages (kg) daily					
Weighing feed refusal daily (kg)					
Weighing morning milk daily (liters)					
Weighing evening milk daily (liters)					
Intervention feeding (IN)					
Weighing feed and forages (kg) daily			100% IN		
Take sample of the Feed/Forage (300g daily)					
Weighing feed refusal daily (kg)					
Weighing morning milk daily (liters)					
Weighing evening milk daily (liters)					

Farmers and cows' selection: - in each of the project sites, Send a Cow- Kenya selected farmers with their cows in similar lactation period by the time intervention forages were ready (i.e in 4 months) to accumulate a harvestable crop. We selected cows in early lactation (2 -3 months) and in 2nd to 4th parity. Farmers, who stall-feed only, were selected to avoid complications with measuring grazing intake, as is not easy. We assisted the selected farmers to establish about 0.2 Ha (0.5 acre of the respective intervention forage on their farms. Mullato II yields approximately, 3200 kg and Maasai 5000 kg fresh herbage equivalent to 154 and 220 kg DM respectively in the selected sites. The values were based on fresh yields realized in initial harvest after planting the forages under trials in the sites in 2019 (Unpublished).

Table 2. On-farm animal feeding trial arrangement for Kenya

Country	Site	Cow	Period 1 (2 weeks)	Period 2 (1 week)	Period 3 (2 weeks)
Kenya	Kakamega	1	FP	Mulato II	FP
Kenya	Kakamega	2	FP	Mulato II	FP
Kenya	Kakamega	3	FP	Mulato II	FP
Kenya	Kakamega	4	FP	Panicum (Maasai)	FP
Kenya	Kakamega	5	FP	Panicum (Maasai)	FP
Kenya	Kakamega	6	FP	Panicum (Maasai)	FP
Kenya	Bungoma	7	FP	Mulato II	FP
Kenya	Bungoma	8	FP	Mulato II	FP
Kenya	Bungoma	9	FP	Mulato II	FP
Kenya	Bungoma	10	FP	Panicum (Maasai)	FP
Kenya	Bungoma	11	FP	Panicum (Maasai)	FP
Kenya	Bungoma	12	FP	Panicum (Maasai)	FP
Kenya	Busia	13	FP	Mulato II	FP
Kenya	Busia	14	FP	Mulato II	FP
Kenya	Busia	15	FP	Mulato II	FP
Kenya	Busia	16	FP	Panicum (Maasai)	FP
Kenya	Busia	17	FP	Panicum (Maasai)	FP
Kenya	Busia	18	FP	Panicum (Maasai)	FP

Data analyses

We used descriptive statistics to summarize the observations

Results and discussion

Farmers feeding practice

Farmers feeding entailed various forages as stipulated in (Table 3). The most common forage was Napier grass across the counties, sweet potato vines and couch grass. Except Bungoma County, the farmers gave dairy meal to lactating cows.

Table 3. Forage and feeding offered under farmers' practice in Busia, Bungoma and Kakamega counties in Kenya

County	Farm	NG	CG	MG	GG	MS	CA	DE	SPV	ST	WJ	DM
Busia	1	√				√			√	√		√
	2	√						√				√
	3	√						√	√			√
	4	√										
	5	√	√									√
	6	√							√			
Bungoma	1	√	√									
	2	√	√			√			√			
	3	√	√			√						
	4	√				√	√					
	5	√	√									
	6	√						√				
Kakamega	1	√		√			√		√			√
	2	√		√	√	√			√			√
	3	√		√				√	√			√
	4	√	√		√		√					√
	5	√	√								√	
	6	√					√					

NG- Napier grass, CG- Couch grass, MG-Mixed natural grasses, GG- Guatemala grass, MS- maize stover, CA- Calliandra, DE-Desmodium, SWV- sweet potato vine, ST- Sugarcane top, WJ- wondering Jew, DM- Dairy meal

Milk production

From the eighteen animals involved in the trial (9 fed on Maasai grass; 9 on Mulato II hybrid grass), there was a mix on increase and decease on milk production. Four lactating cows fed on Maasai grass had an increase and six fed on Mulato II while 5 cows fed on Maasai and 3 on Mulato II decreased milk production.

Animals with increase in milk production (Mulato II)

Comparing farmer's practice, average milk yield, at end of week-2 and the mean for intervention feeding week-3 gives the observed change in milk production. Figure 1 a, the cow had an increase in milk production of 9.5%. Similar values (%) for Fig. 1 b, c, d, e and f respectively are 6, 20, 18.3, 19 and 50.

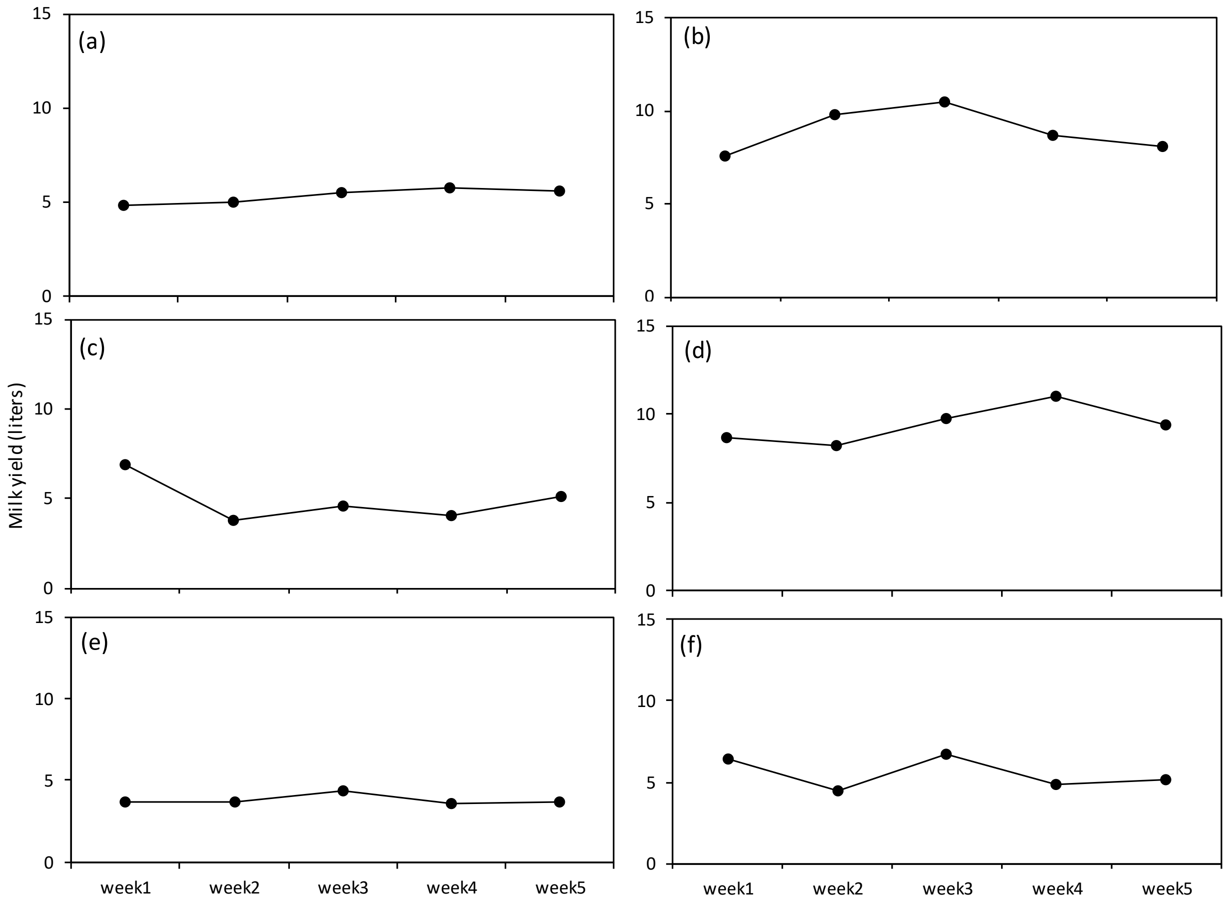

Figure 1. Increased milk production response of lactating cows comparing farmers' practice (weeks 1, 2, 4 5) and intervention (week 3) feeding on Mulato II. The cows are from Bungoma county (a, e), Kakamega county (b, c, f) and Busia county (d).

Animals with increase in milk production (Maasai Panicum grass)

Increase in milk yield from animals fed on Maasai grass ranged (10–55%). Specifically, cow represented in fig. 2a from Kakamega County had an increase of 10%, Fig. 2 b from also Kakamega county 19%, Fig 2c, from Kakamega County 34% and Fig. 2d from Bungoma County 55%.

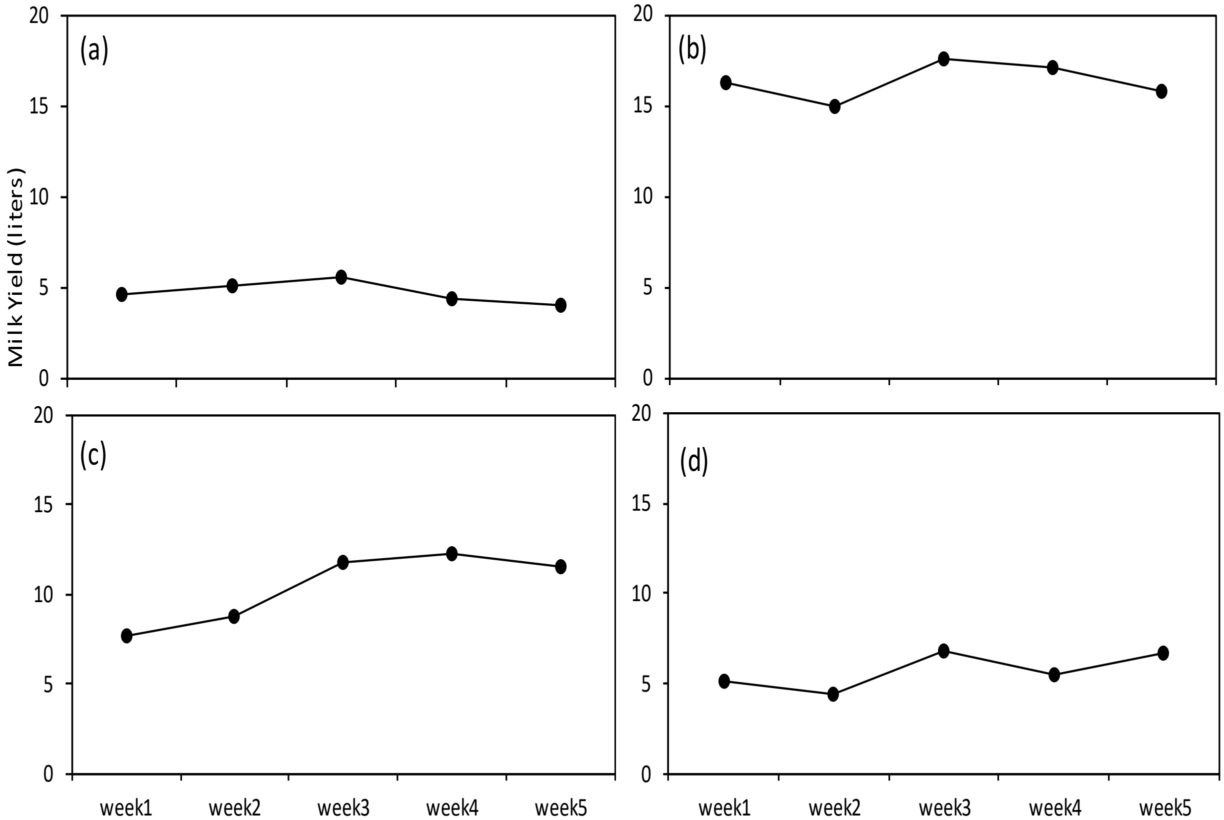

Figure 2. Increased milk production response of lactating cows comparing farmers' practice (weeks 1, 2, 4 5) and intervention (week 3) feeding of Maasai Panicum grass. The cows are from Bungoma county (a, e), Kakamega county (b, c, f) and Busia county (d).

Animals with decrease in milk production (Mulato II)

We observed decrease in milk production in 3 cows fed on Mulato II (Figure 3). The first cow (Fig 3a) from Bungoma County and a 7% drop in milk production comparing farmer's practice and the intervention. Although, the farmer did not feed concentrates throughout the trial, under farmer practice he fed desmodium which he did not consider as supplementation, and which we should have included in the intervention feeding, if we were aware he had desmodium. This is likely to have contributed to the drop in milk production. The second from Busia had a drop of 10 % (Fig 3a). Equally, the farmer fed sweet potato vines, which despite not been legumes, are considered as supplementation due to usually high crude protein levels. The third cow had a drop of 16 % attributable to feeding of sweet potato vines, which as mentioned should have continued as part of supplementation and not as basal diet in intervention feeding.

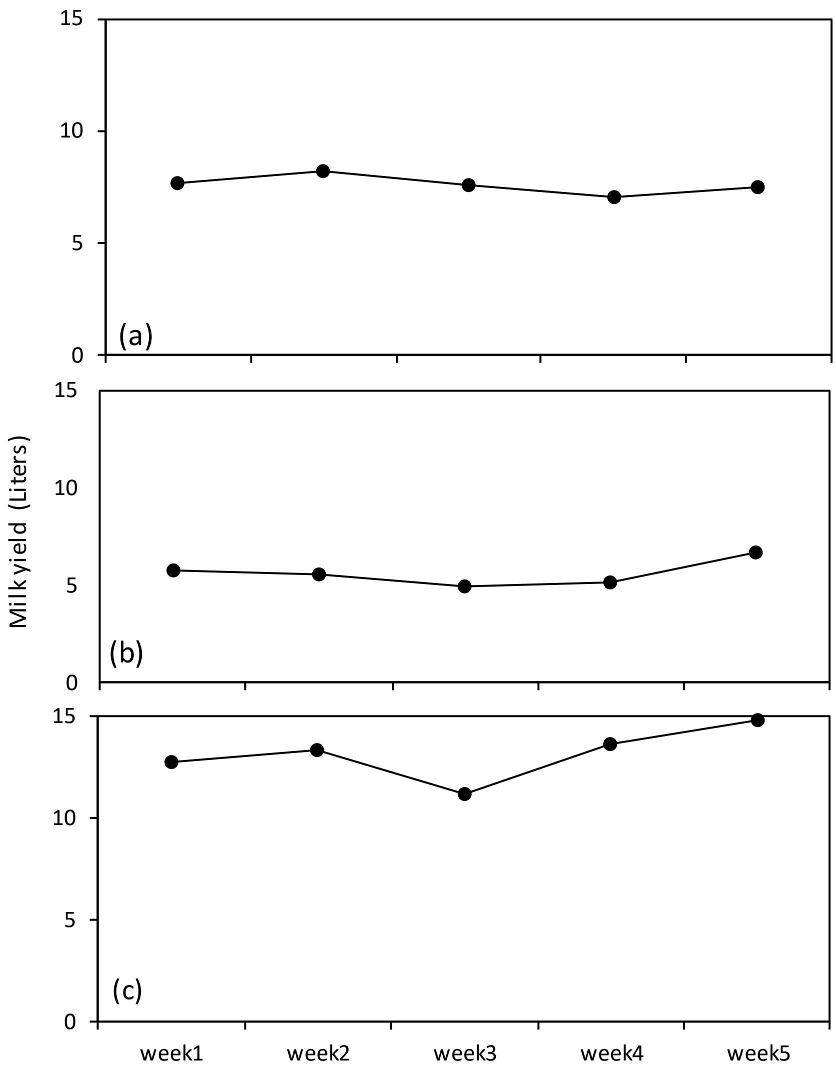

Figure 3. Decreased milk production response of lactating cows comparing farmers' practice (weeks 1, 2, 4, 5) and intervention (week 3) feeding of Mulato II hybrid grass. The cows are from Bungoma county (a), Kakamega and Busia County (b, c).

Animals with decrease in milk production (Panicum Maasai)

Five cows fed on Maasai Panicum grass as intervention dropped milk production compared to farmers' practice. The drop was (%) 2, 14, 2, 15 and 48 respectively for Fig 4 plots a, b, c, d and e. Farmers keeping this cows fed forages which were more of supplementation than as basal diet. The cows in plots (a, b, c) fed on sweet potato vines while cow in plot (c) fed Calliandra and (e) had both *Calliandra* and *Leucaena*. We should have incorporated these supplementation crops in the intervention if the farmers had indicated they use them.

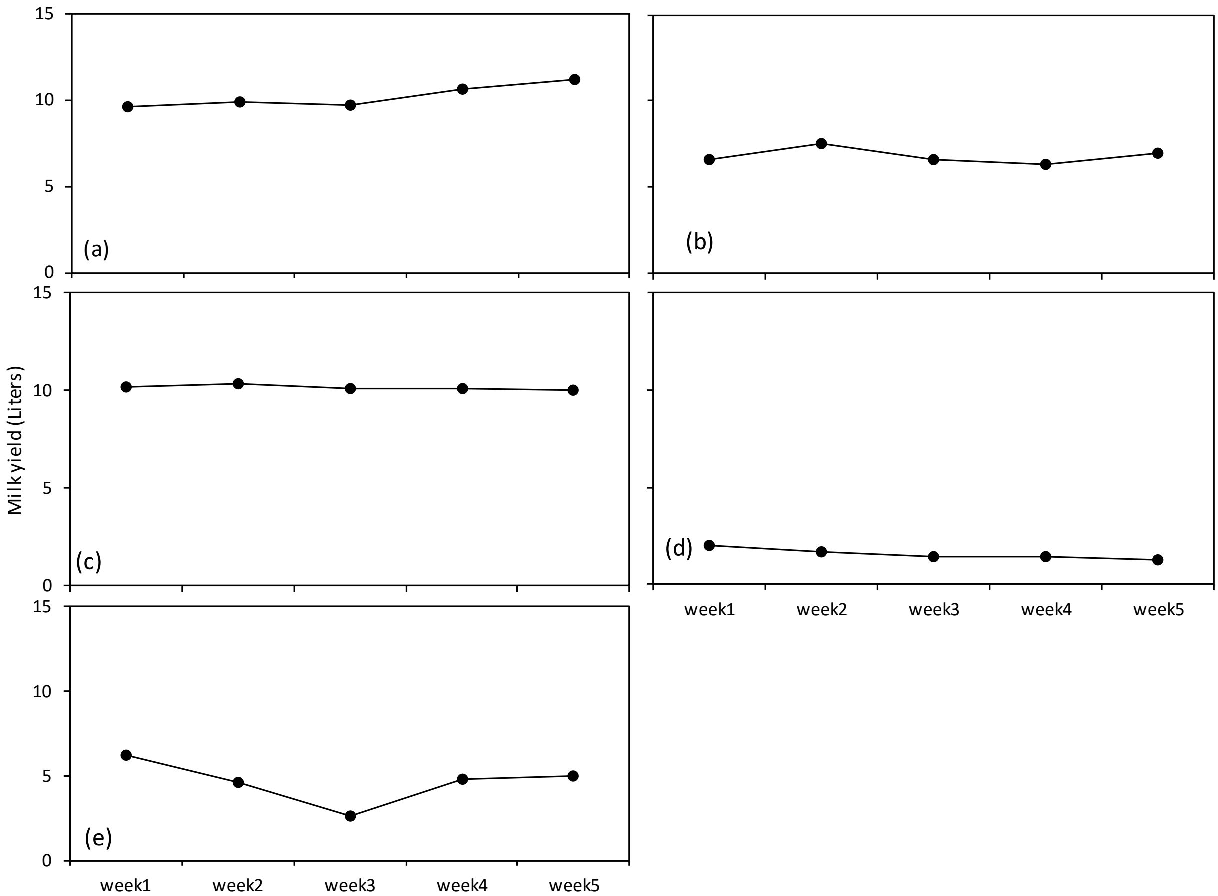

Figure 4. Decreased milk production response of lactating cows comparing farmers' practice (weeks 1, 2, 4 5) and intervention (week 3) feeding of Maasai Panicum grass. The cows are from Busia county (a, b), Bungoma county (c, d) and Kakamega County (e).

Following the use of the supplemental feed by farmers as basal diets, we dropped animals affected in a combined analysis and observed the following in milk production comparing farmers practice and the intervention (Table 4). Milk production increased by 9.5% when both Maasai and Mulato II were compared to what the farmers were doing. This is evidence improved feeding has the potential to increase milk productivity. As shown earlier for the individual animals, there was varied increase in milk production amongst the animals.

Table 4. Milk production (liters) under farmers practice compared with intervention

Feeding type	Milk production (liters)
Farmer practice	7.4
Intervention (Maasai Panicum, Mulato II)	8.1

Maasai Panicum	9.7
Mulato II	6.6

On comparing farmer practice with specific test forages, Panicum Maasai registered greater increase in milk production of up to 31%. However, Mulato II response did not register milk production and noted a drop of 10%. We did not get a clear argument as to why there would be a drop and would be worthy while to investigate further.

Conclusion

There is potential to improve livestock productivity especially on milk production by use of forages with better quality and utilization attributes. By use of feeding trials while engaging farmers is plausible as it raises adoption chances. Previous studies have shown adoption of improved forages at scale is key for realizing forage benefits (Schiek et al., 2018). Awareness creation possibly through multiple avenues is key for raising adoption profile.

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Annex I

Data collection tool

Data sheet Farmers name

WeeK No:…………………………..

Record weight of feed as fed, and refusals in the next morning and, trough cleared off refusals after weighing

Day	*Napier grass (kg)*	*Maize stover (kg)*	*………….(kg)*	*……………(kg)*	*…………(kg)*	*………….(kg)*	*…………(kg)*	……………(kg)	Minerals	water (liters)	Dairy meal (kg)	Minerals	water (liters)	*Morning milk (kg/liters)*	*Evening milk (Kg/liters)*
1															
Refusals															
2															
Refusals															
3															
Refusals															
4															
Refusals															
5															
Refusals															
6															
Refusals															
7															
Refusals															

Annex II photos