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Research Application Summary

Evaluation of milk yield from cattle fed on forage fertilized with specific mineral elements in Western Kenya

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Abstract

The study evaluated the effects of Desmodium (*Desmodium intortum*) as feed supplement to Napier grass (*Pennisetum perpeureum*) on milk yield and density and effects of fertilizer application levels on forage yield. Desmodium was planted using four different fertilizer combinations of Triple Supper Phosphate (TSP) fertilizer, Farm Yard Manure (FYM), Zinc (Zn) and Lime and the treatments included; no fertilizer applied (control), 4t/ha FYM+70kg/ha TSP, 2t/ha Lime+150kg/ha TSP+3kg/ha Zn and 4t/ha FYM+70kg/ha TSP+3kg/ha Zn. Napier grass was planted using uniform fertilizer combination (5t/ha FYM + 100kg/ha (NPK; 17:17:17)). The four Desmodium treatments were formulated into four different rations which were supplemented to Napier grass; 1=Napier grass+ Desmodium with no fertilizer applied, 2= Napier grass + Desmodium planted with 2t/ha Lime+150kg/ha TSP+3kg/ha Zn, 3= Napier grass + Desmodium planted with 4t/ha FYM+70kg/ha TSP + 3kg/ha Zn and 4= Napier grass+ Desmodium with 4t/ha FYM+70kg/ha TSP applied in the feeding experiment. Napier grass was fed *ad libitum* while Desmodium was wilted and fed at 10kg/cow/day. Rations were randomly assigned to four cows in a 4*4 Latin square design and means separated using Tukey's range test at 95% confidence level. Results showed increase in forage quantity across the various cutting times and treatments used. Milk yield increased by 0.193 litres in ration 4, 0.332 litres in ration 3 and 0.593 litres in ration 2, except ration in 1 (control) where it decreased by 0.043 litres. Milk density also increased by 2.85g/l in ration 4, 4.74 g/l in ration 3 and 6.08g/l in ration 2. Fertilizer applications affect forage quantity and quality which consequently affect milk yield and density. Desmodium therefore provides readily available protein supplement for farmers. In order to ensure adoption and sustainability of feed improving technologies there is need to establish forage seed multiplication sites to ensure accessibility to the farmers.

Key words: Desmodium, Farm Yard Manure, fertilizer combinations, milk yield and density, Napier grass

Résumé

L'étude a évalué les effets de Desmodium (*Desmodium intortum*) comme aliment supplémentaire à l'herbe à éléphant (*Pennisetum perpeureum*) sur la production du lait et la densité laitière, et les effets des niveaux d'application d'engrais sur le rendement en fourrage. Le Desmodium a été planté en utilisant quatre combinaisons différentes d'engrais Triple Supper Phosphate (TSP), le fumier de la ferme (FF), zinc (Zn) et de la chaux. Les traitements étaient : pas d'engrais appliqués (contrôle), 4t FF/ ha + 70 kg TSP / ha, 2t de la chaux / ha + 150 kg TSP/ ha + 3 kg Zn/ ha et 4t FF/ ha + 70 kg TSP/ ha + 3 kg Zn / ha. L'herbe à éléphant a été plantée en utilisant la combinaison d'engrais uniforme (5t / ha FF + 100 kg / ha (NPK; 17:17:17)). Les quatre traitements Desmodium ont été formulés en quatre rations différentes qui ont été complété l'herbe à éléphant; 1 = l'herbe à éléphant + Desmodium sans engrais appliqué, 2 = l'herbe à éléphant + Desmodium planté avec 2t de la chaux / ha + 150 kg TSP / ha + 3 kg Zn / ha, 3 = l'herbe à éléphant + Desmodium planté avec 4t FF/ ha + 70 kg TSP/ ha + 3 kg Zn / ha, et 4 = l'herbe à éléphant + Desmodium avec 4t FF/ ha + 70 kg TSP/ ha appliqué dans l'expérience d'alimentation. L'herbe à éléphant été servie *ad libitum* alors le Desmodium a était flétri et alimenté à 10 kg / vache / jour. Les rations ont été assignées au hasard au quatre vaches dans un 4 * 4 Carré Latin et des moyennes ont été séparées en utilisant le test de Tukey au niveau de confiance de 95%. Les résultats ont montré une augmentation de la quantité de fourrage tout le long des divers temps de coupe et les traitements utilisés. La production de lait a augmenté de 0.193 litres pour la ration 4; 0.332 litres pour la ration 3; et 0,593 litres pour la ration 2; sauf pour la ration 1 (contrôle), où elle a diminué de 0.043 litres. La densité laitière a également augmenté de 2,85 g / l pour la ration 4; 4,74 g / l pour la ration 3; et 6.08g / l pour ration 2. Les demandes d'engrais affectent la quantité de fourrage et de la qualité qui affectent par conséquent la production de lait et de la densité. Desmodium est donc un supplément de protéines facilement disponible pour les agriculteurs. Afin d'assurer l'adoption et la durabilité des technologies d'amélioration de d'alimentation il est nécessaire d'établir des sites de multiplication des semences fourragères pour assurer l'accessibilité aux agriculteurs.

Mots clés: Desmodium, le fumier de la ferme, des combinaisons d'engrais, le rendement de lait la densité, l'herbe à éléphant

Background

Livestock is an integral component of crop-livestock systems which is predominant in the tropical countries. Milk in these systems play a crucial role in food security, human health and overall household livelihoods particularly among the resource poor population (Muriuki, 2002; Kabirizi *et al.,* 2014). In Kenya, about 80% of the farmers are smallholder and account for over 70% of the gross marketed production, producing 80% of the country's milk (FAO, 2011). Smallholder crop-livestock farming systems dominate in western Kenya where over 70% of the population is employed in the sector and contributes to poverty reduction (Njarui *et al*., 2012). The system contributes 70-90% of the total meat and milk output in the region too. Even though smallholder dairy producers' account for most of the total milk produced in Kenya, individual cow productivity is low at 5.49 and 6.47litres (Ongadi *et al*., 2007; Wanjala *et al*., 2014).

Low quality and quantity of feed resources is the greatest constraint to improving milk production in the region (Omore *et al*., 1996; Mudavadi *et al*., 2001; Ongadi *et al*., 2007; Kabirizi *et al.,* 2014; Wanjala *et al*., 2014). Milk is a product obtained from feeds and therefore increased milk production from smallholder farming system depends on forage production interventions that ensure production of high quantity and quality feeds. Zero-grazing systems, i.e., stall feeding only and stall feeding with some grazing, are the most common smallholder dairy systems; farmers cut and carry feed to their confined dairy cows (Ongadi *et al*., 2007).

Napier grass is the basal feed of choice that is grown by 98% of the farmers in Kenya (Mudavadi *et al*., 2001; Ongadi *et al*., 2007; Wanjala *et al*., 2014). However, its protein content is too low to sustain adequate milk yields (Serra *et al*., 1996; Kariuki *et al*., 2012). Various supplementation interventions that aim at increasing milk yield have been used to curb the shortfall, mostly from concentrate (Biwott *et al*., 2000; Romney *et al.,* 2014) but is expensive. Smallholder farmers who do live below poverty line cannot afford concentrate and therefore the use of forage legumes as feed supplement to grasses is an affordable protein rich intervention which can be used instead (Kariuki *et al*., 2012; Kabirizi *et al.,* 2014).

Forage legumes have been tested as protein supplements but there are few cases of widespread adoption, especially in the smallholder sector (Kimambo *et al*., 2014). Apart from using forage legumes as animal feed supplement, they also improve soil fertility, conserve soil moisture, control weeds e.g. Striga weed and repel pests such as stem borers (Kifuko-Koech, 2012; Kabirizi *et al.,* 2014, Khan *et al*., 2014). Despite their technically demonstrated usefulness, adoption and sustainability of these interventions have been low or even abandoned after the end of project (Kimambo *et al*., 2014). Desmodiun production is one of such intervention which has been neglected and whose herbage production is highly variable on poorer soils (0.3-4.1 t/ha) (Kimambo *et al*., 2014). Therefore, the objective of this study was to determine the effect of fertilizer on forage growth/yield and effect of desmodium as feed supplement to Napier grass basal diet on milk yield and density.

Study description

Vihiga County is located in western Kenya and lies between latitude 0˚4´N and 34˚40E. It covers a total area of 531.3 km^2 with a population of 581, 594 people and a density of 1095 persons per km^2. The dominant soil types are Acrisols which are deep well drained and slightly acidic. The top cover is humic soils of volcanic origin with yellowish red loams derived from sediments and basements. To a smaller extent humic nitisols and Ferrasols are found (Jaetzold and Schmidt, 2006).

Desmodium and Napier grass planting was done at the beginning of long rainy season of March, 2015. Napier grass *var*. "Nandi songo" was planted using root splits on uniform treatment (5t/ha of Farm Yard Manure (FYM) and 100kg/ha of inorganic fertilizer (N, P, K; 17:17:17)) (Kariuki *et al*., 2012). Desmodium was planted from seed, using four different fertilizer combinations i.e. 1= without fertilizer (control), 2=2t/ha Lime+150kg/ha TSP+3kg/

ha Zn, 3=4t/ha FYM+70kg/ha TSP+3kg/ha Zn and 4=4t/ha FYM+70kg/ha TSP. All agronomic practices such as weed control, gapping, thinning, topdressing and pest control were carried out according to recommended practices (Kifuko-Koech, 2012). Forages were cut 4 months after planting, when desmodium was fully established but feeding experiments were carried out at the second cutting when forage quantities were enough, and three months after the first cutting. Rations were formulated from the forages; Napier grass was treated as basal feed and was fed *ad libitum* while Desmodium was wilted and fed at 10kg/cow/day. Four rations; 1=Napier grass+ Desmodium with no fertilizer applied, 2= Napier grass + Desmodium planted with 2t/ha Lime+150kg/ha TSP+3kg/ha Zn, 3= Napier grass + Desmodium planted with 4t/ha FYM+70kg/ha TSP + 3kg/ha Zn and 4= Napier grass+ Desmodium with 4t/ha FYM+70kg/ha TSP applied were generated based on the above stated different fertilizer combinations applied to Desmodium. The rations were randomly assigned to the cows in a Latin Square Design. Cows were adapted to the feed for 5 days after which data were collected for 40 days with 3-day change over period. The data collected was subjected to analysis of variance using GenStat program (14th Edition) and Tukey's range test at P value of 0.05 to separate the means.

Results

The quantity of Desmodium forage was higher from the second and third cuttings compared to the first cutting (Figs. 1, 2 and 3). Napier grass quantity was also high for the third and fourth cuttings when compared second cutting but first cutting was low overall (Fig. 4). There was gradual increase in milk yield (Table 1 and Fig. 5) regardless of the ration used; 0.193 litres ration 4, 0.332 litres ration 3 and 0.593 litres ration 2, except ration 1 whose yield depicted a decrease of 0.043 litres. Milk density increased by 2.85g/ml ration 4, 4.74g/ml ration 3, 6.23g/ml ration 2, but that of ration 1 remained constant. The rations were significantly

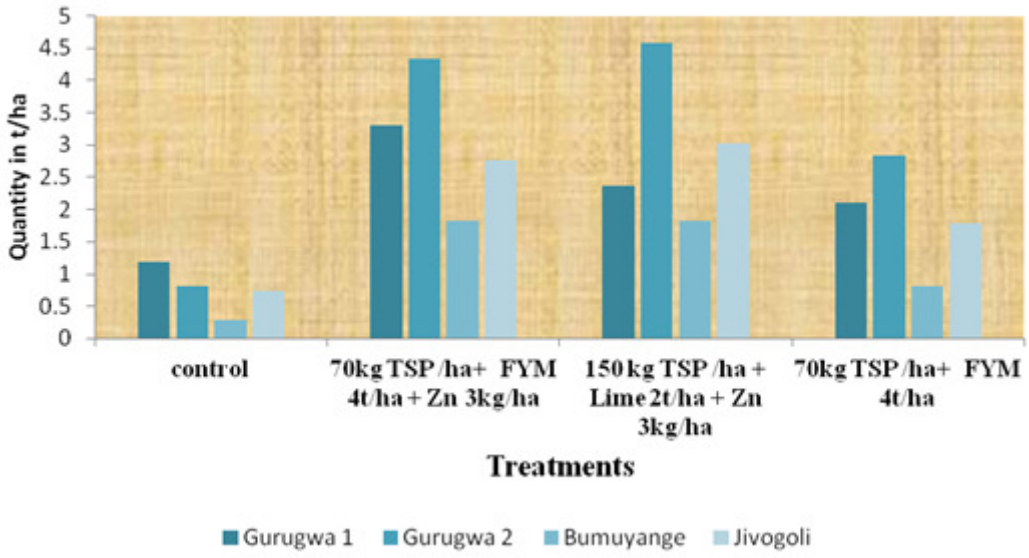

Figure 1. Desmodium yield for the different treatments from first cutting (t/ha)

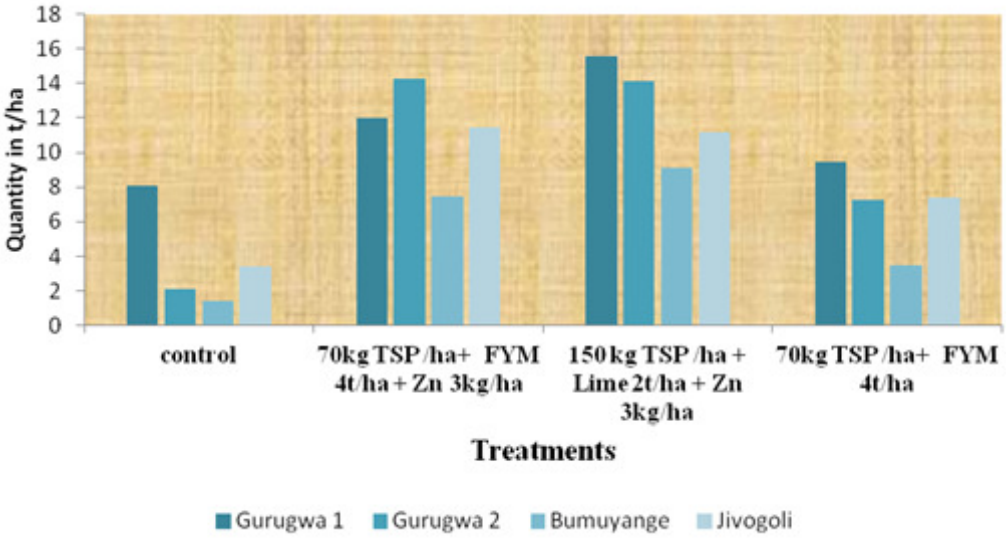

Figure 2. Desmodium yield for the different treatments from second cutting (t/ha)

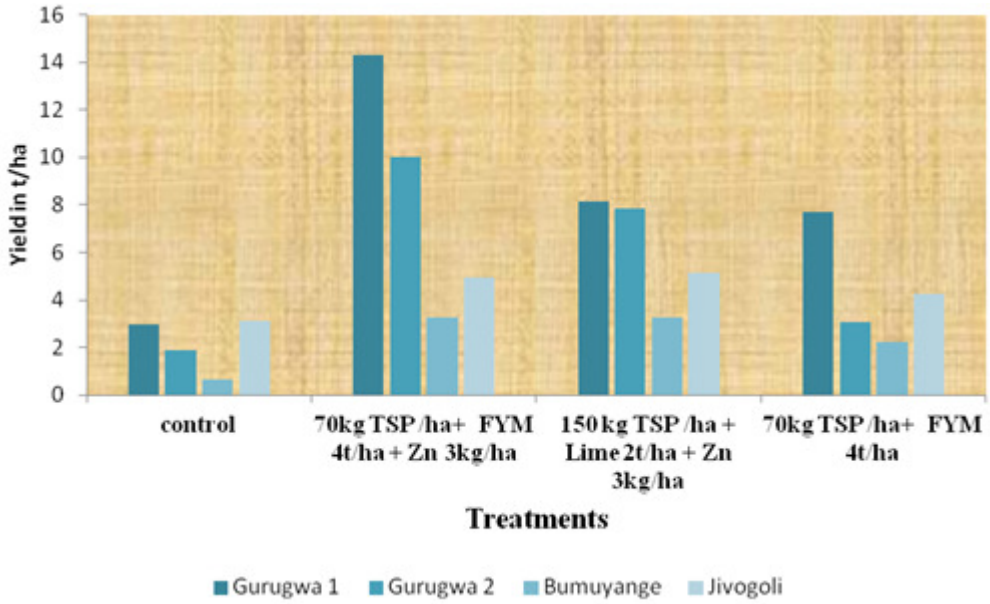

Figure 3. Desmodium yield for the different treatments from third cutting (t/ha)

($p<0.05$) different from each other except ration 3 and 4. Ration 2 gave a higher milk increment ($p<0.05$) in terms of quantity and density hence was the best among the treatments.

Discussion

The current study demonstrated that increase in protein input into animal feeding results into increased milk output and improved quality in terms of density. Fertilizer application

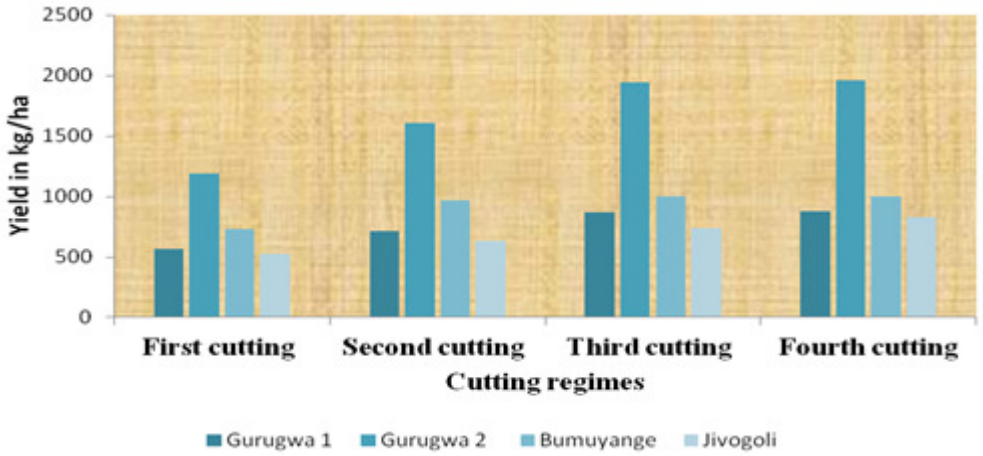

Figure 4. Napier grass yield from four different cutting times (kg/ha)

Table 1. Milk yields (litres) and density (g/mL) increments per treatments

	Milk yield in litres			Milk density in g/mL		
Fertilizer combination=Ration	Morning	Evening	Average	Morning	Evening	Average
Napier grass+ Desmodium with no fertilizer applied=1	1.889[a]	25.25[a]	25.15[a]	2.190[a]	2.039[a]	25.05[a]
Napier grass + Desmodium with 2t/ha Lime+150kg/ha TSP+3kg/ha Zn applied=2	2.515[b]	2.228[b]	2.371[b]	29.75[c]	29.02[b]	29.89[b]
Napier grass + Desmodium with 4t/ha FYM+70kg/ha TSP+1kg/ha Zn applied=3	2.850[c]	2.415[c]	2.632[c]	31.00[d]	31.45[c]	31.23[c]
Napier grass+ Desmodium with 4t/ha FYM+70kg/ha TSP applied=4	2.409[b]	2.055[b]	2.232[b]	27.62[b]	28.37[b]	28.00[b]

* Means with different superscripts in the same column are significantly different ($p<0.05$)

significantly affected nutrient levels and concentrations in forages and consequently milk quantity and quality, as previously reported (Khan *et al*., 2005; Suttle, 2010). Ration 2 gave significantly higher milk quantity and density increment compared to the rest of the rations (treatments). The difference between treatment 2 and 3 in terms of forage and milk produced could be due to the application of lime that lowered soil acidity thus allowing uptake of mineral elements by the forage. These results show that application of specific mineral elements lacking in soil prevents antagonistic effects that exist among the mineral elements thus ensuring their availability to the plant forages (Khan *et al*., 2005).

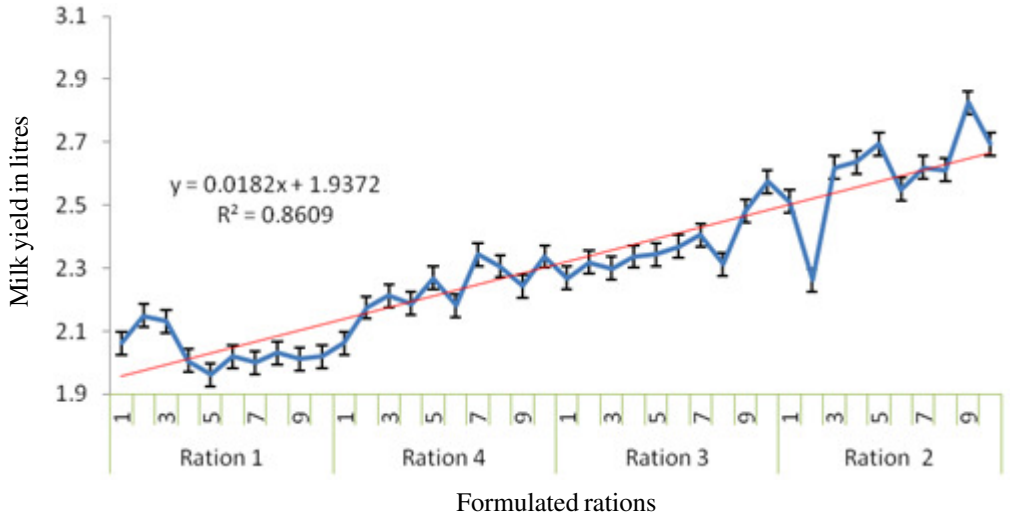

Figure 5. Regression and correlation for formulated rations and milk yield

Desmodium being a legume is high in crude protein content (10-17 %) as opposed to Napier grass (7-10%) (Kariuki *et al*., 2012; Kabarizi *et al*., 2014) and therefore supplementing it to Napier grass is crucial as it increases Nitrogen content in the diet (Place *et al*., 2009). Nitrogen is a structural component of the milk casein and therefore increasing it in cows' diet has a direct influence on total solids; it increases milk fat and hence increases milk density and yield.

Conclusions

This study has shown that application of specific mineral elements lacking in the soil, improves forage quantity and quality and consequently the quality and quantity of milk. In addition, the type of feed consumed by the animal also determines milk quantity and quality (density) in cows. Introduction of forage legumes into grass based smallholder animal feeding systems enhances soil physio-chemical properties, forage yields and quality which translate into improved milk production. In order to ensure adoption and sustainability of feed improving technologies there is need to establish forage seed multiplication sites to ensure accessibility to the farmers. Apart from fertilizer application, milk quantity and quality is also conditioned by the biochemical processes in the cow, controlled by genes which determine milk contents. Further research is needed in this field.

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