

# Dry season forages for improving dairy production in smallholder systems in Uganda

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## Abstract

Economically feasible strategies for year-round feed supply to dairy cattle are needed to improve feed resource availability, milk yield and household income for the smallholder dairy farming systems that predominate in the rural Eastern and Central African region. Currently, Napier grass (*Pennisetum purpureum*) is the major forage in zero-grazing production systems, but dry-season production is often constrained. Our results from 24 farms show that sowing forage legumes, including *Centrosema molle* (formerly *C. pubescens*) and *Clitoria ternatea*, with Napier grass and *Brachiaria* hybrid cv. Mulato improved both yield of forage and protein concentration. Sowing of 0.5 ha Napier-Centro plus 0.5 ha of Mulato-*Clitoria* increased milk yield by 80% and household income by 52% over 0.5 ha Napier grass monoculture. Possible income foregone from the crops which could have been grown on the additional 0.5 ha must be considered in assessing the economic viability of the system.

## Resumen

Para mejorar la disponibilidad, durante todo el año, del recurso forrajero, la producción de leche y el ingreso de las pequeñas fincas lecheras que predominan en África Oriental y Central, es necesario desarrollar estrategias económicamente viables. El pasto napier (elefante; *Pennisetum purpureum*) es el principal forraje en sistemas de producción con animales en confinamiento, pero su productividad en la época seca es limitada. Nuestros resultados, obtenidos en 24 fincas, muestran que sembrando leguminosas forrajeras, como *Centrosema molle* (sin. *C. pubescens*) y *Clitoria ternatea*, en mezcla con el pasto napier y el híbrido de *Brachiaria* cv. Mulato, se logra mejorar la producción de forraje y su concentración de proteína cruda. Con 0.5 ha de pasto napier-Centrosema y adicionalmente 0.5 ha de Mulato-*Clitoria* se logró un incremento del 80% en la producción de leche y del 52% en el ingreso de la finca, en comparación con 0.5 ha del pasto napier solo. Sin embargo, un análisis económico a nivel de sistema de producción debe tener en cuenta la ausencia de ingresos procedentes de un alternativo uso agrícola del área adicional de 0.5 ha.

## Introduction

Smallholder dairy farming systems dominate in the rural Eastern and Central African region, employ over 70% of the region's population and contribute 70–90% of the total meat and milk output in the region (Njarui et al. 2012). Small-scale dairy production plays a crucial role in food security, human health and overall household livelihoods, particularly among climate change-prone resource-poor households in the region. Zero-grazing dairy systems are increasingly promoted, owing to grazing land shortage

and intensive dairy production requirements. Women are immense contributors to and beneficiaries from smallholder dairy production systems (Njarui et al. 2012), which are progressively being devastated by rapid climate change and its attendant extreme weather conditions. The availability of livestock feeds in rural households is being affected by climate change. The lack of effective adaptation to the adverse effects of climate change is likely to jeopardize the achievement of Millennium Development Goals 1 (eradicating extreme poverty and hunger), 7 (ensuring environmental sustainability) and 3 (promoting gender equality and empowering women) (United Nations 2010).

Napier grass (*Pennisetum purpureum*) is the major forage in zero-grazing production systems in Masaka district,

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Uganda (Kabirizi 2006). However, grass productivity is constrained by long droughts, poor agronomic practices, such as lack of fertilizer application and improper cutting frequency and cutting height, and by pests and diseases, the napier stunt disease being particularly important, resulting in a reduction in fodder yield of up to 100% during the dry season. *Brachiaria* hybrid cv. Mulato (Mulato) has high biomass yield and tolerates long droughts and poor soils (CIAT 2001) and could be used to complement Napier grass. It is recommended that Mulato be grown to provide forage, when Napier grass production is low.

It is generally recommended, furthermore, that forages be grown in grass-legume mixtures in order to not only ensure energy-protein balance for livestock, but also harness atmospheric nitrogen (N) via the legume component (Thomas 1995; Kabirizi 2006). Among the best-known, but not widely used forage legumes in Uganda are *Centrosema molle* (syn. *C. pubescens*; Centro) and *Clitoria ternatea* (Clitoria); both are deep-rooting and considered as drought-tolerant. However, regardless of whether sown as a monocrop or in mixture with a legume, the officially recommended 0.5-ha Napier grass area is not sufficient to provide year-round forage for 1 cow and its calf.

This study was designed to develop economically feasible strategies for year-round feed supply to dairy cattle in order to improve feed resource availability, milk yield and household income, by comparing in on-farm trials the newly introduced drought-tolerant Mulato with commonly used Napier, both grown with a drought-tolerant legume.

## Methods

The study was conducted in Masaka district, Central Uganda (00°15'–00°43' S, 31°–32° E; 1150 m asl). Annual average rainfall is 800–1000 mm with 100–120 rainy days, in 2 seasons. Mean temperature ranges between 16 °C and 30 °C, while relative humidity is 62%. The district is typically dependent on crop-livestock systems, with vegetable production as a key income generator.

The study targeted zero-grazing dairy farmers with 1–2 cows and at least 2 ha of land. The treatments involved 2 grass-legume mixtures: Napier with Centro and Mulato with Clitoria. These mixtures were established as forage banks in 0.5 ha each on 24 randomly selected farms using methods described in Humphreys (1995) and CIAT (2001). The mixtures were compared with the farmers' practice of growing Napier grass alone. Farmers participated in all stages of project implementation to enhance rapid uptake of emerging knowledge and practices. The study was laid out in a randomized complete block design with household farms as replications. Fodder and milk yields from all 24 farms were recorded for 2 years. Dry matter yields and

associated feeding periods were estimated using methods described by Humphreys (1995). Data were analyzed with costs of inputs and returns from milk (including home-consumed) recorded for profitability evaluation using partial budgeting.

## Results and Discussion

Intercropping Centro with Napier grass increased fodder availability by 52%, crude protein (CP) concentration by 20% and feeding period (number of days a cow was able to feed on fodder from a given area of land) by 52% (Table 1). The Mulato-Clitoria mixture provided dry matter yields and a feeding period that were intermediate between the 2 Napier treatments but the increase in CP concentration was 73 respectively 44% higher.

**Table 1.** Fodder availability and quality, and feeding period for different forage banks. Figures refer to 2 years.

| Parameter                            | Forage bank           |                     |                       | s.e. |
|--------------------------------------|-----------------------|---------------------|-----------------------|------|
|                                      | Napier grass monocrop | Napier grass-Centro | Mulato grass-Clitoria |      |
| Mean DM yield (kg/ha)                | 10 354                | 15 790              | 12 119                | 307  |
| Feeding period from 0.5 ha (days)    | 167.0                 | 254.6               | 195.5                 | 20.9 |
| Mean crude protein concentration (%) | 7.0                   | 8.4                 | 12.1                  | 0.14 |

Higher total fodder yields and CP concentrations in intercrops (Table 1) could be attributed to the presence of forage legumes that improved growth of the grass. The legume acted as a cover crop to control weeds and conserve soil moisture during the dry periods, apart from the possibility of augmenting N supply to the grass component through symbiotic N-fixation (Kabirizi 2006).

The results confirmed that the currently recommended acreage of 0.5 ha of a mixture of Napier grass with a forage legume (Samanya 1996) will produce additional forage of higher quality than Napier grass alone but cannot sustain an economically producing dairy cow and its calf for a full year. Therefore, establishment of an additional 0.5 ha of a mixture of the drought-tolerant Mulato with a forage legume is recommended for feeding during the dry season, when production of Napier grass monocrop is disadvantaged due to drought, the napier stunt disease and poor agronomic practices.

A second study was conducted comparing the beneficiaries of the drought-tolerant forage technology (0.5 ha Napier + Centro mixture plus 0.5 ha Mulato + Clitoria mixture) with the non-beneficiaries (0.5 ha Napier monocrop) (Table 2). There were no significant ( $P>0.05$ ) differences in land size and number of cattle kept between

**Table 2.** Socio-economic benefits of integrating Napier grass-Centro and *Brachiaria* cv. Mulato-Clitoria in Napier grass-based farming systems.

| Farm characteristics                  | Beneficiaries (n=24) |      | Non-beneficiaries (n=24) |      | F-test  | IA <sup>1</sup> |
|---------------------------------------|----------------------|------|--------------------------|------|---------|-----------------|
|                                       | Mean                 | SD   | Mean                     | SD   |         |                 |
| Land size (ha)                        | 1.7                  | 1.2  | 1.6                      | 0.9  | 0.12 NS |                 |
| Cattle (number)                       | 1.5                  | 0.5  | 1.3                      | 0.7  | 0.03 NS |                 |
| Fodder area (ha)                      | 1.1                  | 0.3  | 0.5                      | 0.3  | 14.4**  | 134.1           |
| Feed offered/cow/d (fresh, kg)        | 55.4                 | 12.3 | 31.4                     | 7.2  | 5.7*    | 76.4            |
| Milk yield (L/d)                      | 10.6                 | 7.2  | 5.9                      | 3.1  | 4.3*    | 79.7            |
| Revenue (US\$) from milk yield/cow/yr | 676.9                | 48.2 | 444                      | 64.1 | 1.66 NS | 52.4            |

<sup>1</sup>IA: Intervention advantage (%).

the beneficiaries and non-beneficiaries of the interventions but sowing 0.5 ha of each of the grass-legume mixtures improved milk yield and household income by 80 and 52%, respectively, over 0.5 ha Napier grass. The beneficiaries fed 76% more high-quality forage, i.e. the milk yield response was largely due to simply feeding more. Beneficiaries, however, had 120% more land sown to fodder, implying they were not harvesting as much forage per ha (if all harvested forage was fed to cows) or were able to sell fodder to others.

In assessing the overall benefits of this production system, it is important to remember that an extra 0.5 ha was sown to a grass-legume mixture and was no longer available for other agricultural purposes.

## Conclusion

Replacing traditional Napier grass forage banks with grass-legume mixtures, including the drought-tolerant *Brachiaria* hybrid cv. Mulato and the deep-rooted legumes Centro and Clitoria, is a promising strategy for year-round feed supply to smallholder dairy cattle in Central and East Africa. The income foregone from the additional area sown to pasture must be taken into consideration in assessing the profitability of this practice.

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