

## Forage potential of eight woody species: intake and growth rates of local young goats in the highland region of Rwanda

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**Key words:** acid upland soils, fodder intake, live-weight gain, tree fodder

**Abstract.** Eight woody fodder species adapted to the highlands of Rwanda were evaluated in terms of dry matter intake in one experiment. Animals were offered a daily diet comprising 4.0 kg of fresh matter of *Setaria splendida* grass supplemented with or without one of the eight fodder species tested. In all cases, total daily feed intake was increased by the addition of woody fodder. Daily intake of the woody fodder was high for *Acacia koaia*, *Mimosa scabrella* and *Acacia koa* at 43.7, 42.6 and 41.9 g/kg BW<sup>0.75</sup>, respectively. The dry matter intake of the other five species (*Alnus acuminata*, *Chamaecytisus palmensis*, *Hagenia abyssinica*, *Acacia mearnsii* and *Acacia melanoxylon*) ranged from 18.9 to 30.1 g/kg BW<sup>0.75</sup> per day. In another experiment, a basic daily diet of 4.0 kg of fodder (in fresh weight) was given to each animal. This ratio comprised *S. splendida* supplemented with *M. scabrella* and incorporated at 0 (control), 45% and 66% (fresh weight basis) of the total daily diet. Improved weight gain was obtained when setaria was supplemented with *M. scabrella* with daily weight gain of 31, 47 and 51 g/animal for 0, 45 and 66% *M. scabrella*, respectively.

### Introduction

The Crete-Zaire Nil region of Rwanda is one of the least populated regions in the country, representing 14% of the total land area with 13% of the population. Its population density is about 150 km<sup>-2</sup> and the farm size 2 ha, compared to a mean density of 500 km<sup>-2</sup> and a mean farm size of 1 ha for the country as a whole (Djimde et al., 1988). Livestock production, which is based on grazing animals in fallow lands and pastures, is one of the main activities of the region (CNA, 1991). The major constraint to the development of livestock in the zone is poor nutrition, arising from low quality and low productivity of fodder resources and a lack of diversity of the existing fodder species. This is largely due to over grazing of available pastures as well as the high acidity and high aluminium content of the soils in the area. The climatic conditions are characterized by frequent hailstorms, strong winds, limited radiant energy and low air temperatures.

Between 1989 and 1990, more than 80 tree species were tested with an overall objective of identifying agroforestry trees and shrubs that could be incorporated into farming systems in the area. A wide range of uses was

considered, with particular emphasis on fodder species for improving livestock feed availability and quality in the zone (Niang et al., 1992). Among the species tested, eight multipurpose trees and shrubs (MPTS) gave good performance in terms of their adaptability in the zone and biomass productivity (Niang et al., 1994). These species are: *Mimosa scabrella*, *Chamaecytisus palmensis*, *Alnus acuminata*, *Acacia koa*, *Acacia koaia*, *Acacia melanoxylon*, *Acacia mearnsii* and *Hagenia abyssinica* (Table 1).

The purpose of this study was to determine (a) the dry matter intake by the local goats fed on these eight woody species, and (b) the effect of *M. scabrella* as a feed supplement on the growth performance of these animals. *M. scabrella* has been chosen because of fodder availability of this species.

Table 1. Centre of origin and uses of species tested.

Species	Centre of origin	Uses	References
<i>Mimosa scabrella</i>	Parana, Brazil	Used as fodder species in Panama	Campos Arce et al., 1985; CATIE, 1991
<i>Chamaecytisus palmensis</i>	Canary Islands, introduced to Australia in 1879 and to New Zealand	Evergreen fodder tree in grazing systems	Davies, 1987; Lefroy et al., 1992; Snook, 1993
<i>Alnus acuminata</i>	Central and South America	Improved pasture fodder species	Camacho and Murillo, 1987; Holdridge, 1951; Martinez, 1987
<i>Acacia koa</i> <i>Acacia koaia</i>	Hawaii Islands	Grazed by cattle and wild goats ( <i>Capra hircus</i> )	Baldwin and Fagerlund, 1943; Scowcroft and Hobdy, 1987; Spatz and Mueller-Dombois, 1973
<i>Acacia melanoxylon</i>	Australia	Used as fodder species in Tamul Nadu District, India	Sam and Samraj, 1989; Boland, 1989
<i>Acacia mearnsii</i>	Australia	Leaves of the species are used as fodder in China, Thailand, Kenya and Zimbabwe	Boland, 1989
<i>Hagenia abyssinica</i>	Highlands of East and Central Africa.	Leaves used as fodder in Ethiopia	Hoekstra et al., 1990

## Materials and methods

### *Study area*

The experiments were conducted in the Crete-Zaire Nil region at the Gakuta Agricultural Research Station (longitude 29°20' E and latitude 2°10' S). The altitude is 2500 m. The average annual rainfall is 1500 mm/year in a bimodal distribution, with a major dry season from June to July and a minor dry season in January. Mean annual temperature is 14.6 °C with a mean maximum of 19.9 °C and a mean minimum of 9.4 °C. The soils are classified as Inceptisols (USDA soil taxonomy system) with 51% sand, 29% clay and 20% silt. They are very acidic with a pH (in water) of 3.5 and an exchangeable aluminium of 6.6 meq/100 g.

### *Experiment 1*

#### *Feed intake trials*

Eight woody species were tested simultaneously in experiment 1 comprising two separate trials run simultaneously. The first trial included *Mimosa scabrella* (Concordia Sanctuary, Brazil), *Acacia melanoxylon* (Richmond, Australia), *Acacia mearnsii* (Gakuta, Rwanda) and *Alnus acuminata* (Zacualtipan, Mexico). In the second trial, the species tested were *Acacia koa* (Umikoa Ranch, Hawaii), *Hagenia abyssinica* (Nyungwe Forest, Rwanda), *Acacia koaia* (Koaia Sanctuary, Hawaii), *Chamaecytisus palmensis* (Victoria, Australia). *Setaria splendida*, collected locally at Gakuta, was also included in each of the trials as a control. The fodder leaves of the woody species were collected from screening trials. Thirty male goats were purchased at a local market and divided into two groups of 15 animals for each trial. The goats were young animals of a local breed aged 5–6 months, with mean live weight of  $10.4 \pm 1.20$  kg. Water and mineral salt were provided *ad libitum*. In each trial fifteen goats were used in a  $5 \times 5$  latin square design lasting for 37 days including seven days of adaptation period at the beginning. Each trial was divided into five 6-day periods, each consisting of a 3-day preliminary period followed by a 3-day measurement period. Each group of 15 animals was sub-divided into five sub groups of three animals. Each sub-group was randomly assigned to a daily basal diet of 4 kg of *Setaria splendida* (fresh weight) per animal per day supplemented or not with 2.0 kg (fresh weight) of specific fodder species per animal per day. Each sub-group was fed in separate pen. The feed was offered twice a day, half at 0900 and half at 1500 hours. At the end of each feeding time, the residual material was removed and weighed and consumption of each forage calculated. Each animal was weighed at the beginning and end of each feeding period and the average of the two weights was used to calculate metabolic body weight ( $\text{kg BW}^{0.75}$ ). Fresh weight samples were collected every day from feed offered and left over for dry

weight determination and further analysis. Percent dry matter (DM) was determined after oven drying for 24 hours at 105 °C. Nitrogen (N) was analysed using the macro-Kjeldal procedure (AOAC, 1990), crude protein (CP) calculated as  $N \times 6.25$ , phosphorus by ashing at 550 °C followed by vanadomolybdate method and K, Ca and Mg by ashing at 550 °C followed by atomic absorption spectrophotometry.

The data from the two trials were analysed together as a single incomplete latin square with five periods, 10 sub-groups of the animals and nine species (the two controls were combined) using the REML procedure in Genstat (Payne, 1990). The lack of balance in the design means that the standard error of treatment differences is not the same for all treatment pairs, so the maximum standard error (SED max) is quoted.

## *Experiment 2*

### *Animal live weight gain*

In experiment 2, twenty-four male local goats, purchased at a local market, six months old with pre-trial mean live weight of  $12.6 \pm 1.77$  kg were divided into three groups of eight animals, each, weighed and fed separately. Each group of animals was randomly assigned to a daily diet of fresh fodder per animal comprising one of the following treatments: 4.0 kg of *S. splendida* (100% Setaria), 2.2 kg of Setaria + 1.8 kg of *M. scabrella* (55% Setaria + 45% *M. scabrella*) and 1.4 kg of Setaria + 2.6 kg of *M. scabrella* (34% of Setaria and 66% of *M. scabrella*). The feed was offered twice a day, half at 0.900 and half at 1500 hours. At the end of each feeding time the remaining material was weighed and the consumption calculated. The animals were weighed weekly to determine the live weight gains. The data were analysed as a randomized complete block design, using GENSTAT 5 [1987]. The duration of the trial was five weeks including one week of adaptation at the start.

## **Results and discussion**

### *Chemical composition*

The chemical composition of the different forages is presented in Table 2. The highest crude protein content is obtained from *M. scabrella* (249 g/kg DM) and *C. palmensis* (233 g/kgDM). These values are comparable with other fodder trees such as *Leucaena leucocephala* (Vadiveloo, 1988; Joshi et al., 1976; Upadhyay et al., 1974), *C. calothyrsus* (NAS, 1983) and *S. sesban* (Topark-ngarm et al., 1989). The lowest CP content was found in grass, *S. splendida* (70 g/kg DM). The crude protein content of the other tree species were all around 160 g/kg DM and similar to other browse species found in Africa (Le Houerou, 1980).

Table 2. Chemical composition of the different forages (g/kg DM).

Species	Crude protein	K	Ca	P
<i>Mimosa scabrella</i>	249	6.2	10.9	2.0
<i>Acacia koaia</i>	165	6.1	3.6	1.8
<i>Acacia koa</i>	141	7.0	3.3	3.0
<i>Chamaecytisus palmensis</i>	233	9.7	4.3	1.9
<i>Hagenia abyssinica</i>	164	14.1	4.6	3.1
<i>Acacia melanoxylon</i>	152	6.4	2.6	1.6
<i>Acacia mearnsii</i>	164	5.8	3.9	2.7
<i>Alnus acuminata</i>	163	7.6	3.5	1.8
<i>Setaria splendida</i>	70	7.6	1.8	2.3

### Feed intake

The intake values are presented in Table 3. In all cases total daily feed intake was significantly increased by the addition of fodder shrubs with values ranging from 53.5 g/kg BW<sup>0.75</sup> (*S. splendida* + *A. acuminata*) to 70.3 g/kg BW<sup>0.75</sup> (*S. splendida* + *M. scabrella*) compared to 37.2 g/kg BW<sup>0.75</sup> per day for *Setaria* alone. These results are in accordance with Vadiveloo (1985) who showed that supplementary feeding of napier with *L. leucocephala* increased total dry matter intake.

The intake of the grass component of the diet was not substantially affected when it was supplemented with a fodder shrub species, except in the case of *A. koaia*, *A. koa* and *M. scabrella*, where *Setaria* intake was significantly depressed, suggesting a substitution effect observed also by Larbi et al. (1993).

Table 3. Daily dry matter intake (g/kg BW<sup>0.75</sup>) of goats fed *Setaria splendida* supplemented with 8 MPTs.

Setaria + Supplements	Grass	Shrub	Total
Setaria + <i>Mimosa scabrella</i>	27.6	42.6	70.2
Setaria + <i>Acacia koaia</i>	25.8	43.7	69.5
Setaria + <i>Acacia koa</i>	26.4	41.9	68.3
Setaria + <i>Chamaecytisus palmensis</i>	33.7	32.3	66.0
Setaria + <i>Hagenia abyssinica</i>	32.7	30.1	62.8
Setaria + <i>Acacia melanoxylon</i>	30.2	26.3	56.5
Setaria + <i>Acacia mearnsii</i>	33.4	21.9	55.3
Setaria + <i>Alnus acuminata</i>	34.6	18.9	53.5
Setaria only	37.2		37.2
SED (max)	3.90	3.42	4.53
CV%	17.9	20.5	11.3

*A. koaia*, *M. scabrella* and *A. koa* gave high fodder shrub dry matter intake values of 43.7, 42.6 and 41.9 g/kg BW<sup>0.75</sup>, respectively, indicating that these were the preferred species. These values were significantly higher than intakes for all other fodder species used as supplement which ranged from 18.9 to 30.1 g/kg BW<sup>0.75</sup> per day.

The high intake achieved with *A. koa* is probably due to the high nutrient concentration of its foliage and its low lignin concentration (Scowcroft, 1986).

*C. palmensis* is considered as a good fodder since its foliage is free from toxic substances, with leaves having high nutrient dry matter digestibility (77% to 82%) (Borens and Poppi, 1986), crude protein from 17% to 22% and crude fibre from 16 to 19% (Snook, 1993). The high nutrient content of Mimosa leaves has been recognised before (Poggiani et al., 1987), but its use as fodder has not been studied.

Despite its high protein content, the intake of *A. mearnsii* is very low because of its low digestibility, estimated at 30% (Goodricke, 1978).

#### *Animal live weight gain*

The comparative results of daily dry matter intake and daily weight gain after a period of four weeks are shown in Table 4.

Significantly improved performance was obtained when Setaria was supplemented with *M. scabrella* at a rate of either 45% or 66%. There were no significant differences in dry matter intake between treatments. The daily weight gain of 31.25 g/animal when the diet was composed of Setaria alone increased to 47 and 51 g/animal when *M. scabrella* was used as a supplement. These results are similar to those obtained by Vadiveloo (1985) with 34.9 g/day/animal when the Napier feed was supplemented with *L. leucocephala* compared to 21.6 g/day/animal, with napier alone.

However, the weight gains obtained from the two rates of incorporation of *M. scabrella* are not significantly different, indicating that the optimum rate of incorporation probably lies in between.

Table 4. Daily live weight gain of goats (g/animal) fed *Setaria splendida* supplemented with *Mimosa scabrella*.

Treatments	Weight gain	Dry matter intake
Setaria only	31.25	584
Setaria + 45% Mimosa	47.13	626
Setaria + 66% Mimosa	50.88	593
SED	7.02	

## Conclusion

The results of these two experiments show that in the high elevation areas with very acidic soils and high aluminium saturation where few fodder tree species can grow, *A. koaia*, *A. koa* and *M. scabrella* can be considered as potential fodder species because of their high protein content and high dry matter intake. *M. scabrella* gave a positive effect on animal growth when it was used as a supplement to a *Setaria* grass diet. However, to confirm these results, anti-nutritive factors analysis and digestibility studies need to be undertaken.

## Acknowledgements

We thank Richard Coe for the help with statistical analyses, R. Otsyina and R. Patterson who, as the in-house ICRAF reviewers provided very useful suggestions for the improvement of the article.

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