

# Agro-Ecological Adaptation and Participatory Evaluation of Multipurpose Tree and Shrub Legumes in Mid Altitudes of Sud-Kivu, D. R. Congo

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## Abstract

Livestock is traditionally managed in mixed crop-livestock production systems in Sud-Kivu, D. R. Congo. Currently, livestock production is facing numerous constraints due to wars and insecurity in the country, with looting of animals, demographic pressure on natural resources, and lack of extension services. Multipurpose trees and shrubs with adequate forage quality could help overcome dry-season feed shortage. The objective of this research was to assess the agro-ecological adaptability of selected forage tree and shrub legumes combined with farmer participatory evaluation. The study was carried out at two distinct mid-altitude sites in Sud-Kivu. Trees and shrubs were planted randomly in eleven lines, with each species/accession consisting of nine plants split into three replications. Following a standardization cut after one year of growth, regular biomass harvests were performed every eight weeks during one year; *Desmodium* and *Flemingia* were cut at 0.5 m above soil surface, while *Leucaena* and *Calliandra* at 1 m. Before every harvest, plant height was measured and number of stems counted. Fresh leaf and stem biomass were weighted, sub samples dried and leaves analyzed for nutritive value. Results from agronomic evaluation

show that *Leucaena diversifolia* ILRI 15551 and *Leucaena leucocephala* had the highest yield in the rainy season on fertile soil; during dry season, *Leucaena diversifolia* ILRI 15551 was superior. On poor soil, *Flemingia macrophylla* CIAT 17403 performed best in both seasons, however, its forage quality was relatively low. Forage tree and shrub legumes chosen by farmers were, in general, the same as those superior ones in agronomic evaluation.

## Keywords

**Multipurpose Trees and Shrubs, Forage Legumes, Adaptation, Participatory Evaluation, Biomass Production**

## 1. Introduction

In the Kivu provinces of eastern Democratic Republic of Congo (DRC), livestock production faces numerous constraints. This has led to a strong decline of livestock due to high animal mortality, insufficient feed, social unrests resulting in livestock pillage [1] among others, within a context of demographic pressure on the natural resources, extreme poverty and alarming nutritional status of the population [2]. Livestock is traditionally managed within mixed crop-livestock production systems, where it performs various functions. Cattle are especially a sign of wealth and social status [2], while they used to be a key element for maintaining soil fertility in the traditional mixed production system [1] [3]. However, the cattle population has been dramatically reduced during the wars and unrest of the past decades [1]. Despite currently relatively low livestock populations in Sud-Kivu, feed availability, especially during the dry season, is perceived by farmers as one of the major constraints [4]. Yet, forage cultivation to feed livestock is not practiced in Sud-Kivu [3] [5]. In order to increase livestock productivity, forage cultivation could be a major component in the crop-livestock system, while benefitting additionally from their environmental functions, especially in sloped areas. Adapted multipurpose trees and shrubs with high forage quality can complement animal feeds, particularly during the dry season, when forage availability is low [4]. Through multi-site evaluations in tropical America, a number of suitable forage tree and shrub legume species and accessions have been identified, which are adapted to different agro-ecological conditions, especially tolerant to acidic soils [6]-[10]. To address the above constraints, promoting forage cultivation could be one of the opportunities available to achieve sustainable animal-agriculture and, hence, improve farmers' livelihoods. The objective of this study was to assess the agro-ecological adaptation of promising multi-purpose tree and shrub legumes in mid altitudes of Sud-Kivu combined with farmer participatory evaluation.

## 2. Material and Methods

Agronomic trials were performed at two mid-altitude sites in the "groupement" of Walungu, Sud-Kivu province; Kamanyola with relatively fertile soils and Tubimbi with low soil fertility (Table 1). The region is characterized by sub-humid climate with bimodal annual rainfall of about 1500 - 1800 mm [11]. Eleven forage tree and shrub legume accessions were tested: *Desmodium velutinum* (CIAT 13218, CIAT 23982 and CIAT 23996), *Flemingia macrophylla* (CIAT 17403 and CIAT 20618), *Leucaena diversifolia* (CIAT 17503, CIAT 22192, ILRI 15551, K780 and K782), and *Leucaena leucocephala* CIAT 17263, as well as locally available *Calliandra calothyrsus* as a check.

All accessions were randomly planted along contour lines in January 2009. There was 1.5 m distance between plots against the direction of the slope and 1 m within the lines. A unit plot for every species or accession included 3 plants, with 3 replications. Overall 11 lines with 2 additional border lines of *Calliandra* were planted. For assessing productivity, in terms of total aboveground biomass, plants were cut at 50 cm (*Desmodium* and *Flemingia*) or at 100 cm (*Calliandra* and *Leucaena*) above soil surface. Before every harvest, plant height was measured and number of stems was counted. After the first standardization cut carried out in January 2010, regular harvests were performed every eight weeks during one year, resulting in a total of six harvests. For every harvest, weight of leaves and stems was assessed with a balance (SF-400, maximum 10 kg, precision 1 g). From every plot and at every harvest, a homogeneous sub-sample of 300 g each of leaves and stems was taken to assess dry matter (DM) percentage. These sub-samples were dried until constant weight in a shed at CIAT-Kalambo, where maximum temperatures reached 40°C - 45°C on sunny days. Nutritive value of one mixed leaf

**Table 1.** Location and soil characteristics of two experimental sites in Sud-Kivu province, DRC.

Site	Soil characteristics*					Latitude	Longitude	Elevation (m asl)
	pH	Exchangeable K	P (Olsen)	C.E.C.	Total N			
	In H <sub>2</sub> O	meq/100 g*	ppm	meq/100 g	%			
Kamanyola	6.42	0.35	2	34	0.25	2.01°S	29.01°E	900
Tubimbi	4.29	0.22	2	3	0.19	2.79°S	23.59°E	1100

\* ppm = parts per million, meq = milliequivalent, C.E.C. = Cation Exchange Capacity; Analyses by Crop Nutrition Laboratory and the World Agroforestry Centre (ICRAF), Nairobi, Kenya.

sample per species/accession was analyzed by NIRS (near infrared reflectance spectroscopy) at the International Livestock Research Institute (ILRI) in Ethiopia. Combined mean fresh leaf and stem yield (MFLSY) was calculated in g/plant. MFLSY data was analyzed by season, *i.e.* harvests 1 in June, 2 in August and 5 in February were during dry seasons, while harvests 3 in October, 4 in December and 6 in April were during rainy seasons. Before every harvest, susceptibility to diseases and insect pests were observed on a scale from 1 (almost none to very little) to 5 (plant died), modified from [12]. The mean value of disease and pest susceptibility was obtained from the 6 cuts.

Farmer participatory selection of forages was conducted in mid-April 2010 during the rainy season at both sites and in late August 2010 during the dry season at both sites with the local farmers involved in the trials, and organized in an association named “cavy and rabbit farmers”. Farmers were arranged in 2 groups according to gender, one team comprising 5 women and the other 5 men. In every location, one field replication was randomly chosen for the exercise. Every participating farmer had to select the three most preferred plots in terms of crop performance by dropping a white paper on the chosen plots. The number of papers per plot was counted and ranks were established. After choosing forages in the field, the two teams met to discuss in order to reach consensus between genders as recommended by [13]. Data are presented as ranks of preference by location.

Data were statistically analyzed by computing descriptive statistics and performing analysis of variance (ANOVA) with GEN STAT for Teaching and STAVIEW version 5.0 software. Tukey’s range test was applied to establish significant differences ( $P \leq 0.05$ ) between treatments. Both agronomic and farmer participatory evaluation data were computed first by site and then across sites.

### 3. Results

#### 3.1. Agronomic Performance

Overall, plants were rather healthy, and disease and pest incidences were minor in both locations, ranging from 1 to 2 on a 1 - 5 scale (Table 2). While in Kamanyola, pest susceptibility was almost non-existent, in Tubimbi, especially *Desmodium velutinum* and *Flemingia macrophylla* accessions had moderate leaf damage. Regarding diseases, *F. macrophylla* accessions had moderate damage in both locations as well as *D. velutinum* CIAT 23996.

There were significant differences ( $P \leq 0.05$ ) of plant height among the different accessions (Table 3). Overall, accessions of *D. velutinum* and *F. macrophylla* were much shorter than those of *L. leucocephala*, *L. diversifolia* and *C. calothyrsus*. On the other hand, the mean number of stems was significantly higher in the accessions of the former two species than of the latter three. Nevertheless, there appeared to be a differential effect of the sites on plant morphology. While plant height was similar in Kamanyola and Tubimbi in *D. velutinum* and *F. macrophylla* accessions, it was significantly higher in *Leucaena* accessions and *Calliandra* in Kamanyola when compared to Tubimbi. With the higher soil fertility of Kamanyola, also number of stems increased clearly in accessions of *D. velutinum*, *Leucaena* and *Calliandra*. *Flemingia*, on the other hand, produced even less number of stems in Kamanyola than in Tubimbi.

Mean aboveground biomass production according to site and season is provided in Table 4. There were significant differences between species and accessions. Also differential adaptation of the tested trees and shrubs to the two sites was found. In Kamanyola highest total biomass yields were achieved by *Leucaena* accessions except *L. diversifolia* CIAT 22192 in both rainy and dry seasons; whereas in Tubimbi, *F. macrophylla* CIAT 17403 attained highest mean biomass yields in both seasons. Especially during the dry season, *Flemingia*,

**Table 2.** Overall scales of disease and pest susceptibility for eleven forage tree and shrub legumes evaluated on a scale (1 - 5) during one year at two sites in Sud-Kivu.

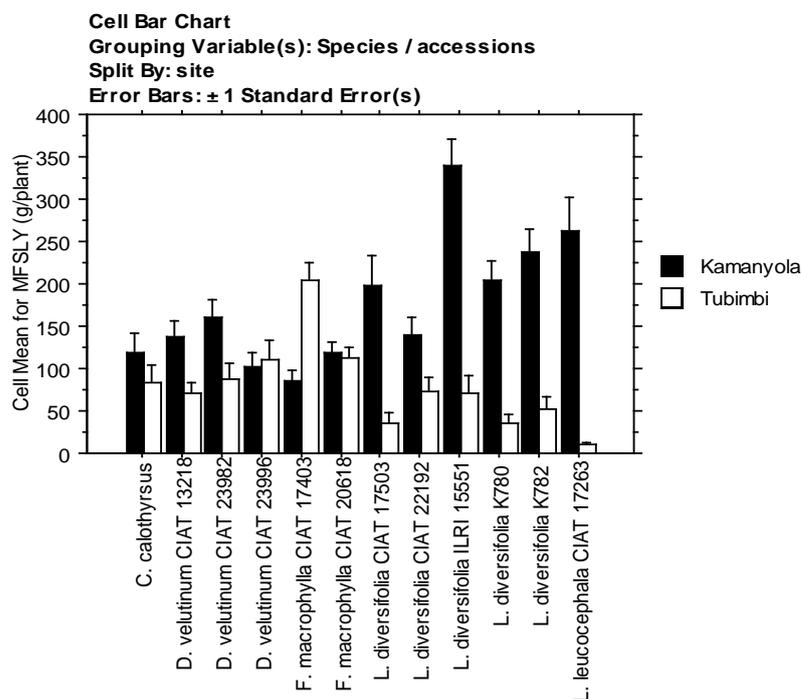
Tree, shrub forage legumes	Diseases (Scale 1 - 5)		Insects (Scale 1 - 5)	
	Kamanyola	Tubimbi	Kamanyola	Tubimbi
<i>C. calothyrsus</i>	1	1	1	1
<i>D. velutinum</i> CIAT 23982	1	1	1	2
<i>D. velutinum</i> CIAT 23996	2	1	1	2
<i>D. velutinum</i> CIAT 13218	1	1	1	2
<i>F. macrophylla</i> CIAT 17403	2	2	1	2
<i>F. macrophylla</i> CIAT 20618	2	2	1	2
<i>L. diversifolia</i> CIAT 17503	2	2	1	1
<i>L. diversifolia</i> CIAT 22192	1	1	1	1
<i>L. diversifolia</i> ILRI 15551	1	1	1	1
<i>L. diversifolia</i> K780	1	1	1	1
<i>L. diversifolia</i> K782	1	1	1	1
<i>L. leucocephala</i> CIAT 17263	1	1	1	1

**Table 3.** Mean number of stems and mean height (cm) of forage tree and shrub legumes evaluated during one year at two sites in Sud-Kivu ( $\pm$ Stdv.); different letters imply significant differences according to Tukey test ( $P \leq 0.05$ ).

Tree, shrub forage legumes	Stems (no./plant)		Height (cm)	
	Kamanyola	Tubimbi	Kamanyola	Tubimbi
<i>C. calothyrsus</i>	14.1 $\pm$ 8.4de	15.5 $\pm$ 22.1cd	145.5 $\pm$ 37.5bc	124.8 $\pm$ 33.5bc
<i>D. velutinum</i> CIAT 23982	87.9 $\pm$ 41.6ab	47.7 $\pm$ 30.9b	87.7 $\pm$ 22.2c	82.0 $\pm$ 14.6de
<i>D. velutinum</i> CIAT 23996	73.0 $\pm$ 43.7b	73.4 $\pm$ 44.7a	76.1 $\pm$ 15.6cd	82.9 $\pm$ 13.1de
<i>D. velutinum</i> CIAT 13218	95.4 $\pm$ 65.0a	63.7 $\pm$ 33.4ab	70.7 $\pm$ 14.6d	82.6 $\pm$ 12.5de
<i>F. macrophylla</i> CIAT 17403	36.9 $\pm$ 17.2cd	58.0 $\pm$ 22.6ab	66.6 $\pm$ 9.9de	90.1 $\pm$ 18.8d
<i>F. macrophylla</i> CIAT 20618	35.9 $\pm$ 13.4cd	43.6 $\pm$ 18.3bc	80.2 $\pm$ 14.0cd	80.3 $\pm$ 10.7de
<i>L. diversifolia</i> CIAT 17503	43.1 $\pm$ 30.4cd	10.4 $\pm$ 25.4cd	161.0 $\pm$ 24.2b	117.9 $\pm$ 19.7bc
<i>L. diversifolia</i> CIAT 22192	19.1 $\pm$ 11.8d	20.1 $\pm$ 11.9c	154.6 $\pm$ 33.3bc	146.1 $\pm$ 21.1a
<i>L. diversifolia</i> ILRI 15551	35.3 $\pm$ 22.1cd	12.6 $\pm$ 8.4cd	188.2 $\pm$ 35.4ab	129.7 $\pm$ 20.7b
<i>L. diversifolia</i> K780	32.6 $\pm$ 17.6cd	13.1 $\pm$ 13.7cd	173.3 $\pm$ 22.4ab	118.6 $\pm$ 20.1bc
<i>L. diversifolia</i> K782	31.9 $\pm$ 16.6cd	14.8 $\pm$ 10.0cd	180.4 $\pm$ 23.0ab	137.1 $\pm$ 17.0ab
<i>L. leucocephala</i> CIAT 17263	50.4 $\pm$ 24.0c	4.4 $\pm$ 2.0cd	188.5 $\pm$ 27.5a	108.2 $\pm$ 16.1c
LSD ( $p \leq 0.05$ )	20.4	17.7	16.5	15.2

*Desmodium* and *Calliandra* accessions obtained similar or even higher biomass yields in Tubimbi when compared to Kamanyola, while *Leucaena* yields were very low.

When comparing the overall mean biomass production of the species and accessions according to site, the differential adaptation becomes very clear (Figure 1). While *Leucaena* and some *Desmodium* accessions were significantly more productive on more fertile soil (Kamanyola), *Flemingia* CIAT 17403 and *D. velutinum* CIAT 23996 achieved superior biomass yields on infertile soil (Tubimbi).



**Figure 1.** Mean leaf and stem biomass production (MFLSY) across six harvests of forage tree and shrub legumes evaluated during one year at two sites in Sud-Kivu (in g/plant  $\pm 1$  Standard Error).

**Table 4.** Mean seasonal aboveground biomass production (leaves and stems) of forage tree and shrub legumes evaluated during one year at two sites in Sud-Kivu (MFLSY (g/plant  $\pm$  Stdv.); different letters imply significant differences according to Tukey test ( $P \leq 0.05$ )).

Tree, shrub forage legumes	Kamanyola (biomass in g/plant)		Tubimbi (biomass in g/plant)	
	Rainy season	Dry season	Rainy season	Dry season
<i>C. calothyrsus</i>	132.6 $\pm$ 89.8cd	55.4 $\pm$ 73.3bc	89.2 $\pm$ 89.4bc	61.6 $\pm$ 64.9bc
<i>D. velutinum</i> CIAT 13218	156.5 $\pm$ 79.3c	41.0 $\pm$ 18.4bc	77.9 $\pm$ 55.0bc	39.5 $\pm$ 7.7bc
<i>D. velutinum</i> CIAT 23982	182.1 $\pm$ 82.4bc	50.9 $\pm$ 17.5bc	92.9 $\pm$ 84.0bc	56.2 $\pm$ 45.4bc
<i>D. velutinum</i> CIAT 23996	117.1 $\pm$ 68cd	32.5 $\pm$ 12.9cd	119.4 $\pm$ 102.5b	63.0 $\pm$ 59.1bc
<i>F. macrophylla</i> CIAT 17403	95.6 $\pm$ 47.4cd	37.4 $\pm$ 7.8c	212.0 $\pm$ 92.8a	163.7 $\pm$ 42.7a
<i>F. macrophylla</i> CIAT 20618	130.1 $\pm$ 46.7cd	60.7 $\pm$ 35.2bc	116.8 $\pm$ 56.0bc	87.7 $\pm$ 20.9b
<i>L. diversifolia</i> CIAT 17503	212.3 $\pm$ 163.7bc	122.1 $\pm$ 29.7bc	41.0 $\pm$ 48.6bc	12.3 $\pm$ 10.8cd
<i>L. diversifolia</i> CIAT 22192	152.1 $\pm$ 94.8cd	78.1 $\pm$ 36.5bc	79.4 $\pm$ 80.3bc	38.6 $\pm$ 31.7bc
<i>L. diversifolia</i> ILRI 15551	335.0 $\pm$ 136.7a	368.2 $\pm$ 125.3a	82.6 $\pm$ 86.9bc	14.1 $\pm$ 13.0cd
<i>L. diversifolia</i> K780	203.8 $\pm$ 104.4bc	201.8 $\pm$ 37.5bc	37.4 $\pm$ 46.4c	18.7 $\pm$ 6.6c
<i>L. diversifolia</i> K782	243.8 $\pm$ 123.2b	212.3 $\pm$ 40.3b	58.7 $\pm$ 59.6bc	22.1 $\pm$ 13.4bc
<i>L. leucocephala</i> CIAT 17263	295.2 $\pm$ 160ab	100.7 $\pm$ 30.0bc	9.5 $\pm$ 9.9cd	n.d.*
LSD ( $p \leq 0.05$ )	78.3	83.3	64.6	68.2

\*n.d., not determined.

### 3.2. Nutritive Value of Leaves

Nutritive values of forage trees and shrubs in both sites are given in **Table 5**. Crude protein (CP) was from 18.6% to 27.0%, whereas organic matter digestibility (IVOMD) was in the range of 47.1% - 51%. In both sites, fiber (NDF) was most variable, *F. macrophylla* CIAT 17403 being very high with more than 60% in both Kamanyola and Tubimbi, while *Leucaena* was lowest (<40%). IVOMD of *Leucaena* was highest, especially *L. leucocephala* with more than 60%. *F. macrophylla* had the lowest digestibility within the range of 47.1% - 49.5%.

### 3.3. Participatory Evaluation

Farmers' choices of forage tree and shrub legumes are given according to site and season (**Table 6**). In Kamanyola, there was no clear preference for a species/accession except for *L. diversifolia* ILRI 15551 and *L. leucocephala* CIAT 17263 that were both ranked highly during rainy and dry season, while *F. macrophylla* CIAT 20618 occupied the fourth rank in both seasons. Similarly in Tubimbi, farmers' choice varied according to season. Species/accessions preferred when emphasizing dry season were *L. diversifolia* K782, *F. macrophylla* CIAT 17403, *L. diversifolia* CIAT 22192 and *D. velutinum* CIAT 13218.

## 4. Discussion

When evaluating diverse multipurpose tree and shrub legumes in Sud-Kivu, eastern DRC, differential agro-ecological adaptation was found that confirmed results from earlier evaluation of the same species in South America [6] [7] [9] [10]. For example, *L. leucocephala* and *L. diversifolia* are better adapted to more fertile soils [13] like in Kamanyola, as demonstrated by their growth of number of stems, plant height and biomass production in contrary to their reduced performance in Tubimbi. *L. leucocephala* is known to grow well on soils between pH 5 - 5.5 ranges [11] [14]-[18]. Therefore, soil pH 4.3 in Tubimbi is too acidic for this species, hindering its proper development. On the other hand, *Flemingia*, *Desmodium* and *Calliandra* are better adapted to poorer fertility and acidic soils [7] [9] [10], like in Tubimbi. It is known that some *F. macrophylla* accessions obtain good yields on acidic soils [15]. Although in Sud-Kivu, biomass production of *F. macrophylla* CIAT 17403 was lower than in Colombia, where maximum rainy season yield was 250 g DM/plant and in the dry season 150 g DM/plant [10]. The morphology of trees and shrubs changed differently according to environmental quality. While the shrubs (*Desmodium* and *Flemingia*) produced more stems per plant with higher soil fertility, the trees

**Table 5.** Mean nutritive value of forage tree and shrub legume leaves across six biomass harvests during one year at two sites in Sud-Kivu (DM, dry matter; OM, organic matter; CP, Crude protein; NDF, neutral detergent fiber; IVOMD, *in vitro* organic matter digestibility).

Tree, shrub forage legumes	Kamanyola					Tubimbi				
	DM	OM	CP	NDF	IVOMD	DM	OM	CP	NDF	IVOMD
<i>C. calothyrsus</i>	30.1	95.3	23.0	38.4	57.7	29.5	96.2	23.7	41.6	56.6
<i>D. velutinum</i> CIAT 13218	31.4	89.5	20.3	48.9	51.0	29.8	90.3	21.5	47.2	56.2
<i>D. velutinum</i> CIAT 23982	30.0	89.0	21.0	50.7	47.9	29.6	90.9	21.7	43.1	58.3
<i>D. velutinum</i> CIAT 23996	30.3	89.2	20.4	47.0	52.8	28.4	90.1	18.6	51.8	54.1
<i>F. macrophylla</i> CIAT 17403	25.3	94.4	20.1	62.4	47.1	24.8	95.0	21.3	72.6	48.7
<i>F. macrophylla</i> CIAT 20618	28.1	94.5	20.1	63.1	46.7	27.9	95.7	20.2	60.2	49.5
<i>L. diversifolia</i> CIAT 17503	30.7	92.9	23.6	36.2	58.8	32.8	94.5	22.6	39.7	57.6
<i>L. diversifolia</i> CIAT 22192	28.2	93.3	27.0	37.5	55.7	31.8	95.4	26.5	46.8	53.2
<i>L. diversifolia</i> ILRI 15551	28.8	93.2	27.0	37.2	56.7	32.1	94.9	24.7	36.2	58.0
<i>L. diversifolia</i> K780	28.3	92.8	25.9	36.6	57.5	29.2	96.0	22.1	33.9	59.2
<i>L. diversifolia</i> K782	30.0	93.4	23.7	33.8	58.6	31.6	95.4	22.3	35.4	60.0
<i>L. leucocephala</i> CIAT 17263	29.3	94.8	19.5	31.9	64.2	18.3	93.9	20.1	35.8	62.7

**Table 6.** Participatory ranking of forage tree and shrub legumes by female and male farmers in consensus according to site and season in Sud-Kivu (ranks in ascending order from 1 to 5).

Forage tree shrub legumes	Kamanyola		Tubimbi	
	Rainy season	Dry season	Rainy season	Dry season
<i>C. calothyrsus</i>	2	0	0	1
<i>D. velutinum</i> CIAT 13218	0	3	1	5
<i>D. velutinum</i> CIAT 23982	0	0	0	0
<i>D. velutinum</i> CIAT 23996	0	0	5	0
<i>F. macrophylla</i> CIAT 17403	0	0	3	3
<i>F. macrophylla</i> CIAT 18438	0	0	0	0
<i>F. macrophylla</i> CIAT 20618	4	4	0	0
<i>L. diversifolia</i> ILRI 15551	1	2	0	0
<i>L. diversifolia</i> CIAT 22192	0	0	2	4
<i>L. diversifolia</i> K780	5	0	0	0
<i>L. diversifolia</i> K782	0	5	4	2
<i>L. leucocephala</i> CIAT 17263	3	1	0	0

(*Leucaena* and *Calliandra*) grew significantly taller in Kamanyola than in Tubimbi. Regarding biomass production, however, it has to be considered that total biomass has been assessed in this study. This will substantially overestimate the biomass useful as forage due to higher stem mass at the more fertile site of Kamanyola because of the inherent higher weight of stems. Overall, plants were rather healthy and disease and pest impacts were negligible in the two sites as compared to Colombia [10], even if *Desmodium* and *Flemingia* showed to be less susceptible than the other species/accessions evaluated.

Leaves from legume trees and shrubs can be a valuable complement for feeding livestock, especially during the dry season when other feed stuffs are scarce or their nutritive quality is low. The nutritive value of several multipurpose trees and shrubs is relatively low [16] [17], depending highly on fiber content and on the presence and quantity of anti-nutritive components, such as condensed tannins or mimosine. High tannin levels result in low rumen protein degradability and low dry matter digestibility [7]. Some of the tree and shrub legumes tested in Sud-Kivu are suitable as forage for smallholder farmers due to their acceptable nutritive value. With its low number of stems, plant height, high yield and nutritional quality, *C. calothyrsus* is among the suitable forages, its nutritive value in terms of *in vitro* digestibility was higher in DRC than previously reported (24% - 47%) [17]. In Colombia, high levels of lysine were found in the amino acid profile of *Leucaena diversifolia*, but it was also high in tannins, thus, limiting amino acid digestibility. In a comparative assessment of nutritive value, lowest degradation (equivalent to digestibility for monogastric animals) was obtained for *F. macrophylla*, while that of *D. velutinum* and *L. diversifolia* was significantly higher, but still much lower than that of cowpea leaves [16]. In Tubimbi, CP of *F. macrophylla* CIAT 17403 was higher than 18.3% in Cameroon [17]; however, fiber (NDF) was also high (57.4%) as observed by [16] in Colombia. High fiber content together with high tannins may result in low digestibility [15]. *F. macrophylla* is especially used to lower costs in smallholder production systems as a dry season supplement, sun shade and wind break, as well as for mulching and as living fence [18]. These multiple roles can make the species attractive, despite its relatively low forage quality. On the other hand, it may be worthwhile to further explore the potential of *D. velutinum* on acidic soils as this species has more favorable forage quality [9].

The results of the participatory evaluation show that farmers' preferences agreed fairly well with the agronomic performance of the species/accessions evaluated. Farmer experimentation can successfully promote a technology and greatly increase acceptance and early adoption [11]. Its results can provide indications for agronomists, in addition to being a way to early involve farmers in possible innovations [13].

## 5. Conclusion

The agronomic evaluation at two agro-ecologically distinct sites in eastern DRC demonstrated that different forage trees and shrub species adapted differently. The species with higher forage quality, *L. diversifolia* (especially accession ILRI 15551) and *L. leucocephala*, performed superiorly at the site (Kamanyola) with higher soil fertility. While in Tubimbi with poor soil, *F. macrophylla* CIAT 17403 performed best. Especially during the dry season, *Flemingia*, *Desmodium* and *Calliandra* obtained similar or even higher biomass yields on poor soil (Tubimbi) than on more fertile one (Kamanyola). It is important to note that different accessions of the tested species showed quite some variations in performance and forage quality, indicating scope for selection. Farmers' preferences concurred largely with the results from agronomic evaluation, indicating that farmers mostly appreciated biomass production. This may differ, if the feeding value of the tested species/accessions would also be evaluated. Farmers' participatory evaluation results should provide good first indicators for agronomists, in addition to being a way to early involve farmers in an innovation process.

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