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Productivity and Participatory Evaluation of Forage Legumes and Grasses in Pour Soils of Ngweshe Kingdom, DRC

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Abstract

Livestock production decreases in DRC during the three last decades. Malnutrition becomes a big challenge especially in animal proteins supply. To improve animal production by the best feeding in rural environment of Sud-Kivu, International Institute of Tropical Agriculture (IITA) selected four legume forages: *Desmodium uncinatum*, *Canavalia brasiliensis* CIAT 17009, *Lablab purpureus* 21603 and *Lablab purpureus* 22759 and grasses *Tripsacum andersonii*, *Pennisetum purpureum* CV French Cameroon and local *Pennisetum purpureum* to test their agronomic performances in Ngweshe kingdom. Trials were in completely randomized blocs and duplicated three times up 2014 to 2015. There were three sites for the legumes and five for the grasses. Results showed that the forage legumes *Canavalia brasiliensis* CIAT 17009 and *Desmodium uncinatum* CV ILRI 6765 had good agronomic performances. *Lablab purpureus* (CIAT 21603 and CAT 22579) didn't present good adaptability. The best forage grasses were successively *Tripsacum andersonii* and *Pennisetum purpureum* CV French Cameroon. These best forage legumes and grasses were also well appreciated by the farmers.

Subject Areas

Agricultural Science

Keywords

Forage Legumes and Grasses, Agronomic Performances, Participatory Evaluation, DRC

1. Introduction

Sud-Kivu province faces malnutrition with 70% of his population due to lack of food especially the animal proteins such as milk, meat, eggs. Prices of these commodities are not accessible to the population [1] [2]. The food insecurity comes from long time in this region and appears sometimes with various intensities [3] [4]. Agriculture is mainly practiced in the traditional system and cannot respond to the demand of population explosion with 2.8% rate of growth [5]. Natural pasture spaces are progressively replaced by the fields with crops. Livestock production is low due to low extension services, lack of animal feeding mostly during the dry season, lack of veterinaries inputs, insecurity, etc. In this way, the promotion of forage crops presents many advantages to the farmers. It can contribute to supplying animal feeding in quantity and quality mainly during the two seasons of the year. Livestock and crops still are producing under the traditional system. Animal feed is principally supplied from the grasslands.

Various studies were carried out in the region to adapt the forage species [6]-[11], etc. Recently the adaptation of some forage legumes from latino-america by the "Centre International d'Agriculture Tropicle" (CIAT) showed that *Stylosanthes guianensis* 11995, *Stylosanthes guianensis* Cook, *Centrosema molle*, *Canavalia brasiliensis*, *Desmodium uncinatum*, *Desmodium intortum*, *Macroptilium atropurpureum* and *Lablab purpureus* 21603 were well adapted according to their yield herbage in the middle and high altitudes of Sud-Kivu and their performances confirmed by the farmer's choice [12]. IITA in the Humid tropics program, mainly in his Cluster 4 project implemented this trial in Ngweshe [13]. The choice of these forages was a continuation of the forage legumes adaptation on which we added some best grasses for cut and carry forage system. The main objective of this study is to evaluate the performance of some forage legumes and grasses and their appreciation by farmers in the Ngweshe kingdom, Sud-Kivu province.

2. Materials and Methods

Location

Mushinga and Mulamba "groupements" are located in Ngweshe kingdom, Walungu territory, Sud-Kivu. Walungu territory is at 2˚35' South latitude and 28˚40' longitude East with an altitude up 1000 to 2500 m in Sud-Kivu, DRC. Figure 1 shows the map of Ngweshe kingdom.

Sites

Legume trials were tested in Mushinga "groupement" in three sites Cirhongo, Karhambi and Mubumbano villages and for grasses in Mushinga "groupement" with five sites Cirhongo, Cizi, Karhambi, Mubumbano and in Mulamba "groupement" at Mulamba road site. Table 1 shows the soil characteristics of these sites.

Trial designs

-Forage legumes

Four legume forages from CIAT were tested: *Canavalia brasiliensis* CIAT

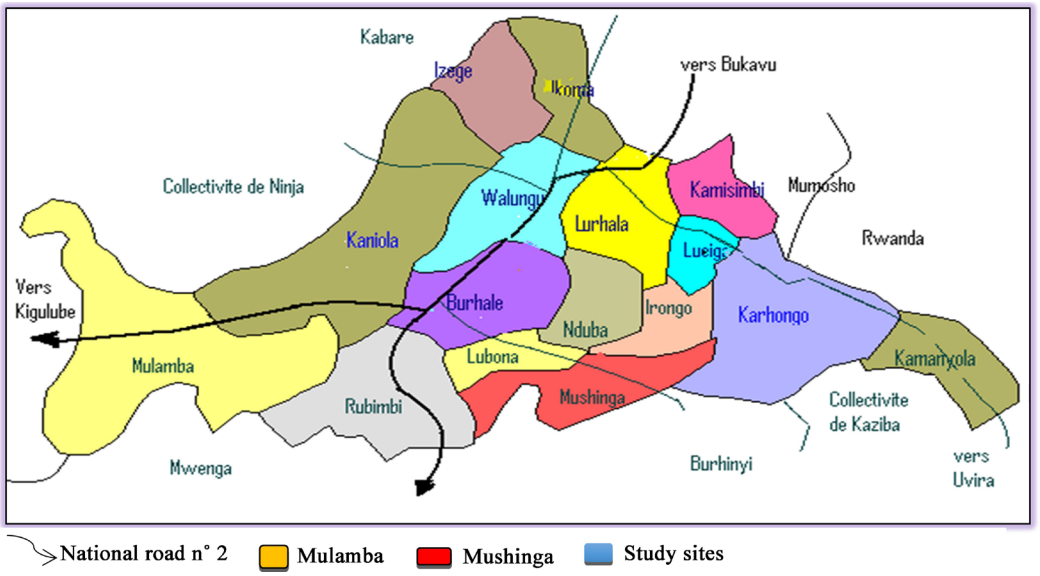

Figure 1. Map of Ngweshe kingdom (Source: Geography department/ISP-Bukavu DRC).

Table 1. Soils characteristics of the sites.

Sites	pH in water	Exchangeable calcium (me/100g soil)	Exchangeable magnesium (me/100g soil)	Exchangeable potassium (me/100g soil)	Extractable phosphorus (mg P/kg)	Total soil organic carbon (%)	Total Soil nitrogen (%)
Cizi	4.71	0.59	0.59	0.07	4.1	1.29	0.16
Cirhongo	4.50	0.98	0.30	0.03	5.3	1.45	0.19
Karambi	4.37	0.69	0.20	0.02	2.8	2.82	0.19
Mubumbano	4.63	0.79	0.49	0.02	5.0	3.09	0.30
Mulamba route	5.01	1.28	0.30	0.02	5.0	3.00	0.43

[14].

17009, *Desmodium uncinatum* ILRI 6765 CV Silver leaf, accessions of *Lablab purpureus* (CIAT 21603 and CIAT 22759). Each plot measured 3 m x 1.5 m and 1 m of pathway between the plots. Sowing spacing within the plot was 0.25 m × 0.5 m. Trials were implemented from October 2014. The regularization cutting was done after 50% of flowered average in the plots in March, 2015. After the regularization cutting, harvests were undertaken after eight weeks at two harvesting times, one in May, 2015 during the wet season and another in July 2015 during the dry season.

-Forage grasses

Pennissetum purpureum CV French Cameroon (P.p.C or French Cameroon), local *Pennissetum purpureum* Schumach. *(P.p.local* or local Napier grass*)* and *Tripsacum andersonii* J.R. Gray were tested.

Plantation held on September, 28th to 30th 2014. They were planted at 1 m x 1 m and each plot measured 4 m x 3 m, pathway between plots measured 2 m. Regularization cutting was done after 6 months of forages establishment in March, 6th 2015, harvest cuttings times in each eight weeks after the regulation

cutting; one in wet season in May 2015 and another one in dry season in July 2015.

Trials were established for both legumes and grasses in randomized complete design with three replications. Following parameters were observed: germination rate, soil cover, height, yield production in dry matter (DM) and farmer's participatory evaluation. Only before sowing and plantation of legumes and grasses, three hands of cattle manure were put in the hollow. Data were analyzed by Statisticx 8.0 and Statview softwares. Figure 2 and Figure 3 were made by Microsoft Excel.

3. Results

Germination

Soil cover rates

As shown in Table 2, there was a significant difference ($P < 0.05$) between the

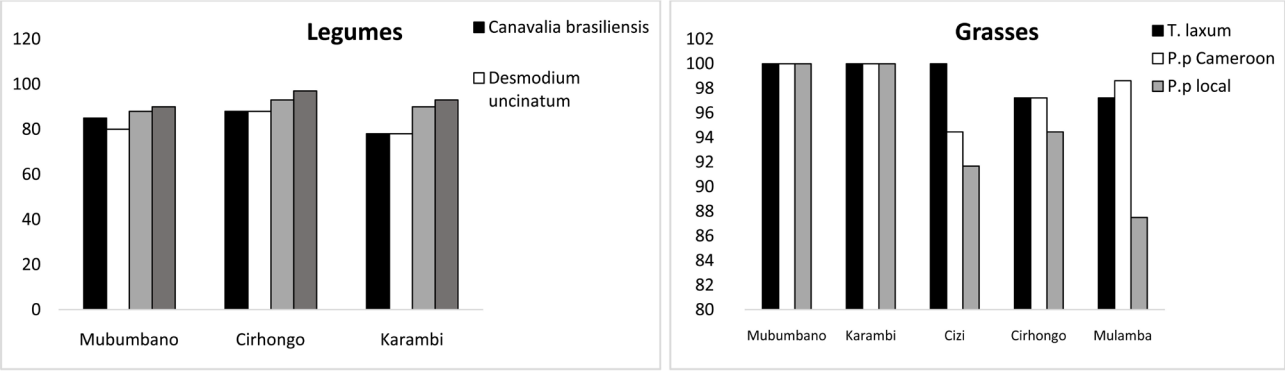

Figure 2. Germination rates. On legumes, means rate of germination of legumes were 82.2% for *C. brasiliensis*, 80.6% *D. uncinatum*, 90.6% *L. purpureus* 21603, 93.3%. *L. purpureus* 22579. The rates mean of germination in the sites were in Cirhongo 89.1%, Karambi 85.0% and Mubumbano 85.8%. The means rate forage grasses of germination were 97.5% French Cameroon, 94.5% local Napier grass and 98.8% *T. andersonii*. According to the mean rates of germination in the sites, Mubumbano and Karambi recorded maximum 100%, Cirhongo 96.1%, Cizi 95.2% and Mulamba road 94.2%.

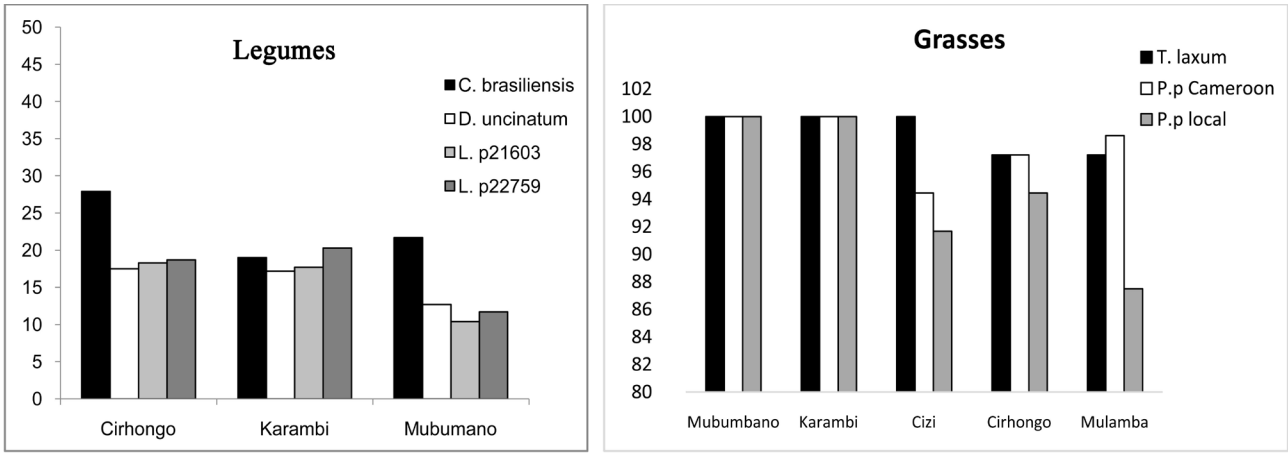

Figure 3. Farmer's participatory evaluation of forage legumes and grasses. On farmer's participatory evaluation, among the legumes, *D. uncinatum* CV ILRI 6765 was the most appreciated. It was followed by *C. brasiliensis* CIAT 17009. On grasses, *T. andersonii* and French Cameroon were appreciated.

means soil cover rates of forage legumes species and accessions from Chi-square test. *C. brasiliensis* had the best soil cover followed by *D. uncinatum*. There was any difference ($P > 0.05$) between the mean's soil cover rates compare to the sites. In general the soil cover is not interesting in the entire site, mainly for the two *L. purpureus*.

As shown in Table 3, the Chi-square test showed that there was no significant difference ($P > 0.05$) between the means of soil cover of forage grasses species and sites. The high of forage grasses species cover mean of was *T. andersonii* while according to the site, Mubumbano recovered more.

Height

As shown in Table 4, the comparison of means heights showed that there was no significant difference ($P > 0.05$) between the means of forage species and accessions. *C. brasiliensis* was the highest while Cirhongo site had the tallest legumes.

Table 2. Legumes soil cover (%).

Legume species	Sites			Grand mean species (*)
	Cirhongo	Karambi	Mubumbano	
C. brasiliensis 17009	74.2	65.8	74.2	71.4 ± 29.0
D. uncinatum	76.7	65.8	68.3	70.3 ± 24.7
L. purpureus 21603	28.3	28.3	20.8	25.8 ± 17.8
L. purpureus 22759	18.3	16.7	18.3	17.8 ± 13.9
Grant mean sites	49.4 ± 30.3	44.2 ± 25.3	45.4 ± 18.0	46.3

Table 3. Grasses soil cover (%).

Grasses species	Sites					Grand mean species
	Cirhongo	Cizi	Karambi	Mubumbano	Mulamba route	
P. p. C	55	60	53	62	45	67.0 ± 4.4
P.p.local	70	65	60	70	70	55.0 ± 6.7
T. andersonii	80	70	65	75	70	72.0 ± 5.9
Grant mean sites	68.3 ± 12.6	65.0 ± 5.0	59.3 ± 6.0	69.0 ± 6.5	61.7 ± 14.4	64.7

Table 4. Legumes forage height (cm).

Legume species	Sites			Grand mean species (*)
	Cirhongo	Karambi	Mubumbano	
C. brasiliensis 17009	27.9 ± 5.4	19.0 ± 7.5	21.7 ± 4.2	22.9 ± 6.7
D. uncinatum	17.5 ± 5.5	17.2 ± 7.3	12.7 ± 2.1	15.8 ± 5.5
L. purpureus 21603	18.3 ± 7.0	17.7 ± 8.0	10.4 ± 5.7	15.5 ± 7.5
L. purpureus 22759	18.7 ± 8.1	20.3 ± 14.2	11.7 ± 5.6	16.9 ± 10.1
Grant mean sites	20.6 ± 5.0	18.6 ± 1.4	14.1 ± 5.1	17.8

As shown in Table 5, there was a high difference ($P < 0.001$) between the means comparison of the height forage grasses species and sites. French Cameroon was the tallest followed by local Napier grass. Cirhongo site had the tallest grasses.

Forages yield

As shown in Table 6, the comparison yield herbage showed a high significant different ($P < 0.001$) between means legumes forage species and accessions and sites. *C. brasiliensis* and *D. uncinatum* performed well than the two accessions of *L. purpureus*. Cirhongo site produced more biomass.

As shown in Table 7, there was a high difference ($P < 0.001$) between the means comparison of the yield forage grasses by species and sites. French Cameroon produced more biomass followed by *T. andersonii* and the local Napier grass was the last one. Cirhongo site produced more biomass followed by Cizi site.

Forages participatory evaluation

Farmer's choice was conducted principally by the following criteria: yield

Table 5. Grasses forage height (cm).

Grass species	Sites					Grand mean species (***)
	Cirhongo	Cizi	Karambi	Mubumbano	Mulamba road	
P.p.C	151 ± 26	114 ± 18	108 ± 43	139 ± 23	111 ± 14	124.6 ± 19.2
P.p.local	136 ± 45	136 ± 28	88 ± 24	112 ± 31	89 ± 38	112.2 ± 23.7
T. andersonii	129 ± 55	92 ± 14	82 ± 44	111 ± 15	89 ± 18	100.6 ± 19.2
Grant mean sites (***)	138.7 ± 42	114 ± 27	92.7 ± 37d	120.7 ± 26	96.3 ± 26	112.5

Table 6. Legumes herbage yield (DM kg/ha).

Legume species	Sites			Grand mean species (***)
	Cirhongo	Karambi	Mubumbano	
C. brasiliensis 17009	1302.3 ± 447.2	340.7 ± 192.6	721.6 ± 343.9	788.2 ± 519.6
D. uncinatum	1047.3 ± 534.7	291.6 ± 114.6	865.7 ± 469.5	734.9 ± 512.5
L. purpureus 21603	246.4 ± 248.3	40.0 ± 31.1	48.3 ± 25.5	111.6 ± 168.0
L. purpureus 22759	241.1 ± 259.6	65.0 ± 27.4	70.0 ± 31.9	125.4 ± 165.7
Grand mean sites (***)	709.3 ± 547.5	184.3 ± 153.9	426.4 ± 48.3	440.0

Table 7. Grasses herbage yield (DM kg/ha).

Grasse species	Sites					Grand mean species (***)
	Cirhongo	Cizi	Karambi	Mubumbano	Mulamba route	
P.p.C	4576.3 ± 3407.8	4374.5 ± 2690.4	2544.3 ± 1604.5	4137.5 ± 1421.1	2754.3 ± 444.8	3677.4 ± 2197.7
P.p.local	2902.8 ± 2158.3	1942.2 ± 1054.3	367.8 ± 214	1991.3 ± 568.6	296.17 ± 73.5	1500.1 ± 1456.7
T. andersonii	2539 ± 1187.5	3224 ± 1311.8	1860.8 ± 1686.3	2989.7 ± 372.2	1485.2 ± 551.8	2419.7 ± 1247.3
Grant mean sites***	3339.4 ± 429.6	3180.2 ± 974.0	1590.1 ± 206.9	3039.5 ± 206.9	1511.9 ± 225	2532.4

production, resistance against diseases and pests, soil cover by the forage etc. The figure below shows the rates of farmer's choice.

4. Discussion and Conclusion

Germination

The legumes rate of germination was observed between 69.0% (*Desmodium uncinatum* CV ILRI 6765) and 98.0% (*Lablab purpureus* CIAT 22759). These results are like those observed by [15]. On grasses, the range of germination was almost equal between 94.5% to 98.8% for the three grasses tested.

Height

On forage legumes, [12] observed that the tallest legumes were *L. purpureus* 21603 with 38.8 cm, *L. purpureus* 22795 with 38.0 cm and *C. brasiliensis* 33.8 cm. Height of these forage legumes was low than those observed previously in Sud-Kivu. The reason to this situation is probably due to the soil fertility gradient. *C. brasiliensis* CIAT 17009 was the tallest (22.8 cm). According to the grasses, the two *P. purpureum* were taller than *T. andersonii*. Zewdu *et al.* observed that plant height at cutting increased from 0.5 m to 1.5 m, *in vitro* digestibility of dry matter declined from 71.74% to 61.03% ($P < 0.05$) [16].

Soil cover

The soil cover of legumes *D. uncinatum* CV ILRI 6765 with 71% was the best and was followed by *C. brasiliensis* CIAT 17009 with 70%. These results were well similar to those observed by [12], except the low rate of the two accessions of *L. purpureus* perhaps due to the degeneration of the seeds. On grasses, *T. andersonii* from his large leaves was the best grass to cover the soil than French Cameroon even if this last had also good leave coverage than the local *P. purpureum*, as observed also [17].

Yield

The herbage yield of *C. brasiliensis* CIAT 17009 and *D. uncinatum* ILRI 6765 was higher than the two accessions of *Lablab purpureus*. This is due to their flexibility of large diversity on soil fertility [18]. We can also observe that in Nyangezi and Tubimbi on acidic soils. *C. brasiliensis* produced without inputs 1132.1 kg/ha. *L. purpureus* 21603 and *L. purpureus* 22759 had respectively produced 451 kg/ha and 741.5 kg/ha [19]. These yield herbages are more important compared to those observed in Mushinga. French Cameroon produced successively with two cuttings in wet and dry seasons 3.7 DM t/ha and local *P. purpureum* 1.5 DM t/ha. With fertilization, *P. purpureum* can produce 10 - 30 t/ha of DM biomass and in unfertile soils 2 - 10 t/ha [20]. In Rwanda *P. purpureum* produced 17DM t/ha harvesting interval was each three months during one year [21]. *T. andersonii* produced during two cuttings 2.4 DM t/ha while [20] reported in good conditions an annual DM yield of 18 - 22 t/ha. In general, forage yield in Ngweshe was low due probably to few cuttings number and low soils quality (see **Table 1**). All the rate of minerals are very low [14], even if Mulamba road had some good rates than the others sites but his ration

C/N 7.0 was very low.

Participatory evaluation

On legume forages, *C. brasiliensis* and *D. uncinatum* were the best chosen by the farmers. Among grasses evaluated, the first choice of farmers was *T. andersonii* followed by French Cameroon. Farmer's choice showed that their decision was practically similar to the agronomic trial outputs [12].

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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