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Brachiaria ruziziensis fodder: A Supplementary Resource for Livestock in the Cotton Production Zone of Mali

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Abstract

For providing vegetation cover, feeding animals during the lean periods and thus reducing the external reliance of producers, research in partnership with producers has undertaken the introduction and development of the *Brachiaria ruziziensis* forage crop in the farming systems. During the 2020-2021 rainy season, experiments were conducted among 40 producers in 8 villages in the cotton production zone of Mali. The experimental setup was a scattered block where each producer represents a replication. At each producer, the plot was divided into 3 treatments as follows: T1 = pure *Brachiaria ruziziensis*; T2 = maize and *Brachiaria ruziziensis* association and T3 = pure maize. Biomass production was highly variable between treatments. It was better in T1 with a production of 6,489 kg DM/ha; it was 4,041 kg DM/ha in T2 and 2,637 kg DM/ha in T3. However, the analysis of variance did not reveal a significant difference (0.4821) between treatments T2 and T3 for seed corn yield. The yield was 2,066 kg/ha in Q2 and 2,347 kg/ha in Q3. This shows that the corn/Brachiaria combination does not significantly affect the yield of seed corn. Economically, the grossmargin of T1 (532,433 CFA/ha) was more profitable than T2 (469,246 CFA/ha) and T3 (343,578 CFA/ha). These results show that the adoption of *Brachiaria ruziziensis* is one of the means for sustainable intensification of agricultural and livestock production systems in the cotton production zone of Mali.

Keywords

Biomass, *Brachiaria ruziziensis*, animal feeding, gross profit, cotton production zone, Mali

1. Introduction

In the cotton production zone of Mali, the use of mineral fertilizers means that the fertility of cultivated are as degrades less while its organic status declines. The biomass produced is of greatinterest to farms, both to provide soil cover [1] and to feed animals during the lean periods, thus reducing producers' reliance on the feed market [2]. It is in this context that research has undertaken the introduction and development of the cultivation of the forage species *Brachia riaruziziensis* in the croppingsystems of producers in field during the 2020-2021 growing season.

Brachiaria ruziziensis (Poaceae) is an herbaceous grass. It is a powerful plant in the production of fodder in quality and quantity. This plant is able to control weeds. It has a deep and powerfulroot system, capable of restructuring soils, injecting carbondeepinto the soil and efficientlyrecyclingnutrients [3].

Brachiaria ruziziensis is better than many other species of the Brachiaria genuswith a percentage of crude protein generally between 7 and 13% (up to 20% depending on fertilization) and a digestibility of 55 to 75% [3]. Its fraction cover is persistent during the dry season [4]. It is a plant adapted to humid tropical zones and able to develop on soils of lessfertility and to restore them eventually. It grows on several types of soilwith a preference for sandy or silty soils [5].

As for forage production, it is strong and rapid in the hot and humid season, but drops sharply in cold and/or dry periods. Under the best conditions, with high nitrogenfertilization, itcanreach 25 t/ha of dry matter for the above-ground mass, in the second year when production is maximum [3].

This studyaims to contribute to the agro-ecological transition of production systems and to the improvement of producers' income in the cotton zone of Mali.Specifically, itaims to improve the availability of feed resources during the dry season and strengthen the capacity of agro-pastoralists to produce fodder crops.

2. Materials and methods

2.1 Description of study areas

The study was conducted in eight (8) villages across the agricultural regions of the cotton production zone of Mali. These villages were: Benguéné, Diolo-Kagoua, Fignana, Faragouaran, Katélé, Bondala, Bouala and Ziguéna (Figure 1).

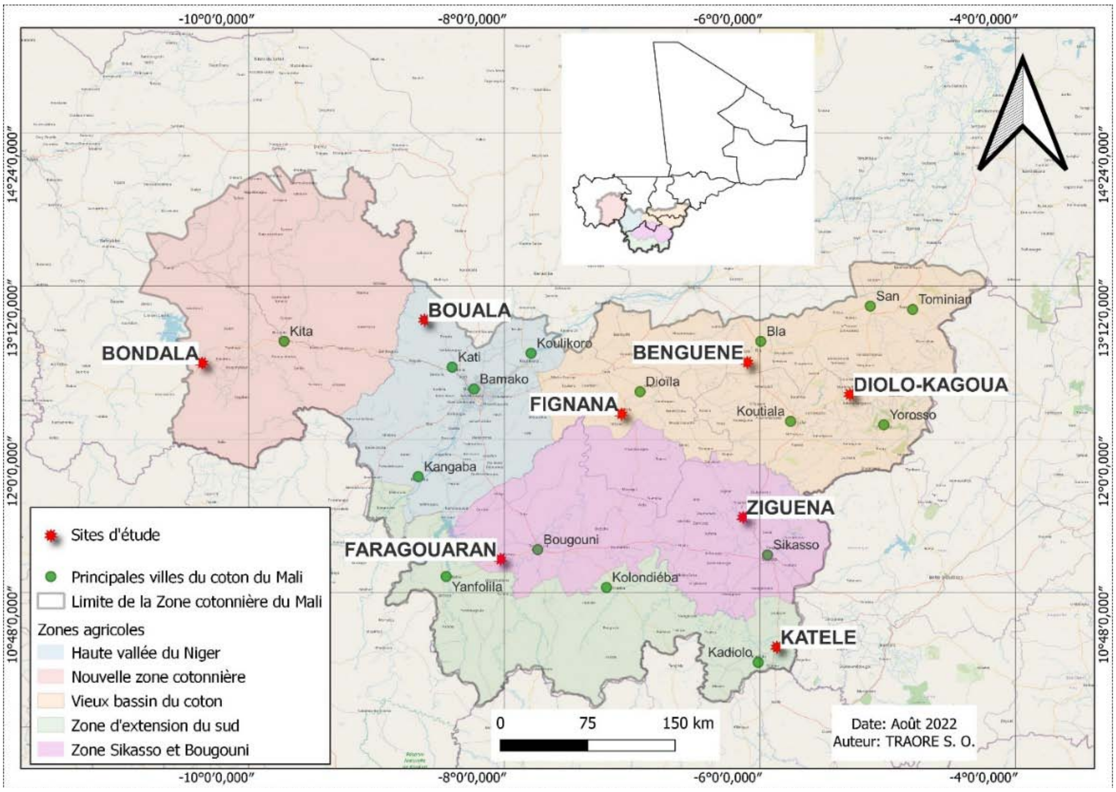

Figure 1. Location of the study villages.

The villages were selected on the basis of established criteria such as accessibility, diversity of agricultural practices, diversity of production systems, etc. Producers in these villages mainly grow the following crops: cotton, maize, sorghum, millet, rice, peanuts, sweetpotatoes and cowpeas. Also, more than 90% of them in the area combine agriculture and livestock breeding. This livestock plays a major role in fieldwork, especially cultivation operations (plowing, weeding, sowing, harrowing, ridging, etc.), and in the transport of yields and compound fertilizer.

2.1.1 Rainfall variation in the study sites

Table 1 shows the recorded rainfall and number of rainy days in the 8 villages during the 2020-2021 rainy season. A large variability was found not only in the annual rainfall but also in the number of rainy days per year. The village of Katélé received a greater amount of rain (1254 mm) and number of rainy days (58) than the other villages. The lowest amount of rain (760 mm) was observed in the village of Benguéné (Sudano-Sahelian zone) with a significant number of rainy days (55 days).

Table 1. Annual rainfall and the number of rainy days in the study villages during the 2020-2021 rainy season

Villages	Annual rainfall	Number of rainy days
Benguéné	759.5	55
Bondala-Sitanikoto	839	42
Bouala	857.5	44
Diolo-Kagoua	962	43
Faragouanran	1025	45
Fignana	925	48
Katélé	1254	58
Ziguéna	1143	42

2.2 Materials

2.2.1 Plant material

The plant material was composed of:
- Maize (*Zea mays*)
- *Brachia riaruziziensis* Germ. & Evrard, 1953

2.2.2 Agricultural inputs

The inputs used were compound fertilizer NPK (17N-17P-17K) and urea (46% N).

2.3 Methods

2.3.1 Investigation device

The experimental design was a scattered block where each producer represents a replication. Each producer's plot was divided into three (3) treatments:
- T1: *Brachiaria ruziziensis* monoculture: 0.25 ha
- T2: Maize and *Brachiaria ruziziensis* in association: 0.25 ha
- T3: Maize monoculture: 0.25 ha

Figure 2. Photographs of the investigation device at a producers field.

2.3.2 Cropping pattern

Brachiaria monoculture (T1) was done in a continuous row with 40 cm spacing [6]. In association (T2), Brachiaria was sown 14 days after maize sowing and between 2 two rows of maize. For T3, the maize was sown at 80 cm x 40 cm spacing. Regarding fertilization, T1 received 100 kg/ha of NPK and 100 kg/ha of urea, T2 and T3 each received 100 kg/ha of NPK and 150 kg/ha of urea.

2.3.3 Measured parameters

The parameters measured were:
- maize plants and seedling holes density;
- mass yield at harvest;
- stocking rate;
- yield of seed maize at harvest;
- economic profitability (gross margin).

2.3.4 Yield estimation method

Mass and seed corn were estimated in the three 5 x 5 m plots. The yield squares were placed along the diagonal in each treatment. Each square was harvested and weighed to estimate the yield of each treatment. 2 kg sample of this green matter was taken and air-dried for a few days to determine the dry matter.

2.3.5 Economic assessment

The financial analysis concerned the gross margin (GM). It is the difference between the total income (TI) and the total expenses (TE). The formula is given as follows:

$$GM(\pi) = \sum TI - \sum TE = \sum PQ - \sum \mathrm{PX}$$

Where Q is the yield (fodder and seeds), X is the inputs and P is the prices. The total expenses considered included the price of seed, seeding, plowing, weeding, fertilizer, mowing and transportation costs. For the estimation of total income, seed and biomassyields per hectare of crops were valued in monetary terms. The prices of a kilogram of seed and mass considered in the calculation were obtained by referring to the market prices.

2.3.6 Overall stocking rates assessment

The stocking rate is the estimated dry matter requirement of the animals expressed in Tropical Livestock Units (TLU) per ha. The calculation of the stocking rate allowed by the biomass produced was based on a daily feed intake of 6.25 kg DM / TLU [7]. The requirements of the TLU are related to the kg of dry matter produced/ha to estimate the number of TLU to be feed for 90 days. The 90 days correspond to the period when feed resource insufficiency is important in the study area.

2.4 Data analysis

The analyses focused on descriptive statistics (mean, standard deviation, percentage, etc.) with Microsoft Excel. Analysis of variance followed by comparison of meansaccording to the Newman and Keuls test at the 5% threshold was used to process the data using R.4.1.2 software.

3. Results and discussion

3.1 Density of seedling holes and plants according to the treatment

The number of maize seedling holes and plants obtained in combination crop (T2) as well as in maize monoculture (T3) is presented in Figure 3. On average, the density of corn seedling holes and plants was low compared to the theoretical density of 31250 seedling holes/ha and 62500 plants/ha. The number of maize plants in Q2 was 36480 compared to 33787 in Q3. For maize seedling holes, the average was 24507 in Q2 versus 23347 in Q3. It was found that the number of maize patches and plants obtained in the pure maize crop was slightly higher than those obtained in the mixed stand but the differences were not statistically significant (0.1595).

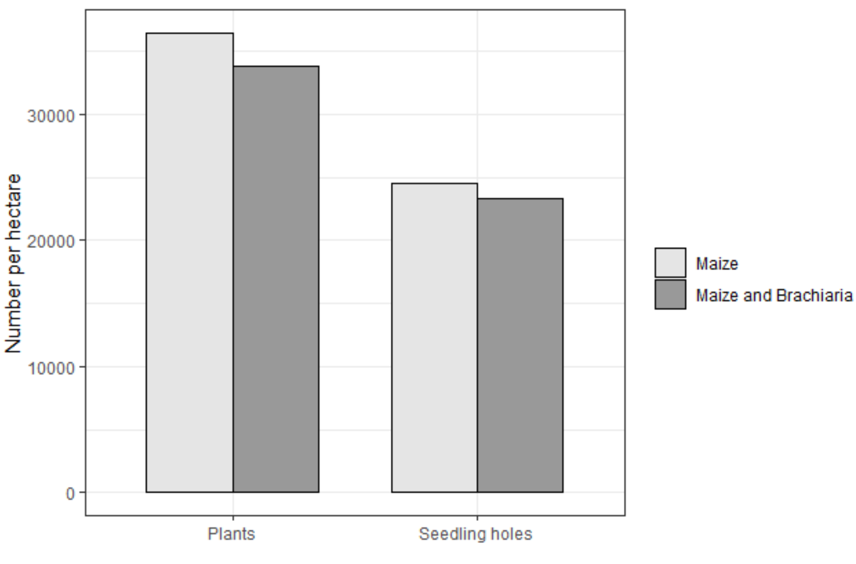

Figure 3. Density of plants and seedling holes according to the treatment.

3.2 Fodder production at the end of growing season

The fodder production obtained from Brachiaria monoculture and in association with maize in the study villages is presented in Table 2. Analysisrevealeddifferencesbetween the 3 treatments (<0.0001). The difference is significant between T1 and T2 and T3. On the other hand the difference is not significant between T2 and T3. The biomass obtained in the Brachiaria in pure was 6489 kg DM/ha. It is higher than the 4041 kg DM/ha produced in the mixed stand. This lowyieldismostly due to the lateseedingof Brachiaria under maize. Some authors claim that the biomass production of *Brachiaria ruziziensis* in monoculture can exceed 20 tons DM/ha [2; 3]. In Burkina Faso, an average production of 4 tons DM/ha was obtained in the pure Brachiaria [8], which is significantly lower than our result of 6489 kg DM/ha observed in the pure *Brachiaria ruziziensis*.

Table 2. Biomass obtained in *Brachiaria* monoculture and in association with maize (kg DM/ha)

Treatment	Biomass in DM kg/ha	
	Mean	Standard deviation
T1 : *Brachiaria ruziziensis*	6489 a	2281
T2 : Maize/*Brachiaria ruziziensis*	4041 b	3134
T3 : Maize	2637 b	1442
Both	4389	2843
Probability	<0,0001	

Note: The averages in the columns followed by the sameletter are not significantly different.

3.3 Fodder requirement

Figure 4 shows the average number of TLU/ha to be feed for 90 days from the mass produced per hectare per treatment in the study sites. The average number of TLU/ha washighly variable between the 3 treatments. The average mass obtained in T1 is sufficient to cover the fodder requirements of an average of 11.57 TLU for 90 days. For T2, the mass can cover the dry matter needs of 7.18 TLU and that produced in T3 can feed 4.49 TLU for 90 days. In the same area, a study on other forage species, notably *Mucunapruriens*, obtained an average of 7.76±2.65 TLU/ha during 90 days in monoculture. In the case of association with maize, the mass covers the fodder requirement of 9.69±3.14 TLU/ha for 90 days [9].

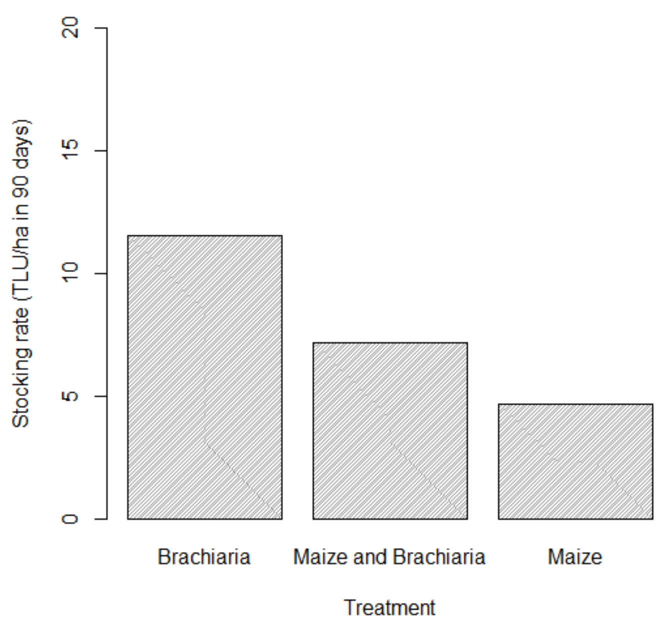

Figure 4. Stocking rate (TLU/ha in 90 days).

3.4 Maize seed yield in the pure maize and association with Brachiaria

The maize seed yield obtained in the pure maize crop and association with Brachiaria is in Table 3. Seed maize yield was different according to the treatment. It was 2066 kg/ha in T2 and 2347 kg/ha in T3. But it is found that the insertion of Brachiaria undermaize did not decrease the yield of seed maize significantly (0.4821). This is confirmed by the results of some previous studies that report that combining forage crops with maize does not significantly decrease the yield of seed maize [7; 8].

Table 3. Maize seed yield obtained in the pure maize and association with Brachiaria

Treatment	Maize yield in kg/ha	
	Mean	Standard deviation
T2 : Maize/*Brachiaria ruziziensis*	2066	1230
T3 : Maize	2347	1276
Probability	0,4821	

3.5 Gross margin obtained in the intercropping system with *Brachiaria ruziziensis*

Figure 3 shows the gross margins obtained in the Brachiaria according to the treatment. The production of Brachiaria fodder is of economic interest to the producers in the study area. Thus, the results show a gross margin of 532433 CFA of the Brachiaria monoculture higher than that of 469246 CFA of the association with maize and that of 343578 CFA of the pure maize crop. This is because pure Brachiaria hay has a higher selling price than Brachiaria hay mixed with maize straw and pure maize straw. In association innovations, operations (sowing, maintenance, harvesting) are more numerous than for pure maize or Brachiaria monoculture. They increase the expenses incurred. The same observation was made in the cotton production zone of Mali for the association maize and Brachiaria [12].

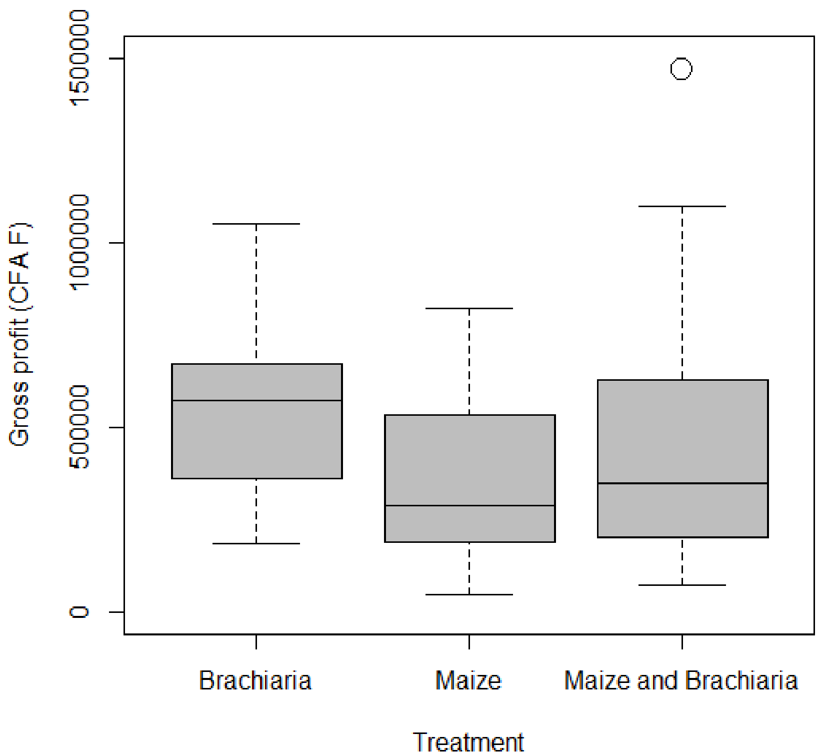

Figure 5. Gross margin of pure Brachiaria fodder production, association with maize and pure maize in CFA.

4. Conclusion and perspectives

Biomass production was highly variable between treatment for the *Brachiaria ruziziensis* monoculture, the association with Maizeand the pure Maize. In the conditions under which the experiments were carried out, the mixed stand makes it possible to increase the global fodder produced, which are necessary to feed the livestock in the dry season. The association of *Brachiaria ruziziensis* with maize does not significantly reduce maize seed yield. Also, innovations are economically profitable for farmers. It would be necessary to conduct studies on the use of fodder in animal feed during the dry season (when there is a significant shortage of fodder), particularly on the supplementation of suckling cows and the conditioning of draught oxen.

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