Forage production for smallholder farmers in the semi-arid region of Brazil

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Abstract

Except for limited areas of irrigation, cultivation practices in the semi-arid region of Brazil involve slash and burn or shifting cultivation, with cropping cycles between three to five years. The low economic status of the farmers in this region results from low rainfall and soil fertility. Pigeonpea, (*Cajanus cajan*), sorghum (*Sorghum bicolor*) and millet (*Pennisetum glaucum)* are drought-resistant crops for food and forage uses in the Brazilian semi-arid region where soil and water may be a limiting factor. Intercropping is used to increase productivity, using resources that would otherwise not be utilized by a sole crop. Our objective was to evaluate forage production by pigeonpea in a sole and intercropping system with millet and sorghum. The experiment was conducted at Embrapa Semiárido, Petrolina, Pernambuco, Brazil. Treatments were: monoculture of sorghum, millet and pigeonpea; pigeonpea intercropped with sorghum or millet; and pigeonpea/millet /sorghum. To have a greater synchronization between the rates of growth of the species, the grasses were sown 10 days after sowing of pigeonpea. Millet showed the highest rate in the launch of panicles followed by sorghum, while the pea flowers first presented 35 days after the grasses. A 'Training Workshop' was held before harvesting the plots with community farmer leaders. They were provided with seminars/and on-site one-on-one site presentations and informational pamphlets were developed and provided to the participants. These results suggest that the farmers will get more forage when they plant pigeonpea and sorghum together. Intercropping systems, therefore, have an economic advantage for low-income farmers. The farmer's leaders suggested that a second workshop with smaller groups should be provided. Rotation farming and intercropping are common practices in the semi-arid region of Brazil by small-scale farmers and pigeonpea seems to be an important crop for this region**.**

Key Words

Pigeonpea, millet, sorghum, intercropping.

Introduction

The sertão area of northeastern Brazil is a semi-arid vegetation bush savanna called caatinga. It covers approximately one million square kilometers and is the country's most economically depressed region (Tiessen *et al.* 1992). An estimated 70% of rural household income derives from agriculture/farming in the Pernambuco region. Low rainfall, low soil fertility (especially low phosphorous) and the high cost of fertilizers/lime lead to low productivity and high poverty levels. Except for limited areas of irrigation, normal cultivation practices involve slash and burn. Northeast Brazil's agriculture requires the introduction of sustainable farming methods and crops to a) increase sustainability and b) encourage farmers to adopt systems that decrease the need for additional deforestation and make better use of the small parcels of land already under cultivation, despite the poor soil fertility of the Caatinga.

Pigeonpea (*Cajanus cajan* (L.) Millispaugh), a pulse crop, enhances soil fertility when intercropped and provides a consumable crop high in protein. The high cost and scarcity of soluble P fertilizer for low-income farmers in marginal environments necessitates use of a crop such as pigeonpea that efficiently processes insoluble P forms and fixes nitrogen (Guedes 1999). It is an important grain legume crop grown in tropical and subtropical regions (Nene and Sheila 1990; Phatak *et al*. 1993; Assis *et al*. 1998; Guedes 1999). It survives well in degraded soil and is drought tolerant. Pigeonpea is traditionally grown in areas of high altitude in the states of Bahia, Ceará and Pernambuco, where the rain is evenly distributed. The traditional genetic material used was introduced into the country during the colonial period and is only slightly tolerant to drought, has a long growing cycle and semi-bush size.

Intercropping systems. The main reason to grow more than one crop simultaneously in the same field (intercropping) is to increase productivity on a land area, using resources that would otherwise not be utilized by a sole crop. Special attention should be given to soil, climate, plant species, and varieties (short or long duration genotypes) to avoid competition for space, sunlight, nutrients and water (Rao and Morgado 1984;

Sumigalskia and Ackerb 2008). Intercropping system in the Brazilian semi-arid region should provide for the necessary insurance against unpredictable weather. If a “good rain” year happens, this planting approach should be more profitable than growing either of the crops alone. Sorghum/pigeonpea is the most common cereal intercropped system in broader range of soils in India and Brazil. They have been planted at the beginning of the rainy season, with more sorghum than pigeonpea in a row. Maize (*Zea mays* L.) and pigeonpea, as well pigeonpea/peanut are common in Africa and south Asia. Information on ratoon cropping and studies are needed to explore the feasibility and economic viability of this system in several agro ecological regions in the world (Ali 1991). Pigeonpea can be planted every year or biannually and stems should be cut (30-45 cm above the ground) during rain season in the second year.

According to researchers from ICRISAT (India) the reasons that farmers prefer extra-short-duration pigeonpea genotypes are early maturity, seed size, and the greater yield when wheat is preceded by pigeonpea in a crop rotation system (Chauhan et. al. 1999; Upadhyaya *et al*. 2006). Intercropping practices were found to be remunerative than sole crop of pearl millet /pigeonpea 2:1 ratio even under drought conditions.

Objectives

1) Research the viability of pigeonpea farming on a small scale of food producers/farmers and its impact on soil fertility in northeastern Brazil; 2) Train farmers to use pigeonpea intercropping techniques and understand the multiple uses of the pigeonpea; 3) Train identified community leaders to deliver pigeonpea training to other farm communities and manage sustainable community demo-plots.

Activities to meet these objectives include: 1) Demonstration plots containing traditional crops inter-planted with pigeonpea in the Caatinga region of Pernambuco by the project team and local farmers. 2) Farmers’ Workshop combining hands-on involvement with a seminar on farming methods, usage and science/technical background.

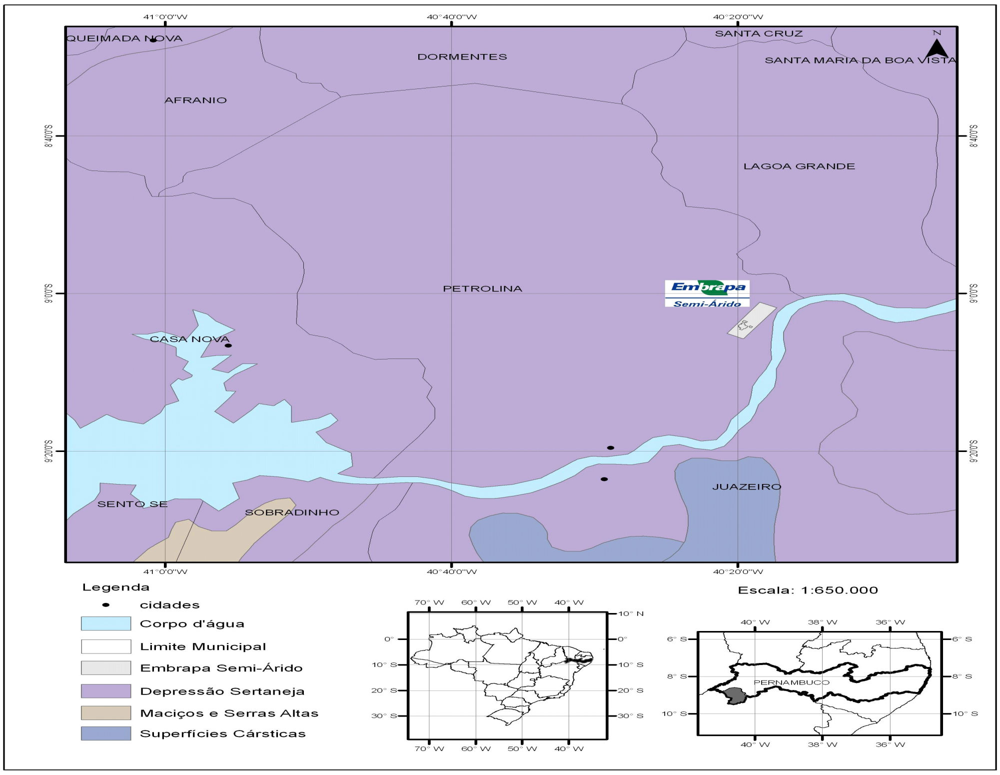

Figure 1. Study site location at Embrapa Semiárido, Petrolina, Pernambuco, Brazil.

Materials and methods

Research was conducted at the Center for Agricultural Research in the Semi Arid Tropics (Embrapa Semiárido), latitude $9^0$23’53”S, longitude $40^0$29’56”W, near Petrolina, Pernambuco, Brazil (Figure 1). The climate is classified as BshW semiarid with annual average temperature of 24^{o}C and annual precipitation around 40cm. The natural vegetation of the area is Caatinga, (semiarid deciduous thorny vegetation). The soil is classified as a podzol plintic (Ultisol) and analyzed according to procedure described by Potter et. al 1991 (Table 1).

Table1. Soil characteristic of field plots at Embrapa Semiárido, Petrolina, Pernambuco Brazil.

pH	(meq/100g)			(µg/g)	%		
Water	Ca^{++}	Al^{3+}	Mg^{2+}	P	Clay	Sand	Silt
5.5	3	0.2	0.4	2.47	7	81	12

Plots were prepared with conventional tillage and 26 kg/ha of P was applied. No N fertilizer was applied because the seeds were inoculated with a multistrain inoculum commonly used for cowpeas and was planted 2 cm deep at the rate of 30 kg/ha with a row spacing of 60 cm and an in-row spacing of 50 cm for pigeonpea and approximately 4 cm for sorghum and millet. Each plot was 3-m wide and 5.50 m long. Treatments were arranged in a complete randomized block design with 4 replications (Figure 2). Treatments were: 1) Grain sorghum (*Sorghum bicolor*) monoculture (S); 2) Pigeonpea [*Cajanus cajan (*L.) Millsp.] var. D2 type monoculture (P); 3) Millet (monoculture (M): 4) Millet /pigeonpea intercropping (P/M); 5) Sorghum/pigeonpea intercropping (P/S); and 6) Pigeonpea/sorghum/millet intercropping. (P/S/M). Plots were arranged on row intercropped and had the same plant spacing as monoculture but species were alternated.

Soil and plant analysis

Aboveground plant samples (stems and leaves excluding grain) were collected at the end of the growing season. Plants were clipped 2.5-cm above the ground from the center 3 m of row, air dried for 3 days, and the green weights recorded. Plant samples were then dried in a forced-draft oven at 65°C and weighed to determine dry matter production. Crude protein and ash content were determined by standard laboratory methods. Additional plant measurements included plant height, and for pigeonpea height to first lateral branch and stem diameter at ground level.

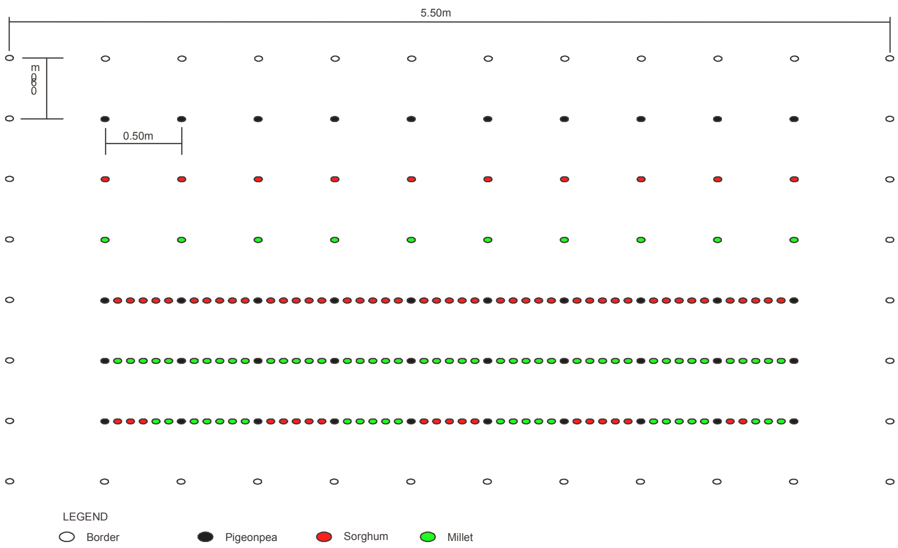

Figure 2. Layout of the blocks for field experiment at Embrapa Semiárido, Petrolina, Pernambuco, Brazil.

Results and discussion

Table 2 gives results from first year field plots. Greatest forage production was in the pigeonpea/sorghum intercopped plots (17.5 Mg/ha). Lowest forage production was for millet alone (8.9 Mg/ha). Similar production was obtained in the other 4 treatments (13.9 to 15.5 Mg/ha)(Table 2). Biomass accumulation essentially is a linear function of the amount of photo synthetically active radiation intercepted by the plant canopy. Therefore, millet's shade in the pigeonpea/millet intercropping might have reduced the amount of solar radiation available to the pigeonpea. Consequently, photosynthetic activities could not effectively take place to produce sufficient energy required to drive growth and developmental processes in the intercropped pigeonpea. Lawn and Troedson (1990) reported a reduction of the mean number of branches per plant of pigeonpea intercropped with sorghum. Lawn had particularly noted that while most pigeonpea genotypes were freely branching, the extent of branching was substantially influenced by inter-plant competition, and was reduced at denser population, and when pigeonpea was grown as an intercrop.

Table 2. Dry matter production and crude protein content of forage samples, plant heights, and pigeonpea growth parameters on plots.

	AFDW[1/]		CP[2/]		Plant Height (m) P[3/]		S[4/]		M[5/]		Pigeonpea Growth Parameters HFLB[6/] (cm)		CD[7/] (cm)	
Trt[8/]	Mg/ha	SE[9/]	Avg.	SE	Avg.	SE	Avg.	SE	Avg.	SE	Avg.	SE	Avg.	SE
S	15.1	2.2	6.36	0.71	-	-	2.48	0.07	-	-	-	-	-	-
P+ M	14.1	0.5	7.71	0.43	2.69	0.09	-	-	2.33	0.05	15.9	1.56	1.48	0.14
P+S	17.5	1.5	6.46	0.57	2.80	0.09	2.48	0.07	-	-	11.1	0,54	1.55	0.09
P	15.5	1.7	6.33	0.49	2.64	0.04	-	-	-	-	11.5	1.72	1.70	0.15
M	8.9	1.9	7.55	0.32	-	-	-	-	2.56	0.05	-	-	-	-
P+S+M	13.9	1.3	7.12	0.49	2.55	0.03	2.37	0.05	2.30	0.07	15.4	1.53	1.55	0.08

[1/] Ash Free Dry Weight; [2/] Crude Protein; [3/] Pigeonpea; [4/] Sorghum; [5/] Millet; [6/] Height to First Lateral Branch; [7/] Crown Diameter; [8/] Treatment; [9/] Standard Error of the Mean (n=4).

Conclusions

Results of this first year's field plots and workshop were very encouraging, and plans for the second phase of the project are progressing. Field plots are being prepared, and the second workshop will be held in January of 2010. These results will be incorporated into the presentation.

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