FORAGE PRODUCTIVITY EVALUATION AND GEOGRAPHIC INFORMATION SYSTEMS IN A TEMPERATE SEMI-ARID AGRO-ECOSYSTEM

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ABSTRACT

700,000 ha of the temperate semi-arid area of Zacatecas state are grown with rainfed crops. Low productivity is obtained from these crops: 350 kg/ha of beans grain and 500 kg/ha of corn grain. This state is characterized by a wide range of topographic and climatic values. A need for alternative crops led to establishment of a trial to evaluate rainfed forages, and to know in what range these could be located. Geographic information systems were used to find out the potential area of the species. Results indicated that sorghum presented a higher yield (5822 kgDM/ha) than sorghum x sudan (5460), pearl millet (4316), corn (3783), barley (3092), triticale (2638), wheat (2540), oats (1934) and beans (1243). Pearl millet presented the highest CP (16.5%) and lowest FAD (28.2%); and sorghum x sudan the lowest CP (6.5%) and highest FAD (38.7%). Sorghum (Sucro) produced 2.07 kg DM per each cubic meter of water evapotranspired, and for beans 0.5 kgDM/m^3. Areas of low productivity potential for the traditional crop (beans) appeared as the medium potential areas for sorghum forage.

KEYWORDS

Forages, sorghum, millet, triticale, barley, GIS, Mexico

INTRODUCTION

An important area of the Central Northern part of Mexico is characterized as a subtropic temperate semi-arid agro-ecosystem. This is the second in importance in Mexico, and it is around 17% of the nation's surface (34,580,682 ha). Zacatecas state has a representative area of this kind of agro-ecosystem, where an important micro-region is sown with rainfed beans and corn. However, low precipitation or undefined rain opportunity cause crop losses. Therefore, rainfed forages become an alternative economical practice to this important area; a study was carried out to evaluate different forages through an experimental trial, and to define their potential alternative area through the geographic information system technique.

MATERIALS AND METHODS

The experimental area is located in the central part of Zacatecas State. The geographical reference of this area is 22°54'34"(N) latitude and 102°39'33"(W) longitude, with an altitude of 2197 masl. The experiment was conducted during the precipitation season of 1994. The basic season period temperatures were: Minimum month average 7.9°C, month mean 17.2°C and maximum month average 24.7°C. There was a total precipitation of 321.1 mm throughout the production period (July-November) and a precipitation/evaporation relationship of 0.48 during the same period. Data were taken and analyzed from a trial where 8 forages were tested and compared to beans and corn as control crops. The length of growing period and growing degree days (GDD) accumulated varied according to each crop. Beans accumulated 127 days and 868 GDD, Pearl millet, Sudan x sorghum and Sorghum (k-100) 160 days and 456 GDD, Sorghum Sucro 106 days and 307 GDD, Wheat and Barley 106 days and 1188 GDD, Oats 82 days and 928 GDD and Triticale 93 days and 1052 GDD. Seed density was of 15 kg/ha for sorghum, 18 kg/ha for Peal millet, 100 kg/ha for cereals, 40 kg/ha for beans and 14 kg/ha for corn. There was applied a unique fertilization with the formula 30-40-00. Dry matter/ha (DM/ha), plant height and fraction as crude protein (CP), acid detergent fiber (ADF) and neutral detergent fiber (NDF) were determined (Goering and Van Soest, 1970).

There was measured through the experiment the water soil availability for beans and sorghum (Sucro) treatments (Perales and Serna, 1992). Also, an economic analysis was realized for beans, corn, sorghum (Sucro) and oats treatments. To evaluate the impact of the experimental results, a geographical information analysis was conducted. The high, medium and low productivity potential surfaces were calculated for each forage and grain crop tested. The variables to study the potential area of the crops were: Elevation and slope, maximum and minimum temperature, and growth period rainfall. The topographic information was used from a Digital Model Elevation (INEGI), elevation was taken every 30-arc seconds for latitude and longitude, and a grid, with an elevation value every 900-x 900 meters was made (Medina et al., 1994a)

RESULTS AND DISCUSSION

The total dry matter produced by sorghum and pearl millet tended to be greater than that produced by corn, but no statistical difference was found (Table 1). Sorghum (Sucro) produced 54% more DM than corn. Cereals were shown not to compete with Sorghum (Sucro). Rainfed forage yield depends on annual rainfall; other authors in the same area obtained 2400 kgDM/ha for sorghum x sudan forage in a 196 mm precipitation period (Garcia and Tiscareño, 1982). However, in a rainy year (411 mm) a yield of 6000 kgDM/ha (García and Ayala, 1981) was obtained. Pearl millet produced higher yield than other reports of the same agro-ecosystem, as reported by Avila (1993) with a yield of 3110 kg DM/ha, and Garcia (1982) 2,160 kgDM/ha, in a 454 and 492 mm precipitation year, respectively. Pearl millet presented the highest CP and one of the lowest FAD. Corn and all forages tend to produce higher dry matter than bean crops. Sorghum (Sucro) produced 2.07 kg DM per each cubic meter of water evapotranspired and for beans 0.5 kgDM/m^3. The economic analysis showed that sorghum (Sucro) had 16% and 113% higher net benefit than beans and corn grain crop respectively. Beans had a foliage grain relation of 1:1 and corn of 3.4:1. Potential plant productivity studies using GIS have showed to be a good tool for soil use alternatives (Medina et al., 1994b). In Figure 1, are shown two maps of three potential levels for beans crop and sorghum forage. No considerable high potential areas were found for both crops in Zacatecas State. However, the areas of low productivity potential for the traditional crop (beans) appeared as the medium potential areas for sorghum forage.

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Figure 1
Alternative soil use with forages in low potential beans area, Zacatecas, Mexico

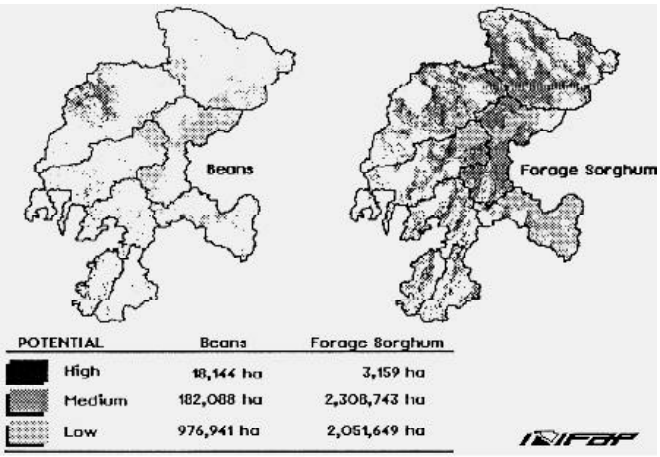

Table 1
Dry matter yield and quality fractions of forages as alternative to corn and beans crop

Crop	DM (Kg/ha)	Height (cm)	CP	FDN	FDA [1]
			(%)		
Sorghum Sucro	5822 [A]	99.5	10.1	66.3	34.9
Sxsudan Su sweet	5460 [A]	130.8	6.5	68.9	38.7
Pearl Millet	4316 [AB]	70.5	16.5	61.9	28.2
Sorghum K-100	4033 [ABC]	97.5	10.8	63.3	31.8
Corn V-209	3783 [ABC]	98.8	8.6	64.2	25.6
Barley Esmeralda	3092 [BCD]	46.8	9.2	63.6	27.6
Triticale Romoga	2638 [BCD]	80.0	9.2	65.0	32.8
Wheat menona	2540 [BCD]	77.0	9.9	66.5	36.7
Oats Cuauhtémoc	1934 [CD]	84.0	11.1	59.6	33.8
Beans F. de Mayo	1243 [D]	27.0	15.4	56.1	24.4
Standard error	951.6				

[1] Dry matter basis
[ABCD] Means with different letter are different (P<0.05).