Tropical and Subtropical Agroecosystems, 13 (2011): 261 - 269

AGROECOSYSTEMS STUDIES

SOCIOECONOMIC AND TECHNOLOGICAL FACTORS IN SUGAR CANE (*Saccharum officinarum* L.) AGROECOSYSTEMS PRODUCTION IN CHONTALPA, TABASCO

[FACTORES SOCIOECONÓMICOS Y TECNOLÓGICOS EN LA PRODUCCIÓN DE AGROECOSISTEMAS CON CAÑA DE AZÚCAR (*Saccharum officinarum* L.) EN LA CHONTALPA, TABASCO]

Liliana Armida-Alcudia, Octavio Ruiz-Rosado*, Sergio Salgado-García, Felipe Gallardo López, Martha Elena Nava-Tablada and José Francisco Juárez-López

Colegio de Postgraduados, Campus Veracruz, Km. 88.5 de la Carretera Federal Xalapa–Veracruz, Tepetates, Municipio de Manlio Fabio Altamirano, Veracruz.
alcudial@colpos.mx, salgados@colpos.mx
**Corresponding Author: octavior@colpos.mx*

SUMMARY

Sugar cane is one of the main crops in the state of Tabasco, Mexico, with a planted area of 27,041 ha, contributing 4 % of the national sugar production and ranking third in acreage at national level. This research aimed to identify main socioeconomic and technological factors influencing yields in sugar cane at Benito Juarez sugar mill factory (BJSMF). A total of 150 growers were interviewed, whose information was analyzed with descriptive statistics. Relevant socioeconomic characteristics were age (51 % growers were 50 to 70 years old); school attendance (40 % coursed primary school); lack of family labor, among others. Relevant technological issues were the higher yields in a smaller area planted with variety MEX 79-431, mean yields ranged from 50 to 60 t ha^{-1}, commonly applied fertilizers are based on the formula known as triple 17 by 30 % of growers and the 20-10-10 fertilizer mix is used by 26 %. The lack of technical advisory access was reported by 58 % of them.

Key words: Sugar cane; socio-economic analysis; technological analysis.

RESUMEN

La caña de azúcar es una de los cultivos pilares en la economía de Tabasco, México, pues se cultivan 27,041 ha que contribuyen con el 4 % de la producción nacional de azúcar, ocupando el tercer lugar en superficie cultivada. Esta investigación tuvo como objetivo identificar los principales factores que impactan los rendimientos en el agroecosistema cañero del Ingenio Presidente Benito Juárez. Se entrevistaron a 150 productores y se analizó la información con estadística descriptiva. Entre las características socioeconómicas de los productores destacan la edad (51 % entre 50 y 70 años), escolaridad (40 % con estudios de primaria), la escasez de mano de obra familiar, entre otras. En cuanto a las tecnológicas destacan el cultivar MEX 79-431 sembrado en menor área pero con mayor rendimiento, de entre 50 y 60 t ha^{1}; la fertilización comúnmente aplicada es triple 17 por 30 % de los productores y la mezcla 20-10-10 es a pliada por 26 %; 58 % de los productores reportó nulo acceso a asesoría técnica.

Palabras clave: Caña de azúcar; análisis socioeconómico; análisis tecnológico.

INTRODUCTION

Sugar industry is one of the main economic activities in Mexico. Nationwide sugar cane is planted in 15 states: Campeche, Chiapas, Colima, Jalisco, Michoacan, Morelos, Nayarit, Oaxaca, Puebla, Quintana Roo, San Luis Potosi, Sinaloa, Tabasco, Tamaulipas and Veracruz, in an area of 812,000 ha. Fifty seven operating sugar mills have a direct economic impact on 2.2 million people. Sugar production accounts for 3000 million dollars annually, 57 % distributed among 164,000 sugar cane growers (UNC, 2010).

Tabasco hosts three sugar mill factories: Presidente Benito Juarez, Santa Rosalía and Azuremex,

associated to 27,041 ha of sugar cane ranking third in acreage nationwide and contributing with 4 % of national sugar production. Presidente Benito Juarez sugar mill factory (BJSMF) planted area is 12,918 ha, with a mean yield of 62 ton ha^{-1} during 2006/2007 harvest period, below national average. Recent occurrence of natural disasters drastically reduced nationwide production of sugar cane, with a mean of 64 ton ha^{-1} for the 2008/2009 at national level and 43.9 ton ha^{-1} for the supplying area of the BJ sugar mill factory (UNC, 2010). Hence, this research was conducted to identify the socioeconomic and technological factors that may influence sugar cane yields at the BJSMF.

MATERIALS AND METHODS

Study area

The BJSMF is situated in the municipality of Cardenas, Tabasco. This factory, established since 1974, is located at the village "C-27 Ing. Eduardo Chávez Ramírez", in the Plan Chontalpa area. This supplying area includes villages identified as C-10, C-14, C-15, C-16, C-20, C-21 C-22, C-27, C-28, C-32, C-33, C-34, C-40 and C-40. During the 2006/2007 period, a total acreage of 12,918 ha was reported, with a mean yield of 62 ton ha^{-1} and mean factory sugar yield of 6457 ton ha^{-1} (UNC, 2008).

Survey

A survey was applied to 150 randomly selected sugar cane producers to analyze socioeconomic and technological factors that may influence yields and competitiveness. This survey included questions about their current situation in socioeconomic aspects, as well as natural resources availability and technology used in their fields (Table 1). A pilot test was made by interviewing five experienced sugar cane producers. After adjusting the questionnaire, the final survey was conducted.

The information was analyzed using descriptive statistics (Statistica, 1995).

Table 1. Socioeconomic and technological variables included in the survey applied to sugar cane growers associated with Presidente Benito Juarez sugar mill factory. Tabasco, Mexico.

Variable	Units	Variable	Units
Socioeconomic factors			
Age	years	Cost per ton	MX$ ton^{-1}
Gender	man/woman	Knowledge on sugarcane payment system	yes, no
Schooling	grades	Total production cost	MX$ ha^{-1}
Family members	number of people	Belongs to an organization	yes, no
Land tenure	ejido/prívate property/civil	Type of polítical organizations	CNC,CNPR, UCD, AC
Plot area	ha	Organizations' benefits	yes, no
Years of planting sugar cane	years	Quality of life	yes, no
Distance home to farmland	km	Migration	yes, no
Additional farmland	yes, no	Benefits of planting	yes, no
Income's diversity	crop's name	Land with sugar cane only	yes, no
Crop's profitability	yes, no	Knowledge about high fructose	yes, no
Tecnological factors			
Machinery use	yes, no	Herbicide spraying month	months
Machinery type	own/rented	Number of sprays	number per year
Planting method	single/double line	Pest control	yes, no
Reseeding	yes, no	Control method	manual/chemical
Replanting time	month	Pesticide type	name
Variety	variety's name	Dose	kg ha^{-1}
Irrigation	yes, no	Disease control	yes, no
Fertilizer application	yes, no	Efficient harvesting	yes, no
Fertilizer type	formula applied	Harvested area	ha
Amount of fertilizer	kg ha^{-1}	Yield	ton ha^{-1}
Application time	month of the year	Technical advisory access	yes, no
	manual/mechanical	Rating advisory	good/poor
Weeding	yes, no	Control method	manual/chemical

RESULTS AND DISCUSSION

Socioeconomic factors

The profile of sugar cane growers that supply the BJSMF indicates that they average 50 years old (std. dev. = 10 years). Also, 45 % are less than 50 years old, 50 % are between 50 and 70 years old, and only 1 % are older than 70 years. A substantial proportion are young growers (< 50 years old), who are able to respond more openly to technological changes optimizing the use of natural resources, compared to elder growers who have built their own ideas and are more reluctant to changes in relation to sugar cane production activities; however, several factors also influence this type of decisions, such as gender, schooling and income, among others. Most interviewed growers are men (80 %). Increasing number of women in charge indicates a gender type impact on sugar cane activity. Men leave their rural home to work in urban areas, making women to broaden their responsibilities to support their families. Acosta (2008) mentions that female presence and work in rural areas has a complementary character, strengthening the social bonds that hold their families. Thus, participation of rural women in economic life is remarkable, although it is minimally recognized yet.

On average, farmers education is five years of primary school (std. dev. = 3.5 years), 11 % did not attend school, 30 % attended but did not complete the basic primary school (one to five of six years), 40 % finished it and a further 19 % studied beyond primary school level. The low educational level and the advanced age of 50 % of farmers (50 to 70 years old) may reduce their ability to take good decisions. Also, they might not be able to demand their leaders for more training and better organization to develop sugar cane activities. Pérez-Cerón and Mata-Garcia (2003) observed similar findings, with more schooling farmers having easier access to training, participation and organization.

Characteristics of land tenure ownership

Land tenure is mostly "ejido" (62 %), with "small private property" representing 27 % and 11 % has another type of tenancy. Same situation occurs in most sugar cane areas, where two land tenure regimes are the dominant, the "small private property" (with regulated property limits) and the "ejido" (where land use is given by the reformed Agrarian Law); all this results in smallholder production areas, where 79 % of the farmers are "ejido" holders representing 68 % of sugar cane area. Also, 64 % of the sugar cane harvested area has an average of 3.9 ha per grower (SIAP, 2009).

Respondents of the BJSMF supplying area mentioned that they average 20 years of experience in growing sugar cane, 55 % of them have planted only sugar cane in their farmland, while the rest have had other crops. This indicates that sugarcane has been cultivated mostly as a monoculture during the last 20 years without any rotation. Sugar cane provides income to 88 % of growers, followed by cocoa plantations, livestock and rice, which are considered as complementary activities (Figure 1). These data are similar to those reported by Lang-Ovalle *et al*. (2007), who indicated that sugar cane is better paid, generating more income than mango plantations in Central Veracruz, and represents an important part of the agricultural economy of national growers.

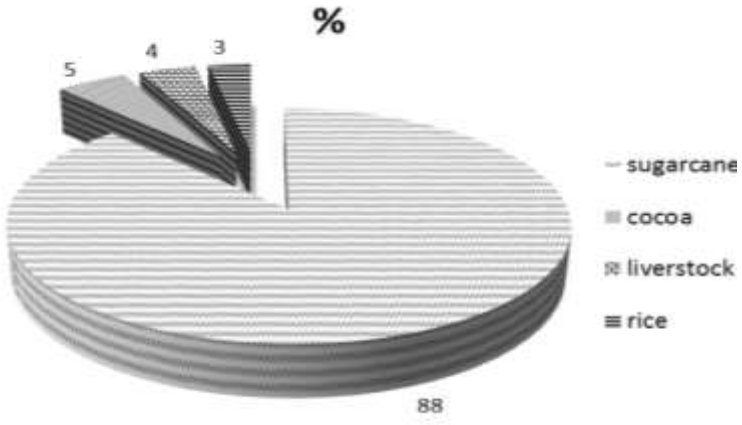

Figure 1. Farmer's income diversity in Presidente Benito Juárez sugar cane mill supplying area.

Family labor input

Family involvement in sugarcane production is low, and depends on paid labor for planting, harvesting and transportation. In Central Veracruz Lang-Ovalle *et al*. (2007) reported similar data, where sugar cane farmers are no longer self-employed, so they hire labor for cultivation practices. In the BJSMF supplying area, one out of five people within the family participates in farming activities dedicated to sugar cane. Data from the BJSMF Sugar Cane Growers Register for the 2006-2007 harvest, indicates there were 2,495 people hired as laborers to work in an area of 12,909.66 ha (SIAP, 2009). This shows the importance of sugar cane crop as a source of employment during harvesting season. In Mexico, approximately 300,000 families depend directly on this activity, 74 % of them being located in rural areas. Furthermore, this crop creates temporal jobs locally in secondary services, providing extra income to families during the five months of harvest.

Political organization

Fifty nine percent of sugar cane producers are affiliated to the Confederacion Nacional Campesina (CNC), 33 % to Confederacion Nacional de Productores Rurales (CNPR) and 8 % to the Union Cañera Democratica (UCD). Fifty four percent knows the aims of their political organization, and 77 % have gotten benefits from their organization, mainly throughout credits, access to a trusteeship and support for activities in their field.

Production costs

Respondents (89 %) said that sugar cane is profitable; however, production costs are high. Producer invests an average of MX$10,000.00 ha^{-1}. The “Comite de Caña de Azucar del BJSMF” (BJSMF Sugar Cane Committee) authorized a technological package for sugar cane cultivation valued on MX$14,041.00. This includes land preparation, planting, cultural practices, application of agricultural supplies and the payment of labor. However, field works and associated costs may vary according to the producer needs. Enriquez-Poy (2005) mentioned that the cost of sugar cane production in Mexico is quite high (about US$38 ton^{-1}), almost three times higher than those from Central and South America countries. High production costs are attributed to small land tenure (< 4.5 ha per farmer) related to “ejido” tenure regime, elevated cost of agricultural supplies, water and energy.

Technological factors

Land preparation

All farmers (100 %) use machinery for land tillage, hiring 93 % of it. Machinery lease increases production costs, but it is essential for most field practices, from land preparation to harvest.

Planting

In th first sugar cane cycle, 88 % of farmers sow with the double-line technique, placing two entire cane stems in a furrow, which are cut into pieces (stakes) to obtain three to four buds from each, which are covered with 2 to 3 inches of soil to facilitate germination. The majority (69 %) use 10 ton ha^{-1} of stems as seed, and 27 % use 12 ton ha^{-1}; most farmers (80 %) perform reseeding to repopulate areas and replace lost rods. Salgado *et al*. (2001) reported that seeding rate is 12 ton ha^{-1} to have a field density of 80,000 to 90,000 seedlings ha^{-1}.

Sugar cane planted varieties

Varieties grown as reported by farmers in order of importance were: Mex 69-290, Mex 68-P-23, SP 70-1284, CP 72-2086, Mex 79-433 and RD 75-1. Salgado *et al*. (2009) mentioned that 95 % of the area grows four out of 16 available varieties. These cultivars are reported as the best nationally, according with the 2005 census. Most area (80 %) is covered by Mex 68-P-23 and Mex 69-290, and only 16 % by SP 70-1284 and CP 72-2086. Due to the land intensive management, fields planted for up to 30 years show substantial decline in soil fertility (Ortiz, 2005). First plant regrowth is called "soca" and the following ones "ratoon"; percentage of ratooning is over 80 %, leaving some field areas with less plant density.

Sugarcane production

Farmers reported yields ranging from 40 to 120 ton ha^{-1}; yields between 50 and 65 ton ha^{-1} were more frequent during the 2006/2007 harvest. The variety with the highest production was Mex 79-431, yielding 71.7 ton ha^{-1} on average; SP 70-2084 and Mex 69-290 had a yield of 65 and 66 ton ha^{-1} each. Cultivars with lower yields were Mex 68-P-23 with 58.2 ton ha^{-1} and closer to that CP 72-2086 (Figure 2). These results are similar to those reported by Ortiz (2005), with yields of > 70 ton ha^{-1} for Mex 79-431; cultivars with little response are the last three, with yields < 65 ton ha^{-1}. There are also many documented cases of productivity

loss by a specific variety. There is a "variety related decline" that could be the result of continuously growing a given variety (Hoy, 2010). Added to this, the decline in yields in these varieties is due to other factors, such as reduced crop management, lack of inspection by the BJSMF personnel, as well as inadequate conditions in the sugar cane field.

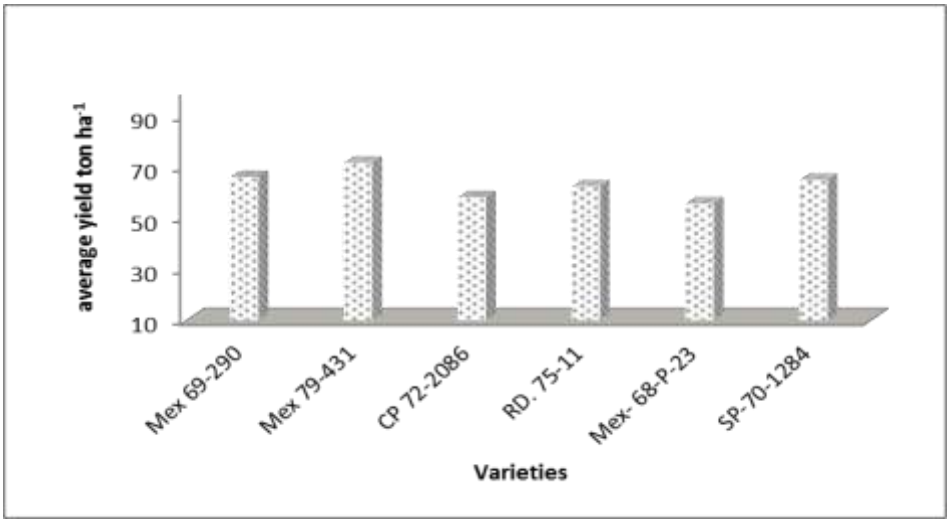

Figure 2. Average yield of sugar cane varieties planted by farmers in the supplying area of the Presidente Benito Juarez sugar mill factory. Tabasco, Mexico. 2006-2007 harvest season.

Irrigation and drainage

Total BJSMF area is based on rainfed agriculture; irrigation is not needed because rainfall amount and distribution are considered sufficient to achieve higher yields. Nonetheless, auxiliary irrigation is needed during the short dry season, and it can be achieved with available shallow water sources. In addition, infrastructure needed to implement irrigation and drainage exist, inherited from a project called Plan Chontalpa. On the other hand, drainage is one of the most important activities due to high rainfall in some parts of the area; clay soil and low altitude above sea level (less than 20 m) are prevalent in the area, causing excess of soil moisture. All this creates unfavorable conditions for the crop. Salgado *et al*. (2009) mention that under these conditions the establishment of drains for lowland areas is essential, as it has been suggested and demonstrated by Carrillo *et al*. (1998) and Mendoza *et al*. (2003).

Fertilization

All surveyed farmers acquired fertilizers from the BJSMF; triple 17 is used by 32 % of them, the fertilizer complex 20-10-10 is used by 26 % and the 20-10-20 by 12 % of growers. Almost all respondents (98 %) apply fertilizer in just one application; 75 % apply a dose of 600 kg ha^{-1} on August; 48 % apply fertilizer manually, 39 % use machinery and 11 % combine both methods. Eighty six percent of producers indicate that the BJSMF defines the application rate; only 1 % uses soil analysis methods to determine their crop fertilization requirements, and 11 % do so from field experience. Palma *et al*. (2002) reported that in the Chontalpa region, experimental yields of sugar cane were around 150, 130 and 110 ton ha^{-1} for first cropping cycle, soca and ratoon, respectively, using the fertilizer formulation 160-80-80 in Mex 69-290 and SP 70-1284 varieties. However, growers opinion on triple17 and complex 20-10-20 is that they are unbalanced fertilizers. Thus, Salgado *et al*. (2009) recommend 350 kg ha^{-1} of triple 17 plus 150 kg of urea in a single application in any cropping cycle.

Weeding

Competition for soil nutrients between sugar cane and weeds affects crop yields. Farmers reported controlling weeds by chemical methods hand spraying mostly Herbipol (Herbipol* 2,4-D Amine No. 6 > Polaquimia: 2,4-D, dimethylamine salt 70 % SCA) mixed with Guerrero (800 Guerrero DF) or urea (CO (NH_2)), using 2 L dissolved in 200 L of water, with one or two applications ha^{-1}. Diaz and Morales (1987) mention that to avoid the harmful effects of weeds, they must

be controlled in the right time. Currently, application of herbicides is the most common method for weed control in sugar cane (Esqueda-Esquivel, 2008).

Pest and disease control

Sugarcane productivity is affected by the incidence of pests and diseases. Despite of it, no grower pays attention to disease control. As they mentioned, there is a lack of information about presence of diseases in their fields. On the other hand, most growers interviewed (92 %) pay attention to pest control; 32 % of growers said that rats are reported to be one of the main pests on sugar cane, 27 % mentioned the stem borers, and the rest of the growers the presence of sugar cane thrips and spittle bugs. Damage caused by rats occurs throughout the year; however, it increases on the driest season during the harvest months, when yields may decrease up to 15 %. Rodenticides (Brodifacoum at 0.005 %) are used by 49 % of growers to control the pest, and 41 % apply dimethyl-(E)-1-methyl-2-(methyl carbomoil) phosphate for spittle bug control.

These results were confirmed assessing 150 farms by visual diagnosis in the sugar cane supplying area as shown in Figure 3, where damages caused by pests such as rats and stem borers, by some diseases such as rust, and weeds are of high impact in the supplying area of BJSMF. Other elements observed in the field affecting the development of sugar cane are: lodging, presence of undesired inflorescences, secondary shoots, thin stem, short stalks, red stripes and yellow leaves, among others.

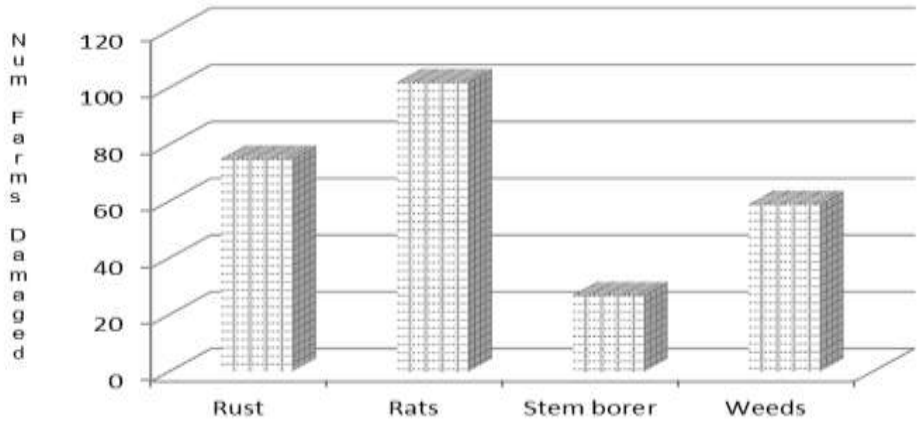

Figure 3. Major damage caused by insect pests, diseases and weeds in the IPBJ sugarcane supplying area.

Harvest

Growers reported 79 % harvesting efficiency during the 2006/2007 crop cycle. The principal activity of interviewed growers (92 %) is to supervise harvesting activities carried out by a hired group; 58 % of growers mentioned that they didn`t receive any technical advisory.

At national level, in Mexico the price per ton of sugarcane was MX$299.00, having a mean annual growth rate of 6 % from 1997 to 2007. San Luis Potosi is the Mexican state where sugarcane has a better price in rural areas. Price went from MX$230 to MX$406 ton^{-1} (SIAP, 2009), which represents a mean annual growth rate of 5.8 % from 1997 to 2007. For the study area, the price paid was MX$ 357 ton^{-1}. Currently, sugar supply is under strong pressure, both nationally and internationally. Adverse weather conditions occurred in India and Brazil that reduced the amount of sugar available to the world (148.7 million ton), 10.7 % less than in the 2006/2007 cycle. In Mexico, the production was low in the cycle 2008/2009 (SIAP, 2009); sugar was reduced in 7.5 kg per ton of sugar cane and the price per ton was not paid proportionally. For the 2009/2010 cycle, net ton of sugarcane payment was MX$ 467.

Benefits of planting sugar cane

Besides the economic benefits, the farmer has social benefits by planting sugar cane. Access to public

health services and a retirement pension are the most important benefits as mentioned by 57 % of interviewed producers, as well as a source of employment, opening and maintenance of roads. On the contrary, 7 % said that planting sugar cane has no benefits for them. No producer mentioned the easier access to markets or other important aspects.

Mexican sugar agro-industry is a major source of employment, as well as the primary production process that ranks fifth in the national agriculture. As an example, during the 2002/2003 harvest, 300,000 people worked in the factory as well as in the farms; 45 % corresponded to the primary sector, harvesters were 28 %, transporters 7 % and 20 % mill workers. These figures indicate the social and economic importance of the crop, which highlights 80 % of jobs held by producers and cutters (Salgado *et al*., 2001).

Moreover, farmers mentioned that the most important problems involved in sugar cane fields are: high incidence of pests and diseases, cutting and harvesting issues, administrative inefficiency of the sugarcane mill industry, among others. Despite this, producers still considered it a friendly good crop, and if the work involved is made on time they are able to increase their profits.

High fructose

High fructose is a liquid sweetener extracted from corn, and imported from the USA, where its production is cheap based on corn subsidies. High fructose entered into the Mexican market in 2008, causing a reduction in the use of sugar in the confectionery and soft drink industries; current imports are 800,000 ton (UNC, 2009). Several (25 %) producers are aware of its use in Mexico and that it would lower the price of sugar from their fields making its cultivation not profitable, while 75 % are unaware of fructose presence.

Analysis of categorical (socioeconomic, technological and ecological) variables

To determine the categorical independent variables influencing yield (dependent variable), the analysis of variance in Table 2 shows the variables with statistical differences in at least one of the categories ($P \leq 0.05$).
In the socioeconomic aspect, variables that had statistic significance were: 1. "Political organization type", 2. "Migration" and 3. “Knowledge about high fructose”. Mean separation indicated that CNC political organization and affirmative action categories are having influence on sugarcane yield: "Political organization type” was highly significant ($P \leq 0.01$), whereas UCD organization was statistically different from CNC and CNPR organizations. UCD organization had an average yield of 71.75 ton ha^{-1} and CNC had the lowest average yield of the three organizations. Analyzing the frequency of varieties planted per organization, it was found CNC mostly grows the cultivar Mex-69-290, while the UCD grows mainly the cultivar Mex-79-431, being the last two cultivars with medium to high yielding in the area.

CONCLUSION

Socioeconomic variables influencing the production of sugar cane agroecosystem are: advanced age of producers, increasing involvement of women as sugarcane producers in the decision making process, low family involvement in farm labor leading to a lack of local labor, and high variability of crop production costs. Technological factors diminishing the production of sugar cane in the BJSMF supplying area were: planted varieties, unbalanced fertilization doses applied and pest damage by rats mainly. All these factors represent good opportunities for the integration of socioeconomic and environmental improvement programs for sugar cane production.

ACKNOWLEDGEMENTS

To Consejo Nacional de Ciencia y Tecnologia for the scholarship granted to the first author (153134). To Fundación Produce Tabasco A.C. for its support through projects FP3-06 and FP4-10. To local sugar cane associations: Asociación Local de Cañeros CNPR, Unidad Cañera Democrática, and Unión de Cañeros, SPR de RL del Ingenio Pdte. Benito Juárez.

REFERENCES

Acosta, R. I. L. 2008. Mujeres trabajadoras en el medio rural. Una aproximación a la agricultura mexicana. Contribuciones a las Ciencias Sociales. 1 (Febrero 2008). http://www.eumed.net/cccss/2008a/ilar.htm (Consulted: 19/10/2010).

Carrillo, A. E., Landeros, S. C., Palacios, V. O. L., Nikolskii, G. I., Nájera, H. F., Mendoza, P. J. de D., Ku, Q. J., Cristóbal, A. D. 1998. El drenaje parcelario en zonas húmedas: una experiencia en La Chontalpa, Tabasco. VIII Congreso Nacional de Irrigacion, México. 334-342.

Table 2. Categorization of variables: socioeconomic, technological and ecological factors affecting suga cane production at Presidente Benito Juarez sugar mill factory, Tabasco, Mexico.

Factor	Variable	Category	P Value
Socioeconomic	Gender	Man/woman	0.39 NS
	Land tenure	Ejido, prívate property/civil	0.54 NS
	Main crop income	Sugarcane/cocoa/livestock	0.90 NS
	Crop profitability	Yes/ no	0.10 NS
	Alternative crop to sugarcane	Yes/ no	0.17 NS
	Political organization type	CNC/CNPR/UCD	0.002 AS*
	Knowledge of organizational goals	Yes/ no	0.39 NS
	Organization benefits	Yes/ no	0.42 NS
	Improvement of living standards	Yes/ no	0.87 NS
	Migration	Yes/no	0.047*
	Benefits of growing sugarcane	Yes/ no	0.42 NS
	Problems in sugarcane cultivation	Inefficiency of sugar cane mill factoy, harvest, delayed inputs, pests and diseases	0.68 NS
	Additional plots	Yes/ no	0.53 NS
	Land with only sugarcane	Yes/ no	0.10 NS
	Knowledge about high fructose	Yes/ no	0.04*
Technological	Machinery	Own/ rented	0.71 NS
	Planting method	Single / double lines	0.35 NS
	Reseeding	Yes/ no	0.22 NS
	Replanting time	Month	0.65 NS
	Fertilizers applied	Triple 17, 20-10-10, 20-20-10, urea, mixtures	0.61 NS
	Application time	Month of the year	0.05*
	Determining fertilizer rates	Own experience, sugar cane factory, indicated in the product package, chemical analysis, political organization	0.008**
	Weeding method	Chemical, by hand, hoeing	0.36 NS
	Herbicide spraying	Month of the year	0.001**
	Herbicide application method	Chemical, manual	0.05*
	Herbicides	Faena, Herbipol, Guerrero, Velpark, Niko, Gesapax, Cuproqua, Hierbamina, Mixtures	0.21 NS
	Pest control method	Chemical, manual, ny air, other	0.37 NS
	Disease control	Yes/ no	0.06 NS
	Cutting sugar cane schedule	Stablished by factory mill, visiting the field, when harvesting time is	0.35 NS
	Role of producer on harvesting time	Coordinator, supervisor, none	0.811271
	Efficient harvesting	Yes/ no	0.99 NS
	Technical advisory access	Yes/ no	0.08 NS
	Cultivar	Mex 69-290, Mex 79-431, CP 72-2086, RD 75-11, Mex 68-P-23, SP 70-1284	0.003**
	Rating advisory	Good, regular, poor, very poor	0.008**

Díaz, Q., Morales, C. 1988. Estudio del Estado Actual del Desarrollo Agropecuario y Social de los Ejidos del Plan Chontalpa. Colegio de Postgraduados. Centro de Estudios del Desarrollo Rural y Centro de Investigación y Capacitación para el Desarrollo Agropecuario, Forestal y Acuícola del Sureste. Montecillo, México.

Enriquez-Poy, M. 2005. Producción de etanol anhidro en ingenios azucarero. http://es.scribd.com/doc/49344897/El-Bioetanol (Consulted: 20/10/2010)

Esqueda-Esquivel, V. A. 2008. Efecto del aceite mineral agratex-he en el control de malezas en caña de azúcar. Agronomía Mesoamericana. 19(1): 93-98.

Hoy, J. 2010. El Cañicultor – La Declinación Varietal y de la Productividad en Caña de Azúcar. Sugar Journal. 2008 (April): 19-22. http://www.sugarjournal.com/past/past_2010.html (Consulted: 19/10/2010).

Lang-Ovalle, F. P., Pérez-Vázquez, A., Martínez-Dávila, J. P., Platas-Rosado, D. E., Ojeda-Enciso, L. A., Ortega-Zaleta, D. A. 2007. Actitud hacia el cambio de uso del suelo en la región golfo centro de Veracruz, México. Universidad y Ciencia. 23(1): 47-56.

Mendoza, P. J. de D., Nikolskii, G. I., Palacios, V. O. L., Landeros, S. C., Palma, L. D. J., Carrillo, A. E., Estrada, B. M. A. 2003. Análisis del funcionamiento hidráulico de diferentes tipos de drenaje agrícola en Tabasco, México. Ingeniería Hidráulica en México. 2: 107-119.

Morales, M. 1987. Manual de malezas. Instituto para el Mejoramiento de la Producción de Azúcar. Centro Nacional de Investigaciones Azucareras. Córdoba, Ver., México.

Ortiz, R. R. H. 2005. Clasificación de los factores limitantes para la producción de caña de azúcar: zona de abastecimiento del Ingenio Benito Juárez. H. Cárdenas, Tabasco. Informe Técnico.

Palma-López, D. J., Salgado, G. S., Obrador, O. J. J., Trujillo, N. A., Lagunes, E. L. C., Zavala, C. J., Ruiz, B. A., Carrera, M. M. A. 2002. Sistema integrado para recomendar dosis de fertilización en caña de azúcar (SIRDF). Terra Latinoamericana. 20(3): 347-358.

Pérez-Cerón, J. R., Mata-García, B. 2003. Conceptos y principios para el empoderamiento tecnológico comunitario. In: Mata G., B. (ed.). Desarrollo Tecnológico Participativo para una Agricultura Sustentable. Chapingo, México. pp. 21-64.

Salgado, G. S., Bucio, A. L., Riestra, D. D., Lagunes-Espinoza, L. C. 2001. Caña de Azúcar: hacia un manejo sustentable. Campus Tabasco, Colegio de Postgraduados- Instituto para el Desarrollo de Sistemas de Producción del Trópico Húmedo Tabasco. Villahermosa, Tabasco.

Salgado-García, S., Palma-López, D. J., Zavala-Cruz, J., Lagunes-Espinoza, L. C., Castelán-Estrada, M., Ortiz-García, C. F., Juárez-López, J. F., Ruiz-Rosado, O., Armida-Alcudia, L. Rincón-Ramírez, J. A. 2009. Sistema Integrado para recomendar dosis de fertilizantes en caña de azúcar (SIDRF): Ingenio Presidente Benito Juárez. Colegio de Postgraduados, Campus Tabasco. H. Cárdenas Tabasco, México.

Sistema de Información Agrícola y Pecuaria (SIAP) 2009.. Caña de azúcar. SAGARPA. http://www.siap.gob.mx (Consulted: 19/10/2010).

Statistica.1995. User Guides Stat-Soft Inc. Tulsa, USA. http://www.statsoft.com Ver. 5.0

UNC. Unión Nacional de Cañeros. 2008. Unión nacional de cañeros A. C.-CNPR.: http://www.cañeros.org.mx (Consulted: 19/10/2010).

UNC. Unión Nacional de Cañeros. 2009. Unión nacional de cañeros A. C.-CNPR.: http://www.cañeros.org.mx (Consulted: 19/10/2010).

UNC. Unión Nacional de Cañeros. 2010. Unión nacional de cañeros A. C.-CNPR: http://www.cañeros.org.mx (Consulted: 19/10/2010).

Submitted February 15, 2011 – Accepted May 06, 2011 – Revised received July 01, 2011