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Usage of agricultural inputs in sugarcane producers of the ejido Jaeros, State of Veracruz, Mexico

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ABSTRACT

Objective: in this research, we assessed the level of organic inputs usage in contrast to chemical inputs in sugarcane producers at the ejido Jareros, Veracruz, in the municipality of Ursulo Galvan.

Design/methodology/approach: Through surveys, a descriptive statistical analysis was conducted on the main socioeconomic aspects of the sugarcane producers in the ejido and an analysis of the means significance of the level of usage of agricultural inputs (chemical/organic) divided into five variables: pesticides, fungicides, acaricides, fertilizers and weed control.

Results: The significance value of the five variables analyzed was: pesticides ($p=0.1774$); fungicides ($P=0.2090$); acaricides (0.3625); fertilizers ($P=0.0005$) and weed control ($P=1.0000$).

Findings/conclusions: Based on the significance values and mean difference of the five assessed variables, it is concluded that the excessive use of nitrogenous fertilizers is the factor with the greatest potential to negatively impact the environmental and edaphic deterioration of arable soils in the Jareros ejido, State of Veracruz, Mexico.

Keywords: sugar cane, chemical inputs, organic inputs, analysis.

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INTRODUCTION

Worldwide, the production of sugarcane (*Saccharum* spp.) is of great importance. It is cultivated in more than 130 countries on a 25.4 million hectares area, with an average yield of 80 t/ha (FAOSTAT, 2013). It is the ninth in importance regarding the value of production (56 billion dollars), but the first crop by the quantity of produced raw material (1800 million tons per year) (FAOSTAT, 2013).

Image by HATEGEKIMANA Danny at Pixabay

Water and soil pollution, soil erosion, and climate change are phenomena related to the agricultural practices that exist in Mexican agroecosystems, including those applied in sugarcane production. Although in Mexico, the sugar industry is one of the most important, there is evidence of the negative impact that sugarcane production causes on the geophysical environment of the soils due to the excessive use of agrochemicals of synthetic origin (Saavedra and Vargas, 2000). Likewise, Rodríguez and collaborators (2007) noted that the soil impoverishment and the annual decrease in the sugarcane agricultural yield relate to nutrient extraction and export, and the continuous loss of organic matter (Rodríguez *et al.*, 2007).

According to Bravo (2015), contamination due to agrochemicals, pesticides, and synthetic inputs in sugarcane areas not only disturbs the environment but also affects human health, causing poisoning by absorption of chemical agents during cultivation, such as insecticides and other agrochemicals application.

Research with long-term experiments in the experimental network of the National Sugarcane Research Institute (INICA) demonstrated that the monoculture of sugarcane contributes to the gradual degradation of soils, with a marked decrease of organic matter content due to inadequate management methods, progressively accentuating when the layer of crop residues is eliminated by burning or other cultural practices, including excessive agrochemicals usage (Pablos *et al.*, 2007).

Cabrera and Zuaznábar (2010) state that sugarcane favors the loss of organic carbon in soils due to the excessive use of nitrogenous fertilizers, the extraction generated by obtaining the stem of the plant, and the burning of harvest residues carried out when the economically important product is cut for harvest.

Jareros is a marginalized rural community from the Úrsulo Galván municipality, it has an ejido of sugarcane producers made up of cooperative members registered in the La Gloria and El Modelo sugar mills, which monopolize the ejido's production. However, due to its location, there is no diagnosis of the phenomenon.

Based on the above and considering the subject's relevance, the objective of this research is to generate a quantitative analysis to compare the degree of organic inputs usage in contrast to chemical inputs, in sugarcane producers from the ejido Jareros, State of Veracruz.

MATERIALS AND METHODS

Study area

The ejido Jareros locates in the Úrsulo Galván municipality, in the State of Veracruz, Mexico. It is geographically located between the coordinates, −96.474722 Longitude and 19.443333 Latitude, and has 516 inhabitants. It has an average maximum temperature of 27 °C and a minimum of 22 °C and an annual 250 millimeters average rainfall. Its main crops are malanga, corn, and sugar cane (INEGI, 2021).

Selection of the study sample

Considering that there is a census of sugarcane ejidatarios that make up the Jareros ejido, the following statistical equation was implemented to determine the sample size (n=17) of a fixed population character (Table 1).

Table 1. Equation to determine the sample size in fixed populations.

$$n = N * Z^{2\alpha} * p * q \,/\, e^2 * (N-1) + Z^{2\alpha} * p * q$$
$$n = 20 * (1.96)^{2\alpha} * (0.5) * (0.5) \,/\, (9.44)^{2\alpha} * (20-1) + (1.96)^{2\alpha} * (0.5) * (0.5)$$
$$n = \mathbf{17}$$

n: sample size, *N*: size of the population or universe, *Z*: statistical parameter depending on the level of confidence, *e*: maximum accepted estimation error, *p*: probability of the studied event occurring, *q*: $(1-p)$ probability that the studied event will not occur (Martínez, 2012; Pérez, 2005; Scheaffer *et al.*, 2007).

Survey implementation

Once the value of "n" was generated, the survey was built considering 17 variables to identify socioeconomic aspects (Table 2) and management of agricultural inputs (Table 3), where the Likert scale (Guil, 2006) was used to generate an analysis. Comparison between the agronomic management of a chemical and organic nature that is given to the cultivation of sugar cane. 17 questionnaires were applied during XXXX.

Results analysis

To accept or reject the null hypothesis (Ho) of the study variables, the information obtained was statistically analyzed using the R studio® Software (R core team, 2011),

Table 2. Socioeconomic variables analyzed among the sugarcane producers from the Jareros ejido, State of Veracruz, México.

Variable	Variable type	Indicator and measurement scale
Gender	Nominal Qualitative	Male Female
Age	Discrete quantitative	Numeric
Education level	Discrete quantitative	Years of study
Number of household members	Discrete quantitative	Number of Members
Sugarcane planted Area	Discrete quantitative	Number of hectares

Table 3. Analysis variables on the use of agricultural inputs in sugarcane producers from the Ejido Jareros, State of Veracruz, México.

Variable	Variable type	Indicator and measurement scale
Implementation of insecticides (Organic - Chemical)	Quantitative discrete	Organic: 1 - 5* Chemical: 1 - 5*
Implementation of fungicides (Organic - Chemical)	Quantitative discrete	Organic: 1 - 5* Chemical: 1 - 5*
Implementation of acaricides (Organic - Chemical)	Quantitative discrete	Organic: 1 - 5* Chemical: 1 - 5*
Implementation of fertilizers (Organic - Chemical)	Quantitative discrete	Organic: 1 - 5* Chemical: 1 - 5*
Weed control (Organic or cultural – Chemical)	Quantitative discrete	Organic: 1 - 5* Chemical: 1 - 5*

*: Likert scale 1=not used, 2=used little, 3=used them in the same proportion as organic/chemical inputs, 4 = frequently used, 5 = always used.

applying descriptive statistics to the socioeconomic variables and the Lilliefors test (Wilks, 2011) to the variables obtained by Likert scale, to determine the type of data distribution and choose an appropriate method for comparison of means.

RESULTS AND DISCUSSION

One hundred percent of the ejidatarios of Jareros are male, with an average age of 37 years and 13 years of studies (Figure 1), 4 members families and a 4 (ha^{-1}) sugar cane plantation (Figure 2).

After analyzing the results of the Likert scales of the two factors (Chemical/organic) from the five study variables (Pests; fungi; mites; fertilization; cleaning of weeds), for the analysis of variance, a non-parametric Mann-Whitney U test was implemented (Turcios, 2015), given the abnormal distribution of the data, obtaining values of $P<0.05$.

Figure 3 shows the graphic behavior of the means analyzed under the Mann-Whitney U statistical method (Turcios, 2015), as well as the significance values obtained for the study variables of the two contrasted factors.

According to Figure 3, the variable with the greatest significant difference was that of the use of fertilizers ($P=0.0005$). Based on the above, and considering the agronomic management shown in Table 4, described by the producers; using the SWAT model

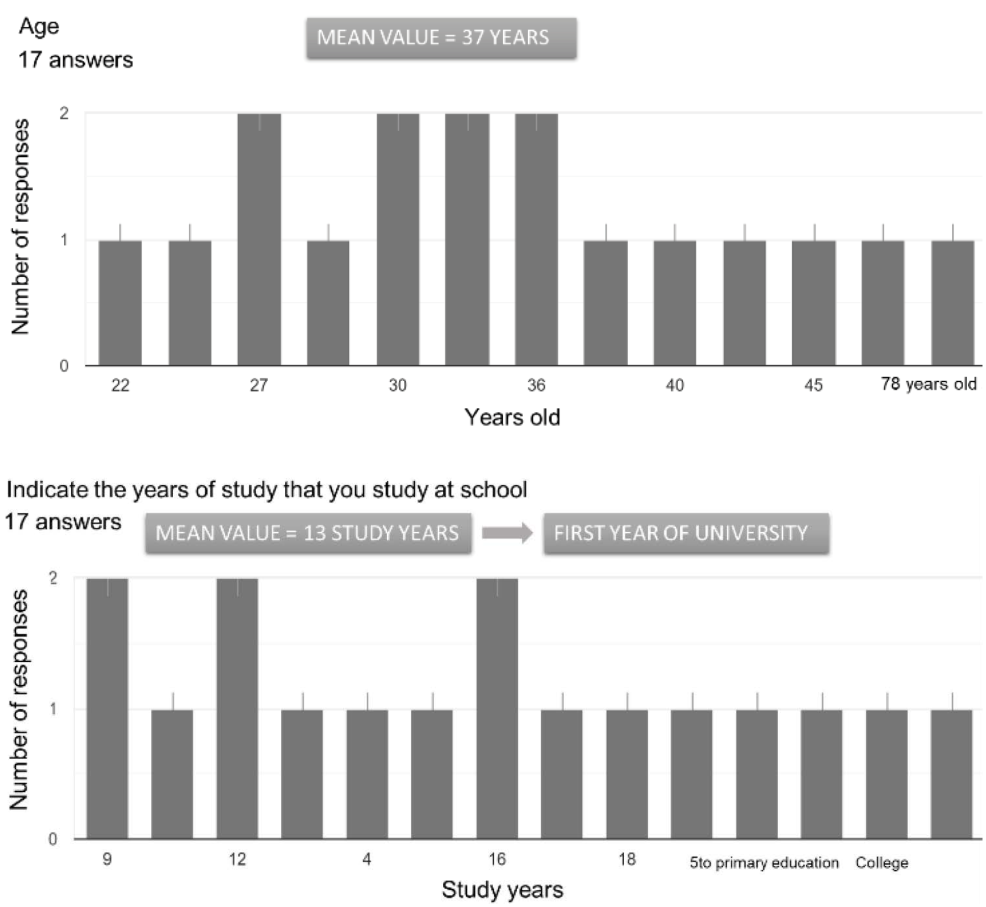

Figure 1. Age and years of studies of sugarcane producers from the ejido Jareros, State of Veracruz, México.

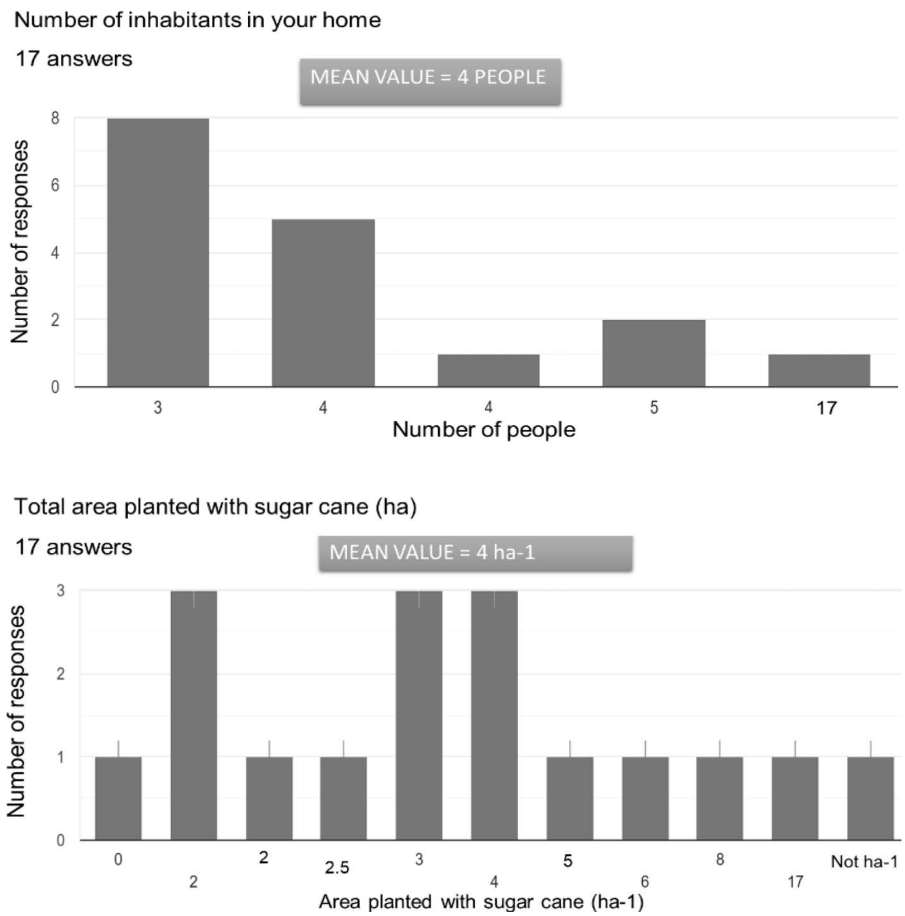

Figure 2. Number of family members and area planted with sugarcane by producers from the ejido Jareros, State of Veracruz, México.

(Arnold *et al.*, 1998; Neitsch *et al.*, 2005; Narasimhan *et al.*, 2005; Garg *et al.*, 2011; Du *et al.*, 2006; Akhavan *et al.*, 2010; Guzmán *et al.*, 2004) and implementing the methodology by Inurreta *et al.* (2013), the potential crop yield in the Úrsulo Galván municipality was simulated, including the area of study under two fertilization scenarios (100% and 70% nitrogen application) during the 2011 - 2020 period and later, through the Dobermann equation (2005), shown in Table 5, the efficiency of the nitrogen fertilization use (PFPN) was also analyzed. The obtained results are shown in Table 6.

Table 4. Sugarcane management introduced to the model under rainfed conditions.

Activity	Year	Operation	Input or activity	Date
Crop establishment	1	Planting	Sugarcane	July 1st
Fertilization	1	1st Fertilization	36-92-00 NPK (kg ha^{-1})	July 30th
	1	2nd Fertilization	218-00-108NPK (kg ha^{-1})	September 30th
Harvest	2	Harvest	Harvest and kill operation	October 30th

NPK: nitrogen, phosphorus, potassium. Source: consensus with ejidatarios from Jareros, State of Veracruz, México.

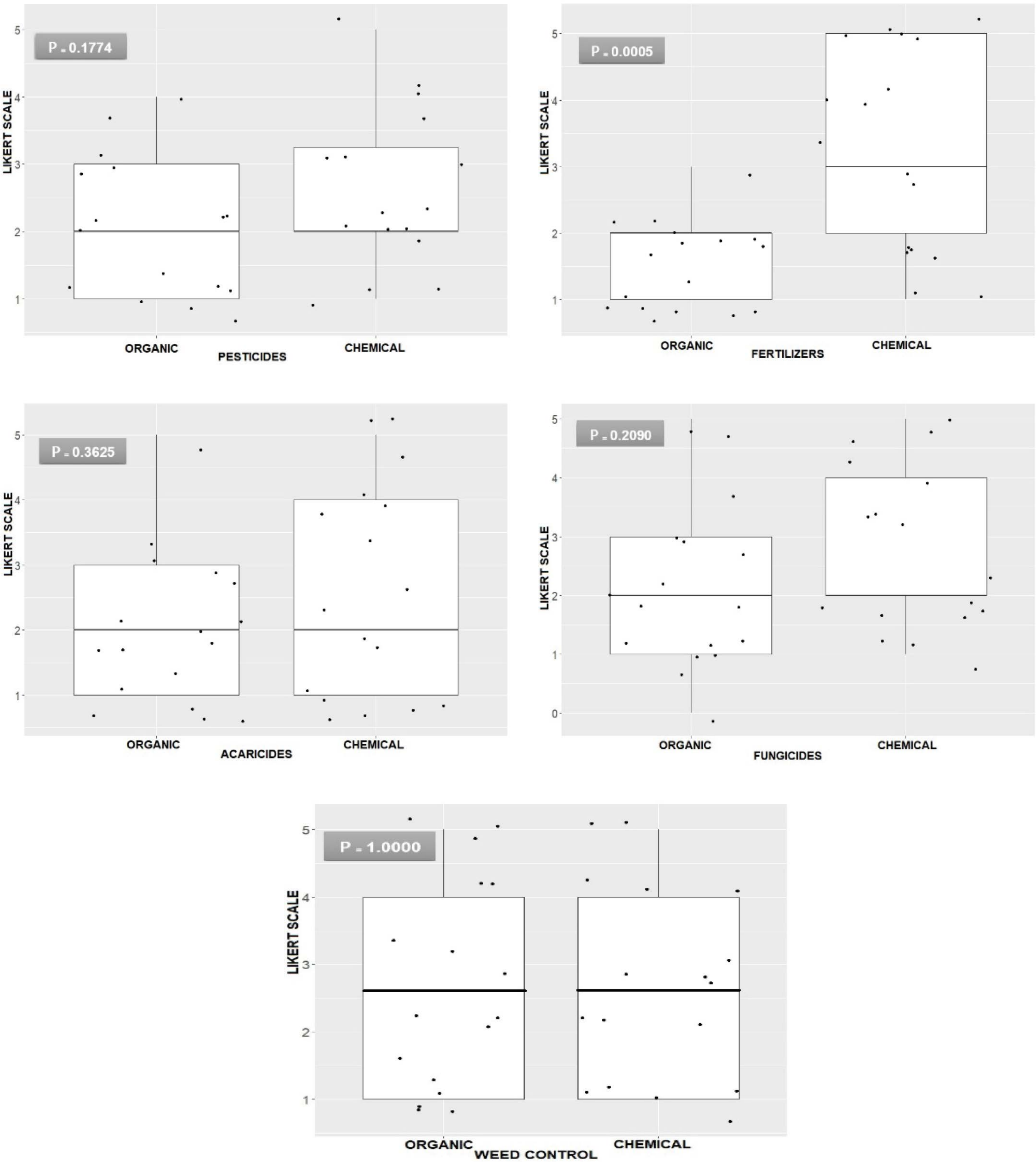

Figure 3. Means analysis of variance from the research developed in the ejido Jareros, State of Veracruz, México.

Table 5. Equation for calculating the nitrogen efficiency.

$$PFP_N = Y_N / F_N$$

PFP_N = Efficiency in the use of nitrogen; Y_N = Yield of the crop under the application of N (t ha^{-1}); F_N = Amount of N applied (Kg/ha^{-1}) (Doberman, 2005).

Table 6. Nitrogen efficiency in sugarcane under 100% and 70% dose of nitrogen application at ejido Jareros, State of Veracruz, México.

F_N Factor	Mean Y_N	Maximum Y_N	PFP_N Value
Optimum fertilization at 100% (254 kg N/ha^{-1})	42.5 t ha^{-1} of sugar cane	70.2 t ha^{-1} of sugar cane	PFP_N (Mean)=0.17 PFP_N (Maximum)=0.27
Fertilization at 70% (178 kg N/ha^{-1})	40.1 t ha^{-1} of sugar cane	68.1 t ha^{-1} of sugar cane	PFP_N (Mean)=0.22 PFP_N (Maximun)=0.38

PFP_N = Efficiency in the use of nitrogen; Y_N = Yield of the crop under the application of N (t ha^{-1}); F_N = Amount of N applied (kg ha^{-1}) (Doberman, 2005).

Table 6 shows that even by decreasing the nitrogen fertilization dose to 70% it is possible to obtain mean and maximum crop yield values like those from the 100% fertilization scenario, the application dose of 178 kg N/ being even more efficient. has^{-1}.

CONCLUSIONS

All the interviewed ejidatarios were men, with 13 years of studies and 4 hectares per producer area, and 37 years age average. Regarding the level of chemical and organic inputs usage, a balanced trend of both inputs was shown in terms of their application for pests, fungi, and termites' control and traditional cleaning management. However, regarding crop fertilization, it should be noted that the use of chemical fertilizers is much higher than that of organic fertilizers. Therefore, it is recommended to carry out training campaigns in the ejido Jareros to raise awareness among producers about the use of other complementary technologies to chemical fertilization, to reduce the environmental and agricultural degradation of the sugarcane agroecosystems in the ejido.

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