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Comparative Analysis of Sugarcane Varieties in the Milagro Canton, Ecuador

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***Abstract*— Sugarcane is of great economic importance for the country; large and small sugarcane growers depend on this crop. In the present research, a comparative study was conducted between sugarcane varieties for a period of five (2017-2021) and ten years (2012-2021). Data from the Valdez mill and CINCAE were processed with descriptive statistical tools. The results indicated that the most cultivated varieties from 2017 to 2021 were ECU-01 and CC85-92; for the period from 2012 to 2021, the varieties CC85-9 and ECU-01. The EC-02 variety stood out in tons of cane harvested per hectare from 2012 to 2021 and the EC-02, ECU-01, and EC-06 varieties from 2017-2021. Varieties EC-06, EC-02, and EC-05 stood out in yield of 50kg bags of sugar per hectare from 2017 to 2021, and in 2012 to 2021 the varieties EC-02 and ECU-01, respectively. Varieties EC-06, EC-04, and EC-05 (2017-2021) and RAGNAR (2012-2021) achieved lower cutting age. Varieties EC-06 and EC-05 (2017-2021) and EC-02 and RAGNAR (2012-2021) presented the highest poll percentage (%). Finally, varieties EC-06 and EC-05 (2017-2021) and RAGNAR and CC85-9 (2012-2012) had better yields in kilograms of sugar per ton of cane (KATC). It is concluded that there is a moderate positive correlation between the variable tons of cane/ha and bags of sugar/ha and a very high positive correlation between KATC and sucrose content in juice (pol grades).**

***Keywords*—Sugarcane varieties; ECU-01; EC-02; EC-04; EC-05; EC-06; CC85-92; RAGNAR.**

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I. INTRODUCTION

The cultivation of sugar cane is one of the most important crops in Ecuador. It is not only because of its high production per year but also because it generates 74,000 jobs per year, 27,000 of them during the harvest season, in addition to the economic movement produced by the mills of sugar bowls. In the province of Guayas, sugarcane is one of the most important crops, concentrating 77.6% of the planted area in Ecuador, including the country's main sugar mills [1].

Bioethanol is obtained from sugar cane as a feasible energy return, panela production, and application in bioremediation. [2]–[4]. The cultivation area in Ecuador is 83,377 ha, producing 500,000 tons/ha per year [5], although it is stated that this crop accumulates a greater amount of heavy metals [6]. Sugarcane yield increases in Brazil have been attributed to the planting of new varieties [7], and these yields are determined by APSIM models that help to estimate the yield of varieties in tropical environments [8]–[10]. In this respect, the Sugar Cane Research Center of Ecuador [11] affirms that between 2011 and 2019, Ecuador strengthened the development of productive improvement in the sugarcane sector, making adaptations of varieties obtained by the Canavieira Technology Center in Sao Paulo.

Among the adapted varieties, we can mention the following: ECU-01, EC-02, EC-03, EC-04, EC-05, EC-06, EC-07, EC-08, and other varieties such as Ragnar of Australian origin, the variety CC-8592, and CC01-1228. It should be noted that the varieties have a productive influence within the study area. In addition, in 2020, CINCAE obtained new varieties, such as EC-09, with productivity characteristics. Therefore, this study aims to carry out a comparative study of various production and quality parameters among the main sugarcane varieties in the Milagro canton between 2017 to 2021 and 2012 to 2021.

II. Materials and Methods

A. Geographic Locación

The research was carried out in the Milagro canton, located in the southern center of the coastal region of Ecuador, on an extensive plain crossed by the Milagro River, at an average altitude of 11 meters above sea level and with a humid tropical climate. During the year, the temperature generally varies from 22 °C to 31 °C, rarely falling below 20 °C or rising above 33 °C, and the average annual precipitation is 1,361 mm [12]. Currently, Sugar cane occupies about 50% of the cultivated area of the Milagro canton.

B. Methodology

For the historical analysis of varieties of the last five and ten years, the data from the Valdez mill and CINCAE was processed using the following statistical tools [13].

1) Descriptive statistics: Summary measures shown through tables and graphs by year and variable [14], [15].

Measures of central tendency

Half

Let x1, x2, x3…xn be a random sample, the arithmetic mean is defined as the sum of the elements divided by the sample size.

$$\bar{x} = \sum_{i=1}^{n} \frac{x_i}{n} \quad (1)$$

2) Median: Let x1, x2, x3…xn be a random sample, the median is defined from the ordered data of the sample.

$$Me = \begin{cases} X_{\frac{n+1}{2}} & ;if\ n\ is\ odd \\ X_{\frac{n}{2}} & ;\ if\ n\ is\ even \end{cases} \quad (2)$$

3) Mode: The observation is most repeated/frequency [16].

Measures of dispersion

4) Variance: Let x1, x2, x3…xn be a random sample, the distance from the mean is defined as the variance, and this is the square divided by the sample size minus one [16].

$$S^2 = \sum_{i=1}^{n} \frac{(x_i - \bar{x})^2}{n-1} \quad (3)$$

5) Standard deviation: Let x1, x2, x3…xn be a random sample, the standard deviation is defined as the root of the variance of the sample.

$$\sqrt{S^2} = S \quad (4)$$

6) Coefficient of variation: Let x1x2x3…xn be a random sample, the coefficient of variation is defined as the quotient between the standard deviation and the arithmetic mean [17], [18].

$$\%CV = \frac{S}{\bar{x}} * 100\% \quad (5)$$

7) Multiple Linear Regression: Multiple linear regression models are much more powerful when it comes to relating a multiplicity of variables; in most science and engineering problems, these models become necessary [19], [20]. The general model of linear regression is:

$$y_i = \beta_0 + \beta_1 x_{i1} + \beta_2 x_{i2} + \cdots + \beta_k x_{ik} + \varepsilon_i \quad (6)$$

The model of the present research was:

$$y_i = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \beta_4 x_4 \quad (7)$$

Where:

x1=precipitation
x2=Temperature
x3=Relative Humidity
x4=Heliophany

Pearson simple linear correlation

Its objective is to measure the strength or degree of association between two quantitative random variables that have a joint bivariate normal distribution [18], [21]. The coefficient is defined by the following formula [22].

$$\rho=(cov(x,y))/(\sigma x\ \sigma y) \qquad -1\leq\rho\leq 1 \quad (8)$$

III. Results and Discussion

Five-year comparative analysis of sugarcane varieties (2017-2021)

The varieties with the largest harvested area in the Milagro Canton were ECU-01 and CC85-92, with 7497.9 and 6126.96 m2 as average harvested area, respectively, as observed in Table 1. CINCAE [23] pointed out that the most planted varieties in the San Carlos, Valdez and COAZÚCAR mills in 2018 were CC85-92, ECU-01, and EC-02.

TABLE I
HARVESTED AREA OF CANE VARIETIES (2017-2021)

Variable	Unit	Variety	Statistics	Value
Harvested area	Hectares	CC85-92	Media	6126.96
			Variance	7448180.27
			Deviation	2729.13
		EC-02	Media	1869.34
			Variance	261742.97
			Deviation	511.61
		EC-04	Media	627.12
			Variance	86115.44
			Deviation	293.45
		EC-05	Media	301.86
			Variance	5564.96
			Deviation	74.60
		EC-06	Media	264.28
			Variance	27197.15
			Deviation	164.91
		ECU-01	Media	7497.90
			Variance	1572292.52
			Deviation	1253.91
		RAGNAR	Media	3278.80
			Variance	1106687.26
			Deviation	1051.99

According to Indonesian studies, TCH production is dependent on furrow width and a decrease in plant population [24]. The varieties with the best values for the variable tons of harvested cane were EC-02, ECU-01 and EC-06 with 88.14; 82.83 and 80.3 as an average of t/ha, respectively, as shown in Table 2. National sugarcane yields rose between 2015 and 2019 due to the adoption of improved varieties, presenting averages that oscillated between 83 to 89 t/ha. However, for

the years 2020 and 2021, yields decreased, with averages of 79.9 t/ha and 87.2 t/ha [25].

It is known that cane age, height, length, weight, and stem diameter positively influence cane yield. [26], [27]. For his part, CINCAE [28] reported experimental values of tons of cane harvested per hectare (TCH) of 79.7 for the CC85-92 variety, 83.2 t/ha for ECU-01, 76.1 t/ha for EC-02 and 69.4 t/ha for RAGNAR. On the other hand, CINCAE [29] reported values of cane harvested per hectare (TCH) between 73.4 and 92.3 for the EC-03 variety and between 85 and 112.8 for EC-04 in the period 2006-2009. Based on the above, it is defined that sugarcane yield variances are dependent on the environment and genetic material and are also based on yield projections[10], [24].

TABLE II
HARVESTED TONS OF VARIOUS VARIETIES (2017-2021)

Variable	Unit	Variety	Statistics	Value
Tons of cane harvested per hectare	Tons/ha	CC85-92	Media	79.43
			Variance	11.40
			Deviation	3.38
		EC-02	Media	88.14
			Variance	5.39
			Deviation	2.32
		EC-04	Media	78.76
			Variance	105.15
			Deviation	10.25
		EC-05	Media	79.42
			Variance	28.01
			Deviation	5.29
		EC-06	Media	80.30
			Variance	131.63
			Deviation	11.47
		ECU-01	Media	82.83
			Variance	21.69
			Deviation	4.66
		RAGNAR	Media	74.45
			Variance	14.92
			Deviation	3.86

The varieties with the highest number of sugar bags were EC-06, EC-02 and EC-05 with 152.7; 148.65 and 142.78 as average bags, respectively, as shown in Table 3. CINCAE (2020), points out that between 2011 and 2019, Ecuador has strengthened the development of productive improvement in the sugarcane sector, developing varieties obtained based on genetic material from the Canavieira Technology Center in Sao Paulo, Brazil.

TABLE III
SACKS OF SUGAR OBTAINED WITH DIFFERENT VARIETIES (2017-2021)

Variable	Unit	Variety	Statistics	Value
Sacks of sugar per hectare	Number of units	CC85-92	Media	131.86
			Variance	362.38
			Deviation	19.04
		EC-02	Media	148.65
			Variance	169.34
			Deviation	13.01
		EC-04	Media	136.90
			Variance	226.32
			Deviation	15.04
		EC-05	Media	142.78
			Variance	47.37
			Deviation	6.88
		EC-06	Media	152.70
			Variance	241.50
			Deviation	15.54
		ECU-01	Media	138.97
			Variance	421.67
			Deviation	20.53
		RAGNAR	Media	128.73
			Variance	196.59
			Deviation	14.02

The new varieties boost sugarcane yields over conventional varieties [30], [31], present resistance and adaptability conditions, as well as product improvements based on yields of bags of sugar per hectare. These varieties are also obtained by molecular and genomic selection. [32]–[34]. On the other hand, CINCAE [28] reported yields of 199 bags of sugar for the CC85-92 variety, 204 bags of sugar for ECU-01 and 184 bags for EC-02 and for RAGNAR correspondingly, which indicates a ceiling under experimental conditions. Important yield for field production of improved varieties.

The varieties with the lowest values for the cut-off age variable were EC-06 with 12.0 months, EC-04 with 12.34 months and EC-05 with 12.36 months, as shown in Table 4. CINCAE [23] indicates that the average cutting age in the main sugar mills in Ecuador was 12 months.

TABLE IV
CUTTING AGE OF VARIOUS VARIETIES (2017-2021)

Variable	Unit	Variety	Statistics	Value
Cutting age	Months	CC85-92	Media	12.83
			Variance	0.28
			Deviation	0.53
		EC-02	Media	12.43
			Variance	0.19
			Deviation	0.43
		EC-04	Media	12.34
			Variance	0.48
			Deviation	0.69
		EC-05	Media	12.36
			Variance	0.47
			Deviation	0.69
		EC-06	Media	12.00
			Variance	0.87
			Deviation	0.93
		ECU-01	Media	12.60
			Variance	0.26
			Deviation	0.51
		RAGNAR	Media	13.12
			Variance	1.52
			Deviation	1.23

The varieties with the best values for the variable sucrose content in the juice were EC-06 and EC-05 with 11.92% and 11.3%, respectively, as observed in Table 5. CINCAE [23]

pointed out that the sucrose content in the juice (pol %) in the main sugar mills of Ecuador in 2018 ranged from 9 to 10.1 pol %, which reflects an increase in this variable in the improved varieties, during the period 2017-2021.

TABLE V
SUCROSE CONTENT IN THE JUICE IN VARIOUS VARIETIES (2017-2021)

Variable	Unit	Variety	Statistics	Value
Sucrose content in the juice (degrees pol%)	Percentage	CC85-92	Media	10.58
			Variance	0.39
			Deviation	0.63
		EC-02	Media	10.66
			Variance	0.50
			Deviation	0.71
		EC-04	Media	10.90
			Variance	1.26
			Deviation	1.12
		EC-05	Media	11.30
			Variance	0.70
			Deviation	0.84
		EC-06	Media	11.92
			Variance	1.29
			Deviation	1.13
		ECU-01	Media	10.54
			Variance	0.26
			Deviation	0.51
		RAGNAR	Media	10.96
			Variance	0.51
			Deviation	0.71

The varieties with the best values for the variable kilograms of sugar per ton of cane (KATC) were EC-06 and EC-05 with 95.74 and 90.44 kg, respectively, as observed in Table 6. Under experimental conditions, CINCAE [28] reported yields of 124.6 KATC for the CC85-92 variety, 122.9 KATC for ECU-01, 120.8 KATC for EC-02 and 132.7 KATC for the RAGNAR variety, indicating that sugarcane growers have an important yield potential to be achieved through proper agronomic management. On the other hand, CINCAE [29] reported values between 102.3 and 110.3 of KATC for the EC-03 variety and between 92.6 and 103.3 of KATC for the EC-04 variety in the period 2006-2009.

TABLE VI
KILOS OF SUGAR PER TON OF CANE IN VARIOUS VARIETIES (2017-2021)

Variable	Unit	Variety	Statistics	Value
KATC (kilos of sugar/ton of cane)	kg	CC85-92	Media	80.50
			Variance	7.49
			Deviation	2.74
		EC-02	Media	85.08
			Variance	32.33
			Deviation	5.69
		EC-04	Media	86.60
			Variance	97.90
			Deviation	9.89
		EC-05	Media	90.44
			Variance	45.94
			Deviation	6.78
		EC-06	Media	95.74
			Variance	92.34
			Deviation	9.61
		ECU-01	Media	84.50
			Variance	16.92
			Deviation	4.11
		RAGNAR	Media	87.72
			Variance	32.70
			Deviation	5.72

8) Analysis of principal components of variables by varieties in five years (2017-2021)

As a result of the principal component analysis, the variables harvested area, cutting age, and tons of harvested cane have a certain relationship. The variables bags of sugar and tons of harvested cane are not closely related, nor do they have a strong correlation. The strongly correlated variables are kilos of sugar per ton of cane and sucrose content in the juice, as shown in Figure 1.

9) Correlation Matrix (2017-2021): The correlation matrix of variables can be seen in Table 7, finding a moderate positive correlation between tons/ha and bags of sugar/ha and a very high positive correlation between KATC and pol grades.

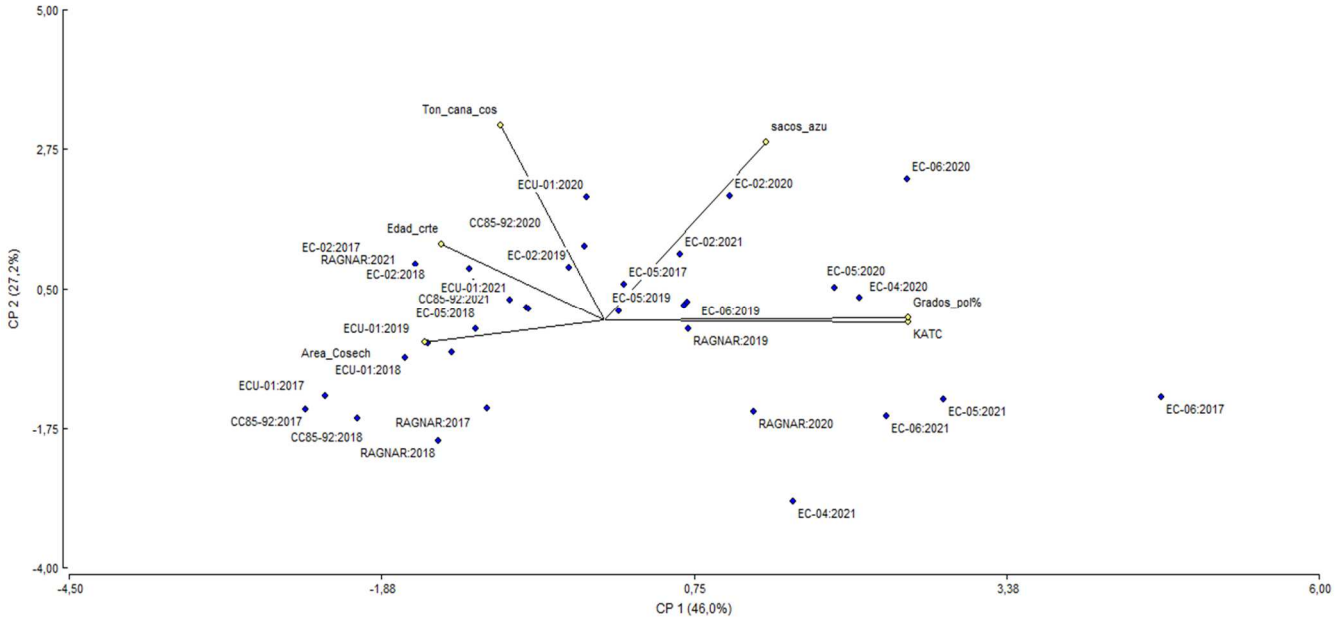

Fig. 1 Analysis of principal components during the period 2017-2021

TABLE VII
MATRIX OF CORRELATIONS OF VARIABLES OF THE LAST 5 YEARS

		Harvested area	**Tons**	**Kilos of Sugar per Ton Cane**	**Bags of sugar**	**POL%**	**Cutting age**	**Precipitation**	**Relative humidity**	**Temperature**	**Heliophany**
Harvested area	Pearson correlation	1	0.040	-0.400*	-0.235	-0.369*	0.252	-0.029	-0.048	-0.003	0.037
	Next (bilateral)		0.818	0.017	0.175	0.029	0.144	0.870	0.785	0.987	0.833
	N	35	35	35	35	35	35	35	35	35	35
Tons	Pearson correlation	.040	1	-0.356*	0.564**	-0.361*	0.303	-0.269	-0.309	-0.314	0.015
	Next (bilateral)	.818		0.036	0.000	0.033	0.077	0.119	0.071	0.066	0.931
	N	35	35	35	35	35	35	35	35	35	35
Kilos of Sugar per Ton Cane	Correlación de Pearson	-.400*	-0.356*	1	0.466**	0.965**	-0.346*	0.314	0.139	0.287	0.363*
	Sig. (bilateral)	0.017	0.036		0.005	0.000	0.042	0.066	0.426	0.094	0.032
	N	35	35	35	35	35	35	35	35	35	35
Sacks of sugar	Pearson correlation	-0.235	0.564**	0.466**	1	0.507**	-0.031	0.137	-0.156	0.077	0.472**
	Next (bilateral)	0.175	0.000	0.005		0.002	0.860	0.433	0.370	0.659	0.004
	N	35	35	35	35	35	35	35	35	35	35
POL%	Pearson correlation	-0.369*	-0.361*	0.965**	0.507**	1	-0.334*	0.330	0.121	0.290	0.422*
	Next (bilateral)	0.029	0.033	0.000	0.002		0.050	0.053	0.487	0.091	0.011
	N	35	35	35	35	35	35	35	35	35	35
Cut-off age	Pearson correlation	0.252	0.303	-0.346*	-0.031	-0.334*	1	0.003	-0.022	0.065	0.146
	Next (bilateral)	0.144	0.077	0.042	0.860	0.050		0.985	0.901	0.710	0.403
	N	35	35	35	35	35	35	35	35	35	35
Precipitation	Pearson correlation	-0.029	-0.269	0.314	0.137	0.330	0.003	1	0.865**	0.936**	0.063
	Next (bilateral)	0.870	0.119	0.066	0.433	0.053	0.985		0.000	0.000	0.719
	N	35	35	35	35	35	35	35	35	35	35
Relative humidity	Pearson correlation	-0.048	-0.309	0.139	-0.156	0.121	-0.022	0.865**	1	0.763**	-0.409*
	Next (bilateral)	0.785	0.071	0.426	0.370	0.487	0.901	0.000		0.000	0.015
	N	35	35	35	35	35	35	35	35	35	35
Temperature	Pearson correlation	-0.003	-0.314	0.287	0.077	0.290	0.065	0.936**	0.763**	1	0.230
	Next (bilateral)	0.987	0.066	0.094	0.659	0.091	0.710	0.000	0.000		0.183
	N	35	35	35	35	35	35	35	35	35	35
Heliophany	Pearson correlation	0.037	0.015	0.363*	0.472**	0.422*	0.146	0.063	-0.409*	0.230	1
	Next (bilateral)	0.833	0.931	0.032	0.004	0.011	0.403	0.719	0.015	0.183	
	N	35	35	35	35	35	35	35	35	35	35

*. The correlation is significant at the 0.05 level (bilateral). **. The correlation is significant at the 0.01 level (bilateral).

TABLE VIII
NOTE: INTERPRETATION OF PEARSON'S CORRELATION COEFFICIENT

Value Rho	Meaning
-1	large and perfect negative correlation
-0.9 a -0.99	very high negative correlation
-0.7 a -0.89	high negative correlation
-0.4 a -0.69	moderate negative correlation
-0.2 a-0.39	low negative correlation
-0.01 a -0.19	very low negative correlation
0	null correlation
0.01 a 0.19	very low positive correlation
0.2 a 0.39	low positive correlation
0.4 a 0.69	moderate positive correlation
0.7 a 0.89	high positive correlation
0.9 a 0.99	very high positive correlation
1	large and perfect positive correlation

10) Comparative analysis of sugarcane varieties in the period 2012-2021: The varieties with the largest area harvested in the Milagro Canton were CC85-9 and ECU-01 with 8191.48 ha and 7455.44 ha, respectively, as shown in Table 8. According to statistics from the MAG [25], in Ecuador an average of between 86,031 and 139,406 hectares of sugarcane is cultivated, which are used for both the production of sugar and the production of biofuels one of the products with the highest demand for labor. work at the national level.

TABLE IX
HARVESTED AREA OF VARIOUS VARIETIES (2012-2021)

Variables	Units	Varieties	Statistics	Value	Error Devi.
Harvested area	Hectares		Media	8191.48	1551.90
		CC85-9	Variance	24083856.28	
			Deviation	4907.53	
			Media	1300.14	223.51
		EC-02	Variance	499557.68	
			Deviation	706.79	
			Media	7455.44	569.87
		ECU-01	Variance	3247531.32	
			Deviation	1802.09	
			Media	3714.98	338.73
		RAGNAR	Variance	1147387.69	
			Deviation	1071.16	

Table 9 shows that the most productive variety in tons of cane harvested per hectare was EC-02 with 97.84 t/ha. Castillo and Silva [5] reported experimental values of tons of cane harvested per hectare (TCH) of 79.7 for the CC85-92 variety, 83.2 t/ha for ECU-01, 76.1 t/ha for EC-02 and 69.4 t /ha to RAGNAR.

TABLE X
HARVESTED TONS OF DIFFERENT VARIETIES (2012-2021)

Variable	Unit	Variety	Statistics	Value	Error Devi.
Tons of cane harvested per hectare	Tons/ha		Media	87.40	3.85
		CC85-9	Variance	148.03	
			Deviation	12.17	
			Media	97.84	3.83
		EC-02	Variance	146.40	
			Deviation	12.10	
			Media	88.99	3.18
		ECU-01	Variance	101.32	
			Deviation	10.06	
			Media	78.36	2.67
		RAGNAR	Variance	71.38	
			Deviation	8.45	

In the variable bags of sugar per hectare, the varieties that produced the most bags per hectare were EC-02 and ECU-01 with 166,425 and 154,155, respectively, as shown in Table 10. On this topic, [23] points out that In 2018, the sugar cane growers had a sugar production of 128.6 bags of 50 kg of sugar, and the mills of 129.5 bags of sugar of 50 kg/ha, which implies an improvement in the yield of the new, improved varieties.

TABLE XI
SACKS OF SUGAR WITH DIFFERENT VARIETIES (2012-2021)

Variables	Units	Varieties	Statistics	Value	Error Devi.
Sacks of sugar per hectare	Number of units		Media	148.92	7.80
		CC85-9	Variance	608.64	
			Deviation	24.67	
			Media	166.42	6.81
		EC-02	Variance	464.36	
			Deviation	21.55	
			Media	154.15	7.19
		ECU-01	Variance	517.44	
			Deviation	22.75	
			Media	141.20	6.445
		RAGNAR	Variance	413.83	
			Deviation	20.34	

Regarding the cutting age, the RAGNAR variety had a lower cutting age (12.88 months) and the others slightly exceeded 13 months, as shown in Table 11. On this point, [35] indicates that sugarcane It is harvested between 12 and 14 months, and then continues its growth in a perennial way in several regrowth or ratoon cycles. The varieties with the highest sucrose content in the juice (pol %) were EC-02 with 11.1% and RAGNAR with 11.4%, as can be seen in Table 12. [23] pointed out that the sucrose content in the juice in the main sugar mills of Ecuador in 2018 oscillated between 9 and 10.1% per cane.

TABLE XII
CUTTING AGE OF VARIOUS VARIETIES (2012-2021)

Variables	Units	Varieties	Statistics	Value	Error Devi.
cutting age	months		Media	13.00	0.45
		CC85-9	Variance	1.99	
			Deviation	1.41	
			Media	13.14	0.41
		EC-02	Variance	1.69	
			Deviation	1.30	
			Media	13.34	0.38
		ECU-01	Variance	1.43	
			Deviation	1.19	
			Media	12.88	0.51
		RAGNAR	Variance	2.56	
			Deviation	1.60	

The varieties that reported the highest yield of kilos of sugar per ton of cane (KATC) were RAGNAR with 91.29 kg and CC85-9 with 88.13 kg, as shown in Table 13.

TABLE XIII
SUCROSE IN THE JUICE OF VARIOUS VARIETIES (2012-2021)

Variables	Units	Varieties	Statistics	Value	Error Devi.
Sucrose in juice (degrees pol %)	Percentage		Media	10.89	0.26
		CC85-9	Variance	0.66	
			Deviation	0.81	
			Media	11.10	0.28
		EC-02	Variance	0.81	
			Deviation	0.90	
			Media	10.94	0.25
		ECU-01	Variance	0.62	
			Deviation	0.79	
			Media	11.40	0.28
		RAGNAR	Variance	0.81	
			Deviation	0.90	

TABLE XIV
KILOS OF SUGAR PER TON OF CANE IN VARIOUS VARIETIES (2012-2021)

Variables	Units	Varieties	Statistics	Value	Error Devi.
KATC (kilos of sugar/ton of cane)	kg		Media	88.13	3.39
		CC85-9	Variance	115.08	
			Deviation	10.73	
			Media	87.10	2.11
		EC-02	Variance	44.47	
			Deviation	6.68	
			Media	87.39	1.95
		ECU-01	Variance	38.22	
			Deviation	6.182	
			Media	91.29	2.28
		RAGNAR	Variance	51.86	
			Deviation	7.20	

11) Analysis of Principal Components of variables by varieties in ten years (2012-2021): The principal component analysis of the 10-year period determines that there is a correlation between the variable's tons of harvested cane and bags of sugar, as shown in Figure 2. Unlike the five-year analysis, the relationship between KATC and pol % is not that close, but there is some relationship.

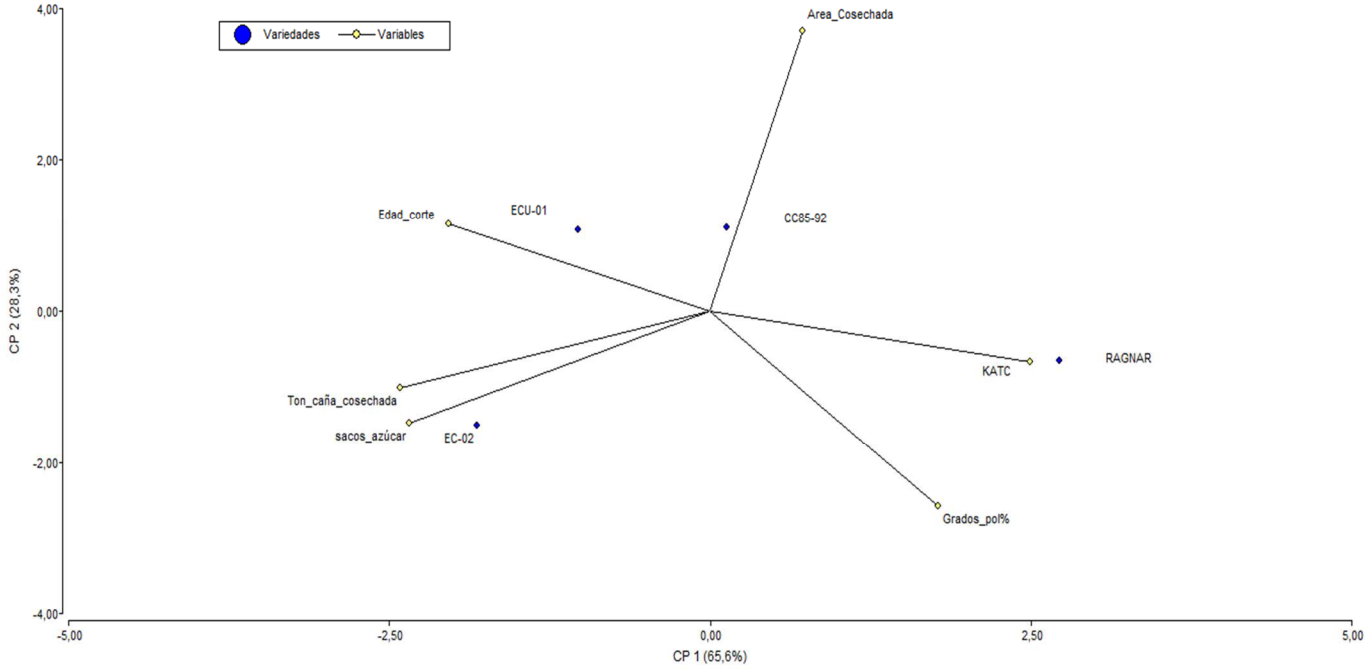

Fig. 2 Analysis of principal components period of 10 years (2012-2021)

IV. CONCLUSION

The sugarcane varieties with the best performance in the Milagro Canton in the 10-year period (2012-2021) were ECU-01 and EC-02. In the 5-year period (2017-2021), new varieties such as EC-05 and EC-06 were incorporated, with outstanding performances in different variables, such as the case of EC-06 and EC-05.

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