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Optimization of the Paddy Rice Husking Process, Increasing the useful Life of the Rollers in Florhuila Plant Campoalegre Mills

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Abstract

The objective of this research is to optimize the peeling process, through the study, measurement and analysis of the results obtained from the behavior of the rollers to increase their useful life, in the company: MOLINOS FLORHUILA SA Campoalegre Plant. First a brief introduction and a little history of rice cultivation in the different countries of the world and then we will go on to talk about the departments in Colombia that grow this product. In this context, the stages of the rice production process will be described in order to clarify our problems. In this study the variables that affect the stages of the rice production process, and then to present the tests that correspond to the results obtained from the behavior of the rollers to increase their useful life to and thus give solution to our problem.

Keyword: Optimization process, peeling process, behavior of the rollers.

INTRODUCTION

Because of globalization, Colombian entrepreneurs and producers are forced to implement in their company's innovative strategies that win new customers and increase their level of satisfaction, as well as adopting new practices that increase their productivity and profitability [1], [2], [3].

At the global level, rice is the second most important crop, concentrated extensively and intensively in the tropical climate. Highlighting its presence in Asian countries such as: China, India, Indonesia, Bangladesh, Vietnam, Thailand, Japan and Burma; in Europe: Italy, Spain, Russia, Greece and Portugal; in America: the United States, Brazil, Colombia, Peru and Argentina; and on the African continent: Egypt, Nigeria, Madagascar and Ivory Coast [4], [5], [6].

In Colombia, the largest agricultural production is concentrated in 4 departments: Meta, Casanare, Tolima and Huila respectively; followed by Cesar, the Atlantic Coast, Cordoba, the Santander, and Valle del Cauca, generating a national production of 450,000 Hectares per year [7], [8], [9].

According to the F.A.O. (Food and Agriculture Organization of the United Nations), rice is the world's largest cereal and is a very valuable source of energy, rich in carbohydrates, calories and protein; it also supplies glucose to the blood in a controlled way which keeps blood sugar levels constant [10], [11], [12].

In a balanced diet, rice should be present several times a week; can be eaten daily and will not cause any harm to health. It contains no cholesterol, fat or sodium, is a complex carbohydrate and easy to digest. It is poor in minerals, especially iron, calcium and zinc; therefore, it is advisable to consume it in combination with vegetables, vegetables, meat or fish [13], [14], [15].

The Colombian rice industry has a strong and balanced competitiveness scheme that includes technical processes with the latest technology and skilled labor, where a vision of continuous improvement predominates. It should be noted that the profits obtained in the rice business are minimal, it is only profitable if handled in considerable quantities. This is because the processes involved are too costly [16], [17], [18].

The production process consists of three main stages: drying, threshing and packaging. The debarking process of the grain (activity performed in the threshing stage) is considered a critical point, since it consists of elements and variables that significantly influence production costs and product quality [19], [20], [21].

Rice as a staple product in Colombian homes has become an important part of the engine driving the national economy [22], [23], [24].

For this and all the, this study seeks to optimize the shelling process by increasing the life of the rollers in MOLINO FLORHUILA S. Campoalegre plant located in the department of Huila [25], [26], [27].

METHODOLOGY

I. Type of study:

The present work is based on a descriptive study of causal type, because it is necessary to know the situations and cases that predominate in the activities of the productive process to identify the relationships that exist between the pressure, velocity and temperature variables. Which present the rollers of the machines; and whose priority is to obtain evidence of the cause and effect relationship of the variables to be analyzed during the peeling stage of the rice production process in MOLINOS FLORHUILA S.A.

Figure 1. Rice husking rollers. Florhuila, Campoalegre

II. Methods:

It is used under the quantitative and descriptive statistical method. The useful life, peripheral velocity and roll time in each shell are calculated to define the regression equation and coefficient of relationship between them, determine the samples to be studied, tabulate the data and analyze the results obtained to maintain the process under the parameters of statistical control [1], [2], [3]. To use these two methods, the following information will be taken into account:

-Collection and review of information: Although the database regarding the rice industry is not extensive, it was found that in a mill in the city of Neiva they implemented a refrigeration system for the rollers [4], [5], [6]. Whose main objective was also to increase their life useful; the documents collated, the people and the procedures performed in the company will be taken as references.

-Visits to the study area: MOLINOS FLORHUILA S.A Campoalegre Plant is the main base for the study, analysis and improvement of the performance of the hullers. The days for the visit, the duration of each visit and the number of times necessary, will be agreed with the head of the plant, if possible, scheduled in advance for Saturdays [7], [8].

-Samples and measurement of the different variables: For this study we will work the qualitative methodology by observing the behavior of the rollers, and also the quantitative with the use of formulas applied to the statistical control.

-Analysis of the results of the measurement of variables and the different samples: The results obtained in the application of the regression equation and coefficient of relation between the peripheral speed and time of use of the rollers. We will be tabulated, plotted and analyzed, and will serve as supports for the improvements to be implemented in the machines after the development of the present study.

III. Sample design:

Although sampling is a basic element within the method-logy of inferential statistics, used as a technique to achieve sample selection within a population; for this research work whose methodology is descriptive statistics will analyze the variables diameter, pressure and peripheral speed of the rollers in each of the six machines [9], [10].

Initially, time takers were installed in each shell to measure the roll time as a starting point for process optimization. After knowing this data, one of the six machines is chosen to measure with a foot of king every four hours the diameter of the rollers. With the above information and knowing that the rollers one and two rotate at a speed of approximately 800 and 1000 RPM respectively, the peripheral speed of each is calculated [11], [12].

At the same time that the diameter is taken, the manometer that each machine brings is taken into account and this value is taken into account to calculate the coefficient of relation between this and the other variables [13], [14].

IV. Stages of the study:

The studies and analysis of the variables witnessed in the behavior of the running rollers will be taken as basis. For this purpose, this research has been generalized in three stages:

-Phase of beginning: Phase of investigation and documentation of similar studies, related to the subject to try to support, to clarify and to give greater validity to the realized study. The study begins with the compilation of general information on rice, the milling industry in Colombia, the production process of MOLINOS FLORHUILA S.A and the study machine.

-Development stage: In this stage the activities and tasks necessary for the study are carried out, such as sampling, tabulation of data, regression graphs and relation coefficient, laboratory analysis, application of equations for statistical control; that allow to identify variables of analysis for the improvement, optimization, effectiveness and productivity of the machines.

-Completion stage: During this stage, the ideas and results that emerge from the studies are concretized and organized; the performance of the machines is analyzed by operating cycles to perform a diagnosis of the improvement actions and to implement them in a safe and reliable way according to the productive process of the mill. The results of the study are delivered and sustained to the interested parties and the work is concluded.

RESULTS

I. Crawler process with three rollers:

To demonstrate that the rotation system with three rollers meets the proposed objectives, a hypothesis test is carried out again, in addition to a comparative table, where the cost of each kilogram threshed for the second half of the year is projected and calculated 2017 with the traditional method and the new method of rotation with three rollers [15], [16].

II. Hypothesis testing

Then the result of the test of hypothesis applied to the same machines but with the system of rotation of three rollers.

Table 1: Hours of the rollers

	MAQ. 1	MAQ. 2	MAQ. 3	MAQ. 4	MAQ. 5
TIEMPO DE DURACION RODILLOS (HORAS)	114	112	113	113	115
	113	117	113	118	116
	117	114	116	116	118
	115	118	118	114	119
	117	115	117	114	113
	118	115	116	118	114
PROMEDIO	115,7	115,166667	115,5	115,5	115,833333
DESVEST	1,97	2,14	2,07	2,17	2,32

Source: own

With the data obtained and recorded in Table 1, the respective calculations are performed (see Tables 2. 3. 4. 5) And the average roll duration in hours is 115.53 with a standard deviation of 1.99

Table 2: Hypothesis test for machines 1 and 2

Prueba t para dos muestras suponiendo varianzas iguales		
	MAQ. 1	*MAQ. 2*
Media	115,666667	115,166667
Varianza	3,86666667	4,56666667
Observaciones	6	6
Varianza agrupada	4,21666667	
Diferencia hipotética de las medias	0	
Grados de libertad	10	
Estadístico t	0,42174117	
P(T<=t) una cola	0,34106829	
Valor crítico de t (una cola)	1,8124611	
P(T<=t) dos colas	0,68213658	
Valor crítico de t (dos colas)	2,22813884	
MAQUINA 1= MAQUINA 2		

Source: own

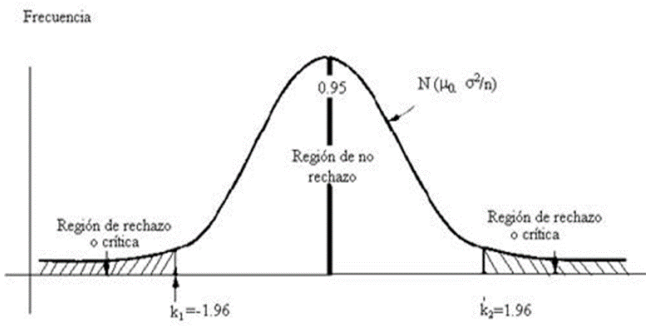

Figure 2: Curve T-student distribution (e)

Source: own

Conclusion: With a significance level of 5% there is sufficient evidence to not reject the null hypothesis, is the average life of the rollers in machine 1 is equal to the average life of the rollers in machine 2.

Table 3: Hypothesis test for machines 1 and 5.

Prueba t para dos muestras suponiendo varianzas iguales		
	MAQ. 1	*MAQ. 5*
Media	115,666667	115,833333
Varianza	3,86666667	5,36666667
Observaciones	6	6
Varianza agrupada	4,61666667	
Diferencia hipotética de las medias	0	
Grados de libertad	10	
Estadístico t	-0,1343523	
P(T<=t) una cola	0,44789479	
Valor crítico de t (una cola)	1,8124611	
P(T<=t) dos colas	0,89578957	
Valor crítico de t (dos colas)	2,22813884	
MAQUINA 1= MAQUINA 5		

Source: Own

Ho: $X_1 = X_2$

Ha: $X_1 \neq X_2$

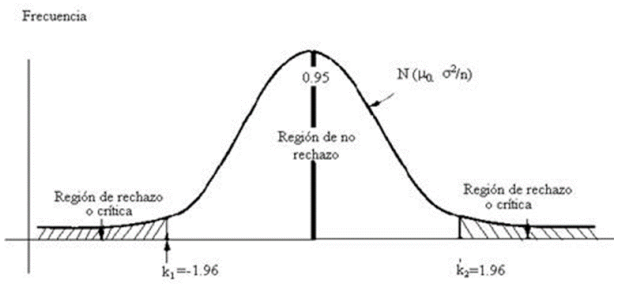

Figure 3: Curve T-student distribution (h).

Source: Own

Conclusion: With a significance level of 5% there is sufficient evidence to not reject the null hypothesis, ie the average life of the rollers in machine 1 is equal to the average life of the rollers in machine 5.

With the above it is possible to conclude that in each of the machines the rollers have a period of equal duration, that is to say; that the machine does not affect or favor its performance, this is the same regardless of which of the machines are being used. Therefore, it can safely be said that prolonging the life of the rollers in the machine 1 will continue to be the same as in machines 2, 3, 4 and 5.

This test confirms again that when performing the rotation with three rollers to optimize the peeling process. The probability that there are other independent variables in each machine that affect productivity is 1%, which means that there is a range of confidence interval of 99%, that for every 100 samples taken, 99 of them will be in the confidence interval of 114.59 to 116.47 hours of use (see Table 4).

Table 4: Confidence interval for rotation with three rollers

CON UN INTERVALO DE CONFIANZA DEL 99%		
PROMEDIO 5 MAQUINAS	115,53333	
DESVEST 5 MAQUINAS	1,995397	
FORMULA	115,53+/-0,938(1,99/RAIZ30)	
INTERVALO DE CONFIANZA	[114,59 - 116,47]	

Source: own

In the same way, with the data obtained in the previous table; the following formula is replaced to obtain the corresponding normal distribution curve (see figure 3):

$$\bar{X} \pm \frac{\alpha}{2}\left(\frac{\sigma}{\sqrt{n}}\right)$$

$$115.53 \pm 0.938\ (1.99 \div \sqrt{30})$$

$$115.53 \pm 0.938$$

$$(114.59 - 116.47)$$

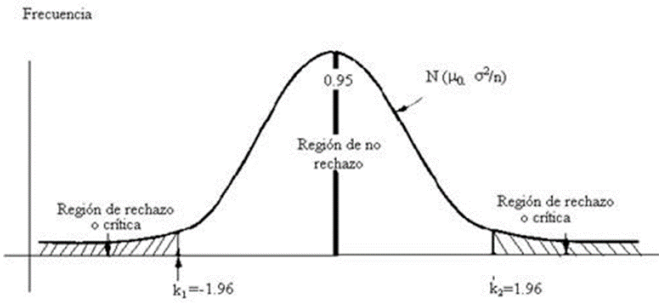

Figure 4. Normal distribution curve for rotation with three rollers

According to the above it is correct to say that, with a confidence interval of 99%; the hours of the rollers in all the machines went from a range of between 43.5 and 52.3 hours with the rotation of two rollers; to occupy values within the range of 114.59 and 116.57 hours of use with the new rotation of three rollers.

III. Projection with the traditional and improved method

After the rigorous study and analysis of the different variables present in the shelling process, and taking as reference the 99% confidence interval demonstrated by the second hypothesis test performed. A correct projection is made on the cost, only of rollers necessary to thresh a kilogram of dry paddy and the time comparative with the traditional method used for the rotation of the rollers (see table 5).

Table 5. Cost of production according to kilos of threshed dry Paddy projected for the second half of 2017.

MES	KG. PADDY SECO PROYECTADOS A TRILLAR	RODILLOS PROYECTADOS A CONSUMIR		COSTOS DE RODILLOS		COSTO DE KG. PADDY TRILLADO	
		METODO TRADICIONAL	METODO MEJORADO	METODO TRADICIONAL	METODO MEJORADO	METODO TRADICIONAL	METODO MEJORADO
JUNIO	7.500.000	89	56	$ 11.570.000	$ 7.280.000	$ 1,54	$ 0,97
JULIO	6.000.000	72	44	$ 9.360.000	$ 5.720.000	$ 1,56	$ 0,95
AGOSTO	7.000.000	83	52	$ 10.790.000	$ 6.760.000	$ 1,54	$ 0,97
SEPTIEMBRE	5.000.000	60	37	$ 7.800.000	$ 4.810.000	$ 1,56	$ 0,96
OCTUBRE	8.500.000	101	63	$ 13.130.000	$ 8.190.000	$ 1,54	$ 0,96
NOVIEMBRE	6.500.000	77	48	$ 10.010.000	$ 6.240.000	$ 1,54	$ 0,96
DICIEMBRE	5.000.000	60	37	$ 7.800.000	$ 4.810.000	$ 1,56	$ 0,96
TOTAL/PROM.	45.500.000	542	337	$ 70.460.000	$ 43.810.000	$ 1,55	$ 0,96

Source: own

The previous table shows a projection of the second half of the year, comparing the amount and total cost of rolls to be consumed with the traditional method (rotation with two rollers) used up to the beginning of the present work vs the improved method (rotation with three rollers) using statistical tools for quality control and process optimization.

The projection results in a decrease in roll consumption of 542 to 337 units, which means a saving of 205 rolls, which represents a decrease in the cost of production of $ 26,650,000 equivalent to go from $ 1.55 to $ 0.96 per kilogram of paddy dry threshed.

CONCLUSION

Being Molino's Florhuila SA, one of the three largest mills in the country, it has a highly-qualified production plant and qualified personnel to carry out each activity of the rice industry with the Highest quality indices and development sustainable.

Emphasizing one of the integral objectives of the mill. It was necessary to detail each part of the process and to understand the stages to detect and mitigate the failures that put at risk or alter the productivity of the plant. For the study the threshing stage was deepened, in which a great part of the costs of production are generated. The study focuses on the shelling activity of dry paddy rice, with the rollers being the main component of each shelling machine and the most representative production cost of the whole process.

In compliance with the general objective of the present project to optimize the hulling process, the study, measurement and analysis of the results obtained from the performance of the rollers was carried out to increase its useful life. With the above it was possible to conclude that although the axes of the rollers work at two different speeds (1000 and 800 RPM).

They must maintain a tangential speed ratio that guarantees correct wear of the rollers and be rotated in a technical way. Costly study of the variables involved in the activity and of the use of measuring instruments, the regression equation and statistical tools; Contrary to how it was done in a very subjective way and without taking full advantage of the rollers.

On the other hand, with the test of hypothesis made it was possible to conclude, with a confidence level of 99% that in each one of the machines the rollers had a duration in the range of 43.5 to 52.3 hours. It can safely be said that the useful life of the rollers of machine 1 is equal to that of machine 2, 3, 4 and 5. The regression equation between the time and wear variables for axis 1 is calculated Y = 0.07464H + 25.57 and Y = -0.0299H + 25.36 for axis 2, which allowed to infer that its level of correlation and causality exceeds 90%.

Considering correlation levels, a regression model was defined between study variables (time, attrition); which helped to define a method of rotation with three rollers that establishes the precise hours to make the timely change between them and to maintain the differences of minimum tangential speeds that guarantee an increase in their useful life and productivity. With this improved method for the rotation with three rollers, and with the help of the meters installed in each machine; it was designed and implemented a format that guides the operator to make the changes of rollers and their location in their respective axes, in the ideal time to optimize the process. In addition, with a confidence interval of 99%, it was possible to increase the useful life of the three rollers in a range between 114.59 to 116.47 hours of use.

To verify the success of the study and taking into account the levels of correlation between the variables, a projection was made for the next seven months of the year and the results are compared with the data recorded in the previous year. The projection results in a considerable reduction of the roller units consumed in the same period, representing a savings of approximately 60 million pesos in a year that are reflected in the costs of production and therefore productivity and profitability of the company.

Finally, it was possible to conclude that in order to optimize the peeling process and increase the life of the rollers, a good statistical analysis and analysis is necessary to keep the processes under control and to guarantee the continuous improvement of the processes make economic and financial investment.

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