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Analysis of the work day of sugar cane harvester CASE IH 7000

Johann Mejías¹, Claudia L. Castrejón², Jesús F. Tejeda², Miguel Escamilla², Miguel Ríos²

¹Electrical and Electronic Engineering Department/ Instituto Tecnológico de Colima, México

²Industrial Engineering Department/ Instituto Tecnológico de Colima, México

Abstract: In this paper the study of the work day of sugar cane harvester CASE IH 7000 in order to understand the behavior of this machine is performed. For this 3 units they were evaluated for total 901 hours by chronometer and photography techniques. The analysis of the results allowed to determine not optimally exploit the productive potential of the combine also observed that the technical and operational indicators are below the established parameters. To eradicate these deficiencies a project for the ransom of the times will increase, theoretically, the coefficient of utilization of the work day making the production process more efficient is proposed..

Keywords: sugar cane; mechanized harvesting; productivity; use of the workday; agriculture

I. Introduction

The cultivation of sugar cane (*Saccharum* spp.) has spread to over 130 countries; Brazil with 30% of the world's leading producer, followed India (21%), China (7%), Thailand (4%), Pakistan (4%), Mexico (3.5%), Colombia (3%), Australia (3%), United States of America (2%) and Indonesia (2%) (Senties & Gómez, 2014; Singh & Solomon, 2015; Narimoto et al, 2015). Mexico ranks sixth in the world in the production of sugarcane (FAOSTAT, 2013; Hernandez, 2014. Dominguez et al, 2014), with 4%, and is the seventh in consumption. In the country's sugar industry it is historically one of the most important in generating more than two million jobs directly and indirectly.

In Mexico it takes place in 227 municipalities in 15 states, with a value of primary production of about 30 billion pesos. There are 55 mills that processed sugar cane from around 790 000 ha in the 2013/2014 harvest, which produced 6000,000 tons of sugar per harvest and whose average yield was 69 t / ha. However, the low sugar prices, high production costs and low crop yields. However, over time it has slowly been the effect of the economic crisis, disputes between cane growers and mill owners, and technological backwardness. (Dominguez et al, 2014. Ortiz et al, 2016).

Despite advances in technology and the importance of this crops, most of the harvesting is done by hand cutting, only the collection is mechanically, causing it reaches the ingenuity with stones and shoots (Castillo, et al., 2007. the performance of this system is approximately 40 tons of cane per hectare, plus burning plant before cutting, which causes continuing loss of soil organic matter is performed, causing the impoverishment of this These are among others the causes that agricultural crop yield decreases considerably over the years (Kingston, et al., 2005. Cabrera & Zuaznábar, 2012; Fatima Cardoso et al., 2013)

To increase productivity and reduce production costs of this crop is necessary to introduce scientific and technological advances in all links of the value chain (Ou, et al, 2013; Castaneda, et al, 2014; Spekken, et al., 2015; Simões et al, 2016). Recently several studies (Matos et al, 2010; Miranda et al, 2015; Suryawanshi et al, 2013; Daquinta et al, 2014; Matos et al, 2014; Sanap et al, 2015; Ahmed & Alam Eldin, 2015) analyze the performance of the machines for the harvesting of this crops and exploitation of the working day, proposing models to streamline the production process (Li & Zhou, 2013).

Faced with this problem SAGARPA (2014) promotes actions to improve the development of sugar cane, where the replacement of machinery are favored, increasing the efficiency of work and reduce production costs, studies that promote improvements in productivity harvest, among others. The measures outlined above are designed to respond to the problems of the sugar industry in the region, which is given by deficiencies in infrastructure, machinery and equipment in the production and harvesting, as well as the poor organization of the production process and the low level of scientific and technological research in the field (Gomez et al, 2014). In order to understand the behavior of the machinery that performs the tasks of harvesting, this paper aims to conduct a study of the work day combine sugar cane CASE IH 7000 and propose a set of organizational technical measures allowing rescue times of the work day making the process more efficient.

II. Methodology

This work was done in the northern region of the state of Colima and the territories of the state of Jalisco, Mexico. It developed the evaluation of 3 CASE IH 7000 harvesters for 26 days effective, with duration of 12 hours per day, 901 hours total working hours of the machines under study were evaluated. The method of movement was back

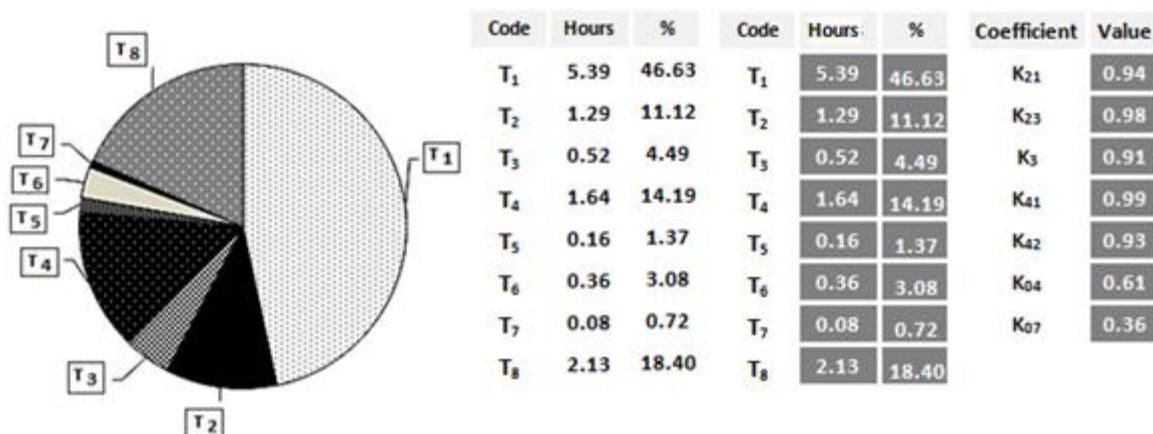
and forth with a turn more body in 180 degree turns in a closed loop, open with recoil and bent-loop, and other used depending on the particularities of the edges of the field in harvest.

For the development of this research the main methodologies for evaluation of machines and / or agricultural equipment were studied, taking as a basis the NC: 34-37: 2003, ISO Standard 8210 (1989), as well as some of the most representative studies (Matos et al, 2010; Miranda et al, 2015; Matos et al, 2014) made in this area. The methodology is focused on determining the time in different conditions and operations of the machine, allowing the calculation of technological and operational indicators derived from the timing of the workday. This procedure allowed to record in chronological order operations and observed times employees, these are: clean Working time (T_1), auxiliary time (T_2), Time Maintenance (T_3) Time for removal of faults (T_4), staff rest time (T_5), vacuum transfer time (T_6) Time of maintenance of means of transport (T_7) and time stops for no fault of the machine (T_8). Control, processing, organization, analysis of experimental data, obtaining parameters, graphs and regression equations that characterize the variables and processes investigated were performed with the electronic tabulator Excel. Measuring instruments used were: digital stopwatches, tape measures and odometers machines. After making the comments, we proceeded to determine the average balance of time structure, by which it was determined the actual balance of the working day, for this computational techniques were applied. Finally productivity rates and operating ratios set out in the rules for this studio attended were determined.

III. Results

The overall analyses of the elements of time of the working day the results shown in Figure 1. Clean work or principal (T_1) represents 46.63% were obtained, this is a low value product losses because times outside the harvesters. The auxiliary time (T_2) with a 11.12%, was generated more by the poor definition of the Gaza turn of the fields, this aspect is not allowed to use rational methods turns. The time of maintenance of the machine under test (T_3), accounted for 4.49%, this value is due to the limited availability of technicians for the execution of maintenance media. The time for fault rectification (T_4) reached 14.19% of the day, mostly because of damage that attended before continuing with the activities, this could have diminished consuming normal time to develop the daily technical maintenance.

Figure 1. Percentage representation of the times of the work day employees and behavior of technical coefficients and exploitation of cane harvester CASE-IH 7000.



The behavior of staff rest time (T_5) was low, with respect to the provisions of regulations of agricultural work, with a value representing 1.37% of the time of the day. The vacuum transfer time (T_6) accounted for 3.08%, the same is the product of the distances traveled by moving between harvested fields. Time maintenance or repair of equipment support (T_7) reached a very low value of 0.72%, exerting little influence on the operating time of the machine under study. The percentage of downtime outside the machine (T_8) amounted to 18.40% of the day in the various effects caused by poor organization of productive activities, negatively impacting the lack of transport units during harvest were detected.

The analysis of technical and operation coefficients of the harvester shown in Figure 1. The behavior of productivity averaged 0.54 ha / h, just as an average yield of 54 t / h was reported, lower than that established by the manufacturer (80 t / h) value and that reference other authors (Uttaro et al, 2015; Masute et al, 2014; Daquinta et al, 2014).

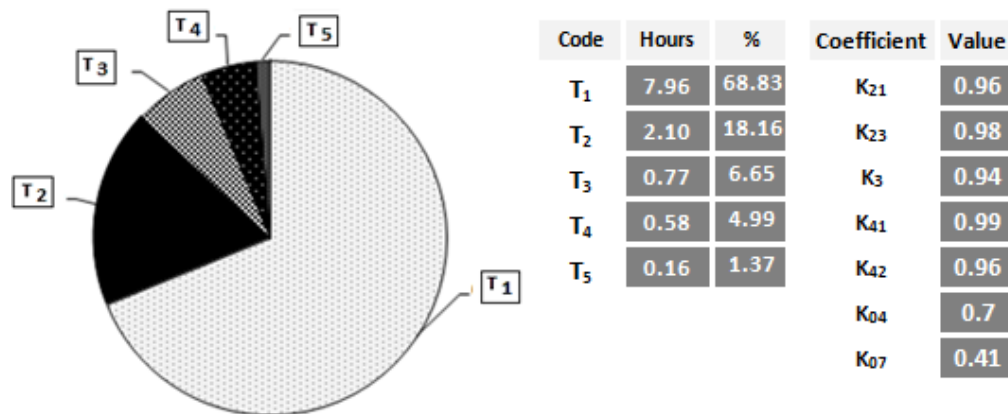
A. Analysis of the work day and exploitation rates projected for the balance.

In order to rescue the reserves of time, and make more rational use of the elements involved in the working day use, the following project is proposed:

- The length of the main working time (T_1), is 5.39 hours (46.63%), by reducing unnecessary time increased 2.57 hours, 7.96 hours until rising occurs.
- In the real balance the auxiliary time (T_2) has a value of 1.29 hours (11.12%), this increase of 0.81 hours reaching 18.16% of the time of the workday occurs. Although organizational technical measures were

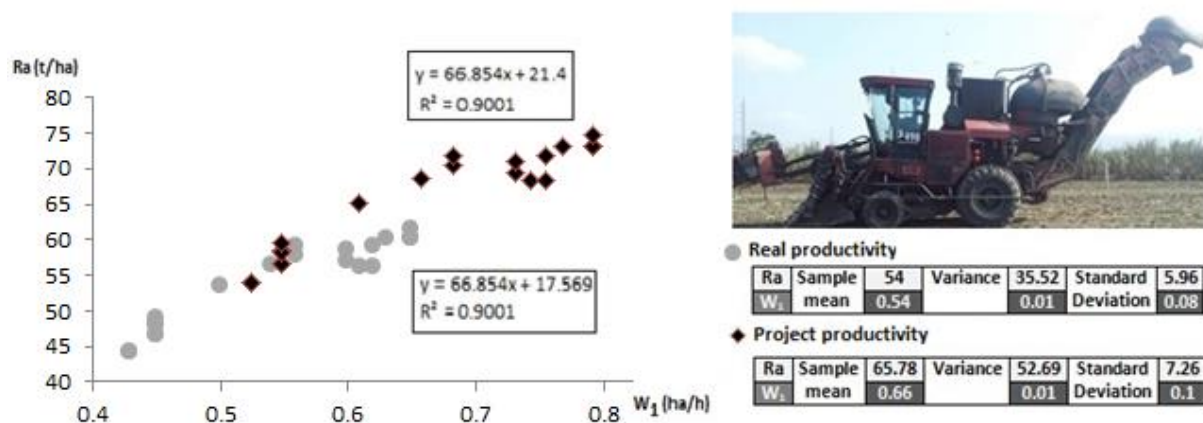
established to reduce this time, this really has to increase, because it is directly proportional to the primary operating time and increases by eliminating downtime losses.

Figure 2. Percentage representation of the times of the work day employees and behavior of technical coefficients and exploitation, after the rescue of reservations ahead of time.



- Maintenance time (T3) has a value of 0.52 hours (4.49%) to the values projected an increase of 0.25 hours in relation to the real balance occurs.
- The time for fault rectification (T4) decreased by 1.06 hours, for it proposes measures to consume the normal time to develop the daily technical maintenance.
- Conclusive preparation time (T5). It lasts 0.16 hours (1.37%) in the project proposal that retains the same value as real, to these activities for the development of activities deem necessary.
- Times Shuttle vacuum (T6), the maintenance or repair of equipment support (T7) and downtime outside the machine (T8) in the real balance amounted to 2.57 pm eradicated in project to improve the organization of productive activities and the transport process during harvest.

Figure 3. Productivity of the sugar cane harvester (W1) depending on the agricultural yield (Ra) for the Real Project and balance.



The analysis of productivity performance after the implementation of the measures proposed is an average of 0.66 ha / h, just as an average yield of 65.78 t / h, lower value established by the manufacturer (80 t / h was reported) and that reference other authors (Uttaro et al, 2015; Masute et al, 2014. Daquinta et al, 2014). Analyzing statistically these values these values is inferred that there may be a better use of the productive capacity of the machine, it significantly affects the elimination of downtime for reasons beyond the day and due to low agricultural yields of the fields in the fotocronometraje he performed. In Figure 3 the curve obtained is observed through the equation $W1 = 66.854x + 21.4$, with an $R^2 = 0.9001$, this shows that there is a strong relationship between productivity and performance.

IV. Conclusion

The analysis of the results allowed to determine not optimally exploit the productive potential of the harvester CASE-IH 7000, largely because of poor organization of the harvesting process, evidencing the existence of organizational technical reserves within the day work.

The technical and operational indicators identified for harvesters CASE-IH 7000 are below the established parameters of this machine, affecting negatively the use of productive working time, which only reaches 46.63% and downtime by other causes which rose to 18.40% of the total observation time.

With the implementation of organizational technical measures to rescue the times of the working day you can raise the productivity of 55.45 t / h to 65.78 t / h.

With the implementation of organizational technical measures to rescue the times of the workday is done to increase theoretically the main time work until 9.96 an hour, 38% more than the current value, and achieving a marked increase in the coefficient of utilization of working time (τ) of 0.44 to 0.66.

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