

Impacts of introducing a new tool for the manual harvesting of sugar cane: the ergonomic analysis contribution

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Abstract. The purpose of this study was to evaluate the impact of introduction a new work tool on health and productivity of manual harvesting sugarcane workers. In this study it was performed a Ergonomic Work Analysis (EWA) to analyze the work tool changes. The study included sugarcane workers, drivers, fiscals, and technical's safety at work. During the analysis process, 134 questionnaires were applied, aimed to identify the constraints that such workers are submitted, to evaluate the tool introduced, in order to propose modifications to improve it. The results showed a decrease in perceived exertion and discomfort, without compromising the cut quality. The main contributions of Ergonomic Work Analysis were the possibility of bringing the logic of the worker, in order to understand the inherent real work characteristics, to the process of developing the new tool. Besides, it was also noted that this methodology, based on the analysis workers activity in a real usage, as an application tool in design projects, providing innovations from the workers perspective.

Keywords: manual harvesting, work tool, sugar cane, ergonomics

1. Introduction

The sugar cane is the most Brazilian export product, and still is one of the frequent employment options and income, especially for workers involved in harvesting. According to Adissi (1997) the sugarcane workers have a dependent relationship with the farming industry. As the sugarcane crop is intended to supply the agribusiness alcohol and sugar needs, this requires the integration between agricultural and industrial production

The sugarcane workers is regarded as a heavy work that by definition, is an activity that requires great physical exertion and is characterized by a high power consumption and high demands of the heart and lungs. Such activity is also characterized by repetitive movements of the arms, legs and trunk, load of cane bundles or weight. Rocha (2007) identified risks of musculoskeletal problems in 17.9% of the workers.

Besides, part of the São Paulo Sugar Cane Agro-industrial Complex has undergone significant changes, with the increase in output / man / ton and the emergence of numerous health problems with this increased production [2].

The issue is still little studied in the scientific community nationally and internationally, with a lack

of specialized literature. Considering the large number of workers involved and the scarcity of research in this area, this study will provide important contributions to the more detailed knowledge of the work of rural workers sugar cane.

The literature review the importance of using an approach that takes as its starting point the understanding of the real work for a better understanding of the work of sugar cane cutters, and that through the methodology of the ergonomic analysis, validate the subjective data collected in a population of cutters, allowing to unravel the determinants of working conditions and workers wear.

This study's aim is to analyze the impacts of introducing a new work tool on the health and productivity of rural workers in manual cutting of sugar cane, based on the application of the ergonomic work analysis.

2. Methodological Formulation

The study was conducted at the Ipiranga plant sugar cane in the town of Mococa, SP, due to recurrences of musculoskeletal diseases and cases in order to improve the manual harvesting of sugar cane. The study used the methodological approach of Ergo-

nomie Work Analysis, which this research was an analysis of workers' perceptions regarding the introduction of a work tool, the machete through the use of observation techniques and footage of workers.

2.1 Steps and Procedures

2.1.1 Demand Analysis

In this stage there was the characterization of the problems in relation to work, through access to medical prescriptions, outpatient data and work orders. It were also conducted exploratory interviews with drivers and fiscal fronts, security team and cane cutters, besides the observations of work pain complaints and obtaining information such as production and organization.

2.2.2 Task Analysis

In this stage it was tried to identify and analyze the prescribed tasks, the organization and production operation and work, in addition to identifying the conditions and work tools.

2.2.3 Activity Analysis

In this stage observations were made by filming, interviews, and information records for the ergonomic tools applications. It performed the validation and return of data on workers, using the pedometer on trem, with the tool previously used and subsequently with the new tool. Then, there was the pre-diagnosis with the workers, drivers and team medical department and the security department.

2.2.4 Pre-diagnosis:

It were applied 134 questionnaires to cane cutters, aimed to identify the constraints that such workers are submitted, to evaluate the tool introduced in order to propose changes aimed to improve it.

2.2.5 Diagnosis

From the validation process and restitution to the workers, it was made a proposal to amend the tool modification. These changes were evaluated by workers through a checklist application.

3. Results

3.1 Task Analysis

3.1.1 Prescription Task

From observations and filming it was found that the cutter, after receiving the EPIs and the tools, starts

the activity picking on the working tool to start cutting cane. The cut must be done close to the ground, the cutter with an arm that moves the cane upright for easy viewing of the cut, holds the work tool in his domain hand and perform the stroke of the working tool to overthrow the cane. In carrying out the activity a male cutter performs 64 strokes with the tool work for minutes, therefore, 3840 moves in an hour.

Regarding to the work prescription, the worker is taken to the crop, to begin the work, after doing the Labor Gymnastics. Then they must perform the following tasks: grinding and washing the work tools on tap from the bus before starting the activities, and when they finish the job, keeping them in their proper places for pruning the next day. The arrival to the workplace occurs at 6:15 A.M., cutting starts after 30 to 40 min, the first stoppage that occurs until 10 A.M. At 10:10, after hydration, the worker returns his activity, stopping for lunch at 11:00 A.M. Workers return to court at 11:30 A.M., up to 1:00 P.M. when there is the second stop for 10 minutes. The work ends at 4:30 P.M. After washing and storing the tools, the cutter enters the bus to return to the city. The bus makes the return opposed to the start of the day, so the cutter who was the first to be picked up will be the last to get home.

3.1.2 Work Organization

The worker's activity requires intense physical effort with manual lifting and carrying weight, causing postural overload. The rigid productivity control imposes excessive rhythms, monotony and repetitiveness. The work is done in shifts, day and night.

3.2 Activity Analysis

3.2.1 Workers' perceptions regarding the activity

During the observations it was found that high work demands physical effort, since the worker must remain standing throughout their workday, performing bilateral movements of upper limbs with force application. According to workers, despite the physical effort, "it's good to work in the industry because standards are being respected and the pay is good."

Regarding the work physical load, though the force involved is high, the high number of movements with the upper limbs and trunk, there were no complaints in the respondents reporting about this variable.

Regarding the organizational aspects, it was found that the workers believe that the cropper's contract record is advantageous. Moreover, according to the interviewees, it can increase the monthly salary

according to their performance, which in this view is positive, despite earlier studies that criticized the pay system.

3.3 Pre-diagnosis: process and development of tool work

The original proposal of changing the working tool was to reduce the weight of it, since it was the detected problem in workers analysis. In order to solve the problem with the tool, which would reduce the blade's weight; three cuts were made in circular blade. From the refunds data, with the workers, there if they criticized the change as to make the cuts flush to the ground; the tool was held at the root of sugar cane, making it difficult to drive it.

Another negative factor mentioned by the workers it was that with the decrease of the tool, they had to put more force on the handle to make the cut. This information was instrumental in reshaping the blade with greater weight. However, a solution was needed of the slide site in which this burden would be allocated, which is the researcher's concern and the worker's (ergonomics and functional aspect) for the new tool formulation.

One of the ergonomist's concerns was in relation to weight gain and reduced life of the blade; it started a change so that weight was allocated at the end of the tool, which is used as the hook cutters. Placement on this site doesn't disturb the tool's life, in addition, promoting the decline in court. Moreover, this change favored the descent, despite causing greater difficulty in returning. The synthesized form, the analysis indicated that the worker's perception the working tool was very heavy.

From these workers validations, a solution was sought as the objective of developing new concepts for the tool to insert the weight into the blade to work as a counterweight, in favor of lowering and rising the tool. Again, the main question was where would be the location for the balance placement, without hindering the blade's life. For this purpose, tests were performed with weights closest and most distant to the cable. After further validation and recovery workers, it concluded that the current model of the balance in the middle of the blade was more efficient, because according to them, the balance in this position favored the rise down to the end of the court. During the validation phase, workers pointed out the improvements by their depositions:

"With this knife cutting becomes easier, we don't need to put so hard on the beat"

"The counterweight helps the return cut"

It was observed in these depositions that the tool was designed by the need to solve a problem, the weight of it, therefore, the researcher focused on building the tool using the testimony of workers, testing and changing the tool, in order to facilitate the activity and contributing to production.

The advantages and challenges on how to develop a concept, is the ability to motivate people to get involved in shaping the future from past and present experiences. In this study, workers with real situation experience could contribute to property, emphasizing the aspects that were crucial [4].



Figure 1. Work tool modified

3.4 Diagnosis

The table below shows the results from the workers evaluation after using the tools.

To evaluate the productivity, held an amount analysis of sugar cane cut. Data were collected using a pedometer during one hour of work, Besides, were analyzed in workers perception, by applying a questionnaire about the tool perception, The data found confirm previous studies that shows a proportional decrease on the work measure over time, but in the end of an hour it can be concluded that the worker who used the tool has moved a greater distance in number of steps and distance traveled. This figure represents that the worker using the modified tool cut more cane.

Table 1
Comparison between tools

FERRAMENTA UTILIZADA						TOTAL/1h
Tempo em Minutos	1 ao 15	16 ao 30	31 ao 45	46 ao 60		
Número de Passos	510	507	502	496		2.015
Distância Percorrida em Metros	400,5	398	393,7	381,9		1.574,10
Kcal	18	17	15	12		62
FERRAMENTA MODIFICADA						TOTAL/1h
Tempo em Minutos	1 ao 15	16 ao 30	31 ao 45	46 ao 60		
Número de Passos	528	524	517	509		2.078
Distância Percorrida em Metros	427	424,3	418,9	410,6		1.680,80
Kcal	19	18	17	14		68
Peso da ferramenta	600 gramas					
Contra-peso	100 gramas					
Peso da ferramenta modificada	700 gramas					

In relation to health at work, perception's of the workers were collected about the new tool. By their reporting, collected from a checklist, it was confirmed that the new tool facilitates the cut, because it is not necessary to impose excessive force by cutting the cane, and returning the end of the climb, the counter weight helps.

4. Conclusion

The results of this study indicate that the proposed changes in the working tool resulted in a decreased effort in cutting sugar cane, and discomfort perceived by employees, without compromising the cut quality.

The Ergonomic Work Analysis (EWA) used in this study made possible to collect information about the strategies and adaptations made by workers to

perform the work activity. Besides, the analysis of the workers comments, associated to the instruments changes, allowed a better understanding about the inherent real work characteristics, enabling improvements in the new tool, from the point of view of workers.

This methodology allowed rescuing the most user interest in solving the problem, therefore, extracting information and close opinions about the experience gained over time and practice of user participant.

It was also noted that this methodology, based on the analysis of the workers activity in the actual use situation, is a tool for application in conception projects, facilitating the action reconstruction from the worker perspective.

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