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COOPERATION IN THE MECHANIZED CUTTING OF SUGARCANE: A MULTICASE STUDY

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Abstract: The mechanization of sugarcane cutting in Brazil has advanced in the last years and completely transformed the work in the field. In the mechanized cut, the harvester always operates accompanied by a transhipment vehicle that receives the load, maintaining a system of synchronism for the displacement. This characteristic of the mechanized cut presupposes the establishment of a cooperative relationship between the operator of the harvester and the operator of the transhipment (tractor). The objective of this work was to deepen the understanding of this cooperative relationship and its role in regulating the workload of the harvester operators. As a methodological approach, it was used the Ergonomic Analysis of Work (AET) with the following research techniques: observations, filming and photographs, open and semi-structured interviews and the interview in self-confrontation. Cutting fronts of three sugar and alcohol mills located in the Piracicaba/SP region were studied. It was observed that the harvest in this region occurs, to a great extent, in terrain with declivity. Although in theory it is not possible to mechanically harvest on slopes higher than 12%, it has been observed

that all the plants allocate the machines in these lands and cut as much as possible. One of the strategies adopted by operators in these situations is the balance of the machine through its lift. However, the success of cutting on sloping terrain also depends on the relationship of cooperation established with the tractor driver given the risk of accidents: the operator rests the lift over the transhipment in order to ensure greater stability. In addition, the cooperative relationship is important as it facilitates various tasks for both actors. Likewise, it has been observed that it may also be a source of additional constraint. It is concluded that the operator-tractor cooperation relationship is complex, directly influencing the process of elaboration of regulation strategies and even, providing a technical limitation of the harvester.

Keywords: Cooperation, Mechanized Cutting, Sugarcane, Ergonomics.

1. INTRODUCTION

The mechanization of sugarcane cutting in Brazil has advanced in recent years. According to data from the Agro-Environmental Protocol of the Sugar-Energy Sector (Agro-Environmental Protocol, 2017), the mechanization rate in the State of São Paulo in the 2015/2016 harvest was 91.3% of the harvested area.

In mechanized cutting, the harvesting machine always operates accompanied by a transshipment vehicle that receives the load, so that these two machines maintain a synchronized system for displacement (SCOPINHO et al., 1999; MAGALHÃES et al., 2008). And, as shown by Narimoto et al. (2011), this characteristic of mechanized cutting presupposes the establishment of a cooperative relationship between the harvesting machine operator and the tractor driver, fundamental for the development of work in the field.

According to Guérin et al. (2001), cooperation implies subjects working on the same work object, in a relationship of mutual dependence. Thus, the different people involved in the action obtain information about the development of the action of others, in order to adjust their operational methods in real time.

Maggi deepens the definition of cooperation by stating that it is "action directed towards the same objective" (MAGGI, 2006, p. 115), the collective action through which subjects contribute to achieving the same result. Therefore, for the author, cooperation is not about sharing means, it is not limited to situations of direct relationships between subjects (as it is possible to achieve the same result by acting in different times and places). What makes actions cooperative is the completion of these actions (MAGGI, 2006).

In view of the transformation of work in Brazilian sugarcane fields, from manual cutting to the operation of complex, large and synchronized machines, the objective of this work was to deepen the understanding of the cooperative relationship between operators of harvesting machines and tractor drivers. The aim was also to understand the role of this cooperation in regulating the workload of harvesting machine operators.

2. METHOD

As a methodological approach, Ergonomic Work Analysis (AET) was used, which places the operator's activity at the center of the analysis (WISNER, 1994) and which enables a global understanding of the work situation.

According to Abrahão et al. (2009), AET presupposes the use of different

methods and techniques that must be chosen and adjusted according to the problem and demand configuration.

The cutting fronts of three sugar and alcohol plants located in the Piracicaba/SP region, here called plants A, B and C, were monitored. Considering the three plants, 12 operators of harvesting machines participated in the study.

To study the complexity of the cooperative relationship established between the actors, the following research methods and techniques were used: observations of workers' activities, filming, photographs, individual interviews, collective interviews and self-confrontation.

Systematic observations were made while the work was being carried out, on different days of the week and different periods of the day (morning, afternoon and night), totaling 150 hours. The observations took place mainly inside the cabin of harvesting machines, but also inside the cabin of tractors and in the field, at a certain distance from the machines in operation.

Filming and photographs served as records during observations for subsequent data analysis.

The interviews took place in open, semi-structured and structured formats, individually and collectively. An average of three individual interviews were conducted for each operator machine studied and eight collective interviews. Most of the individual interviews took place during the operation and the collective interviews, at a time when it was possible to bring together the cutting front workers, such as during meal times and breaks (due to machine breakdowns or lack of trucks). Tractor drivers were also interviewed individually and collectively, with other tractor drivers and mainly with machine operators.

To analyze data from interviews and filming, transcriptions were made to enable the selection of keywords.

The data obtained from the analysis were validated with the self-confrontation interview, which brought together three operators and was carried out outside the work situation, during the off-season.

3. RESULTS

Each operator (except those who cover the days off) is allocated to a machine

specific harvester and remains with it throughout the harvest. Since cutting is simultaneous to loading, this operator is also assigned to work with the same transshipment driver, also called a tractor driver, as the unit that normally tows the transshipment is a tractor.

The practice of the plants studied revealed that the relationship between operator and tractor driver can be between a duo (one operator and a tractor driver), as in

plant A, or a trio (one operator and two tractor drivers), as in plants B and C.

Regarding the prescribed work of the harvesting machine operator, this can be summarized according to one of the managers interviewed:

> (...) the operator has to clean the machine, cut it properly, send the clean sugarcane to the mill, not ruin the ratoon or damage the machine.

The expression "cutting straight" refers to the fact that operators must avoid wasting or damaging the harvested raw material, making the most of the lower part of the stalk, discarding only the leaves in the upper part of the stalk and preserving the integrity of the clump. .

Land that is unprepared to receive mechanized harvesting, with considerable slope, poses a risk of the harvesting machine tipping over. Although in theory it is not possible to place a mechanized front on land with a slope greater than 12%, in practice what was observed was that all the plants studied allocate machines to this land and cut as much as possible.

> We've already cut terrain that we used to walk on with a treadmill because it's so steep! (...) We don't see it, but the tractor driver sees it and says like this [on the radio]: 'he's just walking with a treadmill' Then you squat on the side [holds onto the armrest of the seat] and go!

In none of the plants did the operators report that they had tipped over the machine, but they recognize that the risk is great: "it never happened to tip over, thank God, but there is a risk, right? It's unsafe, it's an unsafe act…"

In this type of terrain, operators are instructed to harvest the sugarcane as far as the machine still has access:

> In the field, I think like this, you have to work more diligently, pay more attention, so much so that you actually cut what you can (...) in this field, you don't even have to put in a harvester, we just cut it.

However, it should be noted that it is up to the operators to determine to what extent cutting is possible and they are free to refuse to cut or continue.

The strategy adopted by operators to cut on slopes is to balance the machine using the elevator: they position the elevator

always against the slope and during maneuvers, pay attention to turning the elevator around 180º, at the same time as the machine:

What holds the harvester upright in one place, I think, is the elevator at the back. If you have a dressing in one place and turn the elevator in the same direction, it will tip over. Automatically, the moment I turn to maneuver, I'm already hitting the elevator too... You can't forget about it.

Therefore, cutting on steep terrain depends on a lot of attention and skills from the operators. Furthermore, the success of cutting in these lands also depends on the cooperative relationship established between the operator and the tractor driver. This dependence exists because the strategy used to harvest in

these lands is to lightly rest the machine elevator on the overflow in order to guarantee greater stability. Figure 1 illustrates mechanized cutting, highlighting the harvesting machine elevator.

Figure 1. Mechanized cutting

Source: CASE, 2009.

This strategy presupposes the establishment of trust between these two actors, as shown in the statement of an operator:

> We know (...) for example, I think: 'oh, I know he's good, so he won't get out of the way'. So you say [to the tractor driver]: 'if it tips, you won't get out from below, you'll only get out when I remove the elevator'. So you meet the guy, explain to the guy how it works, because if you don't, it'll fall apart.

There are two possibilities for cutting on steep terrain: the first consists of "throwing the sugarcane upwards", that is, considering the slope of the terrain, the transshipment is at a level above the machine; and the second consists of "throwing the sugarcane down", which in turn, consists of the transshipment being at a level below the harvesting machine.

Cutting carried out in such a way as to "throw the cane upwards" implies the need for operators to lower the elevator onto the overflow, so that the machine is balanced and also so that the elevator cane does not travel in the opposite direction:

> (...) For example, it's cutting there, it's thinking and it's throwing it upwards (...) you lower the elevator more, you lower the elevator more throwing it upwards because then the treadmill goes normally, because the higher The more you feel down, the elevator becomes easier for you to tip over, because the elevator is heavy. And another thing: the cane goes backwards [from the conveyor], so you have to lower the elevator so the cane doesn't go backwards"

The cut carried out by throwing the sugarcane downwards requires the tractor driver to raise the transshipment to get closer to the elevator. instead of lowering the elevator, because in this case, the machine would tip over:

> If you throw it down, you don't lower the elevator, you ask the guy to raise the overflow, so you can stay on the straight line there, then you ask: 'raise the overflow for me', because if I lower the elevator it's more dangerous..

It is important to highlight that, on sloped terrain, the practice of bringing the elevator and overflow closer together not only allows the stability of the machine but also mitigates possible collisions between the parts:

> If the guy doesn't lift the overflow or I don't lower the elevator, let's say, any punch it [machine] gives, it will hit and destroy the elevator, right? She's doing this here with the overflow: man, man, man! And it breaks, the piston blows, everything blows, the elevator blows... So what do we do? Either by throwing it up, we lower the elevator, or by throwing it down, we tell it to raise it. (...) But it's also close by, right? You can't pull too far because it depends on the transshipment jumping, things like that, it depends like I told you, it depends on the transshipment operator and the operator, more on the transshipment operator....

The cooperative relationship between operator and tractor driver is not only important in the case of steep terrain, but also for the operation as a whole. The tractor driver can provide useful information to the operator, since the harvesting machine offers limited visibility (as it is within the sugarcane line) and requires the operator's attention to several variables:

> The tractor driver is the operator's second eye, right? As the tractor is always in front of the machine and drives cleanly, it is the one who first sees a rock, a ditch, or vegetation and warns them. (...) So the guy helps too, I don't work alone, I depend on him a lot. (...) He can see better than us, I'm paying attention to my street, I'm paying attention to the elevator, the treadmill, the cutting edge mower, I have to pay attention to everything, the clock, the pressure. .. So it's a team, there's no point in saying: 'I'm good', it won't exist, I've never seen a good operator if he takes on a bad tractor driver, he doesn't do anything, he kills the machine's production.

It is worth noting that the cooperative relationship is a two-way street, as operators can also contribute to the work of the tractor driver, especially when he is still in the learning process. However, just as the cooperative relationship can facilitate the operator's work, it can also create an additional constraint:

> There are guys who don't follow us, they listen to music there, they smoke, they talk on their cell phones, they don't pay attention to us, they're knocking, they're walking around crooked, they're crushing brass knuckles. (...) We have to pay attention to so many things and sometimes we have to pay attention to him too, if he's bad, so we don't crash.

As the harvesting machine has a limited speed (maximum 9-10 km/h), which is still influenced by what may occur during cutting, the overflow always follows the machine, adapting to its speed.

> The tractor driver follows the operator. Because if I'm cutting, then I swing, I hold the machine and it has to follow me. Because he's walking in the street and I'm on the street, I can't see anything, and if something happens and I hold him back, he stops. They mark, for example, here the tractor wheel aligned on the line divider, the spout is in the middle of the overflow, so if he sees that I'm walking more and he's getting
>
> Backwards he accelerates the tractor more, it's noticeable, sometimes he doesn't even look back.

The tractor and the harvesting machine are generally located at a distance of 3 meters (two rows of sugarcane), which is also controlled by the tractor driver. And when there are concave curves, for example, the tractor has to get closer to the machine, whereas when the curves are convex, it has to move away.

> I have to walk on the street, right? I can't go there anymore. When he's going to make a turn he has to come closer, or when he's going to make a turn in reverse the machine throws the nozzle that way so he has to go further there.

Despite the conflicts generated by the cooperative relationship, it was observed that there is even great rapport between operators and tractor drivers, especially after some time working together:

> We're used to each other. There is an operator at night, an old man, who is used to the street, turns off the lights to play with the tractor drivers, because if you're used to working together there's not much danger.

4. DISCUSSION

Regulation strategies, according to Daniellou (2002), are essential to compensate for the countless variability present in work activity and allow production to be produced in quantity and quality. How cutting and loading operations are

carried out simultaneously, the strategies adopted by the operators are also based on the cooperative relationship with the tractor driver.

The results showed that this is a complex influence relationship for the operator's activity and the regulation process. While it can make work easier for both parties, it can also represent an additional constraint. This is because according to Guérin et al. (2001), in cooperative work, the different people involved in the action obtain information about the progress of the others' actions so that they can adjust their operating methods in real time. This characteristic in itself already represents a constraint, which can be greater when the tractor driver is inexperienced, as it represents one more factor (among many already described) that the operator must pay attention to.

On the other hand, it was observed that the cooperation relationship presents positive aspects for the operator's activity. It makes some tasks easier and compensates for the operator's low visibility from inside the machine, as evidenced by one operator's statement: “the tractor driver is the operator's second eye”. Furthermore, it is important for social relationships at work, minimizing the effects of isolation due to long periods inside machine cabins.

In normal situations, the characteristic of cooperative work is already present: operators regulate themselves taking into account the actions of the other. And, with the experience and rapport of both, a very great synchronism was observed, with the majority of communications being made through signals and horns, despite the existence of radio. However, when cutting on steep terrain the role of cooperation became even more evident, as in these cases, the actors depend on each other to carry out the cutting in such a risky situation (lowering the elevator, raising the transshipment). In these situations, it can be said that more than cooperation is needed - a relationship of trust: “I know he's good, so he won't let himself go.”

In view of this, although Maggi (2006) states that the cooperation relationship can occur in an imposed manner (as it is in mechanized cutting), for Paradela and Simoni (1999), true cooperation is not linked only to responding to the technical demands of the processes of production. For the authors, cooperation is above all a way for people to relate to each other, being subject to all sorts of social and psychological variables that interpersonal relationships engender.

5. CONCLUSION

The cooperative relationship established between operator and tractor driver proved to be complex, sometimes facilitating and sometimes representing an additional constraint. This relationship has a direct influence on the process of developing regulation strategies, since the actors involved (and this includes the operator and tractor driver) must take each other's actions into account so that they can adjust.

It was observed that this adjustment is highly refined due to the need for synchronization between the machine and the transshipment vehicle and the risk of collisions. Furthermore, in certain situations, such as cutting on steep terrain, this adjustment must be even more precise given the increased risk of accidents.

Therefore, cutting on steep terrain is one of the main determinants of the activity and highlights the fundamental role of the operator in the cutting mechanization process, even in so-called non-mechanizable areas.

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