Revista Engenharia na Agricultura

CONSERVATION CONDITIONS OF CHAINSAWS AND ELECTRIC CHAINSAWS AND SAFETY OF THE FARMERS WHO OPERATE THESE MACHINES

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ABSTRACT

The increasing use of chainsaws in rural areas has demanded the health of rural producers who operate these machines. Thus, the objective of this work was to evaluate the conservation conditions of chainsaws with a 2-stroke Otto Cycle engine and check if they meet NR12 Annex V, as well as confirm whether users meet NR31 in terms of training for use. With the aid of a questionnaire and visits to farms, 103 chainsaws were verified in six municipalities in the central region of the State of Rio Grande do Sul. After organizing the data in an electronic spreadsheet, descriptive statistics and canonical correlation were performed. The questions were divided into four groups, namely: operational, mandatory machine safety equipment, cutting set, and engine. The conservation condition of the machines was seen as worrisome. This is because it was found that 66.01% of machines did not have a saber guard and 49.51% of these were worn out. In addition, 97.08% of the producers did not take a chainsaw operation course, and 85.44% reported not using Personal Protective Equipment (PPE), therefore, in disagreement with the NR6, NR12 Annex V, and NR31 standards. It was clear the need for the operators to carry out training on the safe use and handling of chainsaws.

SITUAÇÃO DE CONSERVAÇÃO DE MOTOSSERRAS E ELETROSSERRAS E A SEGURANÇA DOS PRODUTORES RURAIS OPERADORES

RESUMO

Com o crescente uso das motosserras no meio rural é preciso atenção à saúde dos produtores rurais que operam essas máquinas. Desse modo, o presente estudo teve por objetivo avaliar o estado de conservação de motosserras com motor Ciclo Otto 2 tempos e conferir se as mesmas atendem a NR12 Anexo V, também, confirmar se os usuários atendem a NR31 no quesito treinamento para uso. Com auxílio de questionário próprio e visita às propriedades rurais, foram verificadas 103 motosserras em seis municípios da região central do Estado do Rio Grande do Sul. Após a organização dos dados em planilha eletrônica, foi realizada estatística descritiva e correlação canônica. As perguntas foram divididas em quatro grupos, sendo: operacional, equipamentos obrigatórios de segurança da máquina, conjunto de corte e do motor. O estado de conservação das máquinas foi entendido como preocupante. Isto porque, foi constatado que 66,01% máquinas não possuíam protetor de sabre e 49,51% desses apresentavam desgaste. Ainda, 97,08% dos produtores não realizaram curso de operação de motosserras, e 85,44% informaram não utilizar Equipamento de Proteção Individual (EPI), estando assim, em desacordo com as normas NR6, NR12 Anexo V e NR31. Ficou evidente a necessidade dos usuários realizarem treinamentos para uso e manejo seguro de motosserras.

SECTION EDITOR IN CHARGE

Marconi Ribeiro Furtado Júnior

INTRODUCTION

The use of chainsaws is essential in several work areas, such as forest harvesting, splitting wood into boards, wood cutting for firewood, among others. These machines are easy to be commercialized and have few restrictions regarding purchase in the Brazilian market. In a study carried out to quantify chainsaw brands and models in Brazil, Brandelero *et al.* (2019) highlight that they found 14 brands sold, with a total of 155 models. The chainsaw market, on the other hand, consisted of nine brands that sold 44 models.

The chainsaw is a machine of mechanical constitution consisted of three sets: engine, transmission, and cutting. Also, it consists of a power system, ignition system, starting system, and a clutch system (HASELGRUBER; GRIEFFENHAGEN, 1989; OTTONELLI *et al.*, 2020). Similar in the constitution to chainsaws Brandelero *et al.* (2019) clarify that chainsaws differ in the source of energy to generate work, as they run with electric motors.

Rottensteiner and Stampfer (2013) highlight the importance of the chainsaws as they provided an easier operation and emphasize that this machine is associated with several ergonomic risks, requiring their safe use, to ensure operators' greater safety and performance at work. So, it is necessary to pay attention to Regulatory Standards (NR) 12 and 31, which provide guidelines.

In NR12 (2019) Annex V, chainsaws must have five safety items: manual or automatic chain brake; chain catch pin; rear handguard; left-hand guard and throttle safety lock. On the other hand, NR31 (2018) deals with occupational safety and health in agriculture, livestock, forestry, forestry, and aquaculture, areas that use chainsaws intensively. The standard states that the rural employer or equivalent must offer the chainsaw operators a semi-attendance or on-site training for the safe use of these machines, with a minimum course-load of sixteen hours. This must follow the syllabus relative to the use contained in the instruction manual: a) risks in the use of chainsaws, including noise, vibration, burns, sharp parts, handling fuels and lubricants and chain sharpening; b) tree cutting, pruning and sectioning techniques; c) body postures to preserve the spine and maintain balance during chainsaw operation.

In relation to safety norms, chainsaws are important in rural activities and when used correctly, they bring several benefits. The manufacturers of these machines inform, in their manuals, that to keep the equipment in safe operation, maintenance (daily, weekly, monthly and periodic) are required. Machine maintenance is associated with equipment quality and productivity. According to Marcorin and Lima (2003), the correct maintenance is capable of preventing deterioration in the quality of the machine and its operation caused by failures.

Inspections of agricultural machinery, especially sprayers, are widely used as an attempt is made to reduce accidents When handling chemical products. Inspection programs in sprayers started in the 1940s, intending to identify the conservation condition of sprayers in farming, and thus collaborate with the proper use of such equipment (REICHARD *et al.*, 1991). Currently, the ISO 16122 standard establishes the methodology for carrying out inspections on sprayers, which has mitigated accidents and contaminations. According to the authors Martini *et al.* (2019), the practice of inspection can help reduce maintenance costs, environmental and human contamination, as well as improve efficiency in spraying operations. The authors emphasize the need for the correct revision, maintenance, and calibration of equipment.

As a result, chainsaws, without proper adjustment, lack of safety devices, and unqualified or inexperienced operators, can be important factors in the occurrence of accidents on rural properties. This was observed in the study by Ottonelli *et al.* (2020), where it was detected that only 4% of respondents have some type of training or qualification to operate chainsaws. The authors emphasize that overconfidence in operating a light machine, which is also easy to handle and purchase, may mean that the operator is not interested in taking courses on their use and maintenance.

For a thorough understanding of the conservation conditions of chainsaws, it is necessary to carry out the inspection. So, this must follow a pattern to achieve efficient results. Regulatory Standards (RS) or specific methodology for each type of machine can be used (MARTINI *et al.*, 2019). The lack

of information on the maintenance of chainsaws, even with works related to damage caused by the machine, such as noise (SOUZA *et al.*, 2015) and vibration (MENDES *et al.*, 2019), promotes the development of studies on the conditions of chainsaws owned by farmers. After interpreting the motivation of these words, this study aimed to identify the maintenance conditions of chainsaws and check whether they meet NR12 Annex V, and also confirm whether chainsaw users meet NR31, in terms of training for use the machines.

MATERIAL AND METHODS

Experimental area characterization

The experiment was developed by visiting farmers in the Central Region of the State of Rio Grande do Sul. According to EMATER/RS-ASCAR (2021), this region is made up of 35 municipalities and subdivided into five micro-regions. The economic matrix is based on the cultivation of grains, in addition to the expressive dairy and beef cattle production, with emphasis on sheep farming.

The experiment was conducted in six municipalities in this region. Firstly, the team and the project were introduced and also how the chainsaw conference would be carried out. Operational questions were asked to the farmer and then the machine was checked. For this, basic maintenance tools were used (screwdriver, ratchet wrench, round and flat file, depth limiter, steel brush, brush, and burlap). A questionnaire

that followed the methodology developed by Ottonelli (2020) with open, closed, or multiple-choice questions was applied. Its purpose was to know and determine the conservation conditions of chainsaws and electric chain saws. The questions were divided into four groups, namely: operational, mandatory machine safety equipment, cutting, and engine set (Table 1).

After collection, the data were tabulated in an electronic spreadsheet, which allowed their processing and filtering. The machines were classified into power classes according to the methodology proposed by Brandelero *et al.* (2019). In the analysis construction, it was observed the need to elaborate an age classification of the farmers in order to correlate the operator's age with the time of use of the machine.

Each inspected machine was considered a sampling unit. In the statistical analysis, the IBM SPSS Statistics 26 program was used. The canonical correlation of the data was performed. When performing the analysis, the operational variable was fixed to correlate with the other groups of questions related to the machine. In addition, descriptive statistics of the data were performed. For the analysis, a significance level of 5% was adopted.

RESULTS AND DISCUSSION

The routine of visits allowed to check 103 machines, owned by rural producers. As for the age of the chainsaw operators, it ranged from 20 to 80

Table 1. Basic architecture of the applied questionnaire

Group	Questions	Group	Questions
Operational	Was he or she trained?	Mandatory machine safety equipment	Does it have a saber cover?
	Does it perform cutting?		Does it have a chain break?
	Does it perform splitting?		Does it have a chain catcher?
	Does it split the wood?		Does it have a rear hand guard?
	Does it know PPE?		Does it have a front hand guard?
	Has he or she suffered an accident?		Does it have a safety throttle?
Engine set	Does the clutch work?	Cutting set	Is the saber worn out?
	Is the carburetor regulated?		Is the saber cleaned?
	Does it regulate the carburetor?		Is the saber inverted?

Source: The authors (2020)

years old, with 94.18% are male and only 5.82% are female. They informed that in their routines, they use the machines for the following operations: tree felling, sectioning wood for firewood, and board sawing. In Table 2 some results found in the present work are shown. The complete clothing for the operation of this machine is recommended in NR6, which consists of anti-cut pants, steel-toe boots, leather hooded gloves, goggles, helmet with ear protection, and visor.

Of the inspected machines, nine models of different brands were found. Thus, of the 103 machines evaluated, it was possible to organize Table 3. It is noteworthy that, of three models, the engine power was not found in the aforementioned manufacturers' manuals. In this regard, there is a predominance of the medium power range, which is widely used in occasional services on farms. Only one chainsaw unit with a 2.2 kW motor was identified.

When checking the brands found in the region, the chainsaws of the Stihl®, Husqvarna®, and Toyama® brands predominated with a frequency of 87.38%, 4.85%, and 1.94%, respectively.

When asked about how long they had been using the machine, most farmers reported not knowing the precise period. They explained that they were around generations of the family or that they were second-handed purchased. The oldest pieces had been in use for approximately 45 years, as well as recently-acquired machines were detected.

To observe the relationship between the age of the farmers and the age of the machines, they were organized into age groups and average power (Table 4). It is observed that in the last two age groups the average power of the chainsaws is lower and, therefore, the weight also decreases. This fact occurs because some of the farmers reported that they were no longer able to operate the larger machines, and thus, they migrated to lower power

Table 2. Results of the operations with a chainsaw by farmers

Percentage	Results
97.08%	did not take any course on the use of a chainsaw
85.44%	do not wear personal protection equipment (IPE)
14.56%	out of which were PPE, zero confirm to wear the complete uniform

Source: The authors (2020)

Table 3. Chainsaw and electric chainsaws models are distributed according to the power classes

Class	Power range (kW)	Number of chainsaw	Number of eletric chainsaw	Total
Light	0.7-2.2	31	1	32
Average	2.3-3.7	63	0	63
Heavy	3.8-5.2	5	0	5
Total		99	1	100

Source: The authors (2020)

Table 4. Class of farmer's age, average engine power, and average time of chainsaw use

Age range (years)*	Average power (kW)	Average run time (years)
<40	2.70	12.71
41-50	2.30	10.76
51-60	2.75	11.17
61-70	2.40	13.74
>71	2.14	14.88

Source: The authors (2020)

Caption: *Age of the farmers

classes and, consequently, they are normally lighter.

Chainsaws had an average run time of 12 years. In general, the conservation condition is not suitable for use (Figure 1 A, B, C, D). This is because it was found that 66.01% of the machines did not have a saber guard and 49.51% of these were somehow worn out (Figure 1 J). When the farmers were asked about the saber inversion technique, 25.24% responded they did not have any knowledge about it and, therefore, they did not know how to carry it out. To aggravate, 37.86% of producers said they did not use the chain oil recommended by the manufacturer, but instead, they used the oil from engine crankcase oil or the transmission of automobiles or agricultural machines.

Regarding the mandatory safety items of the chainsaw provided in NR12, it was found that 36.89% of the machines did not have a manual or automatic chain brake (Figure 1 E); 16.50% did not have a chain catcher (Figure 1 F); 6.79% did not have a front hand guard (Figure 1 E); 24.27% did not contain a safety throttle (Figure 1 G), and one machine did not have a rear hand guard.

Also, in relation to the air filter of the chainsaws checked, in four machines this component was not even found, which is extremely worrying. However, in most of them, cleaning is inappropriately performed (Figure 1 H, I). it was found filters that were cleaned using gasoline with a 2T oil mixture, broom, rags, among others, which is not recommended.

It can be seen in Figure 1 the conservation conditions of some of the chainsaws found in this study. It can be seen the precariousness of these machines and their components, which can lead to a reduction in productivity and even accidents in the operation.
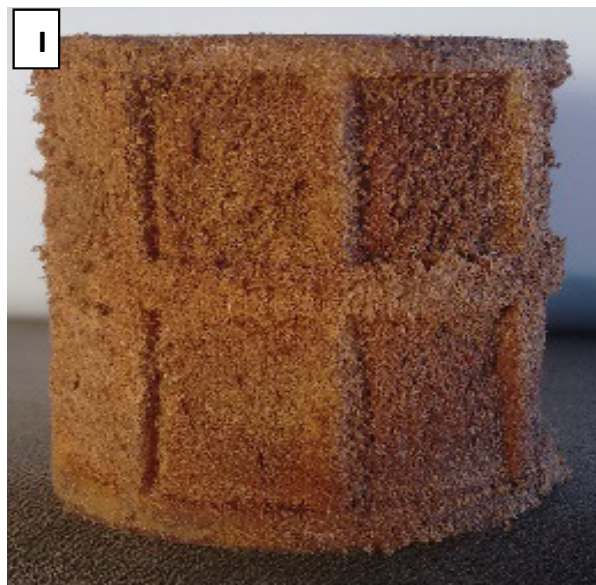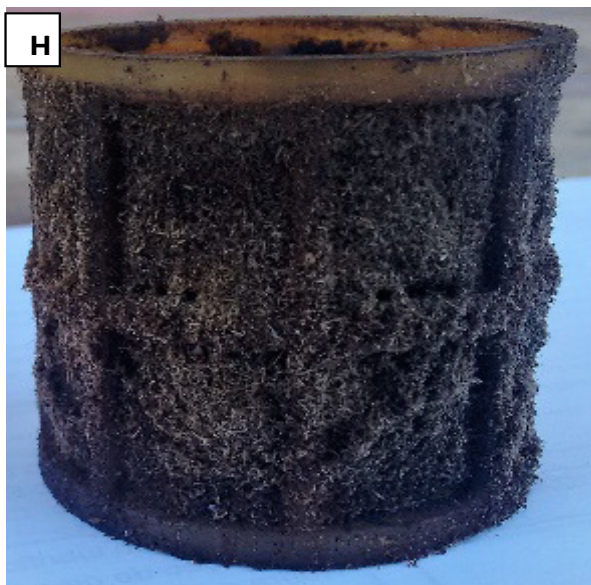
Figure 1. Conservation conditions of chainsaws regarding general maintenance (A, B, C, D); chainsaw without manual chain break and front hand guard (E); lack of chain catcher pin (F); lack of safety throttle (G); air filter needing a cleaning (H, I); worn saber (J)

The correlated variables foreseen in this study through the canonical method showed a significance of 57.70% for operators who were not trained to handle their machines, but confirmed performing the tree-cutting operation. This factor can explain the information that 20 farmers attested having suffered accidents in the operation of chainsaws and that they did not carry out the proper training required by the standard.

When comparing data on rural producers who reported not wearing the PPE correctly for their operations, but confirmed that they had sectioned wood for firewood on their farms, these variables showed a correlation with 98.30% significance. This fact may explain the report of 23 rural producers having suffered accidents in this operation.

When checking whether the rural producers who were not trained to handle their chainsaw with the accelerator lock, the significance between the variables was 71.40%. According to NR12, Annex V, the safety throttle is a piece of safety equipment that helps the operator during the use of the chainsaw, preventing him or her from performing the wrong or involuntary acceleration of the machine.

In the correlation between farmers who did take any training and the cutting set, the study showed a significance of 44.10% for machines that have a worn saber (Figure 1 A). For those who did not perform its inversion, the significance values rose to 74.60%. Even for those who did not clean the saber, a significance of 66.80% was found.

A significance of 92.20% was found at the correlation between farmers who perform wood sectioning and machines with a worn saber. Similarly, a 78.60% of significance occurred when it was correlated with the wood sectioning operation and the adequate functioning of the clutch. Furthermore, it was observed that 53.34% of the chainsaws had some type of worn saber and, in 22.33% of the chainsaws, the clutches were not working properly.

In the comparison between users who section wood with the proper adjustment of the carburetor, it was possible to observe a significance of 69.50%. However, 35.92% of the machines with the carburetor out of adjustment were observed. The lack of EPI by the farmers, on the other hand, showed a significance of 82.30% when correlated with regulated carburetor chainsaws.

As observed in the results, training to handle chainsaws is not executed in the region of this study. This negatively impacts safety during the operation and the conservation condition of machines evaluated in the central region of the State of Rio Grande do Sul.

It was observed that the farmers and the chainsaw operators are in disagreement with NR31, which states that all chainsaw and pruning chainsaw operators and similar must be trained

for the safe use of this machine. The standard recommends a minimum course load of 16 hours of training, which is far from what is desired. In order to seek the ideal conditions of ergonomics and safety in semi-mechanized forest harvesting, Heck Jr. and Oliveira (2015) state that the training and information provided to operators are essential. Consequently, it is possible to reduce damages on the machine and to the operator, primary. The authors also infer that the lack of training is the third impact factor, accounting for 15% of the causes of accidents at work. Finally, they mention that operators reported doubts about the effect of using EPI, which confounded the relationship between the use of protective equipment and the occurrence of accidents.

It was clear in this study that the lack of understanding on the use of personal protective equipment can reduce accidents during the operation. The NR6 (2020) recommends that operators properly wear the PPE used in the chainsaw operations (compounded helmet, anti-cut shirt and pants, gloves, and steel-toe boots). This NR foresees that they must be maintained correctly and within the expiration date. Schettino *et al*. (2019) point out that in addition to accidents caused by the lack of anti-cut clothing, the absence of a matching helmet can damage the operator's hearing. Thus, it is observed, in this study, that the lack of training to operate chainsaws is likely to be associated with the lack of knowledge regarding the use of PPE during operations, and the low offer of extension courses in agricultural machinery.

According to the authors Albizu-Urionabarrenetxea *et al*. (2013), to perceive the dangers during the operation is essential for chainsaw operators to maintain their safety. If this does not occur, there is a risk of exposure to intolerable disasters which strengthens the importance of training as a preventive measure. In a study carried out by Assunção and Câmara (2011) with chainsaw operators, 40% of them reported that most accidents occurred in the tree felling. This operation has a high risk of accidents, requiring investments in training and monitoring, which can mitigate the risk of accidents and occupational injuries.

Lopes *et al*. (2008), infer that the optimization of operating techniques points to the evolution of the performance of machines and operators so that it is possible to increase the productivity of operations. The work carried out by Lopes *et al*. (2018) aimed at determining the effect of age on the learning level of operators. They used a virtual reality simulator and concluded that the 23-37-year-old group is ideal for the best learning. However, all operators made significant gains, regardless of their age and education level. This is in line with the importance of training for operators, as recommended by standard NR31 (2018). Silva (2010) highlights that the increasing number of machines for agricultural use contributes to the demand for guidance campaigns on operation, safety measures, and accident prevention.

It was found in this study that some models are out of the production line, which impairs maintenance and replacement of the parts. For Marcorin and Lima (2003), machines in a deteriorated condition can cause losses in the quality of the operations, reduce productivity, generate damage and failures, as well as a reduction in machine availability besides increasing operating costs.

As a result, it was clear that knowing the profile of the farmers, users of chainsaws, and the conservation conditions of the machines used on their farms can be used as a tool in the development of an extension program aimed at training and building knowledge. It was remarkable in this survey the lack of knowledge of the rules related to this operation and the risks to which producers are exposed for handling machines with evidently inadequate maintenance.

It was observed that respondents are willing to improve such a situation. However, one must take a look at the diversity of interests and individual capacity. Also, it was clear the disparity of information between individuals and the way they understand and interact on the subject.

CONCLUSIONS

- The execution of this work allowed us to conclude that the number of farmers that do not follow NR6 and NR31 is worrying. Most respondents do not wear PPE and also were not trained in relation to the safe

handling of chainsaws. It was also observed the lack of maintenance and conservation of the chainsaws, which increases the risk of accidents, putting the occupational health of operators in attention.

- The need for rural producers in the central region of the state of Rio Grande do Sul, to be trained to perform basic maintenance of their machines, as well as for their safe operation, was highlighted.

AUTHORSHIP CONTRIBUTION STATEMENT

BENETTI, B.B.: Conceptualization, Investigation, Software, Writing – original draft, Writing – review & editing; **BRANDELERO, C.:** Conceptualization, Investigation, Supervision, Writing – original draft, Writing – review & editing; **WERNER, V.:** Conceptualization, Investigation, Supervision, Writing – original draft, Writing – review & editing; **OTTONELLI, J.:** Conceptualization, Investigation, Methodology, Software, Writing – review & editing; **SILVA, R.P.:** Conceptualization, Investigation, Software, Writing – original draft, Writing – review & editing; **FORTES, F.O.:** Conceptualization, Investigation, Software, Supervision, Writing – review & editing.

DECLARATION OF INTERESTS

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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