

QUALITATIVE QUANTITATIVE EVALUATION OF SAFETY IN AGRICULTURAL WORK OF A HIGHER EDUCATION INSTITUTION

Luis Carlos de Freitas¹; Talita Souza Lopes¹; Nilton César Fiedler²; William Masioli²; Joana Letícia Diniz Melo¹

¹ Universidade Estadual do Sudoeste da Bahia - Pós Graduação em Ciências Florestais, Vitória da Conquista, Bahia, Brasil -
luisfreitas@uesb.edu.br ; talitaengflorestal@gmail.com ; joannaldmelo@gmail.com

² Universidade Federal do Espírito Santo - Departamento de Ciências Florestais e da Madeira, Jerônimo Monteiro, Espírito Santo, Brasil -
niltoncesarfiedler@yahoo.com.br; william.masioli@gmail.com

Received for publication: 25/07/2024 – Accepted for publication: 03/02/2025

Resumo

Avaliação quali-quantitativa da segurança no trabalho agropecuário de uma instituição de ensino superior. Esta pesquisa teve como objetivo avaliar as condições de trabalho em um setor agropecuário de uma instituição de ensino superior localizada na região nordeste do Brasil. A amostragem foi composta por 19 trabalhadores envolvidos nas atividades florestais e agrícolas mecanizadas e manuais. A avaliação qualitativa foi realizada por meio da aplicação de um *checklist* com 78 elementos da Norma Regulamentadora nº 31 (NR-31), com observações in loco contemplando registros fotográficos e entrevistas aos trabalhadores. A avaliação qualitativa mostrou que a instituição de ensino possui um índice de cumprimento da NR-31 de 53,84%, sendo encontrados 34 itens em inconformidade com a norma em questão. Quanto às avaliações quantitativas de ruído, vibração de corpo inteiro e vibração de mãos e braços, realizadas com base na NR-15, Normas de Higiene Ocupacional (NHO) nº 01, 09 e 10 respectivamente, constatou-se que os valores de ruído para as máquinas (trator, roçadeira manual e motosserra) estavam acima do limite de tolerância (LT). Os valores de vibração do corpo inteiro não ultrapassaram o LT, porém encontraram-se acima do nível de ação. Os valores de vibração de mãos e braços excederam o LT apenas para a roçadeira manual, já para a motosserra os valores foram considerados acima do nível de ação e abaixo do LT. Verificou-se a necessidade de ajustes no trabalho agropecuário avaliado, com estabelecimento de medidas corretivas e preventivas que possam proporcionar condições adequadas à satisfação, saúde e segurança dos trabalhadores.

Palavras-Chave: Trabalhador rural, ergonomia, segurança no trabalho.

Abstract

This study aimed to evaluate the working conditions in an agricultural sector of a higher education institution located in the northeast region of Brazil. The sample consisted of 19 workers involved in mechanized and manual forestry and agricultural activities. The qualitative evaluation was conducted through application of a checklist with 78 elements of Regulatory Standard No. 31 (NR-31), on-site observations with photographic records and interviews with workers. The qualitative evaluation showed that the educational institution has a compliance rate with NR-31 of 53.84%, with 34 items found in non-compliance with the standard in question. Regarding the quantitative evaluations of noise, whole-body vibration and vibration of hands and arms, conducted based on NR-15, Occupational Hygiene Standards (NHO) no. 01, 09 and 10 respectively, it was found that the noise values for the machines (tractor, manual brush cutter and chainsaw) were above the tolerance limit (TL). The whole-body vibration values did not exceed the TL, but were above the action level. The vibration values of hands and arms only exceeded the TL for the manual brush cutter, while the values for the chainsaw were considered above the action level and below the TL. From the results, it was found that the parameters need adjustments which make it possible to provide adequate conditions of satisfaction, health, and safety for workers.

Keywords: rural worker; ergonomics; safety at work.

INTRODUCTION

The notable increase in workplace accidents began in the mid-18th century during the Industrial Revolution in England due to poor working conditions, which culminated in mobilizations by employees for the State to intervene in relations between employers and employees, aiming to reduce occupational risks. Thus, the first labor standards emerged, initially in central economy countries and later in underdeveloped countries. The first labor regulations in the southern hemisphere emerged with the presentation of the Argentine National Labor Law of 1904 in response to intense labor unrest (POY, 2018).

There has recently been increasing concern about ergonomics with regard to the health, well-being and quality of life of workers during their work activities. Ergonomics involves the study and optimization of people's working conditions to improve the efficiency of the production system (NEAL-SMITH *et al.*, 2021). This work science focuses on people and technologies to ensure compatibility between human capabilities and task demands in the workplace (HUTCHINGS, 2022).

Understanding human limitations in the production process is still incipient, but it can be the key to achieving harmony, comfort at work, health and well-being, increasing income, reducing accidents and

improving work quality (SUCHACKA; HORÁKOVÁ, 2019). Furthermore, productive activities in the agricultural and forestry sector are frequently subject to pressure from the Ministry of Labor, Employment and certification bodies regarding the way in which work is conducted and working conditions are improved (MASIOLI *et al.*, 2020). In this context, it is important to be aware of Federal Legislation, such as Regulatory Standard 31 (NR 31), which is based on occupational health and safety in agriculture, livestock, forestry, logging and aquaculture (BRASIL, 2024).

Employees in rural activity contexts normally work with equipment and machinery with varying levels of noise and vibration. Noise is one of the most important items in occupational health, and when inadequate, it is related to hearing damage, auditory fatigue, and likely to negative psychophysiological effects associated with psychological stress (SANTOS *et al.*, 2020). Vibration above that recommended by current standards has numerous physiological effects which include muscles, circulation and breathing when at low intensity, and visual perception and psychomotor production when at high intensity (NATHAN *et al.*, 2018; ARAÚJO *et al.*, 2020).

Considering that all the factors mentioned above directly and indirectly influence the performance, safety and health of field workers, this study aimed to evaluate qualitative and quantitative ergonomic parameters (noise and vibration measurements) generated by agricultural and forestry activities in a higher education institution in the northeast region of the country, as well as to compare the results with current legislation.

MATERIAL AND METHODS

Characterization of the study area and sampled population

The study was conducted in the agricultural sector of a higher education institution in the state of Bahia, Brazil. According to the Köppen & Geiser Classification, the study region has a tropical highland climate (Cwa) with a dry winter (SEI, 2023). According to INMET (2022), annual temperatures range between 18 and 22°C, with an average annual rainfall of 850 mm. The region has a diverse climate profile influenced by its geographic position between the Caatinga and Atlantic Forest biomes (SANTOS, NÓBREGA, 2023).

The analysis included 19 male workers aged between 20 and 65 years old who performed agricultural and forestry activities at the evaluated institution. Only two of the total number of employees are employed by the educational institution, while the others provide services as third parties. Mechanized/semi-mechanized operations involving tractor, chainsaw and brush cutter operators were evaluated, as well as manual labor including forest seedling production, weeding, irrigation, fertilization, crop harvesting, fence construction and application of pesticides and fertilizers.

A total of 19 workers were analyzed for the qualitative evaluation, while three machine operators were analyzed for the quantitative evaluation.

Agricultural operations for the quantitative evaluations were analyzed with a Sthl MS 310 chainsaw, with a displacement of 59 cm³, power of 3.2 kW, weight without fuel of 6.1 kg, and vibration and noise levels reported by the manufacturer of 4.3 to 4.7 m s⁻² and 115 dB, respectively; with a motorized Stihl FS 160 manual brush cutter, with 29.8 cm³ displacement, 1.4 kW power, weight without cutting tools and protection of 7.4 kg, and vibration reported by the manufacturer of 2.5 m s⁻²; and with a New Holland TL95E agricultural tractor, equipped with an S8000 engine with 100 hp at 2,400 rpm, 4x4 traction, PTO with electro-hydraulic drive, with rotation of 540 rpm, lifting capacity of 3,690 kgf, operating weight of 5,600 kg, and maximum speed of 31 km h⁻¹.

Qualitative evaluation of the work environment

The qualitative evaluation was performed through interviews with workers, with on-site visits, including photographic records and application of a checklist adapted from Lima *et al.* (2021), which portrays the analysis of conformities and non-conformities based on NR-31 regarding minimum adequate requirements for the environment and safety of rural workers.

The checklist covered 78 elements of NR-31 evaluated during the on-site visits. The minimum requirements were addressed according to the following items of NR-31: general provisions; safety management, health and rural work environment; Specialized Service in Safety and Health in Rural Work (*Serviço Especializado em Segurança e Saúde no Trabalho Rural - SESTR*); pesticides, adjuvants and related products; ergonomics, hand tools; machinery, equipment, training and manuals; personal protection measures; living areas, sanitary facilities and places for meals. Three response alternatives were defined for each requirement in the checklist: "yes", "no" and "not applicable". The "yes" answers represented a requirement in compliance with the standard, the "no" answers represented requirements that were not in compliance, while the answers that fell into the category "not applicable" indicate requirements that were unnecessary in the assessment because the institution does not have such a situation addressed in the NR in question.

Quantitative evaluation of the work environment

The quantitative ergonomic aspects evaluated in the study were noise and vibration levels (hands and arms and whole body).

Evaluation of occupational exposure to continuous noise

Machine operators were equipped with a 01 dB WED007 dosimeter. The meters were adjusted to work in the compensation circuit “A” and slow response, with an estimated tolerance limit of 85 dB (A) for an 8-hour workday and a dose doubling factor of 3, as prescribed by the evaluation procedures of regulatory standard NHO-01 (FUNDACENTRO, 2001). The measurements were performed with the microphone of the device fixed to the worker’s auditory zone, considering that the exposure levels for both ears are equivalent. The measurements included: the equivalent noise level (EqL), the standardized exposure level (SEL) and the daily noise dose in percentage (D), which represent the average daily exposure in decibels and percentage, respectively. The values obtained were compared with NR-15 and NHO-01.

Evaluation of occupational exposure to whole-body vibrations

The tractor operator was equipped with a Svantek SV 106 whole-body vibration meter. The triaxial sensor was installed on the machine seat to measure vibration levels on the orthogonal axes (X, Y, and Z) for an 8-hour workday, as determined by the NHO 09 assessment procedure (FUNDACENTRO, 2013). With the integrated sum of each orthogonal axis and the total sum of the acceleration through the parameters representative of the worker’s daily exposure, the acceleration resulting from exposure (ARE), the acceleration resulting from normalized exposure (ARNE), the exposure vibration dose value (EVDV), and the resulting vibration dose value (RVDV) were estimated, with the values obtained being compared with the NHO-09.

Evaluation of occupational exposure to hand and arm vibration

The chainsaw and brush cutter operators were equipped with a triaxial Tecknao NK300 hands and arms vibration meter. Vibration levels were collected on the three orthogonal axes (X, Y and Z) representing the palm of the hand, knuckles and parallel to the forearm bones of the workers during an 8-h workday, as prescribed by the evaluation determinations of NHO 10 (FUNDACENTRO, 2013). Then, the mean resulting acceleration (MRA), the acceleration resulting from partial exposure (ARPE), the acceleration resulting from exposure (ARE), and the acceleration resulting from normalized exposure (ARNE) were estimated. The values were compared with NHO-10.

RESULTS

Qualitative evaluation

The percentage of compliance with the items assessed according to NR-31 is shown in Figure 1. The institution has an NR-31 compliance rate of 53.84%. It presented 42 items in compliance, 34 items in non-compliance, and 2 (two) items classified as “not applicable”.

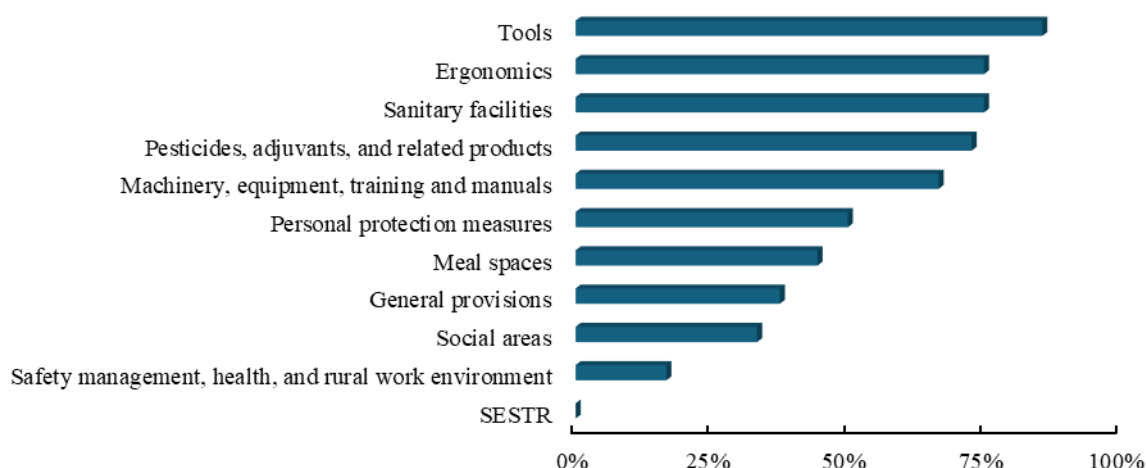


Figure 1. Percentage of compliance with the items evaluated according to NR-31.

Figura 1. Percentual de cumprimento dos itens avaliados de acordo com a NR-31.

Quantitative evaluation – Continuous noise

The minimum and maximum equivalent noise level (EqL) values, the standardized exposure level (SEL) and the daily dose of continuous noise for activities with chainsaws, motorized manual brush cutters and tractors for an eight-hour working day are presented in Table 1.

Table 1. Equivalent noise level (EqL) and standardized exposure level (SEL).

Tabela 1. Nível de ruído Equivalente (Neq) e nível de exposição normalizado (NEN).

Machines	Min EqL dB(A)	Max EqL dB(A)	SEL dB(A)	Daily dose (%)
Chainsaw	40.90	107.50	93.80	338.70
Motorized manual brush cutter	51.50	94.20	91.50	246.20
Tractor	51.40	127.10	89.30	181.50

Quantitative evaluation – Occupational whole-body vibration

The acceleration resulting from normalized exposure (ARNE) and the resulting vibration dose value (RVDV) for whole-body vibrations during activity with an agricultural tractor are presented in Table 2. Mean ARNE and RVDV of 0.93 m.s^{-2} and $20.81 \text{ m.s}^{-1.75}$ were observed for the different agricultural implements coupled to the tractor.

Table 2. Acceleration resulting from normalized exposure (ARNE) and resulting vibration dose value for whole-body vibrations (RVDV) in agricultural tractor activity.

Tabela 2. Aceleração resultante da exposição normalizada (AREN) e valor da dose de vibração resultante para as vibrações de corpo inteiro (VDVR) em atividade com trator agrícola.

Machines	ARNE (m.s^{-2})	RVDV ($\text{m.s}^{-1.75}$)
Tractor-displacement	1.10	26.59
Tractor-mower	0.90	19.79
Tractor-furrower	0.80	16.06

Quantitative evaluation – occupational vibration of hands and arms

The acceleration resulting from the normalized exposure (ARNE) for the hand-arm system for activities with the brushcutter and chainsaw is presented in Table 3. The semi-mechanized activities performed throughout the study presented a mean ARNE of 6.45 m.s^{-2} .

Table 3. Acceleration resulting from normalized exposure (ARNE) for the hand-arm system for activities with the brush cutter and chainsaw.

Tabela 3. Aceleração resultante da exposição normalizada (aren) para o sistema mão braço para atividades com a roçadeira e motosserra.

Machines	ARNE (m.s^{-2})
Motorized manual brush cutter	8.70
Chainsaw	4.20

DISCUSSION

Qualitative evaluation

According to Figure 1, lower compliance percentages were found in the requirements of the items “safety management, health and rural work environment” (16.66%) and “Specialized Service in Safety and Health in Rural Work - SESTR”, where there was no compliance with NR-31.

Only two requirements were found to be in compliance with “safety management, health and rural work environment”, and 10 requirements were found to be in non-compliance with NR-31. This is because there is no regulation regarding the medical examinations which must be performed by workers, nor are there educational campaigns that must be developed to promote greater awareness of the prevention of accidents and illnesses in the workplace and procedures which must be adopted by the company in the event of work accidents as established by the standard under study.

Thus, the outsourced company, or the institution that supervises the work, must develop educational campaigns to reverse this situation, aimed at: prevention and health in the workplace; subject workers, especially those who spray pesticides and similar products, to medical examinations according to the risks to which they are

exposed; allow workers access to health agencies for disease prevention and vaccination; make a first aid kit available at the most remote workplaces, provide training to instruct on its use, as well as train employees on how to draw up a plan for safe removal from the workplace in the event of an accident.

The “SESTR” item is a specialized service intended for developing technical actions, integrated with the practices of safety management, health and work environment to make the work environment compatible with the promotion of safety and health and to preserve the physical integrity of rural workers (BRASIL, 2024). NR-31 requires establishment of this service, composed of the appropriate number of specialized professionals based on the number of workers working in rural activities.

Since there are only 19 workers in the agricultural and forestry sectors of the institution evaluated (much less than 50), the establishment of a Specialized Service in Safety and Health in Rural Work (SESTR) is waived, as long as the employer or representative has training in prevention of accidents and diseases related to work. As it was detected that the outsourced company does not provide this, or the institution does not have someone trained in the aforementioned requirement, the outsourced company must make an Occupational Safety technician available to point out and monitor the necessary modifications to adapt such non-compliance, according to NR-31.

Regarding the items with a percentage below the average: “social areas” (33.33%), “general provisions” (37.50%) and “meal spaces” (44.44%), it can be seen that one of the three requirements analyzed in the item “living areas” was found to be in compliance and two were not in compliance with NR-31. There was a lack of appropriate places for meals and adequate conservation and hygiene conditions, since there are not enough chairs for all workers in the space used for workers’ rest and meals during breaks and lunch times, and the few available are deteriorated, demonstrating that the space lacks better infrastructure.

Next, we found only three requirements in compliance with NR-31 and five in non-compliance for the “general provisions” item, in which we sought to observe the obligations that the employer or equivalent must adhere to in order to provide safety to the worker, as well as one requirement classified as “not applicable”. The latter was due to the fact that no accident had ever occurred in the workplace analyzed.

It was found that all workers, with the exception of tractor drivers, did not receive adequate courses and training to perform their activities in accordance with the requirements of NR-31. Medeiros & Jurado (2013) report that many work accidents occur due to the lack of adequate qualification and professionalization of workers, mainly because the knowledge for performing the function is only passed on by coworkers in most cases.

It was also observed that there are no adequate hygiene and comfort conditions, no commitment to promoting awareness among workers about safety and health at work, nor the prevention of possible risks as instructed by NR-31. For Kromhout (2016), this fact is justified due to the great lack of knowledge of occupational hygiene standards by employers and rural workers.

Thus, it would be necessary to hold awareness-raising lectures to explain the general requirements of NR-31 to employers and rural workers to reverse this situation, aiming to increase involvement of both parties in issues related to health and safety at work.

In turn, four requirements were found to be in compliance with NR-31 and five were not for the “meal spaces” item. The areas intended for meals for rural workers were found to be in non-compliance mainly due to lack of hygiene and comfort. As already mentioned, the institution evaluated does not have a place with adequate infrastructure for meals, does not have a sufficient number of tables or chairs, and does not have a place or container for storing and preserving meals. The ideal situation would be to invest in tables and chairs in order to serve all workers.

Regarding the use of Personal Protective Equipment (PPE), it was observed that workers only wore high-top boots provided by the institution in field activities such as mowing, weeding, building fences and greenhouses. However, one of the workers claimed that he had not worn boots for four months because they were worn out and the company or institution had not replaced them.

In the case of workers who perform general field activities, it is necessary to provide and properly use a hat or other protection against the sun or rain for the head and face, and face protectors against intense light radiation, in addition to the essential use of waterproof and non-slip long-top boots in order to prevent bites from venomous animals, contact of pesticides with the skin and the risk of falling (Brasil, 2024).

It was also found that tractor drivers are not provided with hearing protection as Personal Protective Equipment (PPE), which is essential for workers who operate this type of machinery. As such, one of the workers who has been working for over 30 years claimed to have acquired unilateral deafness, which was confirmed by doctors, confirming the negative effects of non-compliance with the legislation.

According to NR-31, it is mandatory to provide PPE free of charge to workers whenever collective protection measures are technically proven to be unfeasible or when they do not offer complete protection against risks arising from work (BRASIL, 2024). However, distributing hearing protection and requiring its use alone are not enough to preserve hearing. In addition to controlling aggressive agents, it is necessary to implement educational actions, study the hearing profile and analyze the work environment (MAIA, 2019).

Next, six of the nine requirements assessed in the “machinery, equipment, training and manuals” item were found to be in compliance and three were found to be in non-compliance with NR-31. Although all safety devices on the chainsaw and brush cutter were in compliance with the aforementioned standard, it was found that the chainsaw operators and brush cutters were not provided with at least eight hours of training aimed at preventing accidents in the workplace in question when they were hired. It was also observed that the institution does not provide the manuals for the machines and equipment to the workers, making it necessary to comply with this requirement established by the aforementioned standard, since the machines and equipment are the institution’s assets. Another non-compliance situation concerns the tractor activity, where it was possible to observe transport of people with this machinery, which characterizes it as an unsafe action on the part of the workers. NR-31 states that the transportation of people in self-propelled machines and their implements is prohibited when they do not have a workstation designed for this purpose (Brasil, 2024).

Finally, the items that presented a positive compliance percentage with NR-31 were: “tools” (85.71%), “sanitary facilities” (75%), “ergonomics” (75%) and “pesticides, adjuvants and related products” (72.72%). There was only one non-compliance in evaluation of the “tools” item due to the fact that the tools used in the work (sickle, hoe, machete, hammer, scissors, among others) do not have protection. Therefore, it is essential that the company or institution collaborates so that these tools are safe and efficient, providing sheaths for the machetes and protections for the other tools.

The “sanitary facilities” item also presented a positive compliance percentage. Of the eight requirements assessed, only two were found to be in non-compliance with NR-31 due to the lack of urinals on site and doors that provide adequate protection for workers.

Only one requirement was found to be in non-compliance regarding the aspects of the “ergonomics” item, as the company or institution does not adopt ergonomic principles which aim to adapt working conditions to the psychophysiological characteristics of workers in order to provide improvements in comfort and safety conditions at work.

This situation is mainly observed among workers who perform general activities in the field, such as weeding. According to Maziero (2021), weeding presents a high risk of injury or occupational diseases, mainly in the cervical region and upper limbs. There is then a need to transmit knowledge to workers so that they are aware of the postures they should adopt when performing agricultural and forestry activities, as well as to carry out simple ergonomic interventions that can be introduced individually by a professional in the area, aiming to promote a better quality of life for rural workers in their work environment.

Next, eight out of the 11 requirements evaluated for the “pesticides, adjuvants and similar products” item, which includes the requirements regarding handling, transportation, preparation, application, disposal, decontamination of equipment and workers’ clothing, as well as the prevention of accidents with pesticides, adjuvants and similar products were in compliance, mainly due to the fact that the institution provides agronomic prescriptions for preparing the spray, as well as instructing workers on how to apply the products. In addition, it was observed that the institution provides all the necessary PPE for workers to do the spraying in order to preserve the employees’ health.

However, in a study conducted by Faria (2012), it was found that despite high adherence and a higher proportion of cases of poisoning among those who did not use PPE, there were several cases of poisoning among workers who always used these protective measures, which according to the analysis, indicates that environmental and food exposure sources, meaning non-occupational, and the non-use of PPE in work activities in recently sprayed areas may have influenced the poisoning results found.

Therefore, it is necessary for the outsourced company or institution to provide exposed workers with a suitable place to store personal clothing, soap and towels for personal hygiene and training with a minimum workload of 20 hours on accident prevention with pesticides and similar activities to avoid possible poisoning and adapt the requirements in non-compliance according to NR-31.

However, according to Santana *et al.* (2016), knowledge acquisition by workers does not necessarily result in appropriate practical and preventive attitudes, so there is a need for regular awareness campaigns to inform workers about the toxicological and environmental risks of pesticides, since knowledge of these risks is fundamental for preventing and implementing intervention strategies.

Quantitative analysis – Continuous noise

According to Table 1, the SEL was higher than 85 dB(A) in all machines evaluated, and in specific measurements the EqL was close to or exceeded the recommended ceiling value of 115 dB(A). In this scenario, the daily dose values were also higher than recommended (100%), demonstrating the need for immediate intervention and adoption of control measures.

The highest SEL and daily dose values were observed for the chainsaw, with a noise level of 93.8 dB(A) and a daily dose of 338.7%. The minimum EqL for this machine was 40.9 dB(A) (obtained when it was just turned

on), and the maximum EqL was 107.5 dB(A), which was obtained during the tree felling phase. Minetti *et al.* (1998) found a SEL of 99.7 dB(A) aiming to evaluate the effects of noise in forestry cutting with chainsaws, where the highest level was also detected during the tree felling phase. Fonseca *et al.* (2017) found a daily dose of 380.80% for the chainsaw and a SEL of 94.64 dB(A) when analyzing occupational exposure to noise among workers in a forestry company.

Although the workers were using all the protective equipment necessary for their physical integrity, especially ear protectors to minimize sound pressure in their auditory zone (shell-type protectors), when analyzing the results found, it was perceived that there was a need to raise awareness among operators regarding the importance of using PPE, because in this case if the worker was not offered ear protectors, as prescribed in NR 15, they could only be exposed to the noise level for 2 (two) hours and 40 minutes. Furthermore, according to Cunha *et al.* (2009), depending on the quality of the ear protector and the way and time of use, there may be discomfort and damage to the worker's health even with the use of this device.

The motorized manual brush cutter also presented a SEL above the recommended limit, with a level of 91.5 dB(A), dose of 246.2 (%), with a minimum EqL of 51.5 dB(A) and a maximum EqL of 94.2 dB(A). Fonseca *et al.* (2017) found a SEL of 92.88 dB(A) and dose of 298.8 (%) when evaluating the noise level in motorized brush cutters values, constituting similar values to those found in the present study. Like the chainsaw operator, the workers who handle the brush cutter used ear protectors; however, as the level of occupational exposure to noise was above the limit, it is necessary to check the attenuation level provided by the ear protectors in order to ensure that these levels are compatible with the exposure of workers at safe levels. In addition, a SEL of 89.3 dB(A) and a dose of 181.5(%), with a minimum EqL of 51.4 dB(A) and a maximum EqL of 127.1 dB(A) were obtained when operating with the tractor-mower combination.

Even though it had a limit above the recommended limit, the tractor had the lowest noise level compared to the other machines evaluated. Similar results were found by Fonseca *et al.* (2017), who observed SEL values of 88.6 dB(A). In the aforementioned study, it was found that hearing protectors were not offered to tractor drivers, making it necessary to comply with the NR's, especially NR-15 and NR-6. It would be necessary to provide hearing protectors in this condition, or otherwise it would be necessary to reduce the worker's working hours to only 4 hours and 30 minutes.

Quantitative analysis - occupational whole body vibration

Based on Table 2 and the NHO 09 criteria, the recommended limit for acceleration resulting from standardized exposure (ARNE) is 1.1 m.s^{-2} . All values found for this parameter for the tractor in the different conditions evaluated were in accordance with the aforementioned standard.

When the resulting vibration dose value (RVDV) is greater than $21 \text{ m.s}^{-1.75}$, the exposure limit will be exceeded and will require the immediate adoption of corrective measures. The whole-body vibration level to which tractor drivers are exposed was shown to be above the recommended limit for the RVDV parameter only when the tractor was moving. Cunha *et al.* (2009) found a similar result when evaluating work with agricultural tractors in soil preparation. They reported that the worst vibration situations occurred in the direction of the tractor's movement as the engine speed increased. Scarlett *et al.* (2007) attribute this fact to the inability of the tractor seat suspension to attenuate vibration in the horizontal direction, which increases the effects.

NHO 09 also suggests adopting preventive measures for acceleration resulting from normalized exposure (ARNE) values between 0.5 m.s^{-2} and 1.1 m.s^{-2} , or whenever the resulting vibration dose value (RVDV) is between $9.1 \text{ m.s}^{-1.75}$ and $21 \text{ m.s}^{-1.75}$. As mentioned, with the exception of the RVDV in the tractor in motion, the values found for the other situations did not exceed the limit recommended by Brazilian legislation; however, they were above the action level, making it necessary to adopt preventive measures in order to minimize the probability that exposure to vibration may cause harm to the health of workers and prevent the exposure limit from being exceeded.

Quantitative analysis – occupational vibration of hands and arms

According to Table 3, it was found that the ARNE value for the motorized manual brush cutter exceeded the limit (5.0 m.s^{-2}) established by NHO 10. Therefore, it is recommended that corrective measures be taken immediately to control this exposure to the workers involved. The exposure for the chainsaw was considered above the action level, since according to NHO 10, if the acceleration resulting from normalized exposure (ARNE) is between 2.5 m.s^{-2} and 5 m.s^{-2} , preventive measures should be taken to minimize the probability that exposure to vibration may cause harm to the health of workers and prevent the exposure limit from being exceeded.

Cunha *et al.* (2009) report that wear conditions and lack of maintenance of chainsaws, as well as the work methods applied, can cause changes in vibration levels, especially over the years, demonstrating the need for ongoing worker training and equipment maintenance aiming to replace worn or defective components and/or replace new components when it is identified that they produce excessive vibration resulting from manufacturing defects or poor product quality.

CONCLUSIONS

- The agricultural activities carried out at the educational institution were unsatisfactory in terms of compliance with NR-31 (qualitative assessment), requiring immediate interventions in the work environments in order to support the physical integrity of employees and reduce the risk of accidents. Some aspects of non-compliance were worrying, mainly the failure to provide PPE in some mechanized activities.
- Regarding the quantitative assessment, values higher than 50% were obtained in quantifying the daily dose variable in all noise dosimetry, exceeding the action level limit as indicated in Occupational Hygiene Standard 01. Moreover, values higher than 85 dB(A) were verified in quantifying the Standardized Exposure Level (SEL) variable in all noise dosimetry, indicating that the daily exposure tolerance limit for continuous or intermittent noise was exceeded, as provided for in NR-15.
- The exposure levels to whole-body vibration did not exceed the recommended limit; however, they are above the action level, requiring preventive measures. The hand and arm vibration values exceeded the recommended limit only for the manual brush cutter, but the values for the chainsaw were considered above the action level.
- It is necessary to check the level of noise reduction provided by the PPE, more specifically the hearing protectors used in the institution in order to ensure that the attenuation levels are compatible with the workers' exposure.
- The need for training and qualification courses in the field activities evaluated is highlighted in order to reduce occupational risks in the work environments.

ACKNOWLEDGMENTS

This study was funded by the National Council for Scientific and Technological Development (CNPq).

REFERENCES

- ARAÚJO, K. L. B.; MONTEIRO, L. A.; SANTOS, V. C.; MACEDO, D. X. S.; NICOLAU, F. E. A. Vibração em mãos e braços na utilização de trator de rabiça equipado com rotoencanteirador. **Energia na Agricultura**, Botucatu, v. 35, n. 3, p. 352-359, julho-setembro, 2020.
- BRASIL**. Ministério do Trabalho e Emprego. Portaria MTE no 86 de 03 de março de 2005. Norma Regulamentadora no 31. Diário Oficial da República Federativa do Brasil. Brasília, DF, 2024.
- BRASIL**. Ministério do Trabalho e Emprego. Portaria MTE no 86 de 03 de março de 2005. Norma Regulamentadora no 31. Diário Oficial da República Federativa do Brasil. 2024.
- CUNHA, J.P. A. R; DUARTE, M. A. V; RODRIGUES, J. C. Avaliação dos níveis de vibração e ruído emitidos por um trator agrícola em preparo de solo. **Pesquisa Agropecuária Tropical**, Goiânia, v. 39, n. 4, p. 348-355, 2009.
- FARIA, N. M. X. Modelo de desenvolvimento, agrotóxicos e saúde: prioridades para uma agenda de pesquisa e ação. **Revista Brasileira de Saúde Ocupacional**, São Paulo, v. 37, n. 125, p. 17-50, 2012.
- FETHKE, N. B; SCHALL, M. C.; MERLINO, L. A.; CHEN, H.; BRANCH, C. A.; RAMASWAMY, M. Whole-Body Vibration and Trunk Posture During Operation of Agricultural Machinery. **Annals of Work Exposures and Health**, Suite Iowa City, v. 62, n. 9, 2018.
- FONSECA, A.F.C.; SANTOS, F.R.; CATAL, R.E.; AMARILLA, R.S.D. Análise da exposição ocupacional ao ruído em trabalhadores de uma empresa florestal. **Revista Espacios**, Venezuela, v. 38, n. 26, p. 25- 37. 2017.
- FUNDAÇÃO JORGE DUPRAT FIGUEIREDO DE SEGURANÇA E MEDICINA DO TRABALHO** (FUNDACENTRO). Norma de higiene ocupacional: procedimento técnico: avaliação da exposição ocupacional ao ruído. São Paulo, 40 p. 2001.
- FUNDAÇÃO JORGE DUPRAT FIGUEIREDO DE SEGURANÇA E MEDICINA DO TRABALHO** (FUNDACENTRO). Norma de higiene ocupacional: NHO 09: Avaliação da exposição ocupacional a vibrações de corpo inteiro: procedimento técnico. Fundacentro, 64 p., 2013.
- HANS, K. (2016). Hygiene Without Numbers. **Annals of Occupational Hygiene**, Oxford, v. 60, n. 4, p. 403-404, January 2016.
- HUTCHINGS, J. **What Is Ergonomics?** Ergonomics in the dental office. In: PARKER, S. S. New Jersey: Wiley-Blackwell, 2022.

INSTITUTO NACIONAL DE METEOROLOGIA (INMET). Normais Climatológicas do Brasil: Período 1991:2020. Ministério da Agricultura e Pecuária. 2022. Disponível em: <<https://portal.inmet.gov.br/normais>>. Acesso em 28 de jun. 2024.

LIMA, V. A. P., OLIVEIRA, A. F. DE., & ALVES, D. DE A. (2021). Uso das ferramentas e técnicas de gerenciamento de projetos em propriedades rurais através da NR-28 e NR-31. **Scientific Electronic Archives**, Rondonópolis, v. 14, n. 8, p. 1 – 10, agosto, 2021.

MAIA, G. G. MAIA. (2019). Recommendations for prevention of occupational diseases of agro-sector employees. **Theoretical & Applied Science**, Philadelphia, v. 70, n. 2, p. 1 – 5, february 2019.

MASIOLI, W.; FIEDLER, N. C.; LOPES, E. S.; OLIVEIRA, F. M. Exposição de trabalhadores a ruído e vibração em atividades de colheita florestal semimecanizada. **Pesquisa Florestal Brasileira**, Colombo, v. 40, n. 1, p. 1-7, 2020.

MAZIERO, R. Perfil dos trabalhadores florestais e condições ergonômicas do trabalho em atividades de produção de eucalipto. **RETEC**, Ourinhos, v. 14, n. 1, p. 67-80, 2021.

NEAL-SMITH, G.; BUTLER, K.; PATEL, B.; HUNTLEY, D.; WOOD, A. M. 'Ergopaedics': the future of ergonomics in orthopaedics. **British Journal of Hospital Medicine**, Salisbury, v. 82, n. 11, p. 1-4, November 2021.

NOVAES, A. B.; LONGUINHOS, M. A. A.; RODRIGUES, J.; SANTOS, I. F.; GUSMÃO, J. C. Caracterização e demanda florestal da Região Sudoeste da Bahia. In: SANTOS, A. F. DOS; NOVAES, A. B. DE; SANTOS, I. F. DOS; LONGUINHOS, M. A. A. (Org.). Memórias do II Simpósio sobre Reflorestamento na Região Sudoeste da Bahia. 1ª ed. **Embrapa Florestas**, Colombo, v. 1, n. 1, p. 25-43, 2008.

POY, L. An early attempt at labor regulation in the Global South: The Argentine Ley Nacional del Trabajo of 1904 and the response of working-class organizations. **Labor History**, London, v. 60, n. 4, p. 293-308, 2018.

SANTANA, C. M; COSTA, A. R; NUNES, R. M. P; NUNES, N. M. F; PERON, A. P; CAVALCANTE, A. A. C. M; FERREIRA, P. M. P. Exposição ocupacional de trabalhadores rurais e agrotóxicos. **Cadernos Saúde Coletiva**, Rio de Janeiro, v. 24, n. 3, p. 301-307, 2016.

SANTOS, L. M.; ARAÚJO, G.; FERRAZ, M. L.; BATISTA, F. B. S.; MARTINS, B. D.; SOUZA, B. Characterization of noise emitted by a low-profile tractor and its influence on the health of rural workers. **Anais Da Academia Brasileira De Ciências**, Rio de Janeiro, v. 92, n. 3, p., november 2020.

SANTOS, V. J. D.; NÓBREGA, M. A. Physiomic classification of vegetation in the municipality of Vitória da Conquista – Bahia. **Seven Editora**, São José dos Pinhais, v. 1, n. 1, p. 1-21, 2023.

SCARLETT, A. J.; PRICE, J. S.; STAYNER, R. M. whole body vibration: evaluation of emission and exposure levels arising from agricultural tractors. **Journal of Terra mechanics**, Otawwa, v. 44, n. 1, p. 65-73, 2007.

SUCHACKA, M.; HORÁKOVÁ, N. "Sociological Barriers in the Quality of Production" **Conference Quality Production Improvement**, Częstochowa, v. 1, n. 1, p. 1-8, 2019.

SUPERINTENDÊNCIA DE ESTUDOS ECONÔMICOS E SOCIAIS DA BAHIA (SEI). Tipologia Climática KOPPEN & GEISER: Pluviometria 1981-2020 e Temperatura 1911-2020 do Estado da Bahia. Coordenação de Recursos Naturais e Ambientais- CRNA. 2023. Disponível em: <https://ftp.sei.ba.gov.br/Geoinformacao/cartograma/estado/carto_tipclim-kg_ba_6v5m_2023_cor.pdf>. Acesso em 28 de jun. de 2024.