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Assesement of Environmental Risks Caused By Physical Agents In Charcoal Production Units

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ABSTRACT

This study evaluated noise emission and quality of lighting of the production system of charcoal from species of the botanical genus Eucalyptus planted forests. Scientific research was conducted in a charcoal production unit destined for steel, located in Vazante city in the state of Minas Gerais. The analyzed production unit has an industrial-sized, with the entire chain of forest production involved. The unit has planted forested areas, environmental protection area, village house for the employees and the entire logistics structure required for mechanical harvesting of Eucalyptus. The study was carried out with analysis of forestry activities carried out in the vivarium, forestry, harvesting and charcoal production unit. From the viewpoint of environmental factors, risks caused by physical agents to which workers are exposed were analyzed: lighting and noise. Proof that forestry workers are subject to certain risks arising from physical agents was ascertained. The worst lighting levels were found in areas around the coal production furnaces. The machines used in harvesting also had very heterogeneous lighting levels. Regardingnoise, the more critical levels were identified in a plane used for spraying crops. However, in all cases, the use of protection equipment was effective. These risks can be harmful to workers health. To mitigate these problems, objective actions to be taken by the company were suggested. For lighting problems, it is concluded that measures such as reflectors cleaning, adjustment lights of machines and improving signaling can improve the environmental quality of installation. Regarding noise emissions, it is concluded that the use of protective equipment and educational campaigns to use such these could be effective for controlling noise pollution.

INTRODUCTION

With 5 million km², Brazil holds one of the largest tropical rain forests in the world and possesses, approximately, 6 million acres of planted forests of pinus and eucaliptus, that supply industries for glue laminated timber, wood panels, sawed wood, cellulose and paper, charcoal and energy (Pereira, 2010).

Production of charcoal in Brazil supplies the demands of the steel and metallurgy industries and in smaller scale for use in residential urban and rural areas. According to the National Energy Balance(EPE, 2016), in the base year of 2015, wood and charcoal made up 8.6% of the entire countries energy production, which amounts to 24.519 x 10^3 tons of petroleum.

Brazil is the world's largest producer of steel utilizing charcoal for the reduction reactions of iron ore (Souza, *et al*., 2016). It stands as a solid and expanding sector, generating thousands of work positions, large quantities of taxes and income (Brito, 2007).

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Mengod (2013)mentioned that during the practice of his activities, workers are exposed to potentially hazardous environmental agents that can cause workplace health issues. It is possible to identify an inter-relation between three elements: the chemical agent capable of producing the effect, the biological system with which the chemical agent acts upon to produce the effect and the effect itself, considered harmful to the organism.

For Iida (2005) there a series of factors linked to the design of machines and equipment's, the physical environment (lighting, temperature, noises, vibrations), human relations and diverse organizational factors that may have a strong influence on the performance of labor, including causing accidents.

The meaning of environmental risk may be narrowed down to the physical place where workers perform their activities. Noise, vibrations, heat, cold and altitude, when exceeding certain limits may cause illnesses or effect well-being (Gonçalves, *et al*., 2015).

Souza, *et al* (2008) states that the ideal ilumination for different forest activities must be in the range of 100 to 300 lux. On the other hand, the Brazilian standard NBR 5101 (ABNT, 2012) estabilishes that roads with low traffic must have ilumination levels of 3 to 5 lux, depending on the existance of vehicle traffic. Ilumination also depends on wall, floor and ceiling coloration.

Souza, *et al* (2010) state it is common in wood harvesting to find work places and equipment incorrectly iluminated, that may contribute to the increase of visual fatigue, mistakes and accidents in addition to a negative psichological influence on workers andm consequentially, on the machines productivity.

Now, the exposure to elevated noise pressure levels can cause hearing loss due to noise and, consequentially, have lasting effects on the individuals quality of life. The consequence of hearing loss is a psycho-social alteration characterized by isolation, stress, complications in family relations, anxiety, sleeplessness, decrease in selfesteem and depression (Holanda, *et al*., 2011)

Occupational hearing loss represents na important public health issue due to it's high prevailance in the most diverse industrial segments (Alves, *et al*., 2006). Grandjean (1988), states that after the age of 50, male individuals show considerable hearing loss.

The Brazilian standard NR 15 (Brazil, 1978) deals with the allowable noise limits acoarding to the workers exposed time. Besides that, it estabilishes that continuous or intermitent noise levels must be measured in decibels (dB) with noise pressure reading equipment operating on the compensation circuit "A", slow response circuit (SLOW) and with readings taken close to the workers ear level.

The NR 15 (Brazil, 1978) anex I states that exposure to noise levels above 115 dB ate not allowed to individuals that are not adequatelly protected. Still acoarding to anex I, the activities or operations that expose workers to noise levels, continuous or intermitent, above 115 dB, without adequate protection, pose iminent and grave risks. Considering and exposure time of 8 hours, average work time for Brazilian workers, the daily exposure limit is 85 dB.

Cunha, *et al*., (2012) compared noise levels produced by cabined and uncabined tractors, with different operation times. His study concluded that both tractors produced noise levels aboce the 85 dB limit for 8 hour daily work time.

In this context, this study's objective is to evaluate physical agents environmental risks (lighting and noise) related to the operations of plantation and harvest of eucalyptus forests and the production of charcoal, taking place at a charcoal production unit. Knowing the risks, mitigating measures for improving health, well-being, environmental and worker safety can be developed (Lima, et al., 2015).

MATERIAL AND METHODS

Study area:

Responsible for producing 225 thousand m³ of coal per year, the production site is made up of four eucalyptus farms. Together, they total an area of 82.5 thousand acres, of which 50% are used for eucalyptus plantation. The rest is composed of natural reserves, permanent protection areas (34%), residential villages, roads, construction sites, rivers and lakes (16%). The charcoal production area studied is located in Vazante – Minas Gerais, approximately 250 km from Brasília, geographically referenced in UTM coordinates: E 365504 and N 8089757. The farms are located over sandy clayey and sandy soil.

Based on meteorological data gathered at the on-site weather station, the average annual temperature is around 22.5ºC, with maximum measured temperatures of 32 ºC and minimum of 15 ºC. Average annual precipitation is 1.100mm (measurements taken through the years of 1988 and 2012), with periods or rain extending from November to March and dry periods corresponding to the months from May to October. Relative air humidity varies from 25% to 95% and the areas climate is classified as Tropical Humid Cerrado. Average altitude is 530 meters above sea level.

Data gathering and analyses:

662 illuminance measurements were taken on ten nocturnal operating harvest machines and a type RAC 220 furnace for charcoal production, with 60 measurements for analysis in total. Measurements were taken in a

straight line starting from the headlights, in regular 50-centimeter intervals. Analyzed forestry equipment were: Grapple saw; Feller buncher. Skidders and the loading and unloading claws. For purposes of study, the machines were divided into three distinct groups: 4 Grapple saws; 3 loading and unloading claws; 1 Feller buncher and 2 skidders.

Measurement of lighting levels are required for analyses, so the following procedures were undertaken: quantity of light on points and planes where measurements were taken; the light sensor was held parallel to the analyzed surface, approximately 60 centimeters from the soil; the photo cell was levelled on the measurers hand, with care to avoid small differences between readings; shadowing of the photo cell was avoided.

A luxmeter with basic precision of 4% was used for measurements, with manual range adjustment, spectral response following the CIE photopic action spectrum, and Silicate Diode photo type sensor. The equipment was used for measuring ambient luminosity in lux, in ranges of 2000/20000/100000 lux (Minipa, 2007).

For noise, 8280 measurements were taken along 138 hours, covering 24 machines or different activities. The company's areas of forestry, harvest and Charcoal Producing Units – CPU, responsible for turning wooden logs into industry grade charcoal were analyzed, considering the identified average risk groups.

Noise measurements were taken along the workers hearing range, on the horizontal plane where the ear canal is located. A professional noise pressure-measuring device was used, considering regular minute-by-minute time intervals. From the average of the detected points, the maximum value for each measurement was ascertained.

Noise measuring equipment functioned according to standards set by OSHA, MSHA, DOD, ACGIH, and ISO. The equipment may also be used in sound level meter (SLM) setting, were noise levels are monitored from 70 to 140 dB (Extech, 2003).

The qualitive analysis method was used, set by the Ministries of Labor Regulatory standard number 15, annex I from June 8, 1978. According to the standard, noise measurements must be taken with noise measuring equipment operating on compensation circuit "A" and slow response circuit. Prolonged noise may not exceed 85dB and instantaneous noises cannot exceed 115 dB.

RESULTS AND DISCUSSION

Machine Illumination:

Figure 1 presents the resulting illuminance measurements taken. Table 1 shows maximum measured lighting values and at what distance they were observed.

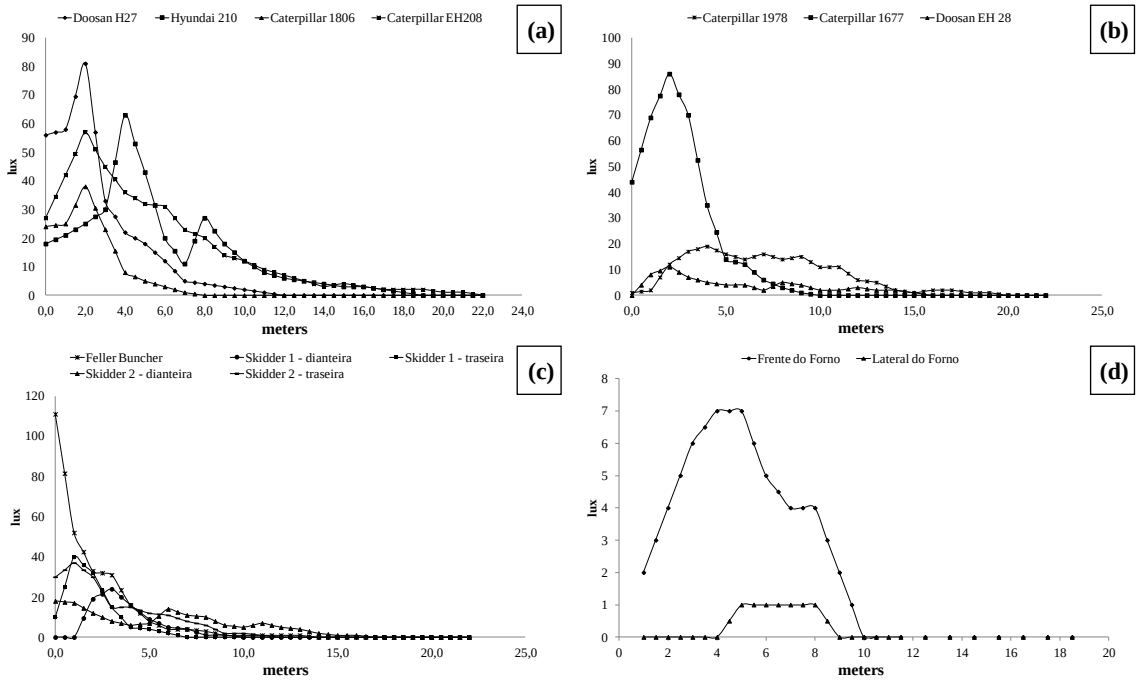

Fig. 1: Illuminance measures: (a) on Grapple Saws; (b) on Loading and Unloading Claws; (c) on the *Feller Buncher* and *Skidders*; (d) on RAC 220 Furnace.

Table 1: Maximum illuminance values on machines and RAC 220 Furnace.

Machine	Maximum (lux)	Distance (m)
Loading and Unloading Claw - Caterpillar 1806	38	2,0
Loading and Unloading Claw - EH208	57	2,0
Loading and Unloading Claw - Doosan H27	81	2,0
Loading and Unloading Claw - Hyundai 210	63	4,0
Loading and Unloading Claw - Caterpillar 1978	19	4,0
Loading and Unloading Claw - Caterpillar 1677	86	2,0
Loading and Unloading Claw - Doosan EH 28	11	2,0
Feller buncher	111	0,0
Skidder 1: Front	24	3,0
Skidder 1: Back	40	1,0
Skidder 2: Front	18	0,0
Skidder 2: Back	37	1,0
RAC 220 Furnace: Front	7	4,0
RAC 220 Furnace: Side	1	4,0

Figure 1 (a) presents the resulting measurements taken on Grapple saws. The illuminance (lux) is shown according to the photocells sensor distance from the headlights. It may be noted that the maximum illuminance values on the three grapple saws occurred at 2 meters distance from the headlights. The Hyundai 210 machine achieved maximum illuminance at 4 meters in front of its headlights. In this case, a second peak value was observed at 8 meters, most likely due to misaligned headlights. A check-up of the Caterpillar's grapple saws headlights and a re-alignment of the Hyundai's headlights is advised.

Figure 1 (b) presents the resulting measurements taken on loading and unloading claws. It was shown that the Caterpillar 1677 loading and unloading claw had a maximum value vastly superior to the others. The Carterpillar 1978 and Doosan EH28 require headlight revision.

Figure 1 (c) presents the resulting measurements taken on the no feller buncher and two skidders. In the skidders case, due to their operational and constructing characteristics, measurements were taken from the front and back of the machine.

Significant difference was shown between the illumination focal point of the feller buncher compared to the skidders. The feller possesses a shorter focal point, reaching maximum values at less than a meter from the headlights. This is due the machines own characteristics, possessing implements located close to movement gears. In the skidders case, non-uniformity was noted between the machines, headlights, and taillights. Maintenance on the skidders focal point is recommended.

Therefore, considering all machines analysed, only the feller buncher reached a minimum illuminance of 100 lx, as recommended by Souza *et al*. (2008).

The situation found increases the risks of accidents and effects nocturnal productivity in the farm. With the exception of the feller buncher, all other machines require headlight maintenance.

Illumination around the Furnaces:

Nocturnal activities are practiced in the Coal Production Unit (CPU) area. The area possesses precarious lighting due to insufficient quantities of reflectors and the large quantities of dispersed smoke. Illuminance produced by the rectangular furnaces was taken in this area. The rectangular furnaces possess standardized illumination reflectors in the front and sides.

The maximum reading in the frontal area was of 7 lux, measured close to 4 meters of horizontal distance from the reflector. In this area, readings above 2 lux were observed located between 1 to 9 meters in front of the furnaces. On the side area, the lux meter only detected lighting after 4 meters of horizontal distance from the reflector. The light detection from the lux meters sensor continued until 9 meters, although with reading of only 1 lux.

The NBR 5101 (ABNT, 2012)sets reference values for public illumination. Even though it may not be the case in hand, in the lack of a specific standard, this was used as a guideline. According to the standard, for low traffic walkways, a minimum illumination of 3 lux is set. In case of vehicle traffic, the demand increases to 5 lux.

Comparing reference values from the NBR 5101 (ABNT, 2012) standard with measured values, it may be concluded that the areas in front of the furnace have adequate lighting. Even so, areas beside the furnance have illumination bellow recommended levels. If we consider Souza *et al*. (2008) studies as reference, all measurements demonstrated insufficient results. This situation favors the occurrence of accidents.

The mitigating solutions of this dire problem are simple and can be a periodic cleaning of the illumination reflectors and an adequate lighting project that guarantees minimal lighting levels in nocturnal work, even with elevated presence of suspended material.

Noise:

Table 2 shows the resulting noise measurements. Eleven machines dedicated to forest harvesting were analysed, all with closed cabins, 4 machines with operations in the forestry industry, 2 of which have closed cabins, and 9 CPU machines, 3 of which have closed cabins.

Table 2: Average value of colorimetric parameters of wood blades of *Balfourodendronriedelianum* for the four treatments and irradiation times studied.

Sector	Duty	Brand	Implement	Cabin	Measurements	Average (dB)	Maximum (dB)	CV (%)
Harvest	Tree Cutting	Caterpillar	*Feller buncher*	Closed	283	75,5	92,8	4,0%
	Dragging cut trees	Caterpillar	*Skidder*	Closed	845	72,5	100,2	8,4%
	Log cutting	Doosan	Garratraçadora	Closed	286	71,6	91,7	5,4%
	Log cutting	Caterpillar	Garratraçadora	Closed	741	72,8	91,8	6,6%
	Log cutting	Hyundai	Garratraçadora	Closed	665	72,8	95,6	7,9%
	Truck Loading	Komatsu	Loading and Unloading	Closed	386	68,7	87,3	3,1%
	Wood Transportation	Volvo	Bitrem	Closed	286	75,2	100,3	8,7%
	Dragging cut trees	Caterpillar	*Skidder*	Closed	458	79,0	93,4	4,3%
	Truck Loading	Doosan	Loading and Unloading	Closed	717	73,0	93,7	7,3%
	Bitrem Driver	Volvo	Log Transport	Closed	184	68,8	80,0	3,5%
	Mechanic	Fiat	Mechanics Tools	Closed	605	76,6	105,4	11,9%
Forestry	Irrigation Operator	Ford	Tank truck	Open	95	79,8	96,8	10,6%
	Airplane Pilot	Ipanema	Fertilizer Aplication	Closed	56	89,9	102,3	12,6%
	Irrigation Operator	Valtra	Tank truck	Open	79	91,5	101,6	7,4%
	Sapling transportation	Valtra	Load Haul	Closed	186	73,8	93,0	8,7%
CPU	Rectangular Furnace discharge	Caterpillar	Dumpster	Closed	246	81,8	117,4	11,4%
	Circular Furnace discharge	Caterpillar	Dumpster	Closed	155	75,1	94,8	8,4%
	Rectangular Furnace discharge	Caterpillar	Dumpster	Closed	223	75,1	99,5	10,0%
	Circular Furnace discharge	Massey	Dumpster	Open	256	71,6	96,5	7,4%
	Opening of rectangular furnace	Massey	Tank Car	Open	308	80,4	103,7	11,6%
	*Barrelamento	Massey	Tank Truck	Open	630	79,4	100,7	13,4%
	*Barrelamento		Mixer	Open	4	73,5	76,7	5,5%
	Agitator		Agitator	Open	4	73,9	91,8	16,2%
	CPU Laboratory		Laboratory	Open	436	71,3	101,7	9,4%

*Application of soil mixed with water

The results of the noise measurements described in Table 2 were divided according to operational sectors. In the harvest sector, in which all machines operate with closed cabins, there were no average noise measurements above 85 dB, considering the operator as a reference. The loudest machine was the skidder, with an average noise of 79dB. Considering the maximum measured values, there was also no surpassing the 115 dB limit for slow response. In this case, the loudest machine was a strada pick-up truck, used by the maintenance mechanics, with peak noise of 105,4dB. It can be concluded that the machines utilized in harvesting follow the noise level emission established on the NR 15 standard (Brazil, 1978).

In the Forestry sector, two machines operate with open cabins and two operate with closed cabins. Average noises above 85 dB were registered in two machines: the fertilizer-spreading plane and the tank truck. The tank truck has an open cabin that registered average noise levels of 91.5 dB. The plane, with closed cabin, used in spreading fertilizer produced average noise levels of 89.9 dB. Observed noise level emissions from the tank trunk coincide with those found by Cunha, *et al*., (2012) for tractors without cabins.Considering the maximum levels, none of the machines used in forestry surpassed the 115 dB limit for slow response.

Analyses of the CPU sector revealed no transgression of the 85dB average noise limit in any of the machines. Considering the maximum values, the 115 dB limit was surpassed in the rectangular furnace discharge machine, Caterpillar 924G with dumpster implement and closed cabin.

For some machines, the measured noise levels were superior to the ones taken by Fiedler, *et al*. (2010)in a workplace ergonomics study in carpentry shops in the south of EspíritoSantor and Filho, *et al*.(2004)in evaluating noise levels from an agricultural tractor on wheels.

Figure 2 illustrates point-by-point the results from to machines: Komatsu Loading and Unloading claw on closed cabin trucks, considered silent;, and Rectangular Furnace discharge Carterpillar 924G machine with dumpster implement and closed cabin, considered noisy.

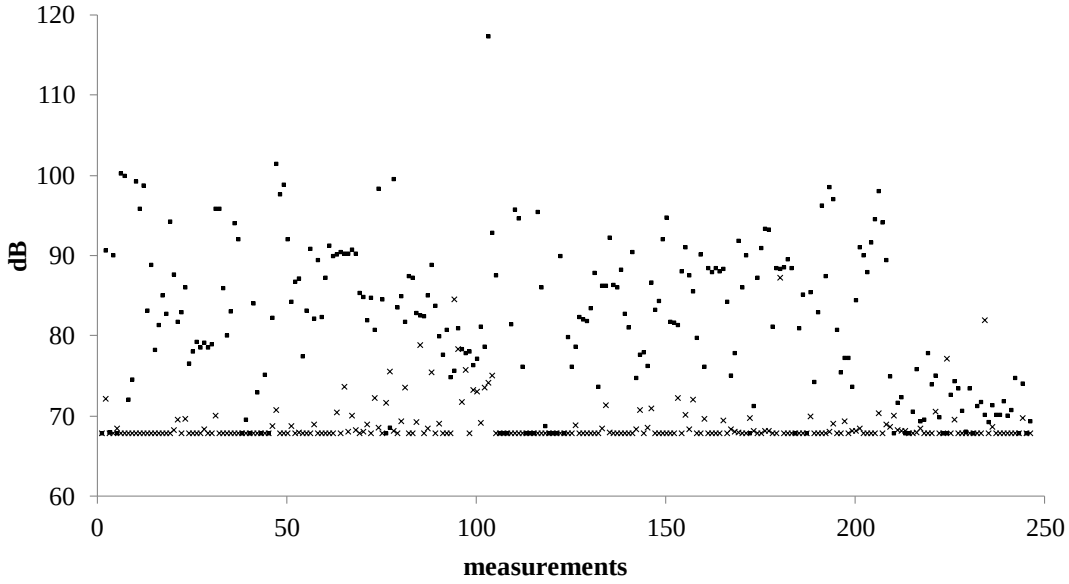

Fig 2: Measurements performed on the Caterpillar and Komatsu claw and in the loading and unloading claw.

Each square point represents a measurement in dB from the loading and unloading Caterpillar machine and the 'x' points represent measurements from the Komatsu loading and unloading machine. The x-axis represents the number of measured points and the y-axis represents the noisy levels in dB. The objective of the figure is to illustrate the high dispersal of points from the Caterpillar machine compared to the Komatsu machine.

Even with results outside the allowed threshold, there was no register of measurements surpassing 20% if the average maximum average established by the NR 15(Brasil, 1978), that is, 115 dB peak noise or an average of 85 dB. Therefore, the use of hearing protection in machines considered noisy constitutes a sufficient protection of workers hearing health (Lima, 2013).

Final Considerations:

The study has proved that workers in charcoal production sectors are submitted to risks caused by physical agents, if neglected, they have the potential to cause unwanted accidents. Measurements taken show improper illumination conditions and the presence of above legal noise levels. It was also possible to identify low-cost solutions to revert this situation.

The evaluation of lighting revealed problems in certain machines utilized in harvesting. Deficient lighting was identified in the CPU area on the sides of the rectangular furnaces. As a form of mitigating these discussed issues, re-alignment of the headlights in harvesting machines and periodic cleaning of the rectangular furnaces reflectors and lighting for the improvement of illumination in the CPU area is recommended.

The study identified some noisy machines in the CPU and forestry areas. Nevertheless, all the impacts found to be caused by noisy can be easily neutralized by use of individual hearing protection equipment. Therefore, the adoption of hearing protection for workers in all machines with open cabins and noisy machines with closed cabins is advised.

Adopting the suggested solutions has the potential to diminish the risk of workplace accidents and leave due to workplace illness related to noise pollution. The perspective of decreasing accidents is a desired effect for the exposition of this study, as much for the social aspect as for the increase of productivity for companies that work in forestry industry.

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REFERENCES

ABNT, 2012. *NBR 5101: Iluminação Pública: Procedimento.* Rio de Janeiro: Associação Brasileira de Normas Técnicas - ABNT.

Alves, J.U. e al., 2006. Avaliação biomecânica de atividades de produção de mudas de eucalyptus ssp.. *R. Árvore,* 30(3): 331-335.

Brasil, 1978. *Norma Regulamentadora nº 15.* Brasília: Ministério do Trabalho e Emprego.

Brito, J.O.d., 2007. O uso energético da madeira. *Estudos Avançados,* 21(59): 185-193.

Cunha, J.P.A.R., M.A.V. Duarte and C.M.A. Souza, 2012. Vibração e ruído emitidos por dois tratores agrícolas. *Idesia,* 30(1): 25-34.

EPE, 2016. *Brazilian Energy Balance,* Rio de Janeiro: EPE - Empresa de Pesquisa Energética.

Extech, 2003. *Dosímetro de Ruído com Interface para PC MODELO 407355. Guia do Usuário.*. São Paulo: Extech Instruments.

Fiedler, N.C., P.P. Guimarães, R.T. Alves and F.B. Wanderley, 2010. Avaliação ergonômica do ambiente de trabalho em marcenarias no sul do Espírito Santo. *R. Árvore,* 5(34): 907-915.

Filho, P.F.d.S. *et al*., 2004. Utilização de um sistema de aquisição automática de dados para avaliação dos níveis de ruído de um trator agrícola de pneus.. *R.Árvore,* 3(28): 381-386.

Gonçalves, W.T. *et al*., 2015. Gonçalves, W. T., Peña, C. R., Serrano, A. L. M.,Britto, P. A. P., Wilbert, M. D., 2015. Strategies for Socio-Environmental Efficiency in Brazilian Agriculture: The Case of the Municipalities in the State of Goiás. *Aust. J. Basic & Appl. Sci.,* 9(23): 164-174.

Grandjean, E., 1988. *Fitting the task to the man.* 4th ed. London: Taylor & Francis.

Holanda, W.T., M.L. Lima and J.N. Figueroa, 2011. Transcultural adaptation of an instrument to evaluate hearing handicap in workers with noise-induced hearing loss. *Cien. Saúde Colet.,* 16(1): 755-767.

Iida, I., 2005. *Ergonomia Projeto e Produção.* 2ª ed. São Paulo: Edgard Blücher.

Lima, C.M., 2013. *Avaliação dos fatores ergonômicos e ambientais em uma unidade de produção de carvão vegetal em Vazante, MG. Dissertação de Mestrado.* Brasília: Universidade de Brasília.

Lima, C.R.P. *et al*., 2015. LSocio-Economic Profile of Workers in Charcoal Production Units in Brazil. *Aust. J. Basic & Appl. Sci.,* 9(33): 454-460.

Mengod, M.O.A., 2013. *Apostila da toxicologia e higiene industrial.* São Paulo: Faculdade Oswaldo Cruz.

Minipa, 2007. *Luxímetro Digital MLM-1011. Manual de Instruções.* São Paulo: Minipa Indústria E Comércio Ltda,.

Pereira, D., 2010. *Fatos florestais da amazônia,* Belém: Imazon.

Souza, A.P., L.J. Minete and E.N. Silva, 2008. *Colheita florestal.* 2ª ed. Viçosa: UFV.

Souza, A.P., L.J. Minette and E.N. Silva, 2010. *Ergonomia aplicada ao trabalho.* 2ª ed. Viçosa: UFV.

Souza, N.D.d. *et al*., 2016. Estudo de Caso de uma Planta de Carbonização: Avaliação de Características e Qualidade do Carvão Vegetal Visando Uso Siderúrgico. *Floresta e Ambiente,* 23(2): 270-277.