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INTERNAL ENVIRONMENTAL CONDITIONS OF SOYBEAN PROCESSING PLANTS AND SAFETY IN WORKPLACE

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ABSTRACT: Currently, the domestic agricultural sector has become increasingly professionalized; therefore, measures aimed at safety in the workplace and monitoring of environmental risks have been gaining major importance in this scenario. Thus, this study aimed at assessing internal environmental conditions of four soybean processing plants (SPPs) operating with a screen-air machine, densimetric table and with or without spiral separator. These plants are in the state of Rio Grande do Sul (Brazil), being assessed on site considering every feature related to machinery and equipment, as well as technological level. Field evaluations comprised measurements of noise, illuminance and suspended dust. Results showed that none of the SPPs is in full accordance with current laws for the investigated parameters, among which noise level is what most threatens the environmental conditions. Moreover, lightening conditions are unsatisfactory since the environments are extremely dark, not reaching minimal standard. Regarding the suspended dust is possible to claim that there is an emerging risk.

KEY WORDS: seed processing, noise map, lighting study, chemical agents.

INTRODUCTION

Economic growth and technological expertise of the national productive sectors require actions on work safety and monitoring of environmental risks, including the agricultural sector.

Environmental risks are related to physical, chemical and biological agents from the workplace, which, depending on concentration, nature, intensity and exposure time, are capable of causing damage to workers' health (BRASIL, 2012).

Control measures against workers' exposure should be taken after a systematic and repeatable assessment of a given risk, aiming at, whenever needed, introducing new measures or modifying existing ones (BRASIL, 2012).

Once agro-industrial plants for seed processing present different risks, their identification may improve monitoring of environmental hazards as well as preventive strategies taken to minimize them, supporting thus occupational health.

Few data have been gathered in seed processing plants and no reports are found in literature. Therefore, taking into account the lack of data and the importance of the sector to the country's economy justifies completion of studies on the subject.

The main objective of this study was to evaluate internal environmental conditions of four soybean processing plants (SPPs) operating with screen-air machine (SAM), densimetric table (DT) and with or without spiral separator (SS). The SPPs were compared under parameters of air quality, noise and light distribution throughout the operating area.

MATERIAL AND METHODS

The study was carried in four SPPs chosen by presenting different technological levels in equipment and procedures and thus varied depreciation. They were numbered according to a scale of 1 to 4, within which (1) stood for the lowest technological level and highest depreciation and (4) for the highest technology and lesser depreciation. The plants that willingly participated in this

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study are located on the state of Rio Grande do Sul – Brazil. One of them is in southeastern state, another in southwestern and the other two are within northwestern state. It must be stressed that we have solely considered internal environmental issues without operators and external environments.

The plants have a similar processing flow chart only differing concerning equipment arrangements within the environment, dimensions of warehouses and SPP 3 has an extra equipment - a spiral separator. Maintenance of all plants were on schedule.

Evaluations comprised measurements of noise, lightening, and suspended dust according to the following methodologies:

NOISE: Noises were measured with use of sound pressure meter (SPL) properly calibrated and certified. The readings were taken during the working day, individually; identifying the noises emitted from the screen-air machine (SAM), from the densimetric table (DT) and from the spiral separator (SS) under two different conditions (open and closed place) besides the final noise composition.

Each SPP was subdivided into 2.5m equidistant points, forming a squared mesh. At each point, it was performed four readings (repetitions). The sound pressure meter operated in compensation circuit 'A' and 'SLOW' response circuit, and readings were taken at 1.5m above the ground as reference.

The mesh was used to interpolate data and generate a map of noise distribution across the warehouse (noise map), identifying critical areas following a safety reference of 85 dB (A), according to regulatory standards. The images composing the noise map were produced by computational resource, using a software for georeferenced mapping and plotting of surfaces in 3D.

ILLUMINANCE: Luminance distribution inside the SSPs was assessed with the aid of a calibrated certificated digital lux meter. The readings were made at points where industrial activities are performed, especially near SAM, DT and SS, in the morning period. Results were contrasted to a standard value of 300 Lux, which is used as a reference according to the item 5.3.31 related to Food Industries of ABNT 5413 standards.

DUST: Dust was quantified by a static collection representing a working day for operators involved in soybean processing. The methodology met the guidelines of NHO 08 - Occupational Hygiene Standards of FUNDACENTRO (2009), using a PVC membrane filter, with a 5-µm pore, 37-mm in diameter and a flow rate of 1.7 L min^{-1}.

The exposure limits were guided by standards of the American Conference of Governmental Industrial Hygienists (AGCIH), which establishes 10.0 mg m^{-3} for Particles Not Otherwise Specified (PNOS); as well as the guidelines in the Appendix 12 of the NR-15 standard, which sets a Tolerance Limit (TL) to silica of 8.0 mg m^{-3}. The results were achieved by calculations following the formula: $LT\ (mg\ m^{-3}) = 24\ (\%quartz + 3)^{-1}$

The qualitative assessment of existing dust inside SPPs was carried out by a method based on gravitation and surface adhesion described by SALIBA (2011). This methodology guides the collection of biological sediments on adhering surface.

Afterwards, a microbial survey was made by the Seed Pathology Laboratory of the Federal University of Pelotas (*UFPel*) through Blotter testing, in which Petri dishes with BDA culture medium were spread inside the SSPs, in four replicates. The dishes were then sent back to the laboratory for cultivation for 7 days, quantifying the growth of each fungus species.

RESULTS AND DISCUSSION

The results presented in Table 1 show that the noises emitted by the equipment exceeded the standard 85 dB (A) of the Annex 1 of NR-15 for an 8-hour working day. Therefore, personal protective equipment use is recommended for workstations near each equipment. The spiral separator SPP 3 was equipment that achieved the highest noise emission - 96 dB (A), it does not have any kind of noise reduction device; thus, the maximum permissible exposure near it is for 1 hour and 45 minutes, according to NR 15.

The threats of noises on humans are related to occupational health and of workers and potential hearing damages. The Brazilian legislation only recognizes the effects of noise on hearing, and these effects can be broken down into 3 phases: temporary change in hearing threshold, permanent change in hearing threshold and acoustical trauma.

By itself, noise presents a danger to human health when its levels are above 85 dB; however, this damage depends on exposure duration and routine. For this reason, audiometry is periodically made in industries from this loudness level. Noise-induced hearing loss (NIHL) is derived from excessive exposure to high-amplitude sounds; this is a chronic and irreversible disease since it affects the hairy cells of the organ of Corti. In addition, several experts recognize this condition as the most prevalent in work environments (GUIDA; MORINI; CARDOSO, 2010).

In general, operators perform multiple activities both inside the plant and in its surroundings; therefore, exposure to noise can be mitigated by switching the tasks of each worker, as a strategy for the prevention of NIHL.

The variations in the recorded noise levels described in Table 1 might be related to the model, manufacturing year as well as installation conditions. Based on, each plant is a different model, manufacturing year and size of installation, these data show that under all these different conditions, recorded values are near or above 85 dB; thus, there is a need for purchasing of new equipment to improve environmental comfort in the SSPs.

TABLE 1. Sound Pressure Level (SPL) emitted by each equipment screen-air machine (SAM), densimetric table (DT) and spiral separator (SS), and total SPL in four soybean-processing plants in the state of Rio Grande do Sul, Brazil (2013).

SPP	SPL SAM dB(A)	SPL DT dB(A)	SPL SS dB(A)	SPL Total dB(A)
SPP 01	92.20	94.80	-*	96.00
SPP 02	91.35	93.95	-*	98.05
SPP 03	94.40	83.00	96.00**	97.60
SPP 04	84.90	85.20	89.50***	94.04

*SPP without SS; **Open SS; ***Closed SS

Working with decibels (dB) generate non-linear data, therefore, the distortion could be expressed on a logarithmic scale (SALIBA, 2011). SPL is measured in decibels, which corresponds to ten times the logarithm to a base 10 of the relationship between sonorous intensity in the environment and a reference intensity, which corresponds to the minimum audible sound for a normal ear.

Total SPL shown in Table 1 is considering noise levels when all machines are operating at the same time, which represents a potential maximum noise inside each SPP studied.

The spiral separator was evaluated in further detail, since its emitted noise levels were checked for the same operating in open and closed environments. The enclosure of this equipment reduced by 6.5 dB (A) noise in the evaluated work places; therefore, it can be considered a useful and applicable strategy, even for the noisiest equipment in SPPs.

In all evaluated SPPs were found values superior to those issued by the NR-15. This way, we can suggest that improvements are to be made both on the machines individually, as on the system as a whole. Among them, changes in management strategy incorporating new technologies and others with potential use in SPPs. YANAGI JR. et al. (2012) reported that noise maps are useful to set management zones to be suited for worker safety and protection, as well as establishing different work plans and personal protective equipment for each evaluated machine.

The first step for building the maps was to make an individualized assessment of each machine, being followed by an evaluation of the set. The present hurdles (machinery, elevators, etc.) associated with the ratio between width and length of the built environment, to the behavior of the sound wave and the characteristics of the emission sources influence the noise map arrangement, as can be seen below:

Figure 1(a) shows noise distribution for SAM where the maximum value was of 92.2 dB (A). The blue stripes represent the areas of acoustical security for the given environment, considering SAM operating singly.

In turn, Figure 1(b) displays noise distribution behavior of DT where the maximum value was of 94.8 dB (A) near the machine; however, the noise map shows that DT working alone is able to eliminate all sound security areas within SPP 1. Total noise in SPP 1 shown in Figure 1(c) show readings above 85 dB (A), and may reach up to 96 dB (A), demonstrating to be an unsafe environment at all sampled points.

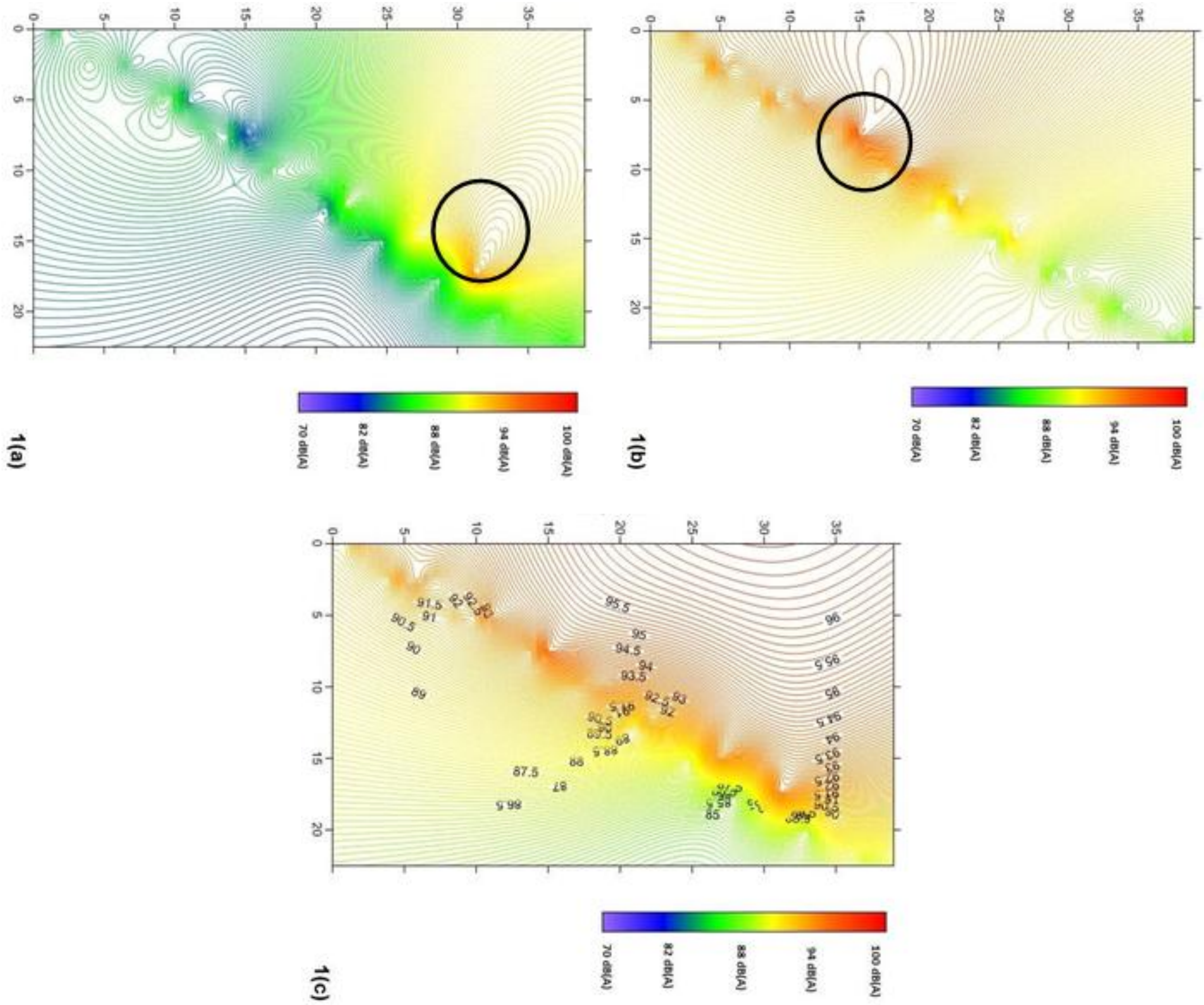

FIGURE 1. Noise map of Seed Processing Plant 1: (a) Distribution of noise emitted by the screen-air machine (b) Distribution of noise emitted by the density table (c) Distribution of the total noise.

Through Figure 2 (a), it is noteworthy that SAM noise distribution has a different behavior in SPP (1). In this case, the equipment is installed at the back of the building, opposite to SPP entrance with an outlet for sound waves produced by machinery. The maximum value found for SAM in SPP

2 was of 91.35 dB (A). This building feature and machinery arrangement enabled a greater acoustical security in the environment.

Yet Figure 2 (b) demonstrates DT noise distribution with a maximum value of 93.95 dB (A). As mentioned above, this building structure also favors noise distribution, however with less efficiency. This is because DT has a greater ability of sound emission and due to its central positioning within this SPP.

The total noise in SPP 2 showed a maximum reading of 98.05 dB (A), being thus an unsafe environment in most of the sampled points with small areas of refuge, as seen in Figure 2(c).

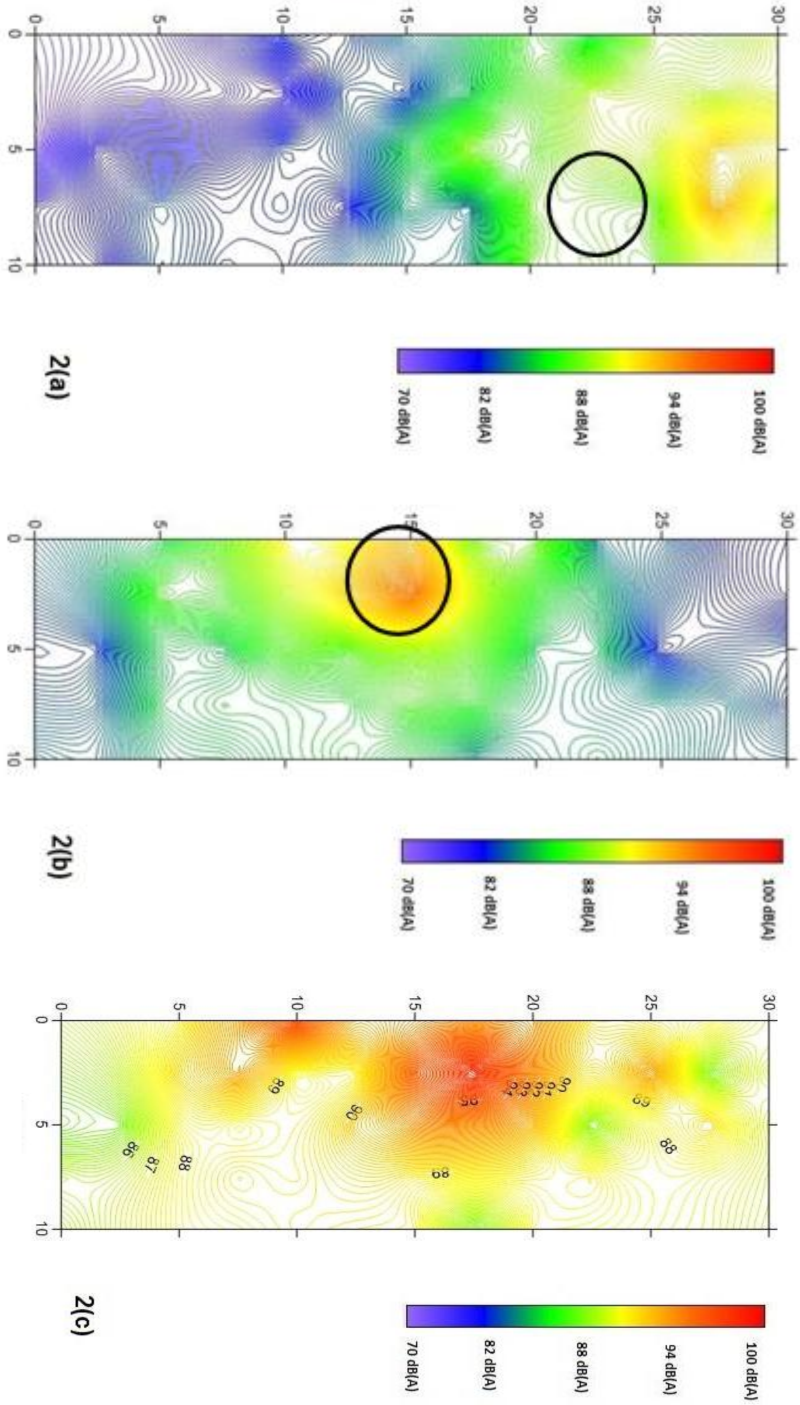

FIGURE 2. Noise map of Seed Processing Plant 2: (a) Distribution of noise emitted by the screen-air machine (b) Distribution of noise emitted by the density table (c) Distribution of the total noise

SPP 3 has as additional equipment an open spiral separator, besides SAM and DT. Figure 3 (a) shows distribution of noises emitted by SAM with a maximum value of 94.4 dB (A). Whereas Figure 3 (b) shows noise distribution for DT, which had a maximum reading of 83 dB (A). SPP entry is located near the blue area in the map. In Figure 3 (a), it is shown a noise outlet, and hence a higher acoustical security region is designed.

The open spiral separator evaluation is shown in Figure 3 (c), in which it is found the highest values for all the evaluated equipment of this SPP. A noise level of 96 dB (A) was produced by the spiral separator, eliminating the existing sonorous safety area observed in individual assessments of SAM or DT. The total noise in this SPP shows a maximum reading of 97.6 dB (A), also being an unsafe environment without any refuge areas, as shown in Figure 3 (d).

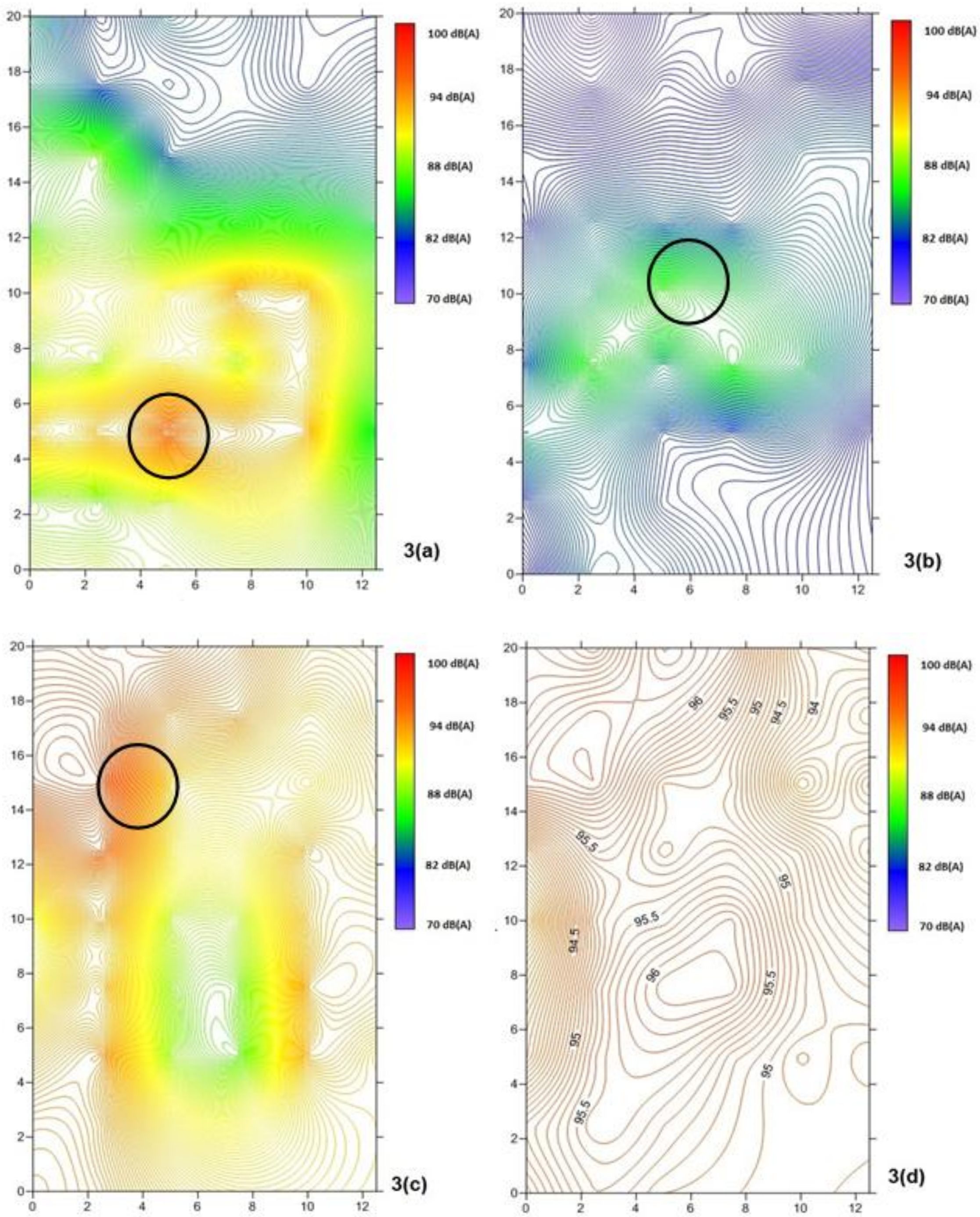

FIGURE 3. Noise map of Seed Processing Plant 3: (a) Distribution of noise emitted by the screen-air machine (b) Distribution of noise emitted by the density table (c) Distribution of noise emitted by the spiral separator in open environment (d) Distribution of the total noise.

Unlike SPP 3, SPR 4 was assessed with spiral separator closed. Figure 4 (a) shows distribution of SAM noise with a maximum limit achieving 84.9 dB (A), while Figure 4 (b) shows distribution of the noise emitted by DT, with a maximum reading of 85, 2 dB (A).

Figure 4 (c) displays the noise map of the enclosed spiral separator, with a noise value of 89.5 dB (A). Even in confinement, spiral remains causing the highest noises; however, the use of this strategy allowed a reduction of 6.5 dB (A). Total noise in SPP 4 had a maximum reading of 94.04 dB(A), distinguishing this environment as acoustically unsafe without refuge areas, as shown in Figure 4 (d).

BOTELHO et al. (2009) emphasized the audiometry relevance both in prevention as in monitoring of occupational hearing losses; moreover, these measurements are crucial for implementing occupational hearing conservation programs for employees exposed to noise levels above 85 dB.

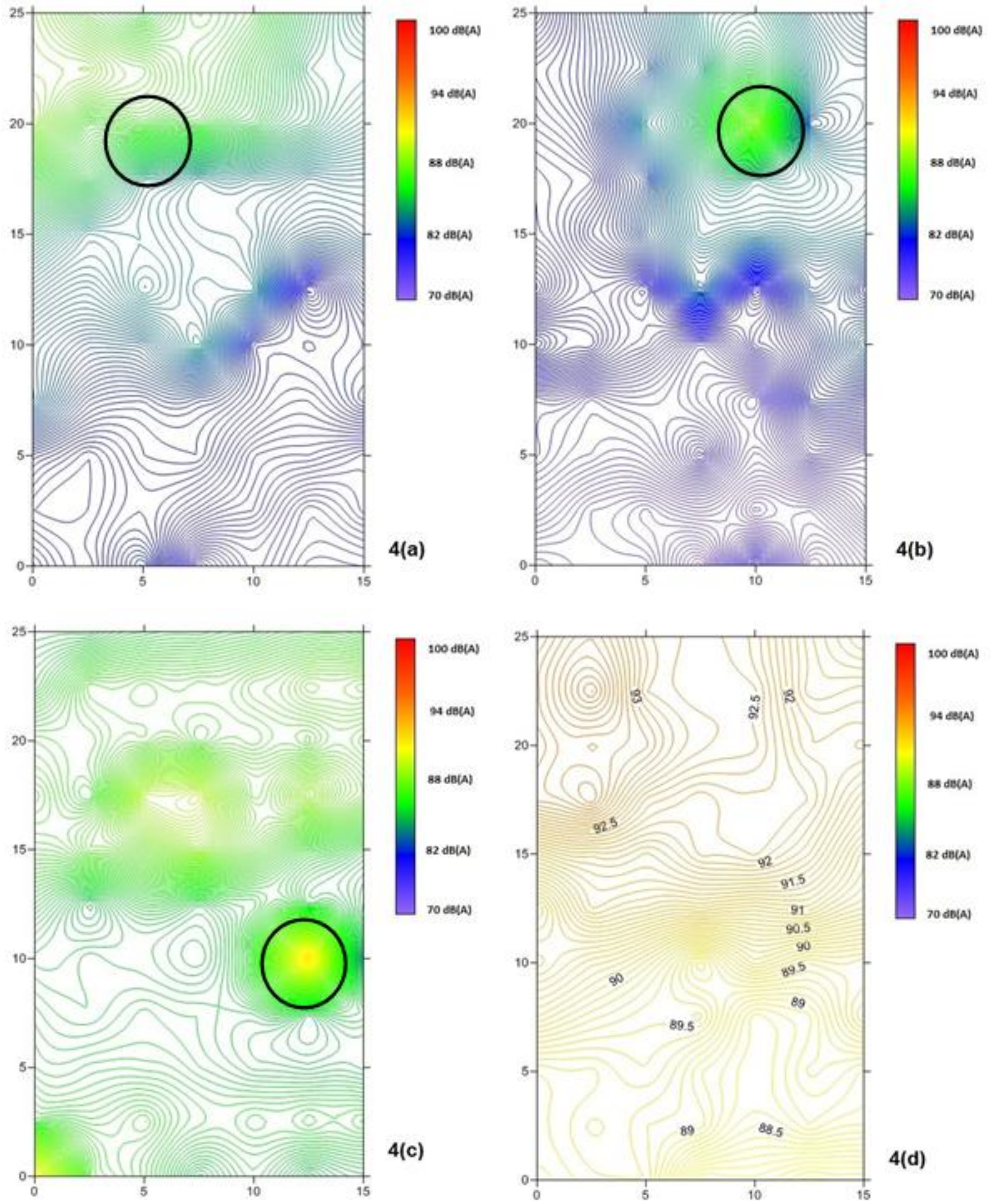

FIGURE 4. Noise map of Seed Processing Plant 4: (a) Distribution of noise emitted by the screen-air machine (b) Distribution of noise emitted by the density table (c) Distribution of noise emitted by the spiral separator in closed environment (d) Distribution of the total noise

Lightning studies for planning and adaptation of an SPP are still incipient, and end up being used standards and recommendations of other types of buildings. Illuminance on SPP workstations has major importance since machines has to be often inspected by operators, requiring certain skills to perform this visual task.

According to information in Table 2, the visual tasks performed in the studied machinery are carried out under 300 Lux, being a reference of the item 5.3.31 Food Industries of the ABNT 5413 standard. Considering this reference and the value of 1080 Lux suggested by TILLEY (2005) for "average machinery", the assessed SPPs work with amounts 3 times smaller. Among all stations surveyed, only DT in SPP 04 showed a higher illuminance level, being above 300 Lux.

TABLE 2. Lightning of the workstations assessed in the study: screen-air machine (SAM), densimetric table (DT) and spiral separator (SS) in four soybean-processing plants in the state of Rio Grande do Sul, Brazil (2013).

	Workstation lightning (Lux)		
SPP	**SAM**	**DT**	**PD**
SPP 01	87	180	147
SPP 02	121	68	252
SPP 03*	71 33	19 24	114 68
SPP 04*	96 90	343 210	249 259

*SPP seed processing dual line

If it were a tangible reality in the assessed SPPs, Table 2 would show an overview of fixed workstation. Therefore, lightning planning of these SPPs should be carefully designed to provide proper illumination to the workstations for the tasks to be handled.

Despite the minimum requirement of 10 Lux for obstacle visualization (DUL; WEERDMEESTER, 2004), the assessed SPPs had spots with lightning values of 19 Lux (SPP 01), 10 Lux (SPP 02), 2 Lux (SPP 03), and 7 Lux (SPP 04) even in morning readings. For that, these areas are at odds with the item 17.5.3 of the NR-17 standard (Ergonomics), which sets proper levels of lightning for each activity.

Poor lighting increases from 15 to 25% the number of occupational accidents in relation to bright environments besides reducing workers' performance by 10 to 40% (PIANTA, 2011). This lighting must be evenly distributed over the environment; nevertheless, it does not occur in any of the SPP visited, exhibiting points of lower illuminance and, consequently, higher risk of accidents. These outcomes corroborates PEREIRA et al. (2012) who reported a large variability in the lighting, which reinforces the need for spatial distribution characterization of illuminance.

The dust suspended in the air of the SPPs, intended to soybean processing, is composed of microorganisms and mixture of particles generated during seed processing. Nevertheless, exposure limits to these chemical agents have not been properly established yet.

The results of this experiment showed suspended dust limits of 8.0 $mg.m^{-3}$, however, the NR-9 - PPRA standard states, in the item 9.3.5.1.c, that when an occupational exposure limit is absent, it must be adopted the reference values of the American Conference of Governmental Industrial Hygienists - ACGIH (BRASIL, 2012). This organization sets a maximum exposure limit of 4.0 mg.m-3 for 8 hours daily for dust originating from processing of wheat, barley, and oats. However, the ACGIH does not cite values for soybean; thus, we used the tolerance limit (TL) recommended for Particulates Not Otherwise Specified (PNOS).

The outcomes of dust quantitative analysis in each SPP were compared to the above mentioned reference values and are displayed in Table 3.

TABLE 3. Dust quantitative and qualitative evaluations in four soybean-processing plants in the state of Rio Grande do Sul, Brazil (2013).

SPP	**- Quantitative analysis - Total Dust Concentration ($mg.m^{-3}$)**	**- Qualitative Analysis - Sedimented microorganisms**
SPP 01	4.41	*Rhizopus* sp., *Penicillium* sp., *Cladosporium sp.*, *Mucor* sp., *Aspergillus* sp., *Alternaria* sp., *Torula* sp., *Epicoccum* sp., *Nigrospora* sp., *Fusarium* sp., *Bacterial Colony*.
SPP 02	0.30	*Rhizopus* sp., *Penicillium* sp., *Cladosporium* sp., *Aspergillus* spp., *Alternaria* sp., *Torula* sp., *Epicoccum* sp., *Nigrospora* sp., *Fusarium* sp., *Trichoderma* sp., *Bacterial Colony*.
SPP 03	3.53	*Rhizopus* sp., *Penicillium* sp., *Cladosporium* sp., *Mucor* sp., *Aspergillus* spp., *Alternaria* sp., *Torula* sp., *Epicoccum* sp., *Nigrospora* sp., *Fusarium* sp., *Bacterial Colony*.
SPP 04	8.78	*Rhizopus* sp., *Penicillium* sp., *Cladosporium* sp., *Aspergillus* spp., *Epicoccum* sp., *Fusarium* sp., *Trichoderma* sp., *Bacterial Colony*.

Reference values: ACGIH (10.0 $mg.m^{-3}$) and NR-15/ Appendix 12 (8.0 $mg.m^{-3}$)

For PNOS, the AGCIH takes into account an exposure limit of 10 $mg.m^{-3}$. Therefore, the levels found in all SPPs are below TL established by the ACGIH, however, SPP 4 show levels above scope of action (SA) foreseen in the NR-9 (PPRA).

If the values found by formula proposed in the Appendix 12 of the NR-15 standard were used as a reference standard, SPP 4 would be above the TL, disregarding work safety standards; and SPP 1 needs an immediate adaptation since exceed the SA, being for the employer to adopt control measures to prevent workers' exposure.

According to the NR-9, SA is the level from which preventive actions should be taken as a way to minimize exposures to environmental agents and avoid them to reach their thresholds.

Our data corroborate findings of VIEIRA et al. (2013) who studied workers in timber sector where there is a significant concentration of particles in suspension, which directly undermines operators' health given the hazard of these components. The same authors observed that noises from wood processing and finishing machinery might endanger physical and psychological aspects of workers. In a global context, it is clear to notice the importance of ergonomics to improve workers' quality of life, with emphasis on physical, cognitive and organizational aspects of work.

The preventive measures include periodic monitoring of exposure, information provision to workers, and medical checkups. For this purpose, a systematic and repetitive assessment of exposure to a given risk should be carried out, allowing thus the input or even modification of a few control measures, whenever appropriate (BRASIL, 2012).

The dust measurements carried out in the SPPs were made along with evaluations of biological agents. The NR-9 standard envisages the identification of biological agents but does not establish an occupational exposure limit, contemplating only a qualitative assessment that confirms the presence or absence of a specific microorganism.

In the studied SPPs, it was found *Rhizopus* spp., *Penicillium* spp., *Cladosporium* sp., *Mucor* sp., *Aspergillus* sp., *Alternaria* sp., *Torula* sp., *Epicoccum* sp., *Nigrospora* sp., *Fusarium* sp., *Trichoderma* sp., bacterial colony, and fungal yeast, among which some are responsible for workers' illness.

The identification of microorganisms associated with quantitative dust assessment is the starting point for the implementation of Respiratory Protection Programs (RPP) suitable for each agro-industry, as part of a Medical Control Program for Occupational Health (PCMSO, acronym in Portuguese); being of responsibility of the occupational physician, the PCMSO coordination.

In Brazil, it is still little known the magnitude of risks from occupational exposure to plant dust; there is also a lack of preventive actions regarding environmental control and early identification of such impacts on the health of workers from agricultural and agro-industry sectors (THITBOEHL FILHO, 2004).

MAIA & RODRIGUES (2012) described the importance of product safety, wherein the working environment quality should be considered of extreme importance as workers are and must always be taken as the main actor of this process. For this, it is emphasized that any security investment reflects positively on worker's quality of life and, consequently, on its production capacity, avoiding potential expenses with compensations and other drawbacks.

Other risks should be taken into account, such as those discussed in reports of RUIZ & ARAUJO (2012), who stated that recently a few national and international documents have included aspects or psychosocial factors in the risk analysis, which traditionally includes solely objective aspects (chemical, physical and biological). We may quote some of these documents, which refer mainly to "events", "factors", or "situations" adverse that may cause endanger workers' health and working safety or even provide production impacts.

Currently, workers' morbidity and mortality in Brazil are characterized by grievances coexisting in certain working conditions, such as typical occupational accidents and "diseases related to work". The latter have their frequency, emergence, and severity related to the type of work. Nonetheless, another factor is the common diseases in population that have no cause relationship to work conditions, however, affect workers' health (FERREIRA et al., 2012).

CONCLUSIONS

The evaluated soybean-processing plants (SPPs) are not in fully accordance with current legislation for parameters related to noise, lightning and dust levels.

Noise is the physical agent of greatest impairment of working environmental quality in the SPPs, highlighting the spiral separator working in an open environment as the most noise-promoting machine in the SPP; and when working enclosed, it reduces sound pressure in 6.5 dB, for the studies conditions.

The lack of official standards for tolerance limit to soybean dust exposure hampers interpretation of results as well as establishment of safety levels for soybean seed processing operations.

REFERENCES

ABNT – Associação Brasileira de Normas Técnicas. **NBR 5413 – Iluminância de interiores**. Rio de Janeiro, 1992. p.13.

BOTELHO, C.T.; PAZ, A.P.M.L.; GONÇALVES, A.M.; FROTA, S. Estudo comparativo de exames audiométricos de metalúrgicos expostos a ruído e ruído associado a produtos químicos. **Revista Brasileira de Otorrinolaringologia**, v.75, n.1, p.51-57. 2009. Acessado em: 10 dez. 2013. Disponível em: http://www.scielo.br/scielo.php?script=sci_arttext&pid=S0034-72992009000100008&lng=en&tlng=pt .

BRASIL. Ministério do Trabalho e Emprego. Manual de Segurança e Medicina do Trabalho: Ed. Atlas, 2012. 816p.

DUL, J.; WEERDMEESTER, B. **Ergonomia prática.** 2.ed. São Paulo: Edgard Blucher, 2004. 137p.

FERREIRA, B.L.A.; VIEIRA NETO, F.G; FRANCO, H.M.S.L.; SOUZA, I.O.P; MOTA, J.D.T.; POLIDO, J.A.; SILVA, M.J. Segurança no trabalho: uma visão geral. **Cadernos de Graduação - Ciências Exatas e Tecnológicas.** v. 1, n.15, p. 95-101, 2012. Acessado em: 10 dez. 2013. Disponível em: https://periodicos.set.edu.br/index.php/cadernoexatas/article/view/209/129

FUNDACENTRO. Norma de higiene ocupacional - **NHO 08: Coleta de Material Particulado Sólido Suspenso no Ar de Ambientes de Trabalho**. São Paulo: **Fundacentro**, 2009. Disponível em: <http://www.fundacentro.gov.br/dominios/SES/anexos/NHO08_portal.pdf> Acesso: 22 julho 2012.

GUIDA, H. L.; MORINI, R.G.; CARDOSO, A. C. V. Avaliação audiológica em trabalhadores expostos a ruído e praguicida. **Brazilian Journal of Otorhinolaryngology**, v.76, n.4, p423-427. 2010. Acessado em: 10 dez. 2013. Disponível em: http://www.scielo.br/scielo.php?script=sci_arttext&pid=S1808-86942010000400003&lng=en&tlng=pt

MAIA, L. R.; RODRIGUES, L.B.. Saúde e segurança no ambiente rural: uma análise das condições de trabalho em um setor de ordenha. **Ciência Rural**, v.42, n.6, 1134-1139. 2012. Acessado em: 10 dez. 2013. Disponível em: http://www.scielo.br/scielo.php?script=sci_arttext&pid=S0103-84782012000600030&lng=en&tlng=pt

PEREIRA, P.A.; YANAGI JUNIOR, T.; SILVA, J.P. DA; LIMA, R. R. DE; CAMPOS, A.T.; ABREU, L. H. P. Technical evaluation of artificial ligthing systems for broiler houses. **Engenharia Agrícola**, v.32, n.6, p.1011-1024. 2012. Acessado em: 10 dez. 2013. Disponível em: http://www.scielo.br/scielo.php?script=sci_arttext&pid=S0100-69162012000600002&lng=pt&tlng=en

PIANTA, J.A.B. **Pericias do trabalho: iniciação e metodologia**. 1.ed. Porto Alegre: NEXT, 2011. 627p.

RUIZ, V. S.; ARAUJO, A.L.L.. Saúde e segurança e a subjetividade no trabalho: os riscos psicossociais. **Revista Brasileira de Saúde Ocupacional**, v.37, n.125, p.170-180. 2012. Acessado em: 10 dez. 2013. Disponível em: http://www.scielo.br/scielo.php?script=sci_arttext&pid=S0303-76572012000100020&lng=en&tlng=pt

SALIBA, T. M. **Manual prático de higiene ocupacional e PPRA**: avaliação e controle de riscos ambientais. 3.ed. São Paulo: LTr, 2011. 352p.

THITBOEHL FILHO, C.N. **As doenças respiratórias ocupacionais causadas pela poeira na armazenagem de grãos vegetais**. II Tese (Doutorado). Programa de Pós-graduação em Medicina Interna - Pneumologia. Universidade Federal do Rio Grande do Sul. Porto Alegre , 2004. 147p.

TILLEY, A.R.**As medidas do homem e da mulher**. Porto Alegre: Bookman, 2005. 104p.

VIEIRA, G.C.; CERQUEIRA, P.H.; FREITAS, L.C. Qualidade de vida dos profissionais do setor madeireiro de Vitória da Conquista-BA. **Floresta e Ambiente**, v.20, n.2, p.231-237. 2013. Acessado em: 11 dez. 2013. Disponível em: http://www.scielo.br/scielo.php?script=sci_arttext&pid=S2179-80872013000200011&lng=en&tlng=es

YANAGI JUNIOR, T. ; SCHIASSI, L.; ROSSONI, D.F.; PONCIANO, P.F.; LIMA, R.R. Spatial variability of noise level in agricultural machines. **Engenharia Agrícola**, v. 32, n.2, p.217-225. 2012. Acessado em: 10 dez. 2013. Disponível em: http://www.scielo.br/scielo.php?script=sci_arttext&pid=S0100-69162012000200002&lng=pt&tlng=en