



Noise Induced Hearing Loss in Agriculture

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Production agriculture can generate high noise levels. Noise is typically defined as unpleasant, unwanted, or hazardous sound. Tractors, forage harvesters, silage blowers, chain saws, skid-steer loaders, grain dryers, squealing pigs and guns are some of the most typical sources of noise on the farm. Studies suggest that lengthy exposure to these high sound levels have resulted in noise induced hearing loss to farmers of all ages, including teenagers. A serious hearing loss injury is not as dramatic nor as sudden as a tractor overturn or machine entanglement injury, but it is permanent. This fact sheet is about how to manage damaging noise levels on farms to reduce hearing loss. Hearing conservation measures that meet Occupational Safety and Health Act (OSHA) Standard 1910.95 are briefly reviewed.

Sound and Hearing

Sound can be thought of as invisible air waves that spread or ripple across space. Sound waves are often referred to as vibrations. Sound waves enter through the ear canal and vibrate the eardrum, both in the outer ear. Three small bones of the middle ear (the hammer, anvil & stirrup) amplify and transmit the vibrations to the cochlea in the inner ear. The cochlea is filled with fluid and tiny hair-like structures, cilia, that wave like grass. The waving of the cilia translates the sound waves into nerve impulses for the brain. Our brain then interprets these impulses as sound (hearing). Figure 1 illustrates parts of the ear important for understanding hearing.

Sound has two properties that are important in preventing noise induced hearing loss: frequency and intensity. Sound *frequency* refers to how many vibrations occur in one second and is measured in Hertz units, abbreviated Hz. *Intensity* is the power or size of the sound pressure. The perceived *loudness* of a sound is dependant upon both

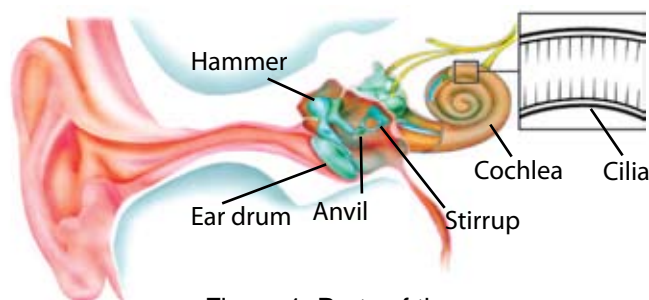


Figure 1. Parts of the ear.

frequency and intensity along with other factors such as how close one is to the sound source and the health of one's ears.

Hearing and measuring increasing sound levels are complex phenomena, in part because humans can hear a very wide range of sounds. For this reason, loudness is measured using decibels (dB), a logarithm scale that allows the use of small numbers to reflect large relationships. The "A" decibel scale (dBA or dB(A)) is the one most often used to reflect human hearing. In this case the increases are on a scale of 10. For example, an increase of sound from 70 dB(A) to 80 dB(A) is 10 times louder and another increase of 10 dB(A) (to 90 dB(A)) is 100 (10 x 10) times louder to the ear. With a logarithm scale, two equal sounds do not add together normally. For example, two sounds, each measuring 90 dB(A), result in a total sound level of 93 dB(A), not 180 dB(A). Finally, measuring decreasing sound level is no less complex: when the distance from the sound source is doubled, the sound level falls to one-fourth the original level in unobstructed space, or roughly 6 dB(A) decrease for every doubling of the distance from the source. This decrease will be much less if the sound is enclosed in a building and is reverberating off of walls, ceiling or other flat surfaces.

Too Much Sound

Sound as air waves is a commonly used analogy in explanations about hearing and noise induced hearing loss. It is also helpful to think of sound waves as "energy" that radiates out in all directions from the sound source. This analogy is useful in understanding what happens when our ears are exposed—or assaulted—with too much sound. Hazardous sound exposure is related to sound intensity (loudness) and length of exposure to the sound. The energy that is associated with sound that is too loud and/or lasts too long will over-stimulate the cilia (hair cells) of the inner ear and leave it in a "flattened" state, interfering with the nerve impulses sent to and interpreted by the brain (hearing).

A way to think about this is to compare over-stimulated cilia to walking on grass. A few people sauntering across a bit of grass and it will hold up just fine. Have an all-day party with twenty or thirty people and it might be a little worse for the wear. Depending upon the activities, it might look pretty good by the end of the week. But have a party every day for a week and there won't be much left. Fortunately, you can reseed the grass. Unfortunately, you can't "reseed" your hearing.

There are many common signs that indicate a person is losing their ability to hear. If you find yourself turning up the TV or radio, if you have difficulty understanding the consonants in words, the high notes of music, or hearing a voice while standing only a few feet away, it may be an indication of hearing loss. It is important to understand that some hearing loss is normal as we get older, and that it can be difficult to separate naturally occurring hearing loss (presbycusis) and lifestyle hearing loss (loud music, hunting) from noise induced hearing loss. If your ears ring after exposure to workplace noise, you can't hear a co-worker standing an arms-length away, or you can't hear normal conversation, TV or radio at the end of a work day, then your hearing loss is more likely to be noise induced. Regular monitoring of workplace noise and annual testing of worker's hearing help establish connections between workplace noise and hearing loss.

Occupational safety and health standards are used to set "safe" levels of noise in the workplace, even though professionals acknowledge that some people may suffer from noise induced hearing loss at levels below the standard. The accepted levels in the United States come from OSHA and are contained in Table 1. While 90 dB(A) is the level of noise permissible for a 8 hour work day, 85 dB(A) is the level at which action for hearing protection is recommended for everyone. This is discussed more in a later section. Exposure to impulsive or impact noise, such as firing a gun, should not exceed 140 dB(A).

Table 1. OSHA Permissible Noise Exposures

Duration per day (hours)	Sound level dB(A)
8	90
6	92
4	95
3	97
2	100
1-1/2	102
1	105
1/2	110
1/4	115

Protect Your Hearing

Protecting your hearing begins with recognizing how much sound is too much and then effectively limiting exposure to hazardous levels. Sound level can vary significantly among similar items, depending on age, maintenance, and specific features. For example, 30-year old tractors without cabs are going to be louder than a new tractor with an enclosed cab. An old air compressor without a muffler will be louder than a new air compressor with a muffler. Typical sound levels from general and agricultural sources are shown in Table 2. Many of the general items listed also exist on the farm.

Protecting your hearing is a smart move for a number of reasons. While hearing aids are a very useful tool they do not correct hearing as eye glasses can correct one's vision. They only aid the hearing process if hearing is not too far gone. Hearing loss also carries consequences beyond not being able to hear. A key element of how we connect with others is affected and relationships suffer. Work and social situations can be uncomfortable and stressful. Work can even become dangerous. Exposure to noise affects more than one's hearing: it increases blood pressure, narrows blood vessels (both which affect the heart) and causes abnormal hormone secretions. It can contribute to sleeplessness which then can affect work.

Reducing Noise

Noise reduction measures must address the sound source and all workers in the area. Noise reduction, noise isolation, administrative controls, and personal protective equipment are the major strategies to be applied. Can methods or actions be used to reduce noise from the source? Can the worker be isolated from the source of the noise? Can work rules be set to limit exposure to high levels of noise? Finally, what personal protective equipment can be best used to reduce exposure to high noise levels? Consider the following:

Noise reduction with farm equipment can be accomplished in several ways, often related to maintenance of the equipment. Worn, loose, or unbalanced machine parts can increase decibel levels during operation. Regular lubrication and parts replacement (bearings, mufflers, silencers, etc.) reduce friction and lower noise levels. Larger engines that can be operated at lower speeds reduce noise levels, and may even conserve fuel. When new machinery is purchased, make sure that it is quieter than old machinery (Figure 2). Vibration isolation pads may be installed under the legs of noisy equipment to reduce noise generated by the equipment vibrating on a cement floor. Newer chain saws and leaf blowers have flexible mountings to reduce vibration-induced noise as well.



Figure 2. Older tractors expose the operator to higher noise levels than tractors with an acoustical ROPS cab.

Table 2. Typical sound levels

Sound levels in dB(A)	General	Agriculture
0	Threshold of hearing (weakest sound)	
40	Quiet office, library	
50 – 60	Normal conversation	
55 - 70	Dishwasher	
74 – 112		Tractor
77-120		Chainsaw
79 – 89	Riding mower	
80 - 105		Combine
81 – 102		Grain dryer
83 -116		Crop dusting aircraft
85 – 106		Orchard sprayer
85 -115		Pig squeals
88 - 94		Garden tractor
93-97		Grain grinding
110	Leaf blower	
110 - 130	Rock concert	
125	Jet plane at ramp	

Sources: *Hearing Loss in Agricultural Workers, National Safety Council, Itasca, IL. League for the Hard of Hearing, New York, NY*

Noise isolation can involve either engineered features or management actions. Tractor and skid-steers can be purchased with sound reducing cabs and tightly fitted cab doors and windows to reduce how much outside noise reaches the operator. Acoustical materials may be installed on walls and ceilings to enclose sound.

Administrative controls involve controlling the employee’s exposure to noise sources. Practices such as workstation rotation, where workers are limited to how long they are at a noisy workstation, can be an effective means of reducing noise hazard exposure. For example, worker A may operate a noisy machine for 1 hour and then moves to a quieter job while worker B operates the machine. It may be possible to bring noise exposure down to an acceptable level by moving a work location farther away from a source, or by re-scheduling some work to be done only during less noisy times. For example, silo unloading operations often result in high sound levels. This may not be the time for another worker to repair the roof of the silo unloading room. Employees with known hearing loss should not be scheduled to work in high noise level areas.

Reducing noise levels through engineering or administrative controls may still not reduce the noise hazard to an acceptable level. If not, personal protective equipment (PPE) must be worn. Without actual noise measurement of each job site, general

decibel levels produced by farm equipment must be used to make these management decisions (review Table 2).

Personal Protective Equipment (PPE)

Personal protection for hearing comes in two basic forms—ear plugs and ear muffs (see insert). Each has its advantages and disadvantages so it’s important for each individual to choose what they will consistently use. Size and construction material contributes to comfort and a snug fit which are important for effective noise reduction.

Ear plugs are made to fit into the ear opening and may be disposable or reusable. Both are available in different shapes, sizes, and stiffness. Ear plugs may also have cords and/or stems attached for removing and inserting them repeatedly or when hands are dirty. Ear plugs can be a source of ear infection so they must be kept clean and sanitized. Do not share ear plugs with others as ear infection can be spread in this way.

Disposable ear plugs are compressed before inserting into the ear and then expand to fill the ear canal. Disposable plugs should be thrown away at the end of the day as they cost only pennies a piece when bought in bulk.

Reusable ear plugs can come pre-molded or moldable, or they can be custom fitted.

Custom molding is most often done by an audiologist but some companies provide materials to create a mold that are then returned for manufacturing your ear plugs. Reusable plugs must be cleaned after each use. The materials ear plugs are constructed of and the amount of their use contribute to how long a reusable plug can be used. Always check manufacture recommendations but no matter what, replace them if they become cracked, dirty or are no longer pliable. Prices range from a few dollars up to \$20 for reusable plugs. Custom molded plugs range from \$75 to a few hundred dollars.

Ear muffs can be used for years and generally cost between \$20 and \$50 a pair. They cover the ear and ear canal to provide a barrier to sound. Make sure they fit well with a good seal against the head and that they are comfortable. They do not block out all sounds, therefore, conversation for information and safety purposes is readily heard. Some models are made for use in combination with other safety equipment such as goggles, a hard hat, and/or respiratory protection. Ear muffs can be uncomfortable in hot and humid weather and can be problematic in confined spaces.

Ear protection devices are ranked by their Noise Reduction Rating (NRR). The NRR is a single-number rating method which attempts to describe a hearing protector based on how much the overall noise level is reduced by the hearing protector. An NRR 25 rating suggests that noise will be reduced by as much as 25 decibels under ideal conditions.

For example, in a 105 dB(A) work area, a device with a NRR of 25 dB would suggest an exposure level of 80 dB(A). This assumes a perfect fit and that the worker is wearing the hearing protector the entire time he or she is exposed to the 105 dB(A) noise level. Numerous field studies suggest that perfect wearing and use of hearing protection is rarely achieved. Most safety and health professionals discount the NRR on ear plugs and muffs by up to 50%.

Summary

Consumer and agricultural equipment often generates high sound levels which can damage a person's hearing with prolonged exposure. Older equipment may pose more intense sound risks than newer equipment due to wear of parts, lack of maintenance, and the equipment design itself. When possible, noise reduction should be achieved using regular machine maintenance and noise isolation techniques. Replacement equipment should be evaluated for noise abatement design and construction which isolates the sound hazard from the operator's workstation. Limiting exposure by scheduling and rotating workers away from extended noise exposure areas can decrease exposure to high noise work. When reduction, isolation, and administrative actions fail to decrease noise levels to acceptable levels, then personal protective equipment (PPE) such as ear muffs or ear plugs is required. "What did you say?" should become a question of interpretation of the work required, rather than a question based upon loss of hearing.

References

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Occupational Noise Exposure. Occupational Safety and Health Standard 1910.95, US Department of Labor, Washington DC. Accessed at www.osha.gov.

Noise Levels in Our Environment Fact Sheet. League for the Hard of Hearing, New York, NY. Accessed at www.lhh.org/noise/decibel.htm.

Information in this Fact Sheet is of value to all agricultural producers and their families. Producers who employ 10 or more employees should also be aware of OSHA standard 1910.95 (Occupational Noise Exposure) to become aware of the hearing conservation program required when permissible noise exposure levels are exceeded.

Information on how to comply with these OSHA Standards is beyond the scope of this Fact Sheet but detailed information and sample programs are available on the web by searching with the words "sample hearing conservation program", reviewing Standard 1910.95 (www.osha.gov, click on Standards) or by contacting local safety professionals or industrial hygienists.

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