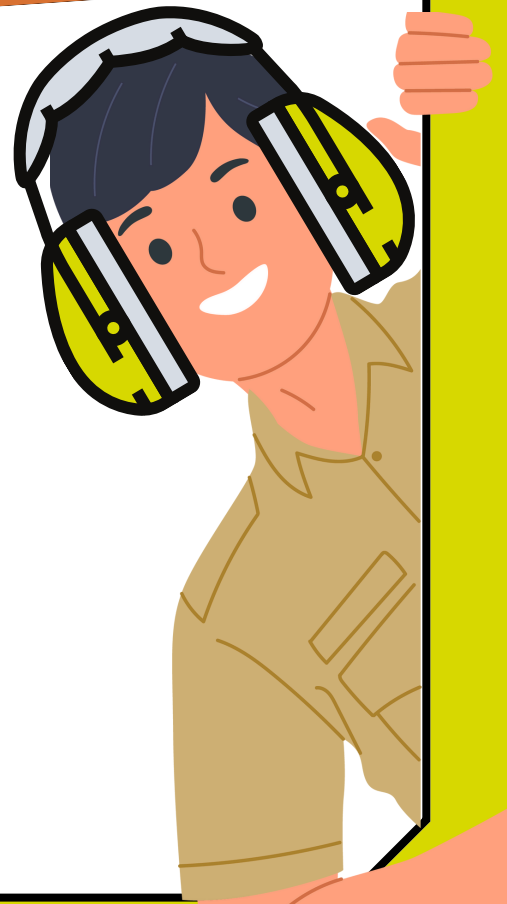# HEARING
PROTECTION
UNIT 4

GREAT PLAINS
Center for Agricultural Health

CHAPTER DISCUSSION QUESTIONS

CHAPTER 1. How Loud Is Too Loud?
When talking with farm workers, how would you start the conversation about noise on the farm?

CHAPTER 2. Assessing Hazards with Smartphones
Go to your telephone's app store and look for sound level meter apps. Find a couple of free ones, check the reviews, and given them a try. Can you set up the meter in A-weighting? Get a TWA of Leq? Select the "NIOSH" setting (exchange rate of 3 dB)?

CHAPTER 3. Hearing Loss Prevention Options
Identify three noise sources and identify which method would be the most appropriate to reduce the risk of long-term hearing damage from each source: Could you buy/use something quieter? Is maintenance needed? Could you move the noise to a location further away from you? Can you minimize time spent being exposed?

CHAPTER 4. Hearing Protection: Selection & Use
Look around the internet and find three examples of reusable plugs and three examples of formable plugs that look like they are different from one another. Pick examples that you would want people to give feedback on which they like better. Make a table with the name, manufacturer and the NRR for each device.

CHAPTER 5. Hearing Protection: NRR & Fit Checks
Use the table you generated for the last section and calculate the (NRR - 7)/2 derating and the NIOSH method (NRR*fraction) - 7 to calculate effective NRRs for the devices you selected. Are you still willing to recommend the devices you selected last time knowing what you know now?
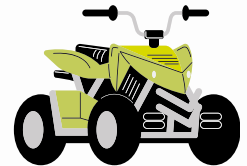
CHAPTER 6. Communicating Risk
Reflect on PPE that you have been required to wear on the job and remember when you first started to wear it. Then reflect on how confident you were with wearing it correctly and how comfortable it was or wasn't. Now, think about how it has become second nature. How would you use your experience to encourage workers to adopt hearing protection?

HOW LOUD IS TOO LOUD?

| Farm Equipment	Noise Level	Max Safe Time*	*Max time without wearing hearing protection
ATV, Push Mower	90 dBA	2.5 HRS	
Tractor/Combine (with Cab), Grain Auger	92 dBA	1.5 HRS	
Air Compressor, Shop Vac	95 dBA	47 MIN	
Pigs Squealing, Irrigation Pump	100 dBA	15 MIN	
Riding Mower, Pressure Washer	102 dBA	9 MIN	
Tractor (No Cab), Grain Dryer	105 dBA	4 MIN	
Leaf Blower	110 dBA	1-2 MIN	
Chain Saw	115 dBA	< 1 MIN	
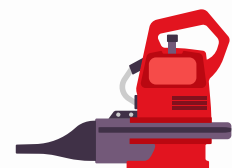
ASSESSING HAZARDS
WITH SMARTPHONES

YOUR APP SHOULD:

- Allow you to take A-weighted sound level measurements.
- Allow for a slow response setting.
- Collect time-weighted measurements (look for "TWA" or "Leg").
- For TWAs, you want to use one that has a criterion of 85 dBA and an exchange rate of 3 dBA, often called "NIOSH" setting.

Look at the two examples (from different apps) located on this page. These graphics illustrate how to look for the components listed above.
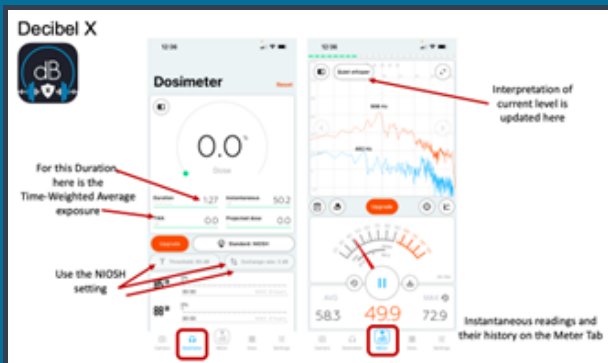
To use a smartphone as a sound level survey, position the phone an arm's length away (so the body is not blocking any noise). Use a slow response setting and obtain a 1-minute average. To measure personal exposures, ideally the phone should be placed near the shoulder (by the ear).
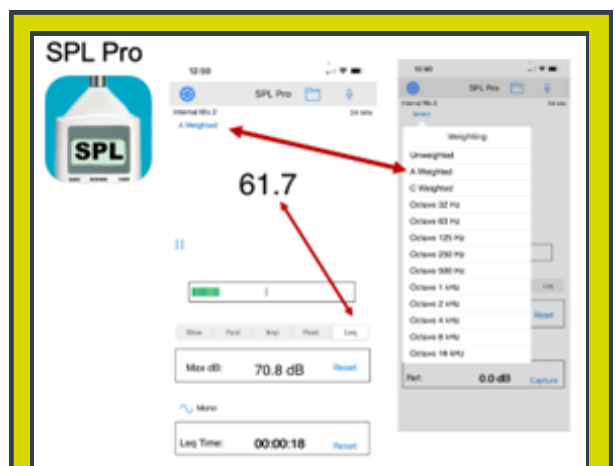
The purpose of using these apps is to find tasks, equipment, and operations where a worker would have exposures above 85 dBA and measure what those sound levels are. **Workers should be wearing hearing protection in these areas.**

HEARING LOSS
PREVENTION OPTIONS

① Reduce sound levels by selecting equipment with the quietest option. When purchasing new equipment, go for what is quiet.

Rule of Thumb: Any new equipment that is 10 dB quieter than the existing noise level that it is being added to will not introduce any new sound to the environment.

② Perform routine maintenance. By keeping equipment lubricated and balanced, sound levels can be reduced substantially.

③ Mark areas/equipment with "HIGH NOISE" signs to remind people to minimize time in the area and to wear hearing protection.

④ Isolate workers from noise. If there is equipment that is loud and that workers do not need to be around, block off the area when it is operating. If you double the distance between the worker and a noise source, the level of noise exposure can be reduced by 6 dB.

⑤ Limit daily noise exposure durations. This includes moving away from noise sources when possible, scheduling noisy work over several days rather than all at once, and other administrative options to spread the exposure and give ears a chance to recover after reduced exposure time to loud noise.

⑥ Select hearing protection that both fit and will be worn in high noise areas. Make hearing protection available at high noise areas.

EXAMPLES

SELECTION & USE

HEARING PROTECTION

What type is best for you?

EARMUFFS

PROS	CONS
Good protection	May not fit well over glasses
Reusable	Higher initial price
Easy on/off	Facial hair may affect fit
Radio option allows you to listen to sports/music	Uncomfortable in hot environment

FORMABLE EARPLUGS

PROS	CONS
Good protection	Easy to lose
Lowest initial price	Disposable
Comfortable	More time to insert
Can be worn with glasses and earrings	Requires clean hands for insertion

PUSH-IN EARPLUGS

PROS	CONS
Low initial price	Lower protection
Easy on/off	Must have correct size
Reusable	Easy to lose
Use stem for quick and clean insertion	Can become uncomfortable after long periods of time

Earplugs are cheaper than hearing aids!

HOW TO INSERT FORMABLE EARPLUGS

1) ROLL between your thumb and fingers

2) REACH over your head and pull up on your ear

3) INSERT rolled plug into ear canal

4) HOLD plug in place as it expands to ensure proper fit

GOOD   BAD

GPCAH.org

NRR & FIT CHECKS

There are two equations that can be used to help determine the limitations of hearing protection devices.

OSHA NRR Conversion to A-Weighted Scale:

- ☐ Adjust NRR by 7 to account for scale

- ☐ Then use 50% safety factor

Effective Reduction = (NRR - 7)/2

NIOSH Derated NRR

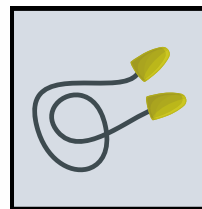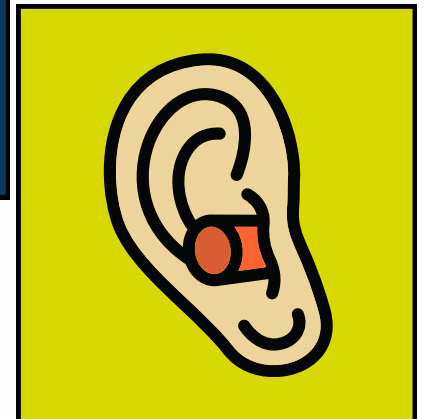- ☐ Use safety factor (function of type of HPD) to derate NRR

  Muffs: 0.75 (NRR)

  Formable: 0.5 (NRR)

  Other: 0.3 (NRR)

- ☐ Subtract this derated NRR by 7 to account for scale

  Effective Reduction = NRR $_{derated}$ - 7

REMEMBER:

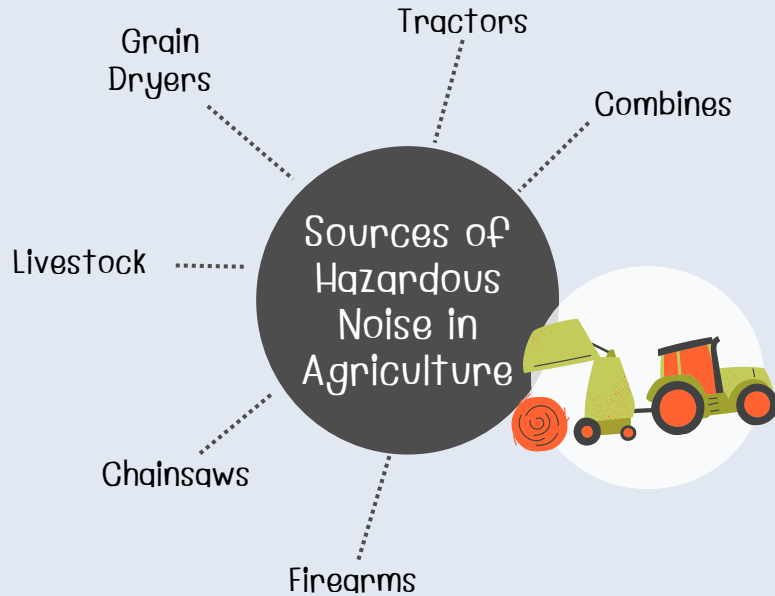The safe level for noise exposure is less than or equal to 85 dBA for an 8-hour day.

COMMUNICATING RISK

Signs & Symptoms of Hearing Loss

- A ringing in the ear or buzzing occurring in the ear
- Difficulty hearing other people clearly
- Listening to the radio or television louder than normal
- Asking co-workers or family members to constantly repeat themselves
- Difficulty hearing on the phone

Sources of Hazardous Noise in Agriculture

- Grain Dryers
- Tractors
- Combines
- Livestock
- Chainsaws
- Firearms

Hearing loss from exposure to noise is common among farmers & agricultural workers

Why should agricultural workers be concerned about hearing loss?
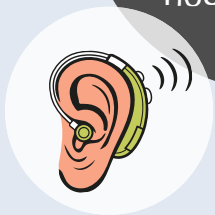
Hearing loss from noise is permanent & irreversible

Hearing loss from noise can be prevented

Hearing Protection
RESOURCES

CHAPTER 1

- Noise Exposures on the Farm: https://onlinelibrary.wiley.com/doi/epdf/10.1111/j.1748-0361.2010.00306.x
- Effects of Common Agricultural Tasks on Measures of Hearing Loss: https://onlinelibrary.wiley.com/doi/full/10.1002/ajim.22077

CHAPTER 2

- *So How Good Are These Smartphone Sound Measurement Apps (2022):* https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4545478/

CHAPTER 3

- CDC: https://www.cdc.gov/hearing-loss/prevention/?CDC_AAref_Val.html
- NIOSH Tips on Preventing Occupational Noise-Induced Hearing Loss: https://www.cdc.gov/niosh/noise/prevent/?CDC_AAref_Val.html

CHAPTER 4

- See posters at: https://gpcah.public-health.uiowa.edu/materials-for-health-care-providers/
- See RACK Cards in both English and Spanish at: https://gpcah.public-health.uiowa.edu/outreach-2/topics/hearing-loss-prevention/

CHAPTER 5

- For more information on testing whether your hearing protection fits: https://www.cdc.gov/niosh/mining/content/quickfitweb.html
- Examples of Calculating Noise Attenuation: https://www.ccohs.ca/oshanswers/prevention/ppe/ear_prot.html

CHAPTER 6

- McCullagh et al. (2016a). Effects of interventions on use of hearing protectors among farm operators: A randomized controlled trial; *International Journal of Audiology*. 2016. 55 (Supp 1): S3-S12. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4740201/
- McCullagh et al. (2016b). Gender differences in use of hearing protection devices among farm operators. *Noise and Health.* https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5227018/
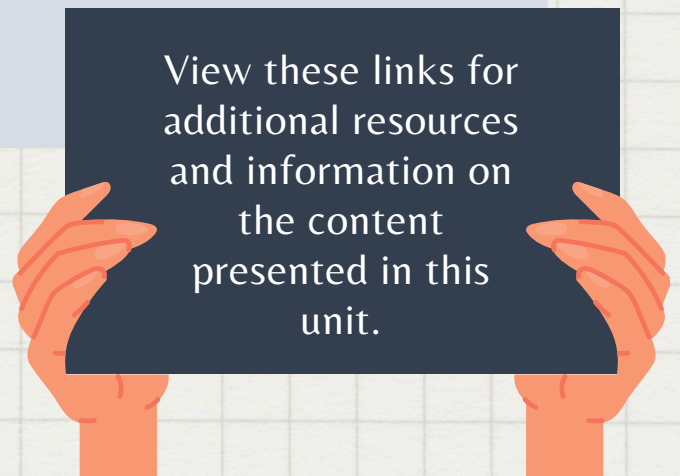
View these links for additional resources and information on the content presented in this unit.

Calculating 8-Hour Exposure Limits

For this bonus section, we will go through an example for calculating 8-hour exposures, using the table described in the bonus chapter audio file.

(1) **The equation for time allowed is:** $\quad Time, hr = \dfrac{8\ hr}{2^{\frac{(Lav - 85)}{3}}}$

(2) **The equation to compute the dose, as a fraction, is:** $\quad Dose = \sum \dfrac{Time\ Exposed}{Time\ Allowed}$

(3) **The equation to compute the daily dose into TWA, in units of dBA is:** $\quad TWA = 10\log(dose) + 85$

Below is our table. We identified tasks, measured Leg from our smartphones, and estimated the amount of time spent doing a particular task on a particular day.

The light gray column (time allowed, hr) is calculated from equation (1). The yellow column (dose) is calculated from equation (2). The orange cells are summations of the numbers in the above columns. The blue cell is the computed TWA using equation (3).

Task	Leg (or TWA) from Smartphone, dBA	Time Doing Task, Minutes	Time Doing Task, Hour	Time Allowed, hr	Dose
Preparing Equipment	86	30	0.5	6.3	0.08
Operating Grain Cart	83.2	90	1.5	12.1	0.12
Combining Grain	85	202	3.3667	8.0	0.42
Unloading Grain Bins	90.3	80	1.3333	2.4	0.57
Operating Grain Vacuum	99	90	1.5	0.3	4.76
		Sum, minutes = 492		Dose =	5.95
				TWA, dBA =	92.75

The day includes just over 8 hours of information (480 minutes in an 8-hour day). We see that the biggest contribution to the day's exposure is operating the grain vacuum. This task should require hearing protection. To get the 99 dBA down to 85, we need an effective reduction of 14 dBA.

Remember that this means that (NRR - 7)/2 needs to be 14, or back calculating, NRR = 14*2+7 = 28+7 = 35. This is the target NRR (reported by the manufacturer) that we need to use. There are some devices that are this effective at noise reduction - but, if devices this effective are not accessible, earmuffs can be worn on top of ear plugs (referred to as "using double/dual protection").

Practice:

Compute the TWA for the following tasks that a worker performs in one 8-hour day. Determine if the exposure is too high and hearing protection should have been used.

Feeding Pigs: 86.1 TWA, 1 hour
Cleaning Building: 88.2 TWA, 5 hours
Moving Pigs: 84.2 TWA, 2 hours

You should calculate a DOSE = 1.68 and the TWA = 87.2 dBA