Episode Title: Grain Bin Safety

Summary: In this episode, we talk about grain engulfment and entrapment. The speed and force of flowing or shifting grain can have deadly consequences for workers who enter grain bins or walk on outdoor grain piles. We will be hearing stories from three guests today: a woman whose brother was rescued from a grain bin, an emergency responder who has been called for grain bin rescues, and Dr. Salah Issa, a researcher at the University of Illinois, Urbana-Champaign, who has been studying grain bin engulfment and will provide recommendations for keeping safe when working with grain. Visit NECAS for future grain bin rescue giveaways: https://www.necasag.org/rescueprograms.

Expert: Salah Issa and Brad Kruse

Episode Quote:

"The moment there's some sort of flow, [grain] starts behaving like a liquid, and that's where it can pull you in rapidly… and that's what makes it so hazardous and dangerous."

– Dr. Salah Issa, University of Illinois Urbana-Champaign

Transcript

00:04 K. Crawford

Welcome to the FarmSafe Podcast brought to you by the Great Plains Center for Agricultural Health. In the blink of an eye, an injury can change your life and your farm forever. During each episode, we share first-hand stories and real-life tips for making safer and healthier decisions while on the farm.

Today we are talking about the grain engulfment and entrapment, which has been a recognized hazard for decades. The speed and force of flowing or shifting grain can have deadly consequences for workers who enter grain bins or walk on outdoor grain piles. We will be hearing stories from three guests today including an emergency responder who has been called for grain bin rescues, and a researcher who has been studying grain bin engulfment and will provide recommendations for keeping safe when working with grain. To start though, we hear from Kayla who shared a story about a time when her brother fell into a grain bin.

00:53 Speaker 1

He's probably four or five years old, my brother, and somehow managed to climb up and get into the grain bin without mom seeing. But he got up there and all of a sudden, you know she noticed him missing and gut instinct she ran up to check it out. And he was in there about waist deep in the grain already and you know she knew exactly how dangerous it was. And, you know he had gotten up there and was already buried and she reached into try to grab him and pull him out from, you know, one of the cut-out openings in the side. And she couldn't physically pull him out. It's scary how much heavier they get so fast. He was probably only 30 pounds, 40 pounds, you know? And she was not able to budge him at all. She just held at that point, and didn't sacrifice her positioning, and she just screamed for help. Somehow, they managed to get him out. They dumped the grain while she held him, so that way it emptied, and they pulled him out.

01:49 K. Crawford

To learn more about grain bin engulfment, I reached out to Dr. Issa, faculty in the department of Agricultural & Biological Engineering at the University of Illinois. Dr. Issa's research covers grain handling and storage and reducing grain entrapment and engulfment.

S. Issa

Hi, my name is Salah Issa. I am an assistant professor at the University of Illinois, Urbana-Champaign. My work is in Ag Safety and Health. I focus more on finding preventative solutions and conducting training.

02:20 K. Crawford

To start today, do you have any information that you can share on how often these events occur?

S. Issa

I have to give a small plugin to my alma mater, Purdue University. They collect these cases on a national basis, and they publish a summary every year. What they've documented, over time, every year we have 30 to 40 grain entrapment cases, and another 30 to 40 cases related to a grain bin structure but are not grain entrapments, so, kind of like falls, getting entangled in the equipment, poisonings, and asphyxiations. Also, another thing to note, of those 30 to 40 cases, about really 60% of them, on average are fatal. It depends on the year.

03:05 K. Crawford

Dr. Issa described grain as a granular material and talked about why that makes it so dangerous and why it makes it difficult to pull someone out of grain.

03:15 S. Issa

When it's still, nothing's moving. It acts somewhat like a solid, you know, you can walk on it, you might get down a bit, but generally you can walk pretty comfortably on it. But what happens is that the moment that there's some sort of flow, it starts acting and behaving like a liquid, and that's where it can pull you in really rapidly, a lot quicker, and that's when, even if you're trying to resist and trying to go against the current, it's actually not possible. And that's what makes it so hazardous and dangerous.

K. Crawford

Kayla also shared us with her story about volunteering for grain bin rescue demonstrations used to train firefighters on how to rescue someone trapped in grain.

03:55 Speaker 1

So, I was the one who was buried in the grain and then rescued by the fire department. So, they bury me in it and explain to the fire department you know how they do and how to keep me calm during it. The grain is up to my waist, and you can just– I mean you can't move your legs. Any sort of motion you do to try to climb up, you just think you'd be able to just keep stepping down and just get on top of it, but you just go further down. It's worse than quicksand. And so, no matter how much I would just randomly step just to see if I could self-extricate, I wasn't going anywhere, and you could just feel that pressure. And then that feeling of relief when you're when they get that tube around you and your start to, they start auguring out the grain.

Afterwards, if you looked at my legs, you would just see my entire legs covered in little shapes of perfect corn kernels. I mean you could see entire shape of the kernel. Every single inch of my legs was covered with them. There wasn't a spot that wasn't, and it stayed like that for almost an hour. That just shows that level of pressure and it's throughout the entire body so I mean you're not going to be able to survive that pressure, even if it gets to your chest, it alone is going to make it so you can't breathe.

05:12 S. Issa

Cause when you are stuck in grain, and the grain basically settles around you it actually ends up applying a lot more force on you. I've measured, if the grain is about six to 10 inches above your chest level, already at that it will apply three to four times of more force than what you've experienced if you are in water. That means two things. First of all, it's harder to breathe. Another thing is that pressure– that's directly tied to friction. So that is a force that's required to pull you– you're resisting that friction against the grain. And then that becomes considerable force. We've seen, if you're fully engulfed in grain, it can take over 1000 pounds of force to pull somebody out.

05:55 K. Crawford

Often, rural fire fighters and other emergency responders are the ones that get called to help pull someone out of grain. Last year, Diane Rohlman from the Great Plains Center sat down and talked to Brad Kruse, a firefighter and EMS first responder about the hazards of grain engulfment and his experience with responding to calls for grain bin rescue.

06:16 B. Kruse

We do grain bin rescue; go out and help fire departments try to get somebody out of something that they probably shouldn't have gotten themselves into. When we get there, a couple of the problems we run into as far as grain— it's a very fluid material, and what I mean by that is, it's always moving. So anytime you try to fight it, it's like quicksand, it's going to suck you in deeper. One of the things about grain—and it could be corn, it could be soybeans, it could be wheat—the thing is a lot of times people try to take a deep breath. Well, it's a very fluid material, so every time you take a deep breath, that grain gets closer to you, and it won't let you exhale. So, now we have someone who can't—they're suffocating—they can't breathe.

One of the biggest things with grain bins is people going in with the auger running. So, a clump of grain gets caught—it won't let the rest of the grain out—so they go in and try to break up that clump. Well, they shut the auger off, they try to break it off, come back out and turn the auger on, it's not broke up— a lot of times they get frustrated and what they do is just leave the auger on and they go in and try to break up the clumps and when they do, the grain sucks them down.

One of the other things we run into— the grain crusts over. Not last year, but the year before, when we had folks combining Christmas day, they're putting the grain away a little bit heavier, or a higher moisture content than they really wanted to. Well then, we get a bad year and what it does is it more or less freezes a layer of grain on top of the bin. So then when the farmers walk on it, they break through— just like you would ice. So, we might be getting called for a grain bin rescue that they were walking across, they broke through, they might have fell 20 or 30 feet and then went down.

08:03 K. Crawford

I asked Dr. Issa to talk about the ways to prevent grain engulfment.

S. Issa

In Occupational Safety, always the safest thing is to eliminate the hazard. There's no hazard, there's no chance you can get hurt. In this case, I think eliminating the hazard means eliminate any reason to enter the bin. Make sure that you take care of your grain quality, manage your grain so you can prevent spoilage, have alert systems or sensor systems in the grain bin so you have basically early alerts if something is going wrong and you can respond to it and take care of it immediately. Plan ahead. In cases where you do expect crusting to be a bad year, or it could be just suddenly that conditions where you live. You can either install, what they call a sump guard, or you can basically install even a small rod that reaches all the way up to the sump, so that at the very least, it allows you to work from outside the grain bin to try to dislodge what's stuck in it.

But even with all these recommendations it's not always possible. Things happen. The next step is putting engineering controls to keep yourself safe. And that could be as simple as making sure that there's nothing that will cause the grain to flow. So, your auger, your grain bin auger, make sure that's locked out and tagged out before anybody enters so that there is no chance that it can flow, or somebody can turn it on while you're inside it. What that specifically means is that you get a lock, and there's a lot of different shapes for it, they can actually fit, for example, an extension cord or they can fit your switch to turn on your equipment or your power, and you lock down, that part that energizes your equipment, and then you tag it with your name so that people know who locked it down and why. And then, you're the only one who has that key to that lock, that's stored with you in your pocket, when you go inside, and you do whatever sort of work you have to do in the grain bin. That's crucial because if anybody else tries to energize, restart the equipment, they will not be able to do it until you're outside of the bin with that lock, and you're unlocking it.

10:11 S. Issa

I have documented a story where three maintenance workers were going inside the bin, to actually just patch the roof. And they went in with their harnesses, they followed all the compliance laws, the grain was not moving, it was solid. There was no risk of entrapment which meant they could take off their harnesses, so they did. And they started maintenance, started patching up the roof. And then a trucker came, and he needed his grain. He didn't see anybody nearby, so he just energized the equipment and hauled out his grain while they were all in it and they all ended up getting engulfed in that bin.

Another thing to do is that when you're entering the grain bin, be aware of the slopes of the grain. If they are at high slopes, that means that it's susceptible to avalanches, so we've actually seen deaths, even in outside piles. And it's just a person walking on the grain, and it was unstable, and it caused this cascading avalanche that ended up burying him. Not much, maybe a just several inches, but it was enough that he could no longer move and ended up dying.

Also, if you're entering any confined space, it's highly recommended to check the atmosphere there. You don't know what's going on.

11:26 K. Crawford

Before entering a grain bin, or any other confined space, you need to make sure there is enough oxygen to breathe. You also need to check for dangerous levels of gases like carbon monoxide, which could form from smoldering grain in the bin, or explosive gases, which could form from leaking propane from dryers. Use a gas meter with LEL sensors to check the atmosphere before entering.

11:47 S. Issa

You don't know what's going on. Turn on your fans in advance in advance before you enter. There's just so many stories of people going into a confined space that looks all right, it looks perfectly fine, because all of these are clear gases, but the moment you go there, and you realize something's wrong, you don't have the time to do anything, it all happens so quickly.

Lastly, but not least, is fall protection. That's something essential when you're going into grain bins. The fall protection now that gets complicated because generally with fall protection you wear a harness, a lanyard attached to anchor point. A lot of our older grain bins do not have anchor points in the center of the bins. You need to contact your manufacturer for your grain bin to discuss if it's possible to attach an anchor point in the center of the grain bin, because every grain bin has its own history, and its own things that it's capable for.

We've seen cases where individuals, attach their lanyard to the inside ladder for a grain bin. And when the grain started pulling them, it pulled it straight off the wall. I've had another case where they've attached it to a beam on the roof, and that beam fell with them, it couldn't support their weight. Again, when you're fully engulfed, there's over 1000 pounds of forces. It's a considerable amount of force to support. If you think of a regular ladder in a grain bin, usually it's rated for about 300 pounds of force.

13:18 K. Crawford

Dr. Issa also stressed the increased risks involved when working alone. If you have to enter a grain bin, you should have someone with you, and you should have a way to call for help if you need it.

13:30 S. Issa

It's always recommended to have a spotter. Make sure you have a source of communications, preferably a radio signal, make sure that you alert people in advance that you go into the grain bin. I can't tell you how many cases I've read where they found the body because the wife was saying, "Hey, John didn't show up for dinner today, can you go look for him?" So please, have a system that allows you to talk to somebody in case anything goes bad.

13:59 K. Crawford

These are all important strategies to protect you from being engulfed in grain. Never enter alone, lockout the power sources for all grain loading and unloading equipment, check the atmosphere with a gas meter, turn on aeration fans, and use fall restraint equipment that is properly anchored. We are working to put together new episodes that focus on each of these areas so let us know if you have questions or want to share your stories about grain bin safety.

14:24 S. Issa

Listen in to the FarmSafe podcast to join in the conversation about keeping safe on the farm.

K. Crawford

We want to hear from you. Share your stories about health and safety issues on the farm, about injuries that made you change the way you work, or about the ways you keep yourself and others safe on your farm. Also let us know if there are any topics that you want to hear about on the air. You can visit our website at gpcah.org or email us.

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Episode Resources

- GPCAH: Grain Engulfment and Entrapment
- Purdue University: Agricultural Confined Spaces
- Grain Safety Week 2022

Photo