



CAUGHT IN THE GRAIN!

George G. Maher
Ag Safety Specialist

How It Happens

People can become caught or trapped in grain in three different ways: the collapse of bridged grain, the collapse of a vertical wall of grain, and entrapment in flowing grain. Moving or flowing grain is involved in all three. People who work with grain – loading it, unloading it, and moving it from bin to bin – need to know about the

hazards of flowing grain and how to prevent a grain entrapment situation.

1. The Collapse of Bridged Grain

Grain can become bridged when it is moldy, high in moisture content, or in poor condition. The kernels stick together and form a crust which may be self-supporting. This gives a false indication that it is safe to stand on the surface of the grain. The worker cannot tell if there is grain under the crust or not.

A hollow cavity will form under crusted grain when some of the grain has been removed from the bin. The surface over this cavity is not strong enough to support the weight of a person. As the person walks onto the grain, the bridge of crusted grain will collapse. The victim instantly falls into the cavity along with the grain and is usually buried under several feet of grain. It will be very difficult to determine exactly where the victim is. (See Figure 1.)

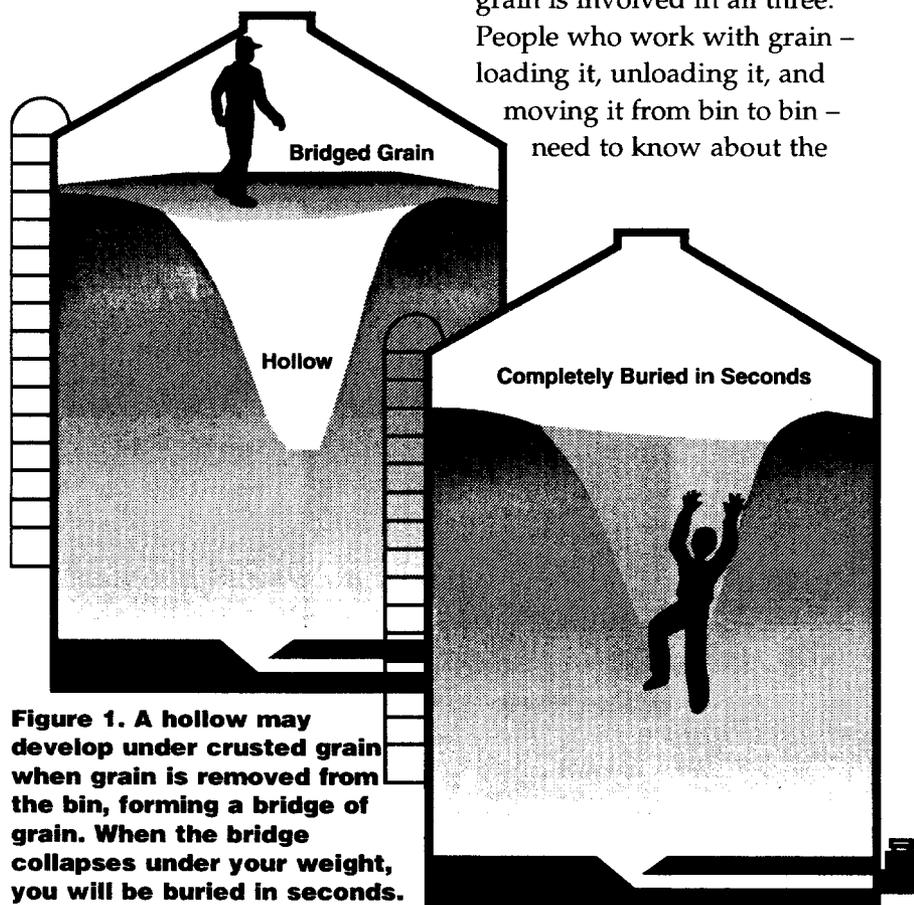


Figure 1. A hollow may develop under crusted grain when grain is removed from the bin, forming a bridge of grain. When the bridge collapses under your weight, you will be buried in seconds.

Safety Precautions:

- Is the grain bridged? Stop the auger and do not go in the bin. Instead, look for a funnel shape at the surface of the grain mass after some grain has been removed. If the surface of the grain appears to be undisturbed and has not funneled down toward the auger, then it has bridged and there is a cavity under the surface. The cavity will be equal in volume to the grain removed from the bin.
- Do not enter the bin to break the bridge loose or attempt to stand on the grain. From outside of the bin, use a pole or other object to break the bridge, causing it to collapse. Tie the pole or other object to a rope which is tied to the bin so you can retrieve it if you drop it.
- If the surface is disturbed and shows evidence of the grain flowing down to the auger, then a chunk of crusted grain has probably moved down to the auger and blocked off the flow of grain. This situation is dangerous if you enter the bin, because the grain at the top of the funnel will break loose and avalanche down.
- Prevent grain bridging by storing grain in good condition and avoiding spoilage, which leads to crusted grain.

2. Collapse of a Vertical Mass of Grain

Grain can “set up” in a large mass against the bin wall or in various formations when it has been stored while in poor condition. The mass of grain can collapse and “avalanche” down on workers who attempt to break it loose with shovels or other objects. There will be no warning when it breaks loose and cascades down. The impact will knock workers off their feet, burying them in various positions. Individuals working in the bin can be buried almost instantly.

If secondary avalanches are possible, it will be very risky for

rescue personnel to dig out the worker. The rest of the grain will have to be stabilized or knocked down so it is safe for rescue personnel to work. (See Figure 2.)

Safety Precautions:

- Do not enter a bin and try to break down grain which has “set up” in a large mass.
- Attempt to break up the grain mass either from the top of the bin with a long pole on a rope, or from outside of the bin, through the door, with a long pole. Entering the bin to do this work can cost you your life!
- Expect, and be prepared for, the grain mass to break free at any time and to cascade down.
- Prevent grain from “setting up” in the bin by storing grain in good condition and avoiding spoilage which leads to this problem.

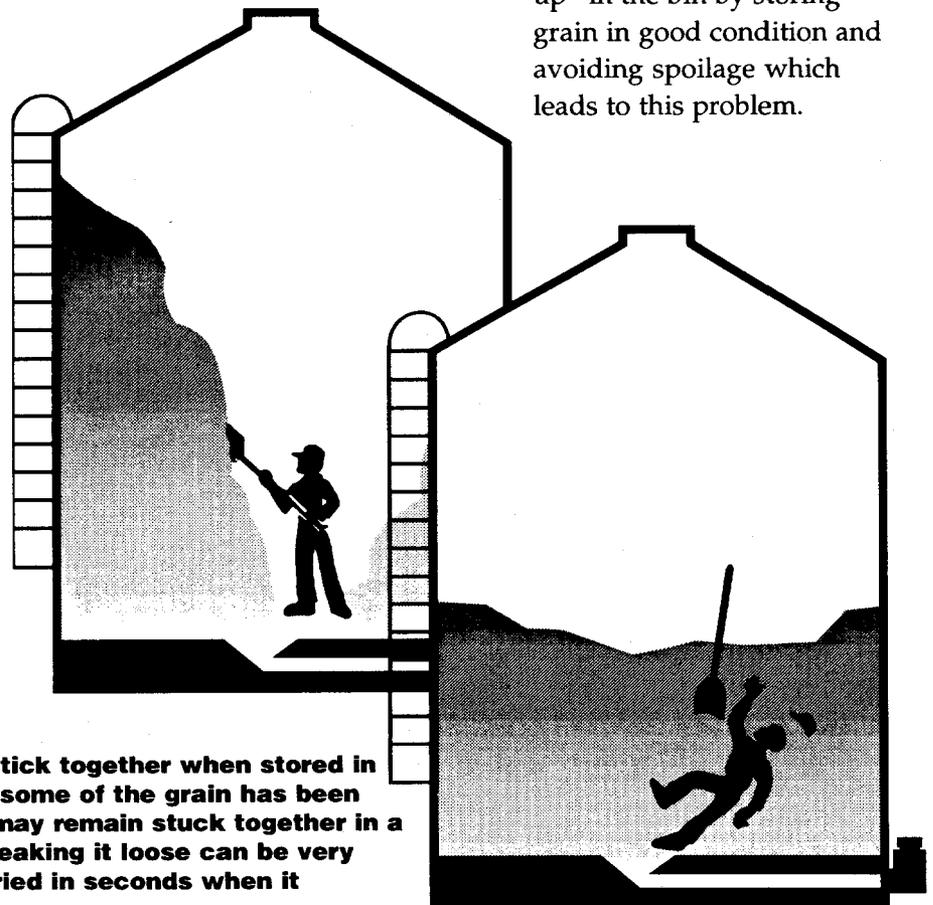


Figure 2. Grain may stick together when stored in poor condition. After some of the grain has been removed, some of it may remain stuck together in a large pile or lump. Breaking it loose can be very risky. You may be buried in seconds when it cascades down.

3. Flowing Grain

Flowing grain will not support the weight of a person. It will pull a person down and into the grain mass as it flows. The "suction" action is strong enough that a person cannot "swim," climb, or walk against it and get out. As grain flows out of a bin the victim will be pulled down and under very quickly with little or no time to react. (See Figure 3.)

A person cannot be pulled from flowing grain without risk of injury to the spinal column if the grain is at waist level or higher. The grain will have a very strong grip on the body. Research has shown that up to 400 pounds of pull is required to extract a body from waist-deep grain.* That is more than enough force to permanently damage the spinal column. (See Figure 4.)

Dangerous flowing grain situations are: grain flowing downward in a bin; grain flowing downward out of a rail car, truck or wagon box; and grain flowing downward in an auger-pit. Workers should not enter any of these containers when the grain is flowing.

Safety Precautions:

- Children should not be permitted to work or play in an area where there is flowing grain. It is an attractive nuisance and is dangerous to people of all ages, especially children.
- All workers involved in situations where there is

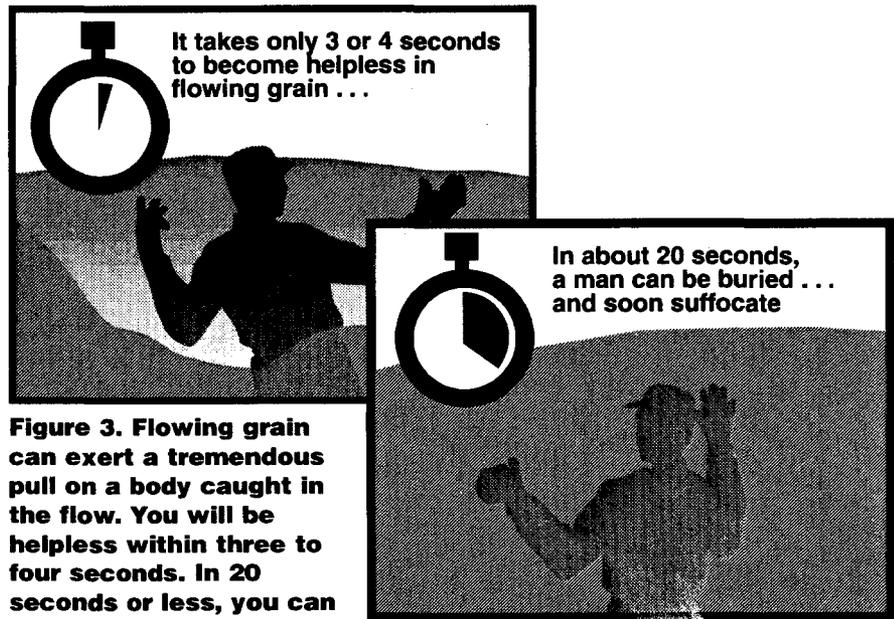


Figure 3. Flowing grain can exert a tremendous pull on a body caught in the flow. You will be helpless within three to four seconds. In 20 seconds or less, you can be completely buried.

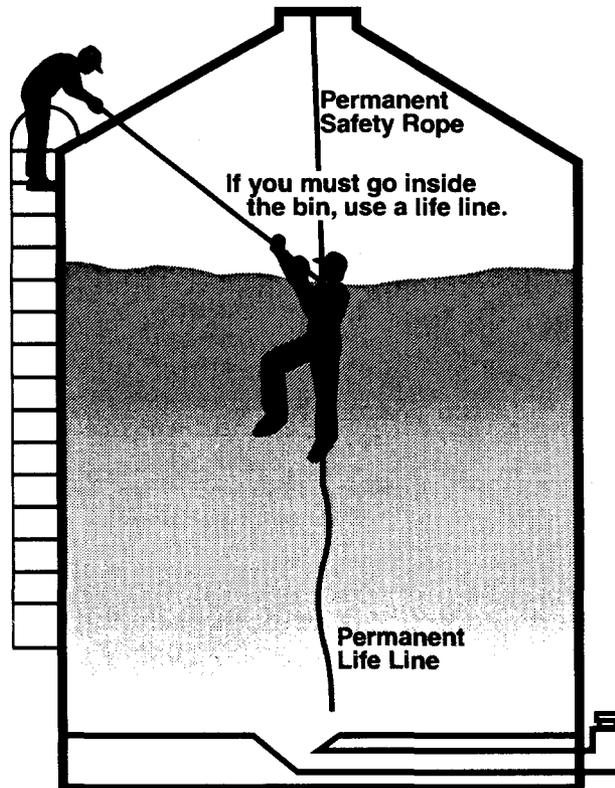


Figure 4. Use a life line if you must enter a grain bin! Always stop the machinery, first! Remember, a life line improperly used can cause injury to the spinal column. Install a permanent life line in each bin.

* C.V. Schwab, I.J. Ross, L.R. Piercy, B.A. McKenzie (1985). *Vertical Pull and Immersion Velocity of Mannequins Trapped in Enveloping Grain Flow*. Transactions of the ASAE Vol. 28(6)

flowing grain should be warned to stay out of the grain.

- Warning decals should be placed at all bin entrances, on all rail cars, truck and trailer boxes used for grain hauling, and on all gravity discharge wagons.
- Never enter a grain bin without stopping the auger first and then using "lock-out/tag-out" procedures to secure it. Use a key type of padlock to securely lock the switch for the auger in the off position. Attach a tag to the locked switch so that other people involved can positively identify it.
- Never enter a grain bin alone; have at least two people at the bin to assist in case problems arise. Use a safety harness or safety line when entering the bin.
- Install a permanent life-line hanging from the center of the bin for a person to grab on to. Tie slip-reducing knots about one foot apart along the life-line. A life-line in a grain bin does not make it safe to enter the bin and should not lead workers to taking undue risks because of a false sense of security. Life-lines are commercially available through safety equipment retailers.
- Control the access to grain storage facilities to prevent grain entrapments.

Rescue Procedures

For the farmer:

1. Shut off all grain-moving machinery. Stop the flow of grain!
2. Contact the emergency rescue service or local fire department.
3. If possible, ventilate the bin using the drying fan without activating the heat source.

For the rescue workers:

1. Work in such a way that additional grain pressure is not exerted on the victim.
2. Protect the rescue workers; be sure the power to the auger is locked out, and use safety lines and respiratory protection or support.
3. Use retaining walls if the grain is above the victim's head. Form retaining walls with plywood, sheet metal, or snow fence and tarps to keep grain from flowing to the victim.
4. Remove grain from around the victim using shovels and a grain vacuum conveyer. Use extreme care when victim is not visible.
5. Cut holes in bin sides to drain grain away from the victim if the person is completely submerged. Cut at least two Vee-shaped or U-shaped holes on opposite sides, or more holes equally spaced around the bin, using a cutting torch, metal-cutting power saw, or air chisel.

6. Apply care to the victim as soon as possible, providing breathing assistance, maintenance of body temperature, and emotional support. Plan ahead for victim removal procedures.
7. Don't give up when conditions appear to be grim. People have survived submersion in grain for up to two hours; sometimes the victim can still breathe while buried in the grain. Never give up!

References:

1. Grain Bin Entrapment: What If It Happens To You?, Jim P. Allen, Extension Engineer and Ronald T. Noyes, P.E., Extension Agricultural Engineer, Oklahoma Cooperative Extension Service, Division of Agricultural Sciences and Natural Resources, Oklahoma State University, 1994.
2. C.V. Schwab, I.J. Ross, L.R. Piercy, B.A. McKenzie (1985). *Vertical Pull and Immersion Velocity of Mannequins Trapped in Enveloping Grain Flow*. Transactions of the ASAE Vol. 28(6).

Helping You Put Knowledge To Work

NDSU Extension Service, North Dakota State University of Agriculture and Applied Science, and U.S. Department of Agriculture cooperating. Sharon D. Anderson, Director, Fargo, North Dakota. Distributed in furtherance of the Acts of Congress of May 8 and June 30, 1914. We offer our programs and facilities to all persons regardless of race, color, national origin, religion, sex, disability, age, Vietnam era veterans status, or sexual orientation; and are an equal opportunity employer.

This publication will be made available in alternative format upon request to people with disabilities (701) 231-7881.

3M-12-95