

Grain Safety

background information & activity book



Grain Safety Educational Packet

Farm Safety for Just Kids is a non-profit organization working to promote youth safety within the rural environment. This is done through the production and distribution of educational materials and the initiation of programs about farm and rural safety and health. Outreach coordinators and a chapter network of grassroots volunteers conduct educational programs to prevent health hazards, injuries, and deaths to children and youth. ATV safety is one topic addressed by Farm Safety for Just Kids. A multitude of resources are available to teach a variety of topics such as machinery safety, livestock safety, chemical safety, and rural roadway issues.

Thank you for your interest in making the rural environment safer by teaching others about staying safe on the farm while around ATVs. Please use the following guide to assist you in your ATV safety program. Feel free to contact Farm Safety for Just Kids at (800) 423-5437 or visit www.FarmSafetyForJustKids.org with questions or concerns.



Authors: Shari Burgus and Dr. Charles Schwab

Design: Design Matters

Funding provided by Cargill



Refer to the Farm Safety for Just Kids website at www.FarmSafetyForJustKids.org for additional information.

Copyright © 2014 Farm Safety for Just Kids

The material developed and disseminated by Farm Safety for Just Kids was peer reviewed and is intended for general information and educational purposes only. It should not be relied upon as medical or legal advice. If legal, medical, or other expert assistance is required, the services of the appropriate professional should be sought.

Table of Contents

EDUCATIONAL INFORMATION

Background	Page 4
Entrapment	Page 4
Complications	Page 5
Prevention	Page 6
Equipment	Page 6
Evaluation	Page 7

LESSON PLANS

Grain's Weight	Page 8
Gravity's Pull	Page 9
Lungs Need Space	Page 10
Grain Type Affects Breathing	Page 11

PUZZLES

Grain Mixer	Page 12
Grain Sudoku	Page 13
Grain's Pull Crossword	Page 14
Secret Safety Code	Page 15
Word Find	Page 16
Dots to Dots	Page 17
Answer Key	Page 18

Educational Information

Background	Page 4
Entrapment	Page 4
Complications	Page 5
Prevention	Page 6
Equipment	Page 6
Evaluation	Page 7

Background

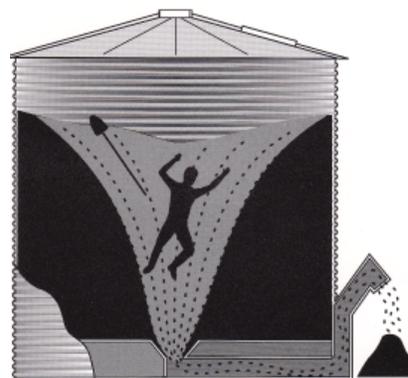
Over 200 million acres in the United States are used to produce various grains including: corn, soybeans, wheat, sorghum, and rice. As with most things on the farm, producing grain can be dangerous. In 2010, there were 51 grain entrapments resulting in 26 deaths. Over the past 50 years, more than 900 cases of grain engulfment have been reported with a fatality rate of 62 percent.

Various aspects of growing grains can be dangerous and sometimes not easy to recognize at first. The flowable nature of harvested grain presents challenges and can result in entrapment. Likewise, the equipment used in the production of grain can be dangerous.

Children and youth lack experience working on farms. Children are also more curious, smaller in size, and have less strength than adults. Grain flow can be mesmerizing in both sight and sound. A child may be tempted to find out what it feels like to flow with the grain not knowing the dangers that exist. All of these factors influence their susceptibility to injuries and death.

FIGURE 1

Entrapment in flowing grain



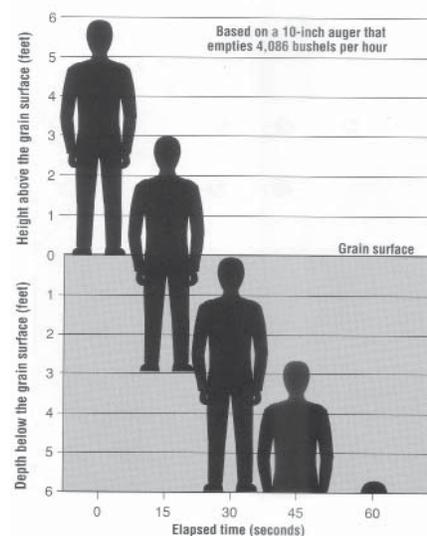
ENTRAPMENT

Grain, in mass quantity, moves like water. That characteristic makes it inherently more dangerous than other crops as it can result in entrapment or engulfment. There are three types of grain entrapment:

- ▶ **Flowing grain:** This happens when grain is being moved by a grain-handling system. When a grain bin is emptied gravity pulls the grain into an auger at the bottom. A gravity flow grain wagon functions the same way. (See Figure 1)

A person in the grain would get pulled in like quicksand. Today's high capacity loading and unloading systems can render someone helpless in a matter of seconds. (See Figure 2)

FIGURE 2



- ▶ **Crusted bridge collapse:** In some situations, like after a wet harvest, a crust will form on top of the grain in a bin creating a bridge. However, as grain is removed it creates a void of empty space forming a sink hole just waiting to collapse. Thinking there is a solid base of grain underneath, a person may stand on it. When the bridge collapses, the flowable nature of the grain will bury them. How deep will depend on how much grain is dislodged. (See Figure 3)
- ▶ **Vertical wall collapse:** Similarly, as the grain is removed from the center of a bin it can form a vertical crust up the wall of the bin. Removing the buildup of grain can cause an avalanche and the flowable nature of grain will bury them. (See Figure 4)

FIGURE 3

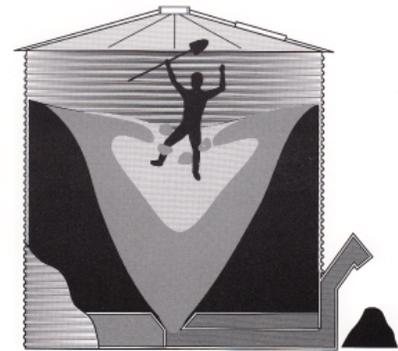
Entrapment by collapsed bridge

FIGURE 4

Entrapment in collapse of vertical wall of grain**COMPLICATIONS**

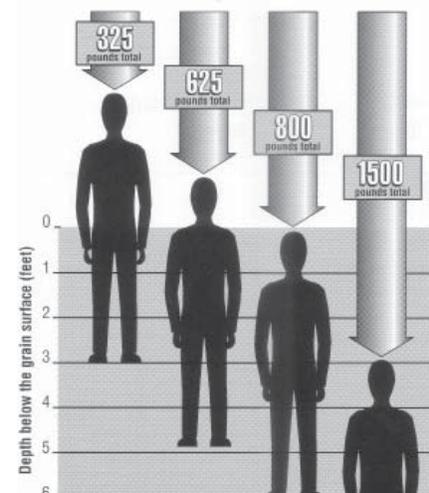
If a person is caught in grain it is nearly impossible to pull them out. Once an adult is buried up to their waist it takes over 300 pounds of force to free them. (See Figure 5)

The only way to free someone trapped in grain is to completely surround the victim with a barricade to prevent the grain from back filling around them. Grain bin rescue tubes are now available for first responders to use in entrapments. Visit grainsystems.com and kcsupply.com for manufacturing information. See page 6 for a photo.

Suffocation can happen if a person is pulled under the grain. The grain kernels do not allow enough oxygen to get to a person submerged under grain. Along with the depletion of oxygen, the heavy grain also puts pressure on the lungs so they have trouble expanding. Every time the victim exhales, the grain settles reducing their lung capacity.

In addition, grain dust can be highly combustible. Great care must be taken not to ignite it causing an explosion.

FIGURE 5



PREVENTION

To avoid entrapment avoid entering the bin all together, but if it cannot be avoided: shut off power to grain-handling equipment before anyone enters the grain bin or structure. The lockout tagout process is a safety procedure used to ensure power supplies are shut off during maintenance. It is accomplished by using a folding scissors clamp with several padlock holes to deny access to the power switches. Each person involved applies their own padlock and the device cannot be powered up until all padlocks have been removed. The additional time it takes to turn the power off before doing any maintenance can be frustrating for producers, but accidents most often happen when people start cutting corners.

It's also important to use the buddy system while working with grain. Never enter a grain structure alone. In employer situations where OSHA applies, their guidelines state anyone entering a grain bin must use a body harness or boatswain's chair with a lifeline that is sufficient length to prevent a worker from sinking further than waist deep. Visit osha.gov for more specifics in employer situations.

In addition, do not assume the grain will hold your weight when using a sweep auger while dislodging crusted grain.

An entrapment can become even more deadly when another person attempts to rescue the victim only to become a second victim. If another person becomes engulfed in grain the first step is to turn off the power - if it was not done before entering the bin. Then call 911 and let trained emergency responders aid the victim/s.

EQUIPMENT

The process of producing grain requires a number of different pieces of equipment and various processes depending on the type of grain and the geographic area. Different methods of moving grain include:

- ▶ Augers
- ▶ Belt conveyors
- ▶ Chain conveyor systems
- ▶ Bucket elevators

Each of these processes create pinch points. Pinch points are the intersection of moving and stationary parts where a person's body part can get caught causing injury. The most common injury from pinch points is missing fingers. Make sure all safety shields are in place and keep your distance from moving parts. Many of these processes are powered by a tractor's power take-off (PTO). Never step over a PTO while engaged. Always walk around. Watch out for loose clothing that can become entangled in the PTO. Additional information about tractors and PTOs can be found in the tractor section of farmsafetyforjustkids.org.



Trained professionals demonstrate how a rescue tube works to free someone from grain.

Evaluation

Conducting surveys of your intended program audience can identify their knowledge about grain safety. If the surveys are done before an educational program takes place, it will give the presenter a basis for where his/her audience is in relation to grain safety. The educational program can then target issues lacking by the audience.

The surveys can be conducted again after the program has taken place in a pre and posttest format. This will identify change in knowledge. The resulting information could make a great newspaper article when reporting the changes made by your audience.

Listed on page 8 are questions related to the information in this packet. Take into consideration what topics you plan to cover in your presentation and program. If you will not be covering crusted grain, don't use the question(s) related to this topic. The questions can be combined or rewritten to be specific to your program.

Surveys can be completed and tabulated several ways. They can be copied, distributed, completed, collected, and tabulated by hand if there are only a few surveys. If many surveys will be completed, an easier way to complete the process is using an electronic software package; some of them are free if you want only basic analysis results. Use their suggestions to ensure a good response rate.

ANSWER KEY: 1:d, 2:a, 3:b, 4:c, 5:a, 6:c, 7:c, 8:b

SELF ASSESSMENT

The self-assessment tool below can be used to identify behaviors used by your audience. If used before your presentation, it can be used to identify areas that need special attention. If used after the program, it can be used to see if your audience has changed their behavior when compared to the assessment done prior to the program. This information is self-reported so there is a chance the information may be slanted.

Student Self-Assessment of Safe Behavior When Around Grain

	Always	Sometimes	Never
I post "No Entry" decals on grain facilities on my farm			
I never enter a bin, wagon, or truck used for storing or transporting grain when it has grain in it			
I have another person close by when working around grain			
I notify someone when I've observed a missing or faulty PTO or auger shield			
I tell someone where I am before working around grain on the farm			

1. What grains are grown in the U.S. requiring storage and transportation?
 - a. Corn
 - b. Soybeans
 - c. Wheat
 - d. All of the above are grown in the U.S. and require storage and transportation
2. Which of the following describes when a person is hurt or suffocated in flowing grain?
 - a. Grain is emptied at the bottom opening which causes a pulling action similar to quick sand
 - b. When grain forms a hard surface on top and is removed underneath a void is formed which can cause a person to fall through when stepped on
 - c. A hard surface of grain is formed on the side bin wall which can break apart causing an avalanche
 - d. None of these describes a flowing grain incident
3. Which of the following describes when a person is hurt or suffocated in a crusted bridge collapse?
 - a. Grain is emptied at the bottom opening which causes a pulling action similar to quick sand
 - b. When grain forms a hard surface on top and is removed underneath a void is formed which can cause a person to fall through when stepped on
 - c. A hard surface of grain is formed on the side bin wall which can break apart causing an avalanche
 - d. None of these describes a flowing grain incident
4. Which of the following describes when a person is hurt or suffocated in a vertical wall collapse?
 - a. Grain is emptied at the bottom opening which causes a pulling action similar to quick sand
 - b. When grain forms a hard surface on top and is removed underneath a void is formed which can cause a person to fall through when stepped on
 - c. A hard surface of grain is formed on the side bin wall which can break apart causing an avalanche
 - d. None of these describes a flowing grain incident
5. How is a person removed from grain if he/she is submerged in the grain?
 - a. A barricade such as a rigid tube is placed around the person
 - b. He/she can be pulled out by another person
 - c. Attach a rope to the person's arm and pull with a tractor
 - d. He should be able to get out by himself by moving his arms in a swimming motion
6. What is a hazard associated with grain storage beyond entrapment?
 - a. Grain can mold when stored for a period of time which can cause health hazards to workers
 - b. Grain dust is highly combustible and can cause an explosion
 - c. Both of these hazards can exist with grain storage
 - d. Neither of these hazards exist with grain storage
7. What is a lockout tagout safety procedure associated with grain storage?
 - a. Game often played while working with grain
 - b. System used to remove a person submerged in grain
 - c. System of padlocks or other fastening devices used to prevent entry into a grain area
 - d. Any hazard associated with grain storage or transport
8. What is a cork-like device used to move grain?
 - a. PTO
 - b. Auger
 - c. Hammer
 - d. Belt conveyor

Lesson Plans

Grain's Weight	Page 8
Gravity's Pull	Page 9
Lungs Need Space	Page 10
Grain Type Affects Breathing	Page 11

Grain's Weight

Objectives:

- ▶ To understand the weight and friction of flowing grain.
- ▶ To determine the proper action to be taken if someone is caught in grain.

You will need:

- ▶ 30-gallon trash container
- ▶ Plywood cut to fit in the bottom of the trash container with a hole cut in the middle
- ▶ 5 feet of heavy rope – large knot tied at one end
- ▶ Grain to fill trash container (corn, soybeans, flax, etc.) at least $\frac{3}{4}$ full

Activity:

Pull rope through hole in plywood disk. If knot is not large enough to hold disk, retie another knot. Place disk in bottom of trash can. Fill can with grain. Have each child pull on the rope trying to pull the disk out. Explain that the weight of grain prevents the disk from coming out just like a person that might be engulfed in the grain.

Note:

Stronger kids may be able to lift the whole container, but the disk should not be able to come out. After several tries, the disk may become dislodged enough so it may slip up one side. If you see this happening, empty the grain into another trash can and start over.

Questions:

Q: In the demonstration what does the plywood disk represent?

A: A person

Q: What holds the disk (person) in the grain?

A: The weight of the grain along with the friction (force between 2 objects) holds the person in the grain and increases the difficulty in getting out.

Q: If a person was caught in grain and buried up to their shoulders, how much force would be required to pull the person out?

A: About 4 times the buried person's weight.

Q: What should you do if another person is caught in grain while you are near?

A: If an auger is running turn the switch off. Run and get help immediately. If you have access to a phone, call 911 and give them your address.

Gravity's Pull

Objectives:

- ▶ To comprehend the dangers of flowing grain.
- ▶ To show family members the dangers of being in grain.

You will need:

- ▶ Toy gravity flow wagon
If you cannot find a toy gravity flow wagon, use a plastic container like a milk jug or a 2 liter pop bottle and cut the bottom off.
- ▶ Unpopped popcorn
- ▶ Plastic toy action figure small enough to just fit the opening in the wagon
- ▶ Empty container to catch popcorn

Activity:

Fill the wagon or plastic container with popcorn. Place the toy figure on the top of the grain. Demonstrate what happens when the door is opened and the corn is released. Open the door of the toy wagon or unscrew the cap on the plastic container. The plastic figure will be pulled towards the door opening. Instruct the children to try to keep track of the figure as the corn comes out the bottom. Shut the opening and start over.

Repeat the same demonstration. Have the children count the number of seconds it takes until the plastic figure stops the grain flow.

Repeat the demonstration. Have the children place the plastic figure in different locations on top of the grain. Have them count the seconds again and compare to the first time they counted. Discuss any difference in time. Repeat the demonstration. Instruct the children to keep track of how the person moves when the gravitational force is pulling the plastic person down.

Questions:

Q: What types of grain is used in a real gravity flow wagon?

A: Corn, soybeans, canola, flax.

Q: Why was there a time difference between the two demonstrations?

A: The flowing grain creates a gravitational pull on the grain directly above what is being released through the opening. If an object (or person) is directly above the opening it will be sucked down before an object (or person) that is farther away from the opening. Both objects eventually end up in the same location – the opened door, but it may take longer if farther away.

Q: Why do gravity flow wagons have one side that is slanted?

A: The slanted side helps funnel the grain toward the opening, helping the last part of the grain to come out.

Lungs Need Space

Objectives:

- ▶ To understand how human lungs are impacted by the pressure of grain.
- ▶ To comprehend the implications of not being able to breathe if surrounded by grain.

You will need:

- ▶ Large round latex balloon
- ▶ Large diameter drinking straws
- ▶ Duct or masking tape
- ▶ 5-gallon bucket
- ▶ Corn, soybeans, or other grain

Activity:

Attach the straw to the balloon securely so no air can be released. Blow up the balloon through the straw. It will need to fit in the bucket so keep it smaller than the bucket diameter. Place a finger over the straw opening so the air is not released.

Hint: Blowing up the balloon several times without the straw first will make it easier to blow up after the straw is attached.

Place the balloon in the bucket holding on to the straw opening so air is not released. Have another person pour the grain on top of the inflated balloon so there are several inches of grain on top. Allow all the children to see that the balloon is covered with grain.

Gradually release the air from the balloon. Have the children watch what happens to the grain level. It should go down as the air is released. After all the air is released, try to blow the balloon up with the grain on top. If enough grain is on top of the balloon this can't be done.

If time allows, have each person do their own balloon and straw. This way there is no problem with spreading germs by sharing straws.

Questions:

Q: What body part does the balloon represent?

A: Lungs.

Q: What happened to the grain height in the bucket as the air in the balloon was released?

A: The grain went down proportionately to the amount of air that the balloon took up.

Q: Why is it more difficult to blow up the balloon when under the grain?

A: The weight of the grain is pushing on the balloon so it can't expand. This same concept works on the lungs of a person surrounded by grain.

Q: How does the grain impact the ability of the lungs to function properly?

A: Just like the balloon, when the lungs must push against the heavy grain they cannot inflate properly. This is when suffocation can take place.

Grain Type Affects Breathing

Objectives:

- ▶ To comprehend the inability of breathing if trapped under grain
- ▶ To determine the differences in grain type that influences a person's ability to breathe

You will need:

- ▶ Various types of dried grains (corn, soybeans, rice, flax, canola, etc.)
- ▶ Paper tubes (toilet paper, paper towel, etc.) cut 2" and 6" lengths
- ▶ Nylon mesh or tooling
- ▶ Masking tape
- ▶ Large candle (not birthday candles)
- ▶ Matches

Activity:

Cut mesh or tooling an inch bigger than the opening of the tubes. Tape the mesh over one end of the tubes. Fill each tube with grain. Tubes need to be full. Cover other end with mesh and tape in place.

Light a candle and place it in a candle holder. Give the students a quick warning about the dangers of fire. Have the students try to put out the candle by blowing through both the long and short tubes. Try the same demonstration using the same length of tube and compare two different types of grain. Talk about the differences in the grain types.

Questions:

Q: What are the differences in size and shape of each grain kernel?

A: Soybeans and canola are round, while all the others have some flat surfaces. Flax kernels are very small and slick.

Q: How do the kernel differences affect the way the grain flows when released in a gravity flow wagon?

A: The smaller and slicker the grain, the faster it will flow.

Q: Why was it more difficult to blow out the candle with more grain?

A: Some air can get between the kernels of grain if it doesn't go very far. The longer the tube, the more air is required to extinguish the flame.

Q: How does this demonstration relate to danger of being submerged in grain?

A: Grain influences the speed that it flows from the wagon, bin, or truck. This principle in turn influences how quickly you can become trapped in the grain. The shape and size of the grain also influences how difficult it is to breathe if caught in the grain. Generally, the smaller the size of the kernel the less oxygen is trapped to breathe. This is why air is sometimes forced into stored grain if a person is trapped.

Puzzles

Grain Mixer	Page 12
Grain Sudoku	Page 13
Grain's Pull Crossword	Page 14
Secret Safety Code	Page 15
Word Find	Page 16
Dot to Dots	Page 17
Answer Key	Page 18

Grain Mixer

Find someone else in the room that fits the statement. Each person can only sign your sheet once. The winner is the first person to fill their sheet either up and down, across, or diagonal like BINGO.

Ridden on a combine with Grandpa	Name a grain that is yellow when mature	Placed a warning decal on a grain wagon	Has several different colored tractors on your farm	Knows what color a flax flower is
Knows the hand signal for "shut it off"	Drives red tractors on your farm	Ridden with mother to the co-op to deliver grain	Knows what SMV stands for	Tasted a raw soybean
Has a toy combine	Grandpa still works on your farm	FREE SPACE	Can list 4 grains harvested in your state	Refused to ride on a combine when asked
Reminded someone not to play in grain	played with a toy combine as a child	Wears a Cargill hat	Harvested corn before September 15th	Placed a warning decal on a grain bin
Knows what PTO stands for	Harvested soybeans after November 30	Has a tractor calendar in their house	Has a toy tractor collection	Can name 2 different kinds of combine heads

Grain Sudoku

To solve sudoku puzzles, place a different letter or symbol in each row, column, and small 9-box square. No letter may appear more than once in any row, column, and 9-box square. Rearrange the shaded letters to make a word associated with grain safety.

#1 ZNTCMSRAO

Z		T			S		C	A
		C	M	T				S
N			Z		R		T	
		Z			O			R
		M	A	R	Z	T		
O			C			N		
	R				N			M
M				A	C	O		
A	Z		O			C		T

ANSWER: _____

#2 LERPGUANF

	L				P			U
				G	R	F		E
E	R		F			G		A
				L	F		N	P
	U						A	
L	P		R	A				
N		L			A		U	F
R		G	N	F				
P			E				G	

ANSWER: _____

Grain's Pull Crossword

Use the clues to fill in the blanks.

WORD BANK

Friction	Flax
Seconds	Gravity
Auger	Weight
Slanted	Bury
Door	

ACROSS

- 5. Cork-like device used to move corn
- 6. Heaviness of grain on the body
- 7. Pull of grain on the body
- 8. Opening near the bottom of a gravity flow wagon
- 9. Moving grain can do this to you rapidly

DOWN

- 1. Very small grain that entraps people quickly
- 2. Force that pulls you downward
- 3. Shape of gravity flow wagon that helps grain move quickly
- 4. You can become entrapped in grain in 10 _____ seconds or less

Secret Safety Code

Decode the secret messages to find out how to stay safe while around grain.

😊	A
▲	B
▼	C
Ω	D
Π	E
&	F

■	G
e	H
○	I
☀	J
◼	K
□	L

🎵	M
—	N
@	O
♣	P
∂	Q
◆	R

◇	S
♥	T
¥	U
♠	V
△	W
◉	X

+	Y
#	Z

○♥

♥😊◼Π◇

□Π◇◇

♥e😊—

@—Π

🎵○— ¥♥Π

♥@

▲Π▼@🎵Π

♥◆😊♣♣ΠΩ

○—

&□@△○—■

■◆😊○—

_____ .

Word Find

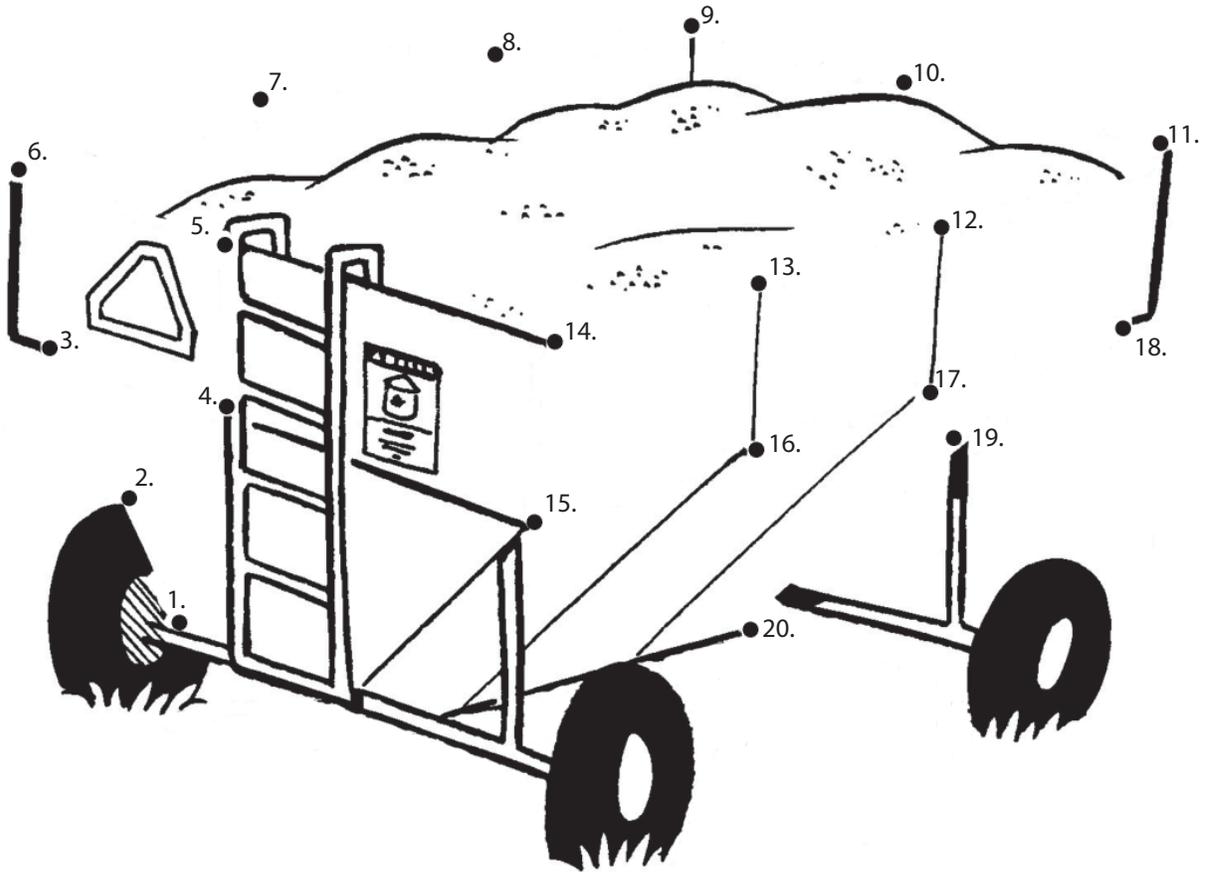
Find these words hidden in the puzzle.

WORD BANK			
Bush	Cow	Hog	Stalk
Cart	Dustmask	Horse	Truck
Chicken	Earplugs	Llama	Wagon
Combine	Goggles	Semi	

C	H	E	M	G	G	K	H	C
O	O	A	R	H	O	G	T	O
M	R	R	A	C	E	O	R	W
B	S	P	B	A	L	G	U	A
I	E	L	U	R	L	G	C	G
N	M	U	S	T	A	L	K	O
E	I	G	H	O	M	E	O	N
D	U	S	T	M	A	S	K	M
C	H	I	C	K	E	N	C	M

Dot to Dots

Starting at number 1, draw a line between the numbers to finish the picture. Identify this piece of equipment when you're finished.



Answer Key

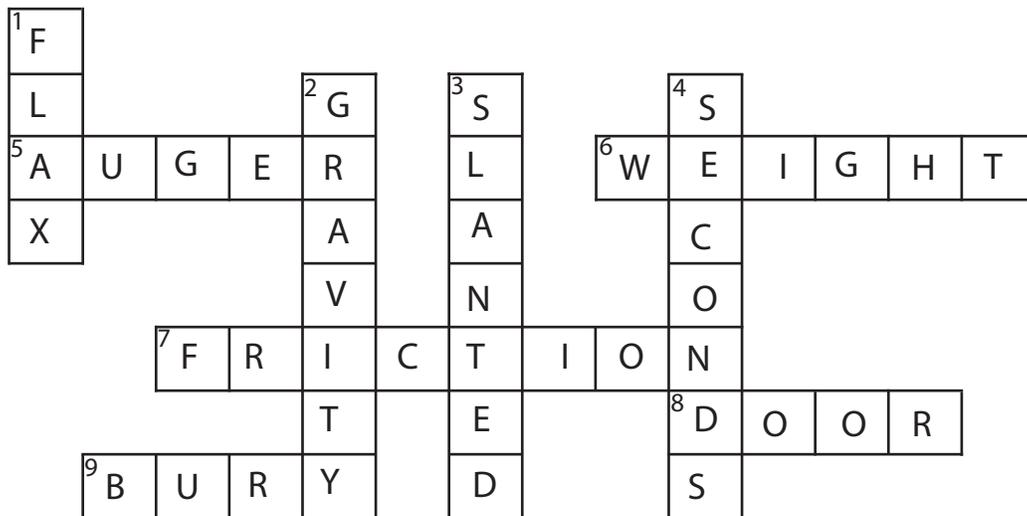
Sudoku #1: Corn

Z	M	T	N	O	S	R	C	A
R	O	C	M	T	A	Z	N	S
N	S	A	Z	C	R	M	T	O
T	C	Z	S	N	O	A	M	R
S	N	M	A	R	Z	T	O	C
O	A	R	C	M	T	N	S	Z
C	R	O	T	Z	N	S	A	M
M	T	S	R	A	C	O	Z	N
A	Z	N	O	S	M	C	R	T

Sudoku #2: Auger

G	L	F	A	E	P	N	R	U
U	N	A	L	G	R	F	P	E
E	R	P	F	U	N	G	L	A
A	G	R	U	L	F	E	N	P
F	U	E	P	N	G	L	A	R
L	P	N	R	A	E	U	F	G
N	E	L	G	P	A	R	U	F
R	A	G	N	F	U	P	E	L
P	F	U	E	R	L	A	G	N

Crossword



Answers Continued

Secret Safety Code

It takes less than one minute to become trapped in flowing grain.

Word Find

