



CANADA
4-H Ontario

www.4-hontario.ca

4-H ONTARIO PROJECT



Farm Machinery - Harvesting

REFERENCE MANUAL

The 4-H Pledge

I pledge my Head to clearer thinking,
my Heart to greater loyalty,
my Hands to larger service,
my Health to better living,
for my club, my community and my country.

The 4-H Motto

Learn To Do By Doing

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INCLUDING STEM IN THE 4-H FARM MACHINERY - HARVESTING PROJECT

WHAT IS STEM AND WHY IS IT IMPORTANT?

Since 1915, 4-H in Ontario has engaged youth in science, technology, engineering, and math (STEM). This has traditionally meant a solid focus on agricultural science, mechanics, entrepreneurship, natural sciences and household science. Today, 4-H has grown to include rocketry, robotics, computer science, environmental sciences, and more. 4-H provides hands-on learning experiences to encourage learning about the world around us. Our lives are completely immersed in science and technology.

Understanding how science, engineering, and technology impact our lives, solve problems and create new ones makes it easier to navigate our modern world.

In school, science classes need to cover a broad range of topics in a limited amount of time while STEM in 4-H allows members and leaders time to dig deeper into ideas and concepts and to spend as much time as desired to work on projects based on personal interests, questions, and skills.

STEM in 4-H allows a person to work on their own questions, design their own tests, create their own models, build their understanding, and share their work with others – learn to do by doing. That’s what science and engineering are, trying to understand the natural universe and develop solutions to the problems faced in our world today. Science is inquiry that uses a specific approaches and skills. But all learning is an inquiry process so working with science helps develop your learning muscles.

Within 4-H, the STEM process can go even further to include the Arts, thus changing the acronym to STEAM – Science, Technology, Engineering, Art & Math.

STEAM IN 4-H ONTARIO PROJECTS

As you work through the Farm Machinery - Harvesting Project, you will see STEAM integrated throughout the project within almost all of the activities provided. Examples of activities include ‘Manual Corn Shelling’, ‘On The Go Protein Analyzers’ and ‘Moisture Content and Yield Data’, amongst many others.

STEAM can be challenging but it can also be fun! Be sure to try out the activities. Observe what works and what doesn’t and how activities can be changed slightly to get different results. It’s all a part of the STEAM learning process!

PLANNING A MEETING

Plan your meetings well. Review all the information well in advance so you are prepared and ready!

Before Each Meeting:

- Read the topic information and activities and photocopy any relevant resources for the members' Record Books.
- Be familiar with the topic information for each meeting. Think of imaginative ways to present the information to the members. Do not rely on just reading the information out loud. Review available resources, plan the meetings and choose activities and themes that complement the ages and interests of your members. The Record Book contains extra activities that can be used if you need to fill in time or if one of the suggested meeting activities does not suit your group of members.
- Gather any equipment and/or resources that will be needed to complete the meeting.
- At least 12 hours of club meeting time is required for every project; including club business, specific project information and social recreation. The delivery format for that material is left to the discretion of the leaders. Before each meeting, create a timeline to ensure that you are providing an adequate amount of instructional time for club completion. Note: the best practice recommendation is that a club have multiple meeting times for each project.

Included on the following page is a Leader's Planning Chart to help with the planning of meetings. In addition to the chart, keep track of what went well and what should be changed next time. That way, each time this project is run, the content of the meetings can be different!

When planning each meeting, a typical 4-H meeting agenda should include the following:

- Welcome & Call to Order
- 4-H Pledge
- Roll Call
- Parliamentary Procedure:
 - Secretary's Report
 - Treasurer's Report (if any)
 - Press Report
 - New Business: local and provincial 4-H activities/opportunities, upcoming club activities
- Meeting content, activities and recipes
- Clean-up
- Social Recreation and/or refreshments
- Adjournment

LEADER'S PLANNING CHART

Meeting #	Date/Place/ Time	Topics Covered	Activities	Materials Needed

JUDGING AND COMMUNICATIONS:

Each meeting must include either a judging or public speaking activity.

- Judging gives the members an opportunity to use judging techniques as part of the learning process. Through judging, members learn to evaluate, make decisions and communicate with others. They also develop critical thinking skills, confidence and self-esteem. Many examples are used in this reference book but use your imagination! As long as members are setting criteria and critically thinking about where items fit within that set of criteria, they are learning the basic skills of judging!
- A communications activity has been provided for each meeting but can be included in the Roll Call or social recreation time. These activities do not need to involve the topic of farm machinery as the outcome is more about understanding the concepts of effective communication.

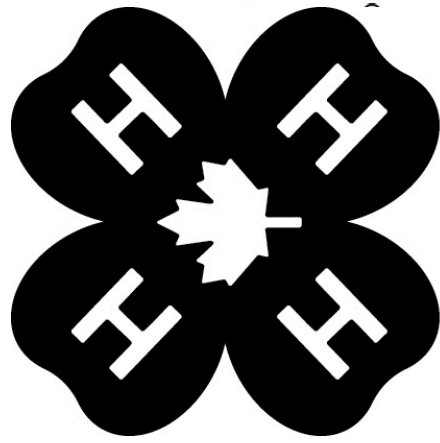
As a club volunteer your responsibilities are to:

- Complete the volunteer screening process and to attend a volunteer training session.
- Notify the local Association of the club, arrange a meeting schedule and participate in club meetings, activities and the Achievement program.
- Review the project material in the Reference, Record and Recipe books to familiarize yourself with the information and adapt it to fit your group. Be well organized and teach the material based on your group's age, interest and experience level.
- Organize the club so members gain parliamentary procedure, judging and communication skills.
- Have membership lists completed and submitted along with fee collected (if applicable) by the end of the second meeting.
- Have members fill out a Participant Agreement Form and identify any health concerns. Ensure that all members, leaders and parent helpers know the appropriate actions during any emergency. Check with members for any food allergies or dietary restrictions and plan snacks accordingly.

As a club member your responsibilities are to:

- Participate in at least 2/3 of his/her own club meeting time. Clubs must have a minimum of 12 hours of meeting time.
- Complete the project requirement to the satisfaction of the club leaders.
- Take part in the project Achievement Program.
- Fill in and complete the Record Book.

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my Hands to larger service
my Health to better living
for my club, my community and my country.**



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MEETING 1- SAFETY

Setting Objectives:

By the end of this meeting members should be able to describe how to safely operate and maintain equipment on the farm, identify key areas of risks on the farm and understand how to work safer.

Suggested Lesson Outcomes

- Machinery maintenance- Where is the grease gun?
- Safe equipment operation- What does this lever do?
- Identify high risk areas on the farm- How do I get out?

Reference Material in this section:

- Owner's manual
- Equipment maintenance
- Workplace Safety and Prevention Services website (www.wsps.ca)
- Infrastructure Health and Safety Association (www.ihsa.ca)

Roll Calls:

- Name one part on a piece of equipment that is dangerous when moving.
- Name one piece of safety equipment that machinery should have.
- Have you ever looked at an Owner's Manual for a piece of farm machinery? What did you look up in the manual?

Activities:

Go over how to grease a piece of equipment with the group.

Go over how to inspect the piece of equipment to see if it is ready to operate

MACHINERY MAINTENANCE AND SAFETY

Which piece of equipment do you use the most? What does the operator's manual say for greasing and maintenance intervals? For a lot of equipment every 50 hours might be normal for greasing. The question is how long does it take to get there? For some pieces of equipment 50 hours might take months, or in spring and harvest times it might take less than a week. Make sure you adapt your maintenance schedule to the work load your equipment sees. If you are working in an area with extreme cold/heat or pushing your equipment to its limit, time between maintenance intervals need to be shorter.

VISIBILITY IS WHETHER YOU CAN SEE OUT!

- Are the windows clean?
- Are the mirrors adjusted?
- Is there appropriate lighting to operate at night?
- Look Back! Check your blind spots before moving equipment in reverse

Look it up!

Reviewing operator's manuals

MAINTENANCE AND CLEANLINESS OF EQUIPMENT

Engine oil

When was the last time you checked the engine oil? Ideally engine oil should be checked daily. Engine oil is crucial to machine operation. Critical damage can occur quickly if levels are low. When was the last time the oil was changed? For most diesel equipment the oil change intervals will be between 100 and 200 hours. Plan your maintenance schedule so your equipment is ready to go at the start of the harvest season.

Hydraulic Oil

How often do you check hydraulic oil levels? Shamefully most of us will likely say when we feel a difference in the controls of the machine, or when you lose lifting capacity. As part of the machine operation hydraulic oil levels should be checked often. Refer to your owner's manual on how to take care of your system.

Tires

Are your tires safe for road travel? Farm equipment is not permitted on the road with tires that:

- have exposed cords, tread or sidewall cuts or snags that expose the cords
- are broken or defective and will cause damage to the roads
- are fitted with flanges, ribs, clamps or other devices attached to or part of the wheels that will cause damage to the road
- have abnormal visible bumps, bulges or knots
- have been re-grooved or recut and the tire was not designed for re-grooving or re-cutting
- are smaller than vehicle manufacturers recommended minimum size
- contact any vehicle component so as to affect the safe operation of the vehicle

The Cooling System

- The coolant in your equipment is only part of the cooling system. Check the level and add the appropriate type of antifreeze.
- If the new coolant isn't the same colour, it is not the same type of antifreeze!
- Check the owner's manual to ensure you are adding the right type
- Check the rad to make sure it isn't blocked with mud or chaff because air flow is key to proper cooling
- If equipment uses an electric fan ensure that it is engaging at appropriate temperatures

MTO Farm Guide

<http://www.mto.gov.on.ca/english/trucks/pdfs/farm-guide-farm-equipment-on-the-highway.pdf>

Shields and Guards

- When maintenance is completed ensure shields and guards are put back in place.

Right size tractor for right size equipment

- Have any members had any close calls, with machines tipping?

OPERATION SAFETY - SPEED, SLOPE

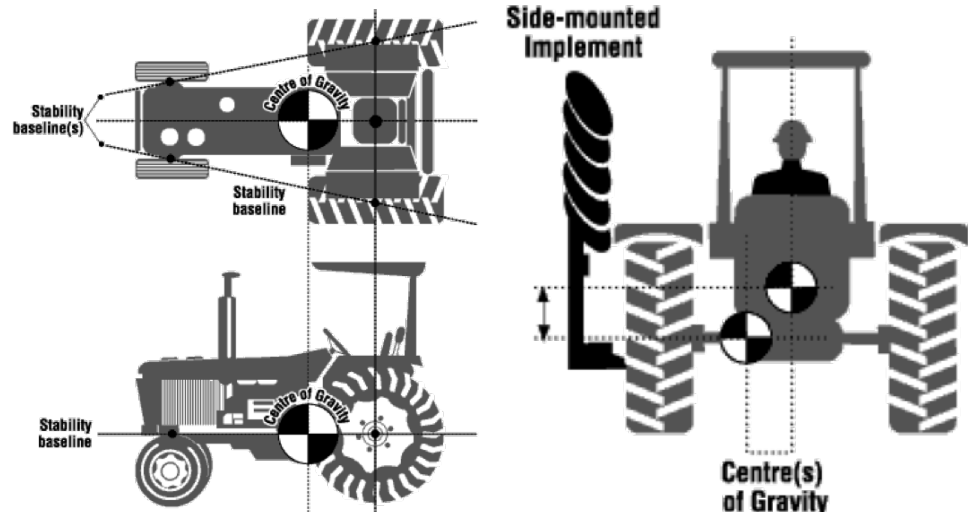
Am I going too fast? We all know how machines should respond, but when towing or working with heavy loads our controls will be less responsive and the center of gravity can change quickly.

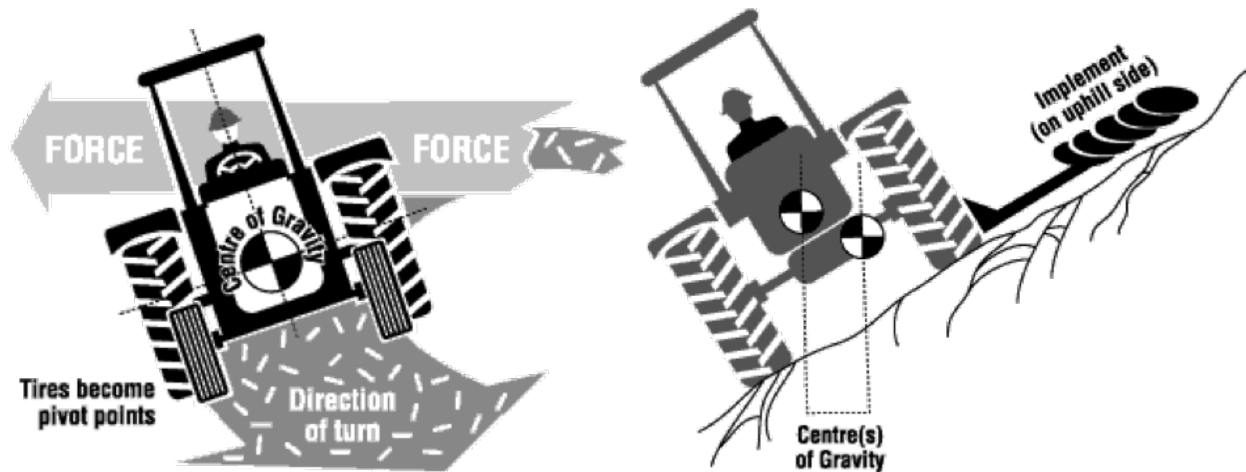
Stability

- Side-mounted implements shift the centre of gravity toward the implement.
- Operate the tractor with the mounted implement on the uphill side of slope.
- Adjust the tractor's stability with wheel weights and counterweights.
- Be aware of depressions in the ground and obstructions such as rocks and stumps. These hazards can change tractor stability on slopes or at speeds greater than a few kilometers per hour.

Talk about it!

Why should equipment be turned off to make minor repairs?





Instability can tip a tractor sideways. The outside wheels become pivot points.

The outward tipping force varies according to the tractor speed and turning radius. Sharp turns increase the force.

A tractor is more unstable when turning uphill. Avoid this type of turn whenever possible or make it at a slow speed.

The force becomes more dangerous as the tractor's centre of gravity is moved higher. Examples are when a front-end loader is raised, or when spray tanks are mounted high on a tractor chassis.

How can you maintain stability on various Gradients - (https://www.ccohs.ca/oshanswers/safety_haz/tractors/stability.html)

MACHINERY FIRES

- Do you have a fire extinguisher? What's your plan if your piece of machinery catches fire? Every year combines and other equipment burn up because there was a buildup of organic matter or due to improper maintenance.
- Consider incorporating a heat gun, or other temperature indicating devices into your diagnosing tool kit.

Programs like Farm Food Care Ontario lend out heat cameras for farmers to inspect facilities and equipment. (<http://www.farmfoodcareon.org/farm-animal-care/flir-lending-program/>)

Use the "Pass System"

- **Pull** the Pin (or Press the lever)
- **Aim** at the base of the fire
- **Squeeze** the handle
- **Sweep** from side to side

Expand on it!

What machine failures have 4H members seen? Could they have been avoided? What were the warning signs?

Activity idea!

Demonstrate how to use a heat gun to check bearing temperatures. Or better yet, use a thermal camera to inspect a machine that has just been used for any hot spots.

Think About it!

What is the procedure to use a fire extinguisher?

Talk about it!

Where are the fire extinguishers at your farm? Are there enough?

ARE YOU READY TO TAKE CONTROL?

Age and maturity of operators

Farmers and farm workers take on responsibility at a young age to get all the work on the farm done. As a result, you are often asked to operate equipment at a young age. Are you ready though? The equipment found on farms is much larger and faster than it used to be, so operators have to be especially diligent to ensure they're in control and understand the consequences of their actions.

- Ensure your mentors and trainers take the time to train you on the complete operation of the unit prior to you taking control. If you don't understand any function on this piece of equipment- You shouldn't be in control of it yet!

ARE YOU FIT FOR DUTY? (HAVE YOU GOTTEN ENOUGH SLEEP?)

Farmers are known to work long hours to get the job done, which is necessary at times. But you have to ask yourself, when is it time to call it a day and get some sleep?

In the trucking industry, drivers are only allowed to drive a certain number of hours each day. They are also required to maintain a log book to show their hours off. When was the last time you came to work too tired? If you're in a tractor on the road you can be charged the same fines as if you were in a vehicle. **You must make sure you're in control of the vehicle.** Other drivers on the road don't understand how heavy tractors are, or how much distance is needed to stop a piece of farm equipment. Drive defensively, lives depend on it.

DRIVER QUALIFICATIONS

HTA 32, 37, Reg. 340/94 Criminal Code of Canada 253, 254, 259

A driver's licence is not required to drive a tractor along or across a road. Drivers must be 16 or older to drive on, or along, a road. Drivers under 16 are only allowed to drive a tractor directly across a road.

Farm Guide, Farm Equipment on the Highway - <http://www.mto.gov.on.ca/english/trucks/pdfs/farm-guide-farm-equipment-on-the-highway.pdf>

JOURNEY MANAGEMENT ON THE FARM

Do you tell anyone where you are going or when you'll be back? Create check in times and estimated time of arrivals. If you don't show up on time or check in then your farm manager will know somethings gone wrong.

Will anyone notice you missing?

Look it up!

The Ministry of Transportation has a "Farm Equipment on the Highway" guide.

Digging Deeper- Does your farm have Health and Safety Policies?

Does your farm have more than 6 employees on staff? If so you will need to get health and safety policies in place to be in compliance with the Ontario Ministry of Labor.

CONFINED SPACES – CAN YOU GET OUT?

Every year farm workers die in confined spaces due to exposure to gases or low oxygen environments.

Confined Spaces are often:

- Unidentified
- Mislabeled
- Hazardous
- Deadly

Look it up!

WorkSafeBC videos on
YouTube!

What confined spaces exist on your farm?

A confined space means a fully or partially enclosed space:

- (a) That is not both designed and constructed for continuous human occupancy, and
- (b) In which atmospheric hazards may occur because of its construction, location or contents or because of the work that's done in it (Ontario Safety Group)

Is your space designed for human occupancy? Consider the cab of your tractor or your living room, both are comfortable with easy access to the entrance and exits. If it's not comfortable or easy to get into and out of you might be dealing with a confined space.

Is there the potential for atmospheric hazards? That means either not enough oxygen or too much of a bad gas! Is there constant air movement through this space? If there isn't you might be dealing with a confined space!

ATMOSPHERIC HAZARDS- WHAT'S THAT SMELL?

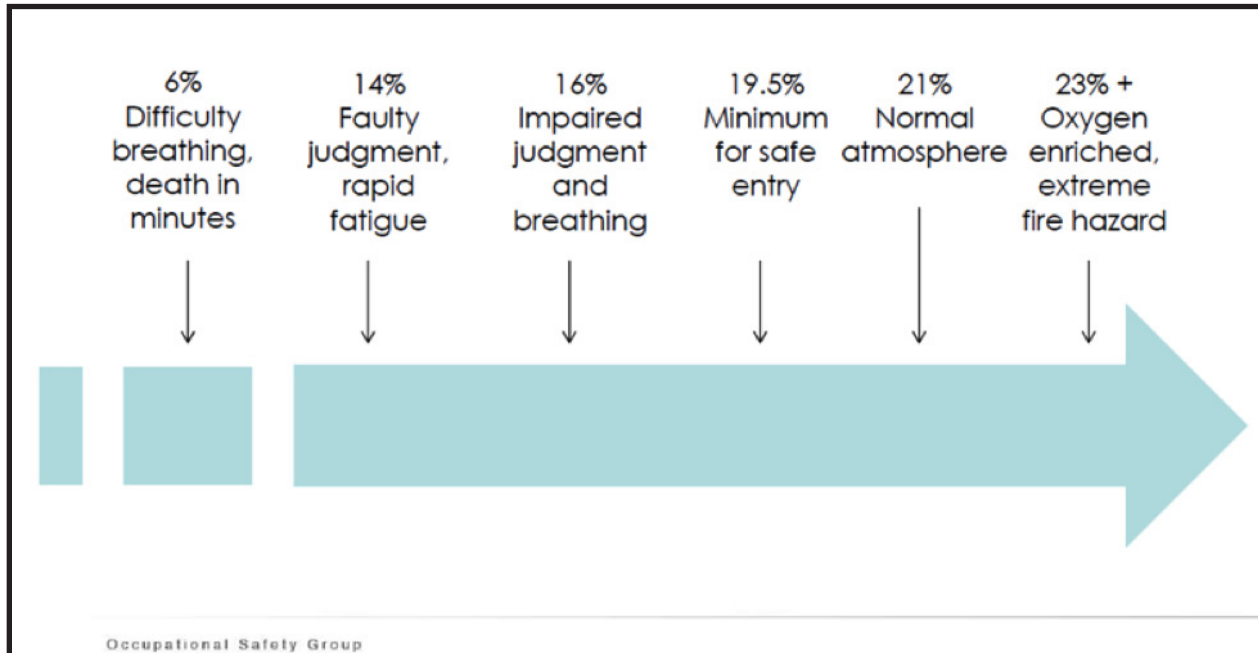
- The presence of an odour can warn you about a possible atmospheric hazard.
- What sources do you have on your farm? Chemicals? Decomposition of organic matter? Manure? Welding? Solvent cleaning? Carbon Monoxide? (if the birds in your shop start drooping you forgot to open the door!)

What should you do before starting a job that involves a confined space?

Ask yourself: can you do the work without getting in the space? Maybe you're cleaning a manure tank for maintenance. Clean the tank from the man hatch and then let it air out before entry.

Maybe there's another hatch you can open to get a cross wind through the space? Ensure ventilation before entering.

OXYGEN LEVELS IN THE ATMOSPHERE



A normal atmosphere contains between 20.8% to 21% oxygen. Below this level, an oxygen-deficient atmosphere is created when oxygen is displaced by inert gases such as carbon monoxide. Above this level, an oxygen-enriched atmosphere is created presenting a significant fire and explosion risk.

WHAT GASES COULD BE PRESENT?

Carbon Monoxide (CO)

Carbon Monoxide is lighter than air, and is generated by incomplete combustion of fuel. Carbon Monoxide (CO) can be created by a vehicle running close to the space, petroleum fueled heaters, generators or fork lifts.

If a machine moves under power and doesn't have to be plugged in every night, it is likely a source of carbon monoxide.

Methane (CH₄)

Methane is a naturally occurring gas, lighter than air and commonly found in:

- Livestock barns
- Manure storages
- Natural gas
- Land fills
- Basements
- Crawl spaces
- Water wells

Hydrogen Sulphide (H₂S)

Hydrogen sulphide is a poisonous flammable gas that smells like rotten eggs. However, at high concentrations your sense of smell is paralyzed and you may not realize the danger. Even short term exposure can result in death. H₂S is heavier than air so its commonly found in low lying areas such as:

- Basements
- Man holes
- Sewer lines
- Manure Pits

Silo Gas (Nitrogen Dioxide- NO₂)

Nitrogen dioxide, or NO₂ is a gas that's created after plant material is placed in the silo. Even short term exposure can result in death. It has an odour is similar to bleach and, in severe concentrations, may be visible as a reddish-brown haze.

TO AVOID EXPOSURE TO SILO GAS:

- Avoid the silo for several weeks after filling
- If you need to enter the silo after filling then do so immediately before the chemical process starts and gases accumulate. Keep the blower on to provide fresh air
- If entry is required into a silo where nitrogen dioxide is present, lifelines and supplied air may be necessary.
- OMAFRA- Forages: Harvest and storage
- <http://www.omafra.gov.on.ca/english/crops/pub811/3harvest.htm>

You should consider worst case scenario, maybe you're doing maintenance inside a silo. Is it possible that someone could turn it on while you are inside? Does everyone at the farm know this work is being done?

Are you inside a bin, wagon or a pit? Is it possible that fluid or grain could flow into this area while you're working? What could you do to prevent this?

Activity Look Up!

Work safe BC video-
Confined spaces www.youtube.com/user/worksafeBC/videos

Expand on it!

Activity: What are the areas at your farm that could accumulate gases?

What could change while in the confined space?

Could any fluids or grains move into the space while the work is being performed?

Look it up!

Google farmer dies in tank and find a local example as this happens far too often.

Activity!

Set up a mock confined space rescue and have members attempt to rescue other members from an area to mimic the difficulty of confined space rescues!

WORKING AT HEIGHTS

Examples:

- A height within a structure, is there a loft in your barn or shop?
- Ladders
- Machinery - Working on your tractor/combine - think about how far up it could be!

CASE STUDY

Suppose you are working in a hayloft of a barn and you notice a large hole in the floor. What should you do?

If you have to work in close proximity to the hole you should have a cover made that can handle your weight.

Activity!

What areas at your farm would be considered working at heights?

Activity!

Ask members for examples of close calls in confined spaces!

Talk about it!

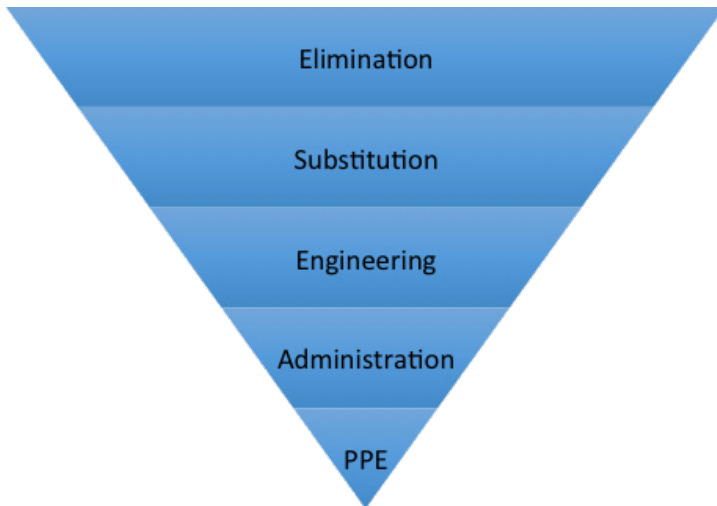
What hazards can you see in this picture?



Occupational Safety Group, Working at Heights

HIERARCHY OF CONTROLS

Elimination: eliminate the hazard- perform work at ground level if possible (can you do the work with a tool from the ground?)



Substitution: Use a man lift instead of a ladder

Engineering: Redesign the fall hazard out of the job (stair way around a bin instead of ladder)

Administration: Install barriers or covers over holes and ledges

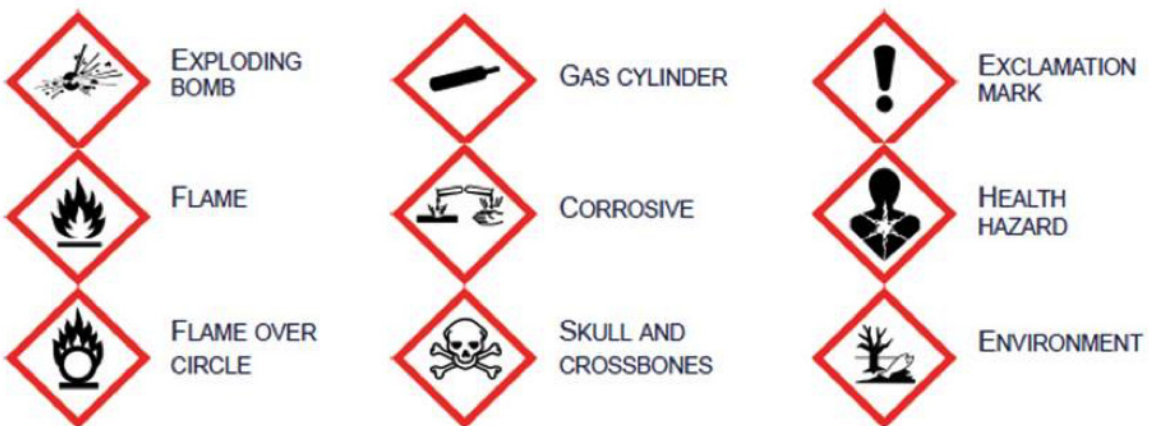
PPE: Wear a fall arrest system as a last resort

WHMIS

What is WHMIS?

WHMIS is the Workplace Hazardous Materials Information System. WHMIS is how we communicate the dangers associated with chemicals that we use every day.

WHMIS 2015 PICTOGRAMS



Occupational Safety Group

What are Safety Data Sheets?

SDS sheets provide information about products that is:

- Accurate
- Reliable
- Trustworthy

Talk about it!

What chemicals do you have around your house and farm? What precautions do you take to store them and use them properly? Are there any containers on the farm that aren't labeled?

There are 16 required sections on safety data sheets:

- Identification
 - o What is the product?
- Hazard Identification
 - o What are the hazards? This section will show pictograms for all the hazards
- Composition information
 - o What is the product composed of?
- First Aid Measures
 - o If you ingest it what should you do?
- Fire Fighting Measures
 - o If it catches fire how do you put it out?
- Accidental Release Measures
 - o If it is released into the environment what are the spill response measures?
- Handling and storage
 - o Where should it be stored?
- Exposure Controls
 - o What are the exposure limits for the product?
- Physical & Chemical Properties
 - o At what temperatures does it ignite or freeze?
 - o What does it look like? Does it have an odour?
- Stability and Reactivity
 - o Does the product react with oxygen or water?
- Toxicological Information
 - o Does it cause cancer?
- Ecological Information
 - o How would it effect the environment?
- Disposal Considerations
 - o What is the appropriate way to get rid of it?
- Transport information
 - o If you are transporting it in bulk what placards do you need?
- Regulatory Information
 - o Applicable laws/regulations about the product
- Other information
 - o Date of the last revision of the Safety Data Sheet

Pick one product used on local farms and review the Safety Data Sheet:

- What are the hazards?
- What are the controls?
- Are they being used on the farms?

LOCK OUT TAG OUT

People are hurt every year by working on equipment without controlling stored energy hazards.

How do you isolate the energy?

The best way to control stored energy is a process called lock out/ tag out. This process requires you to isolate the piece of equipment from any energy release. Once energy is released, you lock it so it can't be re-energized.

So what does this mean on the farm? Say you're working on a tractor and you take a break half way through fixing it. To prevent any other person from using the unfixed tractor while you are away, you would take the keys out. Say you're working on this same tractor but are hidden from sight because you are underneath the tractor, then you would take the keys out to prevent someone from turning this tractor on and harming your safety. This is how lock out/tag out works.

For tasks that involve electricity you need to make sure the circuits aren't live. You could flip the breaker and then lock the panel shut so no one else will turn the power back on. Then cycle the on/off switch at the device to make sure the electricity to the unit has been isolated before working on it.

For stored hydraulic energy, turn off the piece of equipment and cycle the levers to make sure no lines are still pressurized.

There are many types of energy you need to account for to be safe on the farm or a job site!

TALK ABOUT IT!

Is what you're working on live? Is there stored energy? What are the types of energy?

ELECTRICAL

Electrical energy can be found outdoors with power lines, or using tools and equipment. If you are wiring on a piece of equipment remember that's electrical too! Disconnect the battery to protect yourself and the electronics you are working on! Electrical energy is found in the following:

- Panels
- Sockets
- Capacitors
- Machinery

PNEUMATIC

Pneumatic energy is anything that has air pressure. Remember there is stored energy in air hoses. Don't work on devices that still have air pressure in them. Pressure could be released and cause harm! Pneumatic energy is found in the following:

- Piping systems
- Tools
- Ag Vacuums
- bin blowers

HYDRAULIC

Hydraulic energy is found all over the farm. Is there still pressure in your hydraulic hoses? Is there a suspended load? If so, you have stored hydraulic and gravitational energy! Hydraulic energy is found in the following:

- Loaders
- Hitched equipment
- Presses

MECHANICAL

Is the piece of equipment still moving? Could it move unexpectedly? Belts, fans and chains are dangerous when they are moving. Make sure to stay clear until the machine has stopped moving! Mechanical energy is found in the following:

- Kinetic energy- motion
 - Belts and chain drives
 - Fans
 - Gears
 - Saw Blades
- Potential Energy- Stored

Does the equipment have springs, or steel that could act like a spring when it malfunctions? Springs store a lot of energy, and can hurt you quickly. Refer to the owner's manual to find a way to release the tension in a controlled manner to avoid injury! Stored energy can be found in the following:

- Springs
- Flex augers
- Hoists
- Presses
- Belts and chain tensioners

THERMAL

Is the equipment extremely hot or cold? Wait for the equipment to return to room temperature before working on it. Plan your work! Thermal energy can be found in the following:

- Corn Dryers
- Heaters
- Motors
- Steam lines

CHEMICAL

Are you using Chemicals? Does the equipment you're working on contain chemicals? How dangerous are these chemicals? Are they corrosive or flammable? Is there a heat source nearby? Read the safety data sheets to understand the hazards of the chemicals you are dealing with. Plan your work to prevent chemicals from reacting. Always wear the appropriate PPE to prevent skin contact from harsh chemicals! Chemical energy can be found in the following:

- Flammables
- Corrosives
- Explosives

MEETING 2- TECHNOLOGY

Suggested lesson objectives and outcomes:

By the end of this meeting members should be able to:

- discuss the effects technology has had on agriculture and harvesting methods and,
- describe how technology is driving production and productivity on the farm.

Roll Calls:

- Does your family's vehicle have a GPS system? What do you use it for?
- Look into the future. What new technology can you imagine will be used in agriculture 50 years from now?
- If money was no object, what piece of new technology would you purchase for your farm or home?

GLOBAL POSITIONING SYSTEM

Global positioning system or GPS is the most common type of positioning system used in agriculture today. GPS was developed by the United States military and still uses military satellites today. GPS provides us with accurate information to guide our machines and track our yields.

What do you need for your GPS system?

Antennae

- Receives the GPS signal

Receiver

- Each GPS signal needs a receiver to decode the signal so it can be used and interpreted by the device you are using.

Display and Storage

- The display allows you to see the GPS data so it can be used. The data stored can be used to create reports or later interpret that data.

Interfacing with other devices

- Is the tractor or combine steering automatically? If so, the GPS system is “interfacing” with that steering system

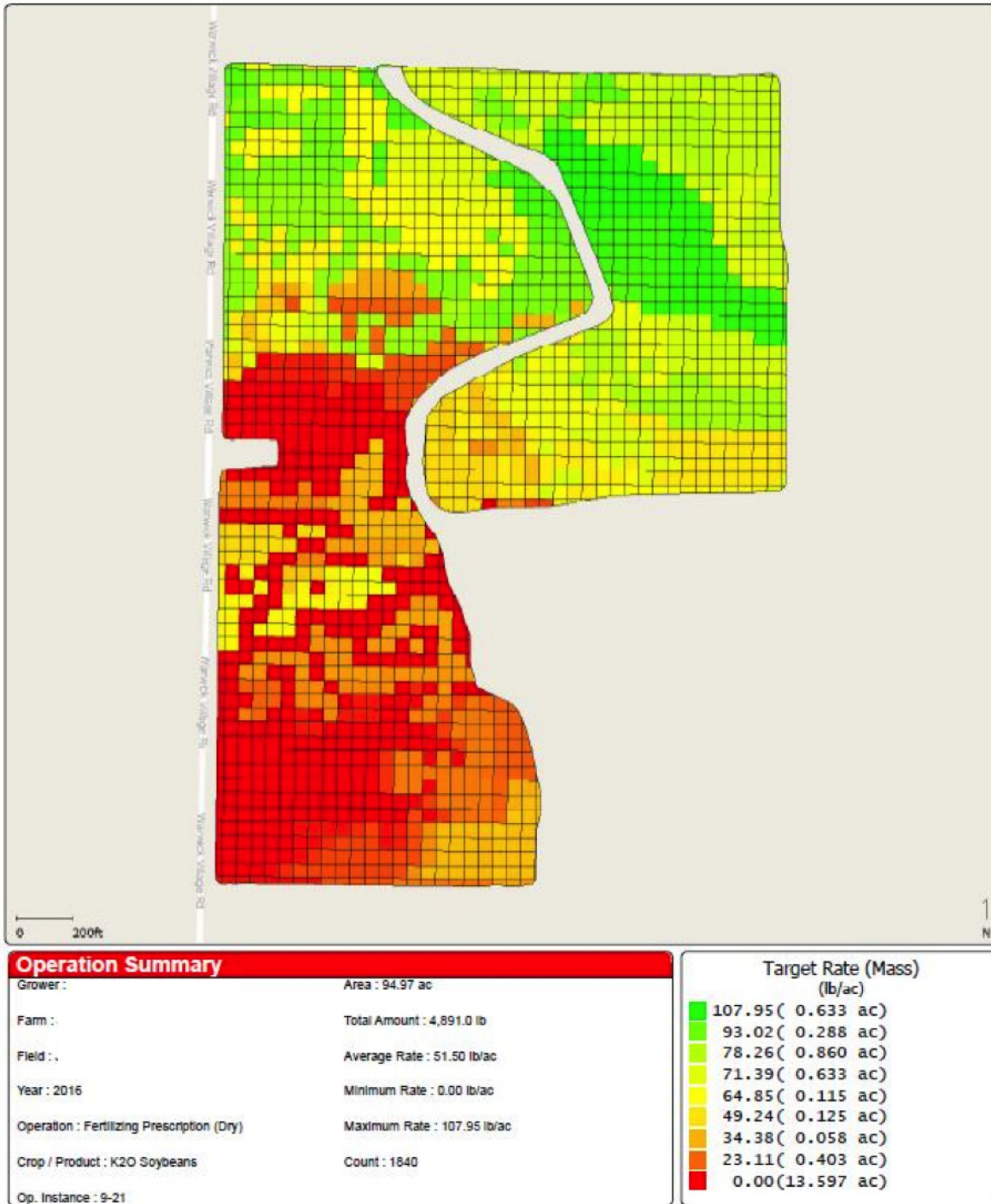
WHAT ARE THE APPLICATIONS OF GPS IN AGRICULTURE?

Guidance

- Ensuring rows are planted straight!

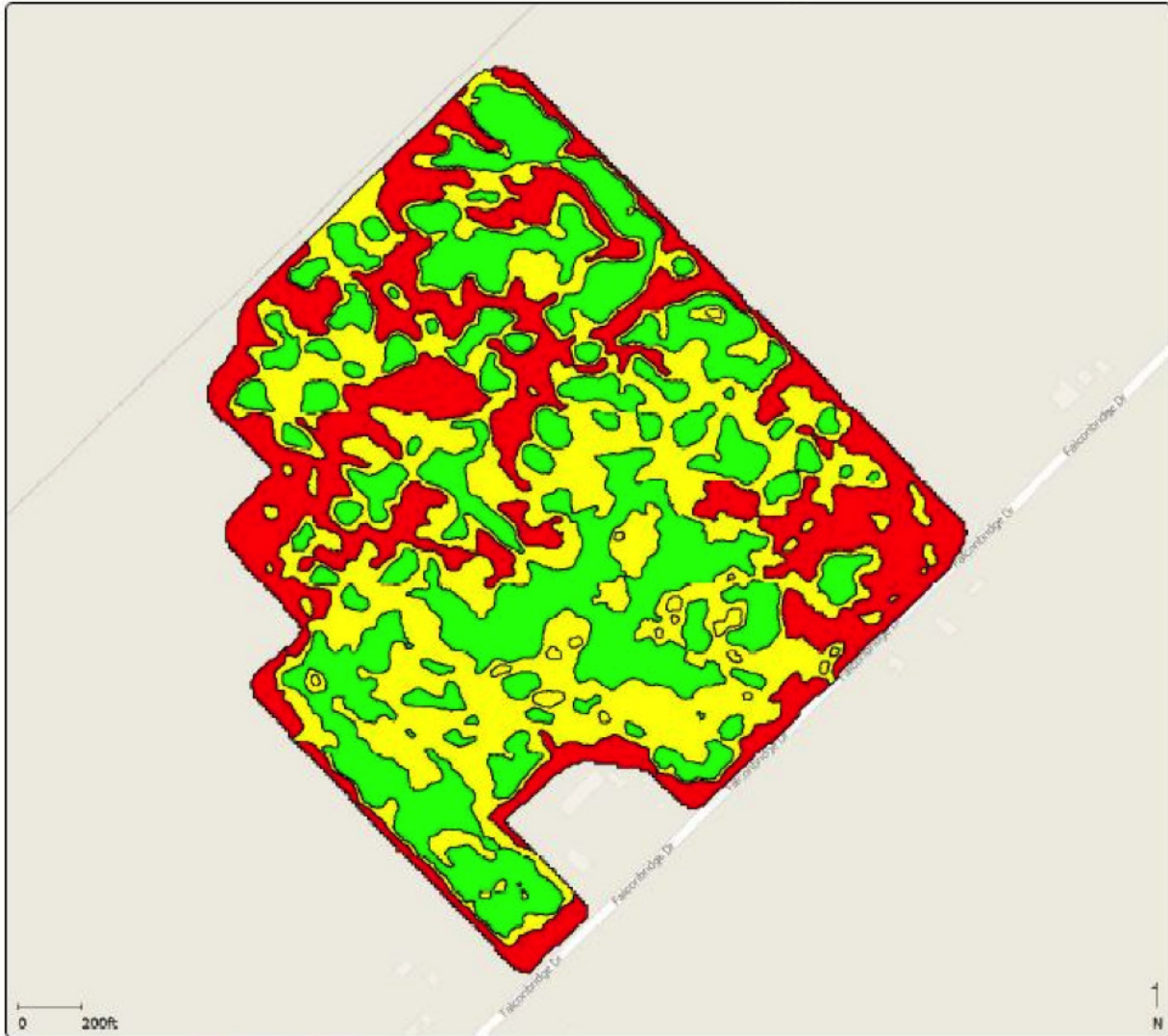
Variable Rate application

- Apply the nutrients and chemicals where they are needed to increase efficiency and profitability



Fertilizer Prescription Map from Veritas

Fertilizer prescription maps enable farmers to apply only the nutrients needed to the plants that will use it.



Grower : Farm : Field : Home Year : 2016 Product : NO Product Area : 89.46 ac Total Target Rate (Count) : 2,871.2 ksds Average Target Rate (Count) : 32.09 ksds/ac	Target Rate (Count) (ksds/ac) 34.00 32.00 30.00
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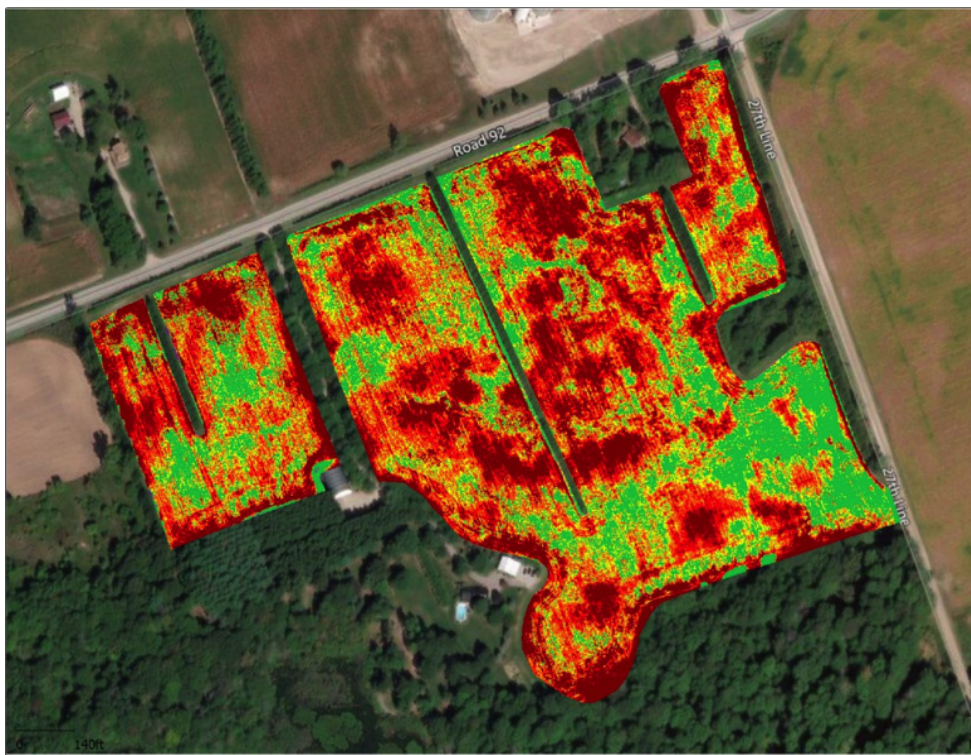
Planting Prescription showing seeds per acre to be planted

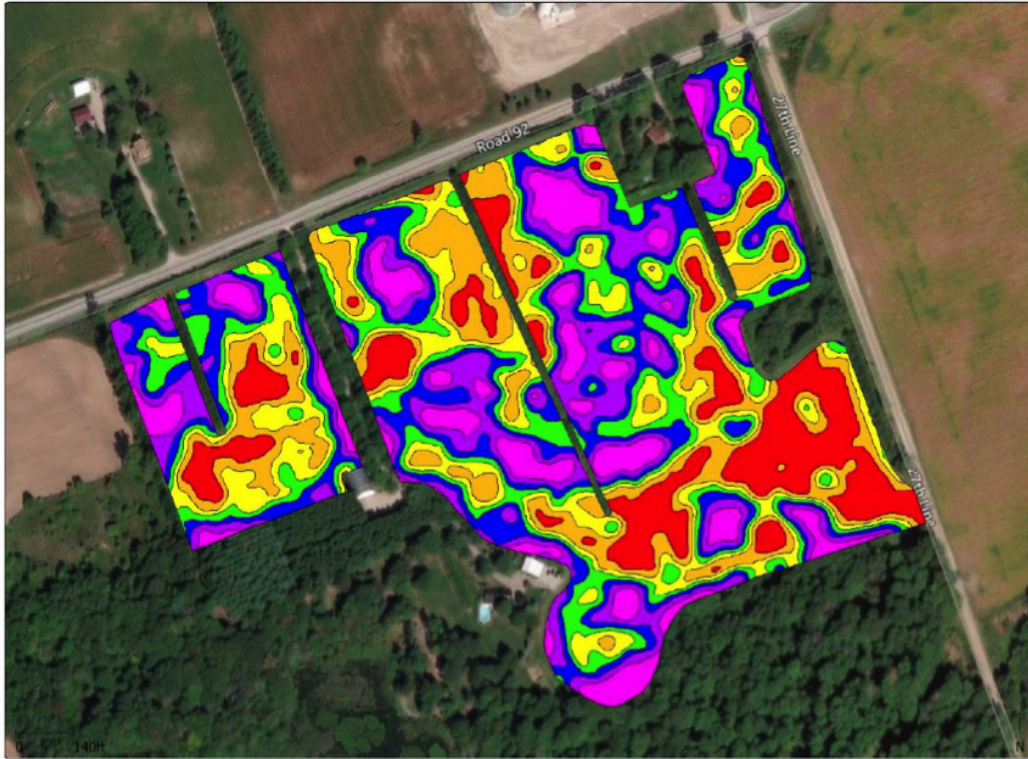
Variable rate planting allows farmers to target areas of the field that will respond well to higher seed populations.

DRONE IMAGERY

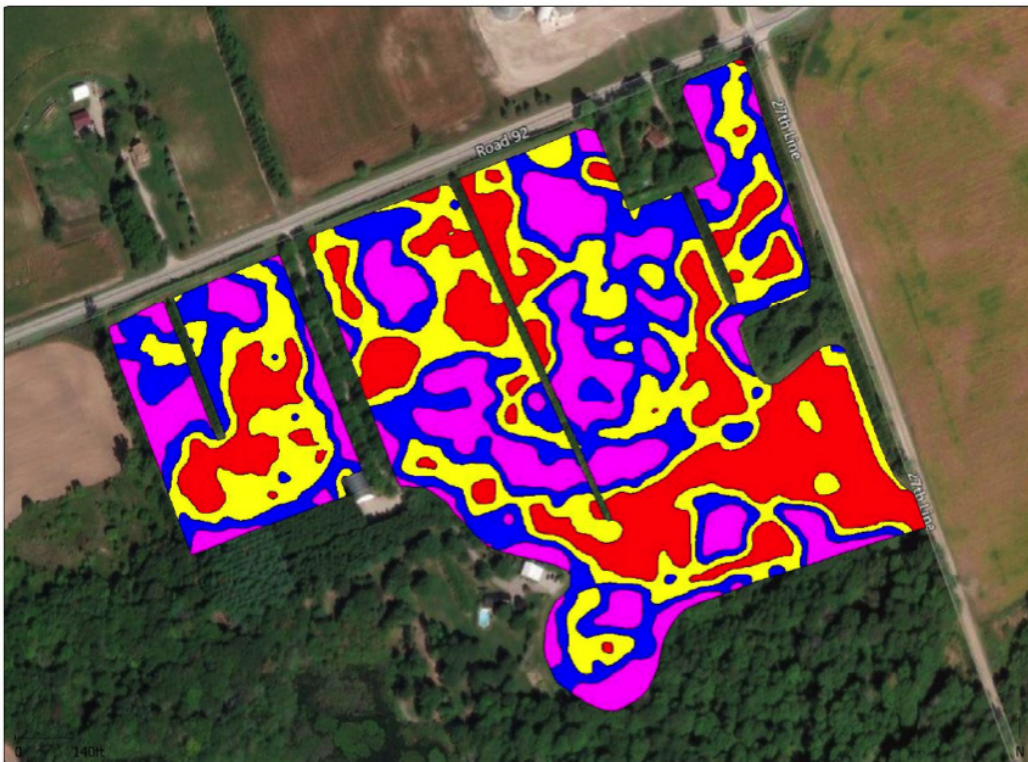


Filtered with NDVI or Normalized Difference Vegetation Index, which essentially measures and shows how much green area (or live plant matter) the area has. As you can see in the maps below, the areas with less green matter are shown in red.





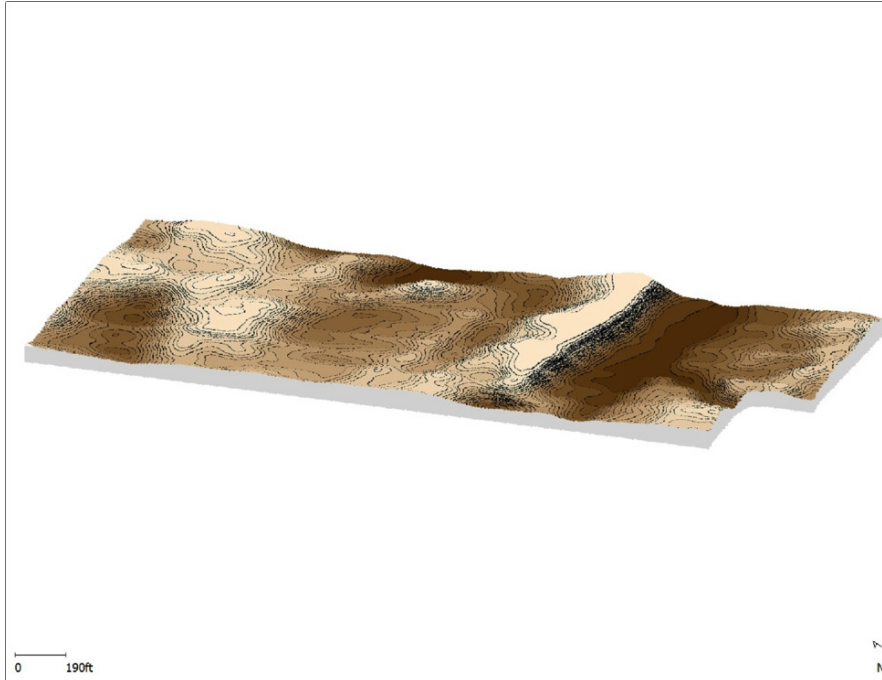
Map showing 7 control zones from the NDVI imagery



Map showing 4 control Zones from the NDVI imagery



- Chemical application/prescriptions
- Yield Mapping
 - o Records of yield variability across the farm
 - o Profitability maps to allow informed decisions



Veritas

Topographic Map to use with soil sampling

Variable rate maps can also be implemented for pesticides and fungicide applications.

WHAT DOES THIS MEAN FOR FARMERS?

Farmers can now manage our fields more efficiently than ever before. We can plant, apply nutrients and chemicals systematically. We can track what pests have effected which areas of the fields then track the yield data over land maps to show which areas yielded the best and why.

With that data we can make scripts to manage each section of the field for maximum yield, and track the profitability of each area. Is there a sandy knoll that gets burnt every year? Look at the data, does it produce profit?

https://www.bae.ncsu.edu/topic/agritourism/docs/GPS_Applications_in_Agriculture_NCASAE.pdf

<p>Talk about it!</p> <p>Does this technology interest you? It might be a career worth looking into!</p>	<p>Expand on it!</p> <p>What will these maps change about the way farmers manage fields?</p>
<p>Talk about it!</p> <p>How has technology on the farm changed in your life time? What do members think farming will look like in the future?</p>	<p>Digging Deeper</p> <p>Ask members what systems are being used on their farms. Ask whether data is being monitored and used to plan their farming choices</p>

AUTONOMOUS STEERING EQUIPMENT

As technology advances so does agriculture. Companies are experimenting with autonomous concept tractors.

What does that mean?

Autonomous means to act independently! Companies are experimenting with self-driving tractors that could help with the employee shortage across the ag industry. As motorized equipment changed the face of agriculture in the early 1900's we may be on the verge of another agricultural revolution!

The autonomous tractor would rely on remote control, sensors and advanced mapping systems for control and could be used to perform any functions a driver could.

But can the average farmer implement this technology?

Case study! Matt built his own!

Matt Reimer is a Saskatchewan farmer that developed his own autonomous system to control one of his tractors. He designed the system so it would control his grain buggy tractor while he was harvesting. When the combine is ready to unload he presses a button to call the grain buggy, the tractor pulls alongside the combine and he starts unloading. When unloading is done he presses another button and the tractor pulls to the side to wait for the next load.

Look it Up!

Mathew Reimer's Autonomous tractor at work <https://www.youtube.com/watch?v=Ybxhvlyw-X0>



Manitoba Farmer uses Robot Tractor for Harvest. <http://www.producer.com/2015/08/video-manitoba-farmer-uses-robot-tractor-for-harvest/>

Matt didn't have a programming background when he started. He built the whole system as open source so any one with the patience and determination could build their own.

Talk About it!

What tasks on the farm could you automate to save time or labour?

YIELD & MOISTURE MONITORS

Yield Mapping is the starting point for any precision farming. Yield maps establish a baseline for which areas of the farm produce well and which areas produce poorly. The maps show variability in yield, and the farmer can then try to figure out what is causing the variability.

What variables will your map show?

- Soil type
- Nutrient availability
- Drainage status
- Slopes
- Pest pressure

Once Variability is identified using the data from a yield monitor, management zones can be created for every input on your farm to address this variability. Crop management plans will be pivotal in making management choices as long as data is interpreted properly.

“A Yield monitor is a great tool for collecting data and showing you what actually took place in a field. The interpretation of the data is what will lead you to change management practices.” (Grant Mangold) http://www.awgfarms.com/Yield_Monitors_and_Yield_Mapping.html.htm

HOW YIELD IS CALCULATED ON THE GO!

In basic terms:

- What is the flow rate of product entering the bin on the combine? (kilograms or pounds per second)
- How fast is the equipment going? (kilometers per hour)
- How wide is the combine head? (measured in feet, inches or rows)

Moisture content in grain will vary between fields and areas within the field. Grain at different moisture contents weighs different amounts. If moisture content isn't taken into account, yields between fields won't have a baseline for comparison!

RTK GUIDANCE

- What is RTK? Real Time kinematic (RTK) guidance is a technology that takes GPS signals and couples them with on ground signal stations to increase accuracy to increments of less than an inch.
- Row sensing guidance systems detect the plants on the go and control steering to minimize crop damage. Row sensing is done by sensors using either sonar or mechanical means to tell the machine where the rows are.

Dig Deeper!

Why is moisture content so important in yield data?

Digging Deeper!

On the go protein analyzers can now be fitted to your combine now. Have the group discuss the benefits of having information at the field about protein. How will that help farmers market their grain more efficiently for crops like IP beans and hard red wheat?

MEETING 3 – DRY HAY

Suggested lesson objectives and outcomes:

- By the end of this meeting members should be able to describe the process of harvesting hay and straw and the equipment needed for this process.

Roll Calls:

- What type of baler do you have on your farm?
- Do you harvest forage on your farm? If so, what types of forages are harvested?
- How does weather play a factor in harvesting forages?

MOWER CONDITIONERS

The objective in conserving forage is to dry it as quickly as possible so that it keeps its natural colour and does not lose its nutritional value. Time and weather are very important.

Weather is crucial in forage harvesting.

- Too much rain/moisture will delay harvesting and compromise nutrient content and quality.
- Wind and sunshine help in drying the crop.
- Too much sun and drying time will cause the crop to become brittle and burnt. At this point the nutrition loss is substantial.

The purpose of mower-conditioners is to cut, windrow and condition forage in one single operation. In normal weather conditions no further operations are needed to prepare the forage for baling or storing as silage.

Rakes are used to speed up the drying process, and ensure consistency and quality.

Basic Mower-Conditioner Components

- Cutterbar – knife or disc
- Conditioner
- Float springs or hydraulics
- Windrow/swath shield
- PTO Drive Shaft and Controls
- Frame, Hitch and Wheels



The Case IH TD102 pull-type disc mower (caseih.com)

REEL. On mower conditioners with knife cutter bars a reel is used. The purpose of the reel is to gather tangled and downed crops for cutting. A reel acts like a barber’s comb.

THE CUTTERBAR. There are two types of cutter bars

1. The conventional knife or sicklebar is still used on farms today. It is reliable and easy to repair. The knives slide between two guards to cut the crop. After cutting the forage flows into the conditioner.

Extra heavy duty guards and different knife designs can be used for different conditions. Wet crops plug up the sicklebar and slow down the rate of work. A forward speed that is too fast will plug the cutterbar especially in heavy (thick) crops.



Case IH SC Series sicklebar mower conditioner (caseih.com)

2. Disc type mower-conditioners are the preferred choice today. A disc mower cuts efficiently at very fast forward speeds even if the crop is very wet. It takes more power than the cutter bar design. The discs, fitted with two or three knives, spin at speeds of up to 3000 rotations per minute (RPM). They are driven by gears under the discs.

Disc mowers cut in a similar way to a house hold garden rotary mower. They “slash” – not cut- the grass



Cutter Bar (caseih.com)

CONDITIONERS

Before mechanical conditioners were invented forage was left in windrows to dry (cure) in the field at the mercy of the weather.

Forage plants contain fluids (water and nutrients). By removing some of the fluid quickly it is possible to make better hay or haylage. Conditioners crush or crack the stem of forage plants. This allows some of the water to evaporate quickly and leave the nutrients behind. For silage, forage is left a very short time to wilt (leaves sag and the stems bend). With hay it is left out to dry longer so that molds do not form and spoil the hay.

Conditioners consist of two rolls with a steel or molded rubber surface. The surface is designed to crimp or crush the forage so as to speed up the wilting and drying time.



Crimper Roller- <http://somerstractor.com/tubeline/accelerator-hay-conditioner/>

Think About It!

Most barn fires that start in hay storages are the result of the biological processes that start when hay is not properly dried! Do you monitor your hay storage for signs of heating?

Crimper rolls are gear-like. The corrugated surfaces interlock. Forage passing between the rolls is “crimped” (or bent) and this allows the water to evaporate faster.

Crusher rolls have a lumpy or rough surface to “crush” the forage. Some designs of conditioner have one rough surfaced roller and one smooth one. Crusher conditioners are gentler than crimpers, and do not damage the crop as much. However, the drying time is longer.



Crusher Roller- <http://www.innovativeforage.com/the-crusher-hay-conditioner.html>

Swath gates or windrowing shields direct conditioned forage into a windrow or swath. If the windrow is left “fluffy, loose and open, air will circulate through taking the moisture away and drying the forage.

The setting of the gap between rolls and the angle of the windrowing shields will make a lot of difference in the drying time and damage to the crop.

SETTINGS AND ADJUSTMENTS

Flotation and tilt

All types of mower-conditioners are fitted with flotation springs and/or hydraulics. No field is perfectly flat, ground conditions vary. The cutterbar needs to work close to the ground to cut as much of the crop as required. Springs and hydraulics that are properly adjusted keep the mower- conditioner stable. They prevent the cutterbar from dropping too low and raising too high. This maintains an even cut and prevents damage to the cutterbar from hitting the ground. A good operator will check the operator’s manual for the correct adjustments.

Reel Setting

On mowers with a sickle bar the reel setting will make a difference in how much of the crop is cut and gathered-especially in difficult ground conditions.

Opening Up The Field

Opening the field sets the stage for the rest of the cut. Usually this is done by going around the outside of a field next to the fence known as the “headland”. It should be done at a slow speed. Often there are obstacles and fences to avoid on the outside. Turns should be made carefully. Planning the mower pattern helps cut down time. Operator’s manuals often have useful advice for opening and mowing patterns to most efficiently use your mower.

Ground Speed

A common-sense approach is recommended. Slow Speeds are best for “downed” and flattened crops. If the ground is level, faster forward speeds can be maintained. A good operator observes how the machine is coping and how much stubble is left by the machine. Disc mower-conditioners can generally travel at very high ground speed over 15km, check for current number on level ground, without affecting the cutting efficiency. Be safety conscious at all times and alter your cutting speed to accommodate slope and field conditions, just because you can drive fast doesn’t mean you should.

PTO Drive and Controls

The PTO shaft from the tractor to the mower-conditioner must be regularly checked. The PTO angle has to be correct, to avoid damage. Some machines have slip clutches, which slip if the cutterbar or conditioner plugs up. Slip clutches are fitted to protect the tractor and mower-conditioner from damage. Some machines have shear bolts which are designed to break and stop power transfer from the tractor to the implement at a certain torque or equipment load.

OTHER TYPES OF CONDITIONERS

We have discussed mower-conditioners, but there are other kinds.

- Self-propelled harvesters, cut and condition like a mower conditioner but have their own engine and are suitable for larger forage operations (Refer to self-propelled harvesters in MEETING 4)
- Hay rakes are also conditioners because they help in the drying of the crop and leave it in a windrow for baling or forage harvesting.
 - o Rakes of one sort or another have been around since agriculture started. Crude hand rakes like the ones we use for leaves were used to gather newly cut hay. By the 1800's the horse drawn sulky rake was in use and was gradually replaced by the side delivery rake. In time as the tractor replaced the horse, better rakes were developed.

The purpose of the rake is:

1. To put newly cut forage into a windrow for drying and make pick up easier
2. To put multiple windrows into one,
3. To speed up wilting and drying by turning the windrow.



John Deere Sulky (Dump) Rake 1930's http://www.tractorshed.com/cgi-bin/gallery/gallery_pic.cgi?sz=lrg&pic=http://www.tractorshed.com/gallery/iphotos/c51652.jpg&w=iphotos&cc=0&s=ts

To maximize forage quality, rows must be turned carefully. Otherwise, the high protein leaves are lost, leaving the coarse stalks and branches.

TYPES OF RAKES

- Parallel Bar rakes- Single or twin
- Wheel Rakes
- Rotating Head Rakes

PARALLEL BAR RAKE. The most common are single bar or side-delivery rakes.

- The crop is delivered to one side by a moving bar with spring mounted fingers, driven by a series of chains and belts.
- The rake is driven by the transport wheels or by the PTO from the tractor.
- Most rakes are trailed or towed behind the tractor.
- Twin Bar rakes deliver two or more windrows into one single windrow behind the tractor.

Expand on it!

Watch a video on sulky rake operation and discuss the evolution of farm machinery!

- Bar rakes tend to “roll” the crop into a windrow
- Normal operating ground speeds are 3 to 12 km/h



New Holland 56 Rake- <http://www.yesterdaystractors.com/cgi-bin/viewit.cgi?bd=implment&th=220817>

WHEEL RAKES. These rakes boast a simple design

- They are relatively inexpensive and simple to operate
- The wheels are driven by contact with the ground
- The wheels “roll” crops into a tight windrow
- They work at high ground speeds



Wheel Rake- (www.caseih.com)

ROTATING HEAD RAKES. These are PTO driven machines, which will rake and ted the hay. Tedding is spreading out the windrow to dry faster, before windrowing (making into a swath) again for picking up.

- These machines are designed to be gentle with the crops and “fluff” the crop to speed up drying.
- These rakes are usually combined Tedder-Rakes
- Working height is controlled by gauge wheels.
- Spring finger tines on rotating heads pick up and move the crop.

- On some models the rotating head is close to the ground. The tines stick out horizontally.
- On other models the tines are on the end of vertical arms attached to the underside of the rotating head.
- The direction and speed of the rotating heads can be changed to suit what you need to do with the crop.
- These machines can work at very high ground speeds
- There are several different makes of tedder-rakes
- These machines are more complex than the first two groups.

Special care must be taken when operating rakes. Make sure manufacturers recommendations and instructions are followed carefully.

OPERATION AND MAINTENANCE

- Check the operator' manual to make sure the machine is being operated correctly, and that it is adjusted properly. Check manual for greasing and maintenance requirements.
- Some models of rakes can operate at very high ground speeds. Take care to slow down on rough ground or slopes.
- Loose tines can fall off. Tines in forage and hay can cause considerable damage to forage harvesters and balers. Check for loose tines before you start, or else you can expect to find them in your metal detectors or tires.



RR 23 Rotary Rake www.deere.com/en_US/products/equipment/frontier_implements/hay_equipment/rotary_rakes/rr23_series_rotary_rake/rr23_series_rotary_rake.page

BALERS

The first hand-operated baler was designed before 1820. Until then, loose hay was collected by hand, dried and piled up in barns.

The first balers used regularly on farms appeared in the 1920's. These balers were stationary and were mainly custom built machines. A lot of hand labour was required to run them. By the 1930's a few mobile balers were produced with their own pick up devices. It wasn't until the 1940's that balers became completely automatic with invention of the first mechanical knotters.

The purpose of the baler is to “package” hay and straw- the main materials baled on the farm.

Baling is necessary because:

- Handling is easier, bales can be handled by people or machine
- Storage is more efficient as bales are packed and can be stacked neatly
- Transport is more economical

To reduce the labour needed to handle bales a farm can use equipment such as:

- Bale throwers, to throw bales from the baler into wagons
- Bale accumulators or bunchers, to collect and pile bales in the field
- Bale conveyors, to move bales into the mow
- Large square and round bales that can be loaded and unloaded quickly.

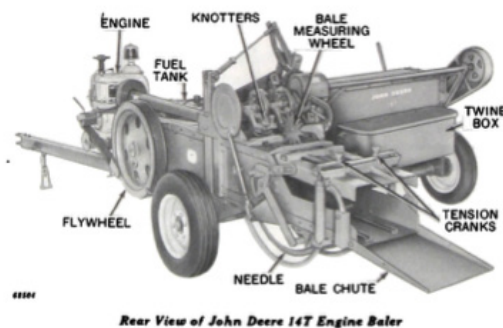
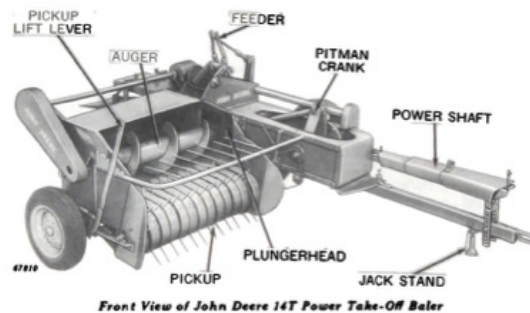
The most common types of balers today are the large square baler, and the round baler. Most farms have moved towards larger bales for efficiency and labour constraints.

LARGE/SMALL SQUARE BALERS

BASIC BALER COMPONENTS

- PTO Drive
- Pickup and feeder Mechanism
- Bale Chamber and plunger
- Needles and knotters
- Chute

PTO DRIVE ASSEMBLY. Modern balers are powered by tractors. The PTO drive consists of a shaft and flywheel. The flywheel is generally a solid, heavy wheel, and the force of this wheel as it rotates keeps the baling mechanism operating at a constant speed. It takes a lot of power to slow down the rotating flywheel.



THE PARTS OF A BALER – John Deere 14t Baler <https://farmmanualsfast.com/john-deere-14t-baler-operators-manual.html>

PICKUP AND FEEDER. The pickup on a baler is adjustable. The height can be changed to cope with the amount of material and to avoid picking up stones, dirt etc., especially on rough ground. A cross conveying auger feeds the material into the baling chamber.

BALE CHAMBER AND PLUNGERS

- Material is fed into the bale chamber by feeder teeth or packer fingers.
- Feeder teeth are timed (synchronized) with the plunger to keep up a steady “feed and compress” action until the chamber is full and the bale is completed. When the feeder teeth move into the chamber, the plunger is moving backwards.
- The plunger is driven by a crank arm and pitman. It travels back and forth in the bale chamber packing the material.
- The plunger knife cuts off loose material as the plunger travels forward.
- Hay dogs keep the compressed material in the chamber when the plunger withdraws.
- Tension bars at the end of the chamber control the density of the bale. Normally, the tension bars are adjusted by hand but can be controlled hydraulically.
- The measuring wheel turns as the bale grows inside the chamber. When the wheel has turned the pre-set amount, it starts off (trips) the tying mechanism.
- There are “protection” devices in the chamber and plunger to prevent damage to the baler. There is usually a safety stop in the chamber and a shear bolt on the plunger. Each make has a slightly different arrangement. Use an operator’s manual for more information.

NEEDLES AND KNOTTERS

The heart of the baler is the tying mechanism. It consists of needles and knotters. Wire can be used to tie bales, but twine is still more common.

The knotter mechanism was a very clever invention. Understanding knotters is not difficult. It’s just a matter of carefully following each step of the process.

THE KNOTTER AND HOW IT WORKS

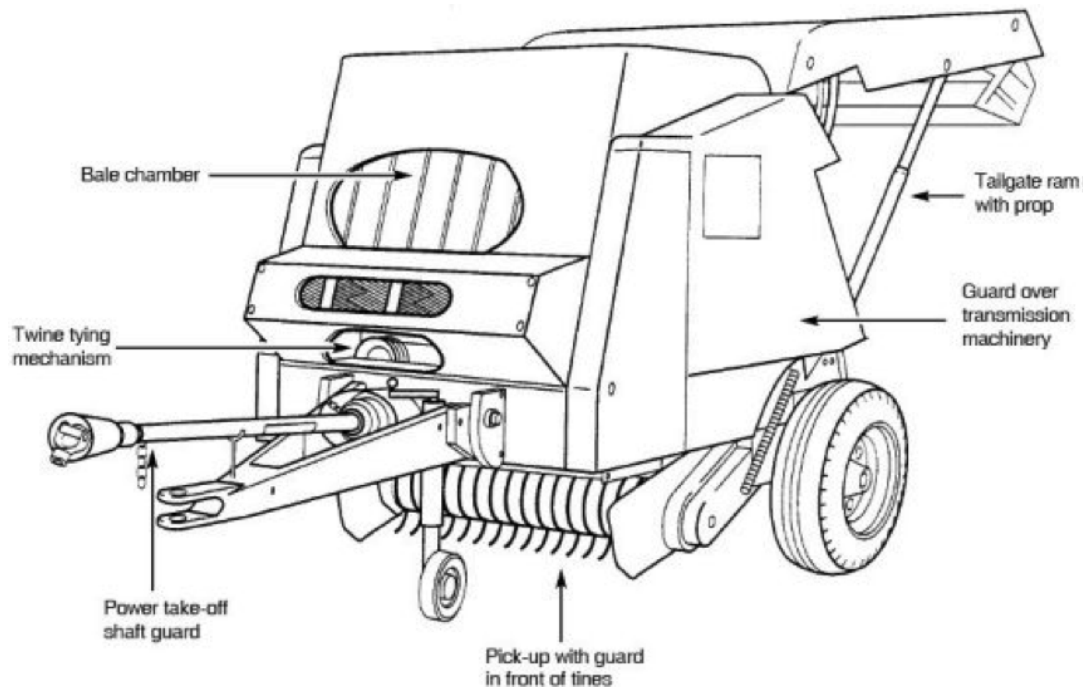
1. One end of the twine is held by the disc. As the bale forms twine is pulled from the twine box and passed around three sides of the bale.
2. When the tying starts, the needle (carrying the twine) comes up across the front of the bale over the billhook and into the twine disc.
3. The twine disc rotates enough to hold the twine against the twine holder. The billhook starts to rotate (make the knot).
4. The billhook turns and forms a loop of twine around the hook. The hook jaws open. The needle starts to withdraw and leaves twine in the disc for the next bale.
5. The billhook’s jaw closes and holds the twine. The twine is cut by the knife arm, which pushes the knot from the billhook. The billhook holds onto the twine and pulls the knot tight before it slips off as the bale leaves the chamber.
6. There are two knotters for each small square baler.
7. At the end of the cycle, one end of the twine remains in the twine disc ready for the next bale.

RECAP - HOW A SQUARE BALER WORKS

1. The measuring wheel trips the tying mechanism
2. The needles, carrying twine come up through the chamber.
3. The knot is tied by the billhook knotter, which takes about 3 seconds.
4. The needles then withdraw to their original position until the next bale is ready to be tied.

Look it up!

Youtube - Square Bale knotters in slow motion!
Series of Diagram Pictures



Safe use of Big Round Balers <http://adlib.everysite.co.uk/adlib/defra/content.aspx?doc=110247&id=110248>

CAN WE BALE IT WET?

HAY INOCULANTS AND PRESERVATIVES

What's in an inoculant?

Inoculants contain bacteria and ingredients like yeast or enzymes to inhibit (stop) the growth of micro-organisms that cause spoilage in hay.

What is a Preservative?

A preservative like Propionic acid acts as a fungicide in the hay, limiting the growth of aerobic microorganisms that cause heating and mould in the hay. – Preventing Hay using Propionic acid- OMAFRA - <http://www.omafra.gov.on.ca/english/crops/index.html>

Look it up!

Youtube Round baler operation! <https://www.youtube.com/watch?v=zBcJUME026w0>

HAY HEATING

If hay is baled at too high a moisture content spontaneous combustion can occur!

OMAFRA released the following temperature ranges for hay;

- 65 degrees Celsius-Entering the danger zone, Monitor temperatures daily
- 70 degrees Celsius-Danger! Inspect every four hours to monitor if temperature is rising!
- 80 degrees Celsius-Fire pockets may form. Call the fire department
- 100 degrees Celsius- CRITICAL! In the presence of oxygen ignition will take place

Source : <http://www.omafra.gov.on.ca/english/engineer/facts/93-025.htm>

BALE WRAPPER

Bale wrappers are used on haylage or forage to limit oxygen access to the bale to allow the fermentation process to take place.

Most bale wrappers work the same, the bale stays stationary and the wrap is moved around the bale. Multiple layers of thin plastic seal together to protect the bale.



Inline bale wrapper- Anderson- <http://www.grpanderson.com/en/agricultural/wrappers/inline-bale-wrappers/>

MEETING 4 – FORAGES

Suggested lesson objectives and outcomes:

- By the end of this meeting members should be able to describe what the different types of forages are, how the different types differ in nutrients and what the pro's and cons are to each type.

Roll Calls:

- Name one type of forage.
- Name one piece of forage equipment.
- What is one item on forage equipment that could cause serious injury or death if not used properly?

FORAGES

Many crops are grown for animal feed. There are also many methods for harvesting the crops. One method is to use a forage harvester. A crop harvested using this method is often called a forage.

Forage is the whole plant (grain and stalk together) harvested before the grain is ripe. It is fed still green or stored as silage. The hay version is called haylage. It costs more to harvest and conserve than baled hay, but there are nutritional benefits for the animals.

Stored forage makes it possible to feed animals when it is impossible to grow crops outside.

The three main types of forage harvested today are haylage, baleage and silage. Haylage is made from partially dried grass/alfalfa and stored in silos or bunks. Baleage is forage that has been baled and wrapped in plastic. Silage is corn storage stored in a silo/bunk or silage bag.

Other types of forages include barlage, wheatlage and oats & pea silage.

Regardless of type, forages are stored in a way that limits oxygen from getting into the crop. This is done by packing the forage tightly and either wrapping/covering with plastic or storing in a sealed silo. Without oxygen, an anaerobic environment is created which causes the forage to ferment without rotting. The fermentation preserves the nutritional quality.

<https://www.uky.edu/Ag/Forage/Baleage%20FAQ%20-Hancock%20Sears%20Smith%20SENA%20Review.pdf>

The purpose of the forage harvester is:

1. To pick up and chop forage, and
2. To blow forage into a wagon for transport

There are two main types of forage harvesters used in Ontario.

1. Pull type – pulled behind a tractor
2. Self-propelled - with their own engine

PULL TYPE HARVESTER



Pull type forage harvester: (<https://www.caseih.com/northamerica/en-us/products/forage-harvesters-blowers/pull-type-forage-harvesters>)

Talk About It!

What types of forages are being used in your area?

SELF PROPELLED HARVESTERS



<http://www.claasofamerica.com/product/forage-harvesters>

The basic components are the same in all types of harvesters.

- Forage head
- Drive Train
- Feed Rolls
- Cutter heads- Knife sharpener and stationary knife
- Blower or fan

HOW IT WORKS

A conventional forage harvester gathers up forage with the pickup after cutting. The forage is delivered by feed rolls to the cutter head to be chopped. Chopped forage travels to the blower, where it is blown up the discharge spout into a wagon.

Flail forage harvesters work differently. Flails cut and pick up the forage. An auger delivers the chopped forage to the blower, which blows it up the discharge spout.

FLAIL FORAGE HARVESTER



<https://www.deere.ca/en/hay-forage/harvesting/flail-chopper/>

Self-propelled harvesters have similar mechanics to the conventional pull type machines but they are typically larger and high horse power units for use on larger farms or custom operations.

<i>Windrow Pickup head</i>	Windrow Pickup. It may suit conditions to cut forage with a mower or swather first. The crop is put into a windrow to start drying, before chopping. This head picks up the windrow. Retractable fingers and an auger feed it into the feed rolls. Adjustable gauge wheels or skids are used to regulate the working height. (low enough to pick up the crop, while avoiding stones)
<i>Row Crop Head</i>	Row Crop Heads. These heads are for harvesting silage corn. The number of rows will vary by the age and model of the unit. Corn plants are cut at the base of the stem and delivered by chains to the feed rolls.

Feed Rolls gather material and deliver it evenly into the cutter head to be chopped. There are usually two or three rolls.

The Cutter head cuts, shreds or chops the forage and feeds it into the blower. The cutter head is the heart of a forage harvester. Forage should be cut into equal lengths with its ends square and clean. Cutter heads are designed differently by each manufacturer but the basic parts are similar.

- Cylinder – with knives fitted
- Shear bar
- Knife sharpener

Cylinder. Cylinders can be fitted with as many as 12 knives. Two things affect the size of the chop, number of blades on the cylinder and the speed at which it spins or rotates. Cutter heads usually rotate at 100 rpm and cut forage in short lengths (5mm)

CUTTER HEAD AND SHEAR BAR



<http://www.claasofamerica.com/product/forage-harvesters/jaguar-880-840/crop-flow/knife-drum>

The blades are sometimes set at an angle so they slice rather than cut the material. Cutting material any finer than necessary for proper farm storage or animal feeding wastes time, power and reduces harvester capacity.

Shear Bar. The Knives cut the forage against the shear bar, cutting like scissors. The knives must be kept well sharpened and the shear bar properly adjusted. Sharp knives make chopping forage easier and more efficient.

Knife sharpener. The Sharpening stone is mounted on a hand or automatic hydraulically operated bracket which is drawn across the knives to sharpen the cutting edge. This is done while the cylinder is rotating. Check the operator's manual for details. Knives should be sharpened often. Do not try to remove the deep nicks on the knives.

If the product is evenly cut it flows easily and stores more efficiently. It packs tightly and excludes air. This means better conditions for conserving forage, which in turn means better quality feed.

Recutter screens are removable curved plates with holes and slots cut in them. Fitted behind the cutter head, they offer a selection of different sizes of cut forage.

The **Fan Blower** blows the crop up the discharge spout. It is a separate unit. Air pressure comes from high speed rotating paddles, which must be correctly adjusted for proper "blowing" ability

On smaller forage harvesters, the high speed cutter head rotates fast enough to "throw" forage up the discharge spout. These "cut and throw" machines do not need a separate fan-blower.

SILO BLOWERS

Blowers are the most efficient machines for delivering chopped forage into silos. The blowers must keep up with harvesting equipment.

A general rule: the capacity of the blower should be double that of the forage harvester!

Basic Blower Components:

- Power Take-Off (PTO) Drive shaft
- Hopper and conveyor
- Blower Housing – with fan blades
- Blower Pipes and attachments

VERTICAL SILO BLOWER



PTO Drive. On most blowers the <http://agriculture1.newholland.com/nar/en-us/equipment/products/forage-equipment/forage-blower>

PTO drives the fan directly (without any belts or chains). Tractors or electric motors drive the blower. You must check what power take off (PTO) speed is required for the blower- usually only 540 revolutions per min (rpm) is needed. Some blowers fitted with a special gear box work on 1000 rpm or 540 rpm pto speeds.

The horsepower required on a blower for a silo is roughly 1 HP per foot of height, on a 60-foot silo its recommended to have a 60 horse tractor.

Hopper and Conveyor/Auger

- All blowers have either a conveyor or auger to feed the blower

Blower housing- The blower housing consists of a fly wheel with four to six fan blades. These blades are called paddles.

A blower is more of a thrower than a fan. The rotating paddles move material up the silo pipes. Paddles are adjustable to improve efficiency.

There are air vents in the housing that let in air to stop vacuum forming behind the paddles. A vacuum slows down the flywheel.

A water inlet keeps down the build-up of gum when handling alfalfa and other similar forages

Blower Operation

To make the blower work best:

- Keep the flywheel speed steady, to keep an even flow of forage going up the pipes;
- Start unloading slowly and increase speed to avoid plugging. Blockages happen because the pipes get overloaded.

FORAGE WAGONS

There are two main types of forage wagons:

1. Forage boxes
2. Dump Wagons

FORAGE BOXES

Forage Boxes are self-unloading and are mounted on running gears. Forage boxes usually unload from the front. Some have the option to unload from the rear though.

The purpose of forage boxes are to:

1. Transport hay and forage,
2. Unload forage and rations into feed troughs, blowers, and pit silos or onto conveyors, and
3. To harvest, transport and unload silage, green chop, bales, haylage and ear corn.

Basic Forage Box Components:

- Chassis – Running Gear or Truck
- Box – Sides, ends and floor
- Beaters
- Floor Conveyors
- Cross Conveyor and Extension
- Drives and controls

Chassis - Running Gear. Normal running gear as would be used on hay wagons

Box and Attachments - Boxes vary in size and have a roof for use with forage harvesters to prevent loss of blown forage. The sides and floor can be made of steel, wood, aluminum or a mixture of these materials. Slots and screens let out the air when filling from a blower. A rear unloading door is usually the full width of the wagon and hinges at the top.

Beaters - Most forage Boxes have at least two beaters to help unload and mix at the same time. They are placed between the floor conveyor and the unloading conveyor. Each manufacturer will have their own design.

Cross Conveyers - These are usually at the front. As the material moves forward a cross conveyor (chain, belt or auger) moves it outside of the box.

Drives and Controls - Forage wagons have lots of chains, belts, gears and shafts which make up the drives to various components. The controls for these are located in different places on different makes of wagon. There are safety clutches to protect components when there are blockages. Be safety conscious when near a working machine.

Expand on it!

What are the parts of a forage wagon?



http://www.donallisonequipment.com/MillerPro_ForageBoxes_5300.asp

DUMP WAGONS

As the farming community shifts towards bunk silos for efficiency and simplicity, dump wagons are being used more often to load bunks. Dump wagons have fewer moving parts than forage boxes which means less maintenance and down time.

The basic parts of a forage dump wagon are the chassis, the dump box and the hydraulic cylinder. Depending on the size and age of your forage wagons brakes and lights may be included. Ensure that both are working properly.



http://www.berkelmanswelding.on.ca/farm_dump_trailers.html

STORING FORAGES

The three most common ways to store silage are in a:

- Tower silo
- Bunk
- Silage bag

Tower Silo

Tower silos take longer to fill than bunks, but due to design packing is done by gravity alone to manage air exposure. There is a high initial cost but the only annual costs are for



Let's talk about it!

What type of storage for forage have you seen on farms in your area?

maintenance of the silo unloader.

<http://www.omafra.gov.on.ca/english/landuse/gis/censusmaps.htm>

Bunk

Bunk silos have a high capacity, can be loaded and unloaded quickly. They have low annual maintenance costs, but have a higher initial investment. The quality of the feed depends largely on how well the pile was packed and covered though. For smaller herds a large bunk will be less cost effective than a tower silo if feed is spoiling before being used.



Silage Bag

A silage bag has the lowest initial cost for your farm, and can be implemented quickly if extra storage is needed. Because the feed face of a silage bag is smaller and more manageable smaller farms can use this system efficiently. There is a high annual cost to this system because of the cost of plastic and the labour to bag it. The plastic is not reusable which creates a large amount of waste associated with this system. www.Agmanager.info/node/7138

<http://wieserconcrete.com/product-guide/agricultural-products/bunkersilo/>



<http://www.bpsindustries.com/silagebag.php>

MEETING 5- COMBINE- INSIDE

Suggested lesson objectives and outcomes:

- By the end of this meeting members should be able to identify the inside parts of a combine as well as the manner by which the combine processes the crop that it is harvesting.

Roll Calls:

- Name one crop that a combine is used to harvest.
- Name one part found on the inside of a combine.

HOW IT WORKS?

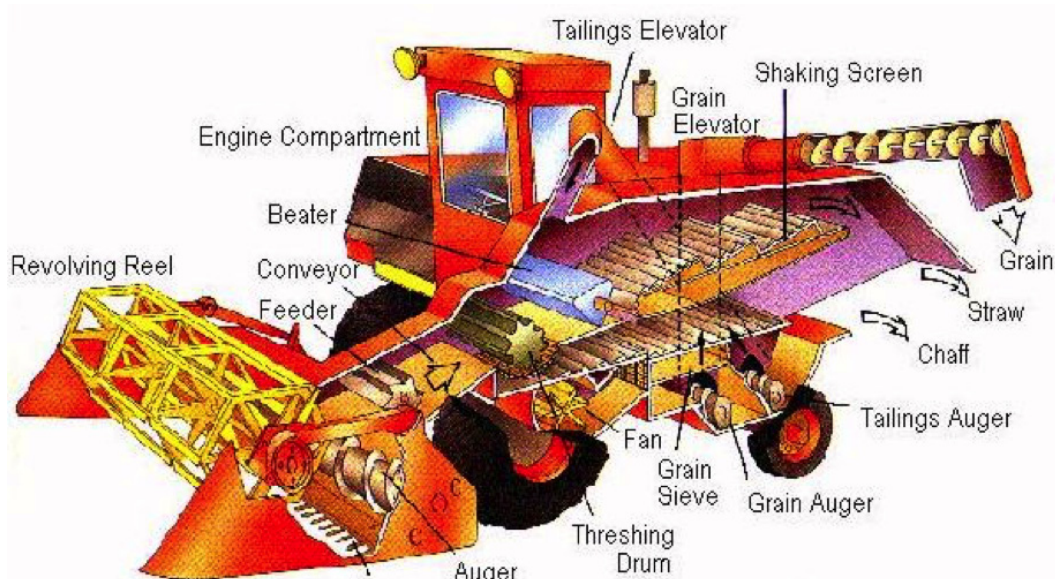
A combine gets its name because it “combines” many harvesting processes into one machine: cutting, threshing, separating, cleaning, grain handling and chaff spreading. The combining process starts by cutting mature crops off at the ground with a cutting bar at the header, feeds the plants to the center of the combine by the header auger or belt conveyor and moves it up through the feeder house of the combine to the threshing drum. The threshing drum spins at high RPM’s and works the plant material against the concaves to loosen the grain. The rest of the plant material or chaff is moved towards the rear of the combine over the straw walker (if equipped). Below the straw walker are various sieves which will allow grain to fall down into a collection pan while keeping the larger lighter material working towards the rear of the combine. If any lighter material makes it through the straw walker or the sieves it is blown out of the rear of the combine by a large fan. This process works well as the grain is always the heaviest and densest part of the plant so it collects and is transferred to the grain hopper while the lighter chaff is blown out the back of the combine.



<https://www.caseih.com/northamerica/en-us/products/harvesting/corn-heads>

LET’S LOOK CLOSER!

Conventional Combine Diagram



Open Source Ecology- http://opensourceecology.org/wiki/Combine_Function_Diagram

Rotary Combine Diagram



<https://www.caseih.com/northamerica/en-us/products/harvesting/corn-heads>

Axial or Conventional? What's the difference?

Conventional combines use a rotating cylinder or drum at the front of the combine that spins on parallel with the front wheels to remove grain and separate chaff.

Axial combines (or Rotary) by contrast use a rotor to remove the grain. The rotor is mounted between the front wheels lengthwise. The rotary design allows for more efficient grain processing which results in saving time in the fields.

Now you understand the basics, how do we set it up?

1. Check the grain bin on the machine. Is there trash in it? If there's trash in the tank the combine may be threshing too much or the fan speed is too slow. Is grain cracked? If so you will need to adjust the concaves.
2. Now check the header and make sure that the crop is using the full width of the feeder house during operation. If not, adjustments to the header may be necessary. If the feeder house isn't being used evenly the whole threshing system is working at a reduced capacity.
3. Now check the concaves and the drum or the rotor. Check where unthreshed ears are. If the system is allowing unthreshed ears to pass then the clearances may be too large, or the rotor speed is too low.
4. Now check the grain pan. "if unthreshed ear tips are appearing at the front of the grain

Experience it!

Track down a corn sheller so members can see how it works and try running the machine manually. Corn shellers work on the same basic principle as the threshing drums and concaves on a modern combine!

pan, speed up the drum and then close up the concave. Only tighten the concave after maximum RPM is reached.” (fwi.co.uk)

5. LEAKING LIKE A SIEVE! The front sieve should be completely clean. The middle section should carry a mixture of grain and crop residue. The rear third should carry only trash. If the sieve is completely covered increase fan speed. If the front half is clear decrease the fan speed. Heavy top sieve loadings can also be caused by over threshing in dry, brittle crops. Reduce the aggressiveness of the threshing system to help.
6. ITS ALL ABOUT THE RETURN! Take a sample from the returns. There should be an assortment of unthreshed ears and chaff with little to no clean grain. If there is an excessive amount of chaff, then you should close the top sieve. If clean grain is present, the bottom sieve needs to be opened up.
7. WALKER LOSS? Check the chaff that’s been processed through the combine. If there’s any grain in the chaff adjustments need to be made. speed up the drum, tighten the concave or slow forward speed

Article: Check the Grain Tank Sample- Farmers Weekly

<http://www.fwi.co.uk/machinery/check-the-grain-tank-sample.htm>

Expand On It!

What differences are there when setting up a rotary combine?

MEETING 6- Combine- Outside

Suggested lesson objectives and outcomes:

- By the end of this meeting, members should be able to describe the pros and cons of different types of combines, the effects of tracks versus tires on soil compaction and the different types of headers that can be used.

Roll Calls:

- What is one way a farmer can try to minimize soil compaction during harvest?
- Name one type of header for a combine.
- Name one advantage to using a combine that has tracks instead of tires.

COMPACTION

Every farmer attempts to avoid excessive soil compaction if at all possible, but nature doesn't always give us the option to wait until conditions are right.

Some steadfast rules to help with soil compaction are:

- Choose traffic lanes in each field to limit compaction to those areas
- Avoid the wet areas of the field, and if the equipment has to pass through make sure it is as light as possible
- If possible spread the weight out by increasing tire size, adding tires or switching to tracks
- Refer to the owner's manual for appropriate field tire pressures, and drop tire pressures for the field

Tracked vehicles and wheeled vehicles both have their advantages. Depending on your scenario either could be the appropriate choice.

The advantages of tracks are:

- Better flotation
- More stability on hill sides
- No power hop
- Smoother ride in fields

Some disadvantages of tracks are:

- Higher initial cost
- Higher cost to maintain
- Rough ride and more vibration on hard surfaces
- Lug wear will be faster than tires for road travel



<http://www.claasofamerica.com/product/combindes/lexion-780-670>

HEADERS

What's leading your machine?

CONVENTIONAL HEAD

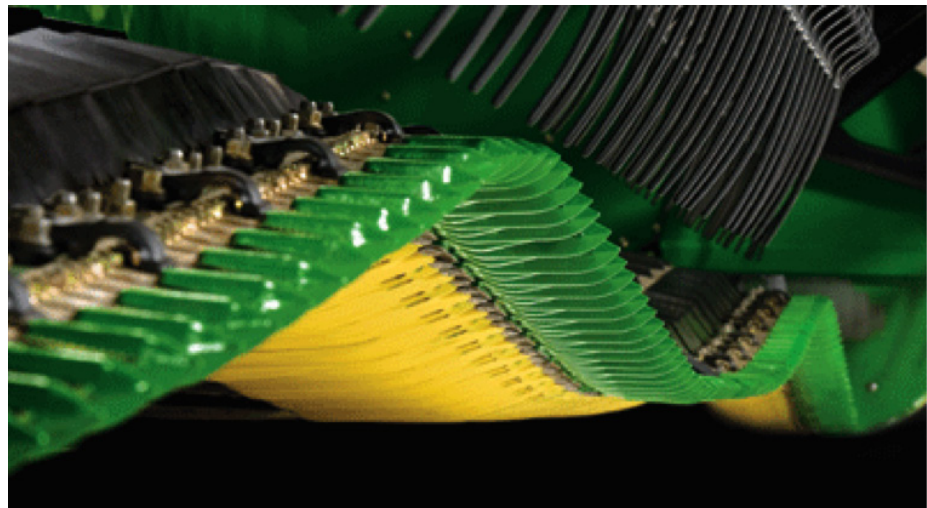
Conventional type headers use an auger to move crop to the intake at the center of the header.



Flex Auger Head- <https://www.caseih.com/northamerica/en-us/products/harvesting/flex-auger-heads>

FLEX HEADS

Flex heads are now being used to increase the amount of crop effectively being harvested. This technology is especially crucial on larger heads or in areas with more variable topography.



Flex Head - https://www.agweb.com/article/new_harvesting_heads_from_john_deere/

DRAPER HEAD

Draper heads use conveyor belts instead of augers to move the crop to the throat of the combine.



What is a Flex Draper- <http://thefarmerslife.com/flex-draper/>

STRIPPER HEAD



http://www.shelbourne.com/uploads/asset_image/2_161_e.jpg

Stripper heads are more commonly used in the western provinces. Their purpose is to remove the grain from the stalk and leave as much plant material standing in the field as possible. Less material flows through the combine so material can be processed faster with minimal wear and tear.

FOLDING HEADERS

The folding corn header is a big advancement for farmers who need to travel between fields often and quickly. Instead of trailering the header it can be folded to be ready for road travel almost instantaneously.



Folding Corn Header- <https://www.realagriculture.com/2014/02/caseih-folding-corn-header/>

MEETING 7- Horticulture

Suggested lesson objectives and outcomes:

- By the end of this meeting members should be able to recognize what horticultural harvesting equipment looks like, what crops are grown in Ontario and describe how these crops are harvested.

Roll Calls:

- Name a horticultural crop grown in Ontario.
- What is your favourite fruit or vegetable that is grown in Ontario?
- Name one way of harvesting a horticultural crop in Ontario.

Ontario has some of the most southern farmland in Canada, which allows Ontario to grow a wide variety of crops including a substantial amount of fruits and vegetables not found in other areas of Canada.

Some of the more prevalent horticultural crops include: apples, Asparagus, beans, beets, blueberries, broccoli, cabbage, carrots, cauliflower, celery, cherries, corn, cucumber, eggplant, grapes, lettuce, nectarines, onions, peaches, pears, peas, peppers, plums, potatoes, radishes, raspberries, squash, strawberries and tomatoes.

According to statistics from OMAFRA, in 2016 the vegetable and fruit crops that had the most acres planted were apples, sweet corn, peas, tomatoes, beans. Let's look at how those high acre crops are harvested.

Expand on it!

What crops are grown in your area?

COMBINING BEANS



Jason Rauhe- (Glan-R-Vest Farms)

BEAN HARVESTER

Bean harvesters essentially use stripper heads and high powered fans for harvesting. The header does most of the processing by removing the beans and leaves from the stalk which are then moved up the throat of the combine by two separate conveyors. When the beans transfer from



<http://www.oxbocorp.com>

one belt to the next, two sets of high powered hydraulic fans blow air through the material to remove the lighter plant material which is mostly stems and leaves. The remaining material is transferred to the dump box over the rear axle. The Oxbo in the picture above has a capacity for 16000 lbs of beans and dumps the whole bin over the side of a buggy or truck to offload.

COMBINING SWEET CORN



Sweet Corn Harvester - <http://www.oxbocorp.com/Products/SeedCorn/Harvesters/8430.aspx>

Sweet corn pickers are similar to bean harvesters because the header does most of the processing. The corn head chops the corn stalks down and moves the crop to the center of the combine. Once at the throat of the combine, the beater removes the corn from the stalks and then transfers the corncobs on the throat conveyor. There are fans to remove the chaff, as well as a stalk roller to remove the corn stalks before the cobs are transferred to the hopper.

COMBINING PEAS

Pea combines are more complicated than other harvesters. The header has picking fingers that rotate at about 180 rpm which strip the pea pods, stocks and leaves and transfer them to the throat of the machine. The crop travels up the throat on a belt to the viner, then enters the cylinder towards the rear of the combine. The perforated cylinder is roughly seven foot in diameter and beaters inside the cylinder rotate at about 34 rpm to work the peas against the



cylinder to break the pods open. Once the peas are out of the pods they can fall through the 5/8" holes in the cylinder. After the peas have worked through the cylinder they are moved towards the hopper at the front of the machine by a conveyor belt. The peas are passed by a fan to remove more chaff and plant material before the peas are stored in the hopper bin. The combine transfers the peas to a buggy via a conveyor belt to unload them.

HARVESTING ASPARAGUS

Automated machinery to replace hand harvesting hasn't become economically viable to replace hand labor for picking asparagus. Below is a picture of the carts used to pick asparagus daily during the spring. The farms that grow asparagus require a large work force to bring the crop in.



*Asparagus Harvesting- Koteles Farms in Oxford County, Ontario, Canada
<http://kotelesfarms.com>*

HARVESTING APPLES

Apples are another specialty crop that are harvested predominantly by hand. However for some types of apples, mechanical harvesting is possible.

The tree shaker in the picture here requires a second machine on the other side of the row to direct apples from the far side of the trunk to the conveyor. Both machines extend booms with tarps towards the trunk to catch falling apples and direct them towards the conveyor. A hydraulic arm is used to grasp the tree then shake it to loosen the ripe apples.

<https://www.youtube.com/watch?v=25YhYagC15Q>



Think about it!

Have a job for the summer yet? Harvesting crews are always in need of seasonal operators!

Look it up!

Pea Picking Machines Speed Harvest! <https://www.youtube.com/watch?v=2XOIxtub6Ks>

Look it up!

Tree shakers are one method of mechanical harvesting for apples.

Cider apples can be harvested from the ground with separate pickers. Marking and bruising in cider apples is less of an issue. These cider apple pickers typically use brushes to move apples on the ground towards conveyor belts. The conveyor belts move the apples towards a hopper. Some machines are equipped with blowers to remove leaves and other ground debris.



Cider Apple Picker - <https://www.youtube.com/watch?v=65ZUBc52SvY>

HARVESTING TOMATOES

Tomato harvesters pull the whole plant from the ground onto a conveyor. The complete plants are then dropped on to a large shaker to separate the plant from the tomato. Plant matter is removed by rotating bristles that only catch the stalks, not the tomatoes. From there the tomatoes are transferred to a sorting area on the machine where laborers manually remove tomatoes that cannot be shipped. Tomatoes are then loaded onto buggies or transports to travel to the processing plant!

Look it up!

Check out You tube to see how tomatoes are harvested!



Tomato Harvester in action - <https://www.youtube.com/watch?v=K27SrVlqmlU>