CANADA
4-H Saskatchewan

Field Crops

Member Manual

4-H Motto

'Learn To Do By Doing'

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'

4-H Grace

(Tune of Auld Lang Syne)

We thank thee, Lord, for blessings great
On this, our own fair land.
Teach us to serve thee joyfully,
With head, heart, health and hand

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General 4-H Information

Mission

Saskatchewan 4-H is a project-based youth organization, devoted to strengthening the skills of responsible citizens. We focus on the growth and development of our members, leaders, volunteers and staff through our motto: *"Learn to do by doing".*

Core Values

We respect the importance of family and honour our 4-H traditions by upholding all of these core values:

- Honour and Integrity: Treating one another respectfully, fairly and justly.
- Reliability: Being dependable and responsible for our actions.
- Co-operation: Working as a team to achieve our goals.
- Fun: Creating positive and enjoyable experiences.

We do this within a safe, caring and positive environment.

4-H Pledge

I Pledge:

My HEAD to clearer thinking
My HEART to greater loyalty
My HANDS to larger service, and
My HEALTH to better living, for
My club, my community and my country

4-H Motto

Learn to do by doing.

4-H Grace

(Tune of "Auld Lang Syne")

We thank Thee Lord for blessings great
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Teach us to serve Thee joyfully
With Head, Heart, Health and Hands

4-H Saskatchewan

Although the 4-H program has its roots in rural Saskatchewan, the Saskatchewan 4-H Council serves all youth, 6 - 21 years of age. 4-H members develop leadership skills and responsible citizenship primarily through the completion of projects. In 4-H club work, members direct their own activities, learn to work effectively through their association with others and work in partnership with adults.

The 4-H program strives to encourage individual growth in young people by developing self-confidence, the ability to make wise decisions and responsible attitude toward community service. Creating a deeper interest, understanding and appreciation of our natural environment are important objectives of the 4-H program development.

The Saskatchewan 4-H Council recognizes adult leadership and volunteerism as the foundation to its success in accomplishing its mission.

4-H Emblem

The national 4-H emblem is a green four-leaf clover with a letter 'H' inscribed on each leaf and the word 'Canada' forming the base. The four 'H's stand for Head, Heart, Health and Hands. These symbolize the ideals and objectives of this educational movement for young people through:

- Training the head to think, plan and reason.
- Training the heart to be kind, true and sympathetic.
- Training the hands to be useful, helpful and skilful.
- Promoting good health for effective home and community service.

The Canadian 4-H Council officially adopted this four-leaf clover in 1952. The four-leaf clover signifies "good luck" and "achievement".

The official colours in Canada are green and white. The white is for purity. Green is nature's most common colour and is symbolic of youth, life and growth.

Trademark and Copyright

Trademark and copyright protect the 4-H name, emblem, pledge and motto. This means they cannot be changed in any way. In order to preserve continuity of meaning and to engender public awareness, alterations, additions or deletions to the 4-H name, pledge, emblem and/or motto are strongly discouraged.

Project Completion Requirements

Welcome to the 4-H Field Crops Project

We are excited that you chose to become involved in the 4-H Field Crops Project. We hope you have a great time this year working with your fellow 4-H members, making new friends, taking part in 4-H activities, working with your field crops project and learning more about being a crop producer!

To complete the 4-H year in the Field Crops project, you must:

- Complete four to six units in the manual
- Take part in an Achievement Day
- Complete a Record Book
- Participate in public speaking at the club level
- Follow the constitution/or policies of your club
- Have fun!

About the Field Crops Project Material

This project material contains all levels of the Field Crops Project. The intent is for 4-H members to progress through the three levels at their own pace. The recommended age for levels for Level 1 is 9 to12; Level 2, 13 to 15 and Level 3, 16 to 21 years of age.

About the Record Book

You will be using the Field Crops Record Book. At the beginning of the year you, your club and/or project group will need to set some prices for what it will cost you to complete your project. Use these costs for calculating the cost of your project. All the forms you need are in your record book. There are spaces in the record book for you to add pictures, newspaper or magazine clippings to help make the record book your own.

Available Crops Projects

You are required to complete a crops project in an area of at least five acres. What you grow and how large an area you use is dependant on the types of machinery you have available to you. The best way to establish how big an area you will use is by measuring the width of the equipment that you will be using for your crops project. It is important that the area you choose will allow for the widest piece of equipment you will use.

You may choose to use one corner of a field, a strip down one side of a field, a part of a field, or maybe you have a small field of your own to use. Depending on the equipment and how much space you have available, you may want to grow more than one crop.

You are not limited to the major crops grown in Saskatchewan. You can grow anything you wish as a crop subject, provided you have the proper equipment to handle it. You might want to grow something from the following list:

Cereals	Oats, Barley, Wheat, Winter Wheat, Tritical, Rye
Oilseeds	Sunflower, Canola Flax
Pulses	Field peas, Dry Beans, Chickpeas, Lentils
Forages	Alfalfa, Brome Grass, Timothy, Clover
Market Garden	Potatoes, Carrots, Peas, Pumpkins, Zucchini, Corn
Fruit	Raspberries, Strawberries, Saskatoons, Apples
Spices	Coriander, Caraway, Dill, Borage

Achievement Day Requirements

For Achievement Day you should:

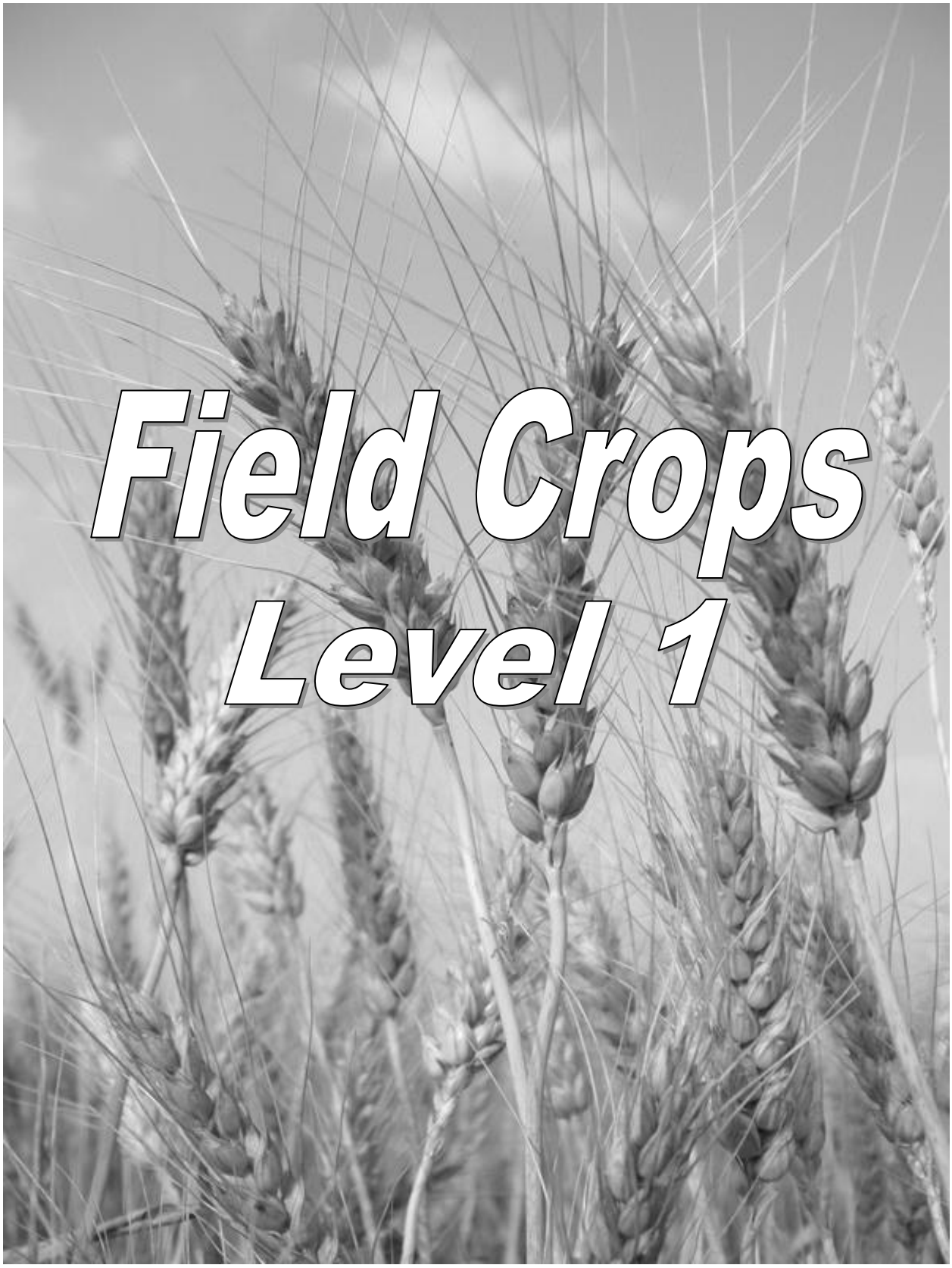
- Display your completed record book
- Exhibit samples of your field crops project
- Take part in field crops judging class
- Complete a 4-H Questionnaire
- Participate in any other activities the club has planned

Other Opportunities in 4-H

The crops project is only part of 4-H. Many activities are offered at club, district, regional and provincial levels or through your local agricultural society or exhibition association. You can take part in club fundraising, social events, meetings, public speaking, tours and many more activities. Contact your Regional 4-H Specialist for the activities happening in your Region or District.

Internet Reference Sites

Saskatchewan – www.agr.gov.sk.ca
Alberta - www.agric.gov.ab.ca
Manitoba - www.gov.mb.ca/agriculture



Field Crops
Level 1

SOIL

Roll Call

Name something that is found in soil.

Keep a list of what other members mention.

What is Soil Made of?

Crops that we grow begin their life thanks to soil. Plant roots feed on food and water stored in soil. You might think of soil as the ground we walk on, or the dirt in the garden a few centimetres deeps, but it is so much more than that!

Have you ever thought of soil as a living, breathing thing? Soil is many metres thick. Soil is a storehouse of decaying vegetation, moisture and plant nutrients. It is home for insects and micro-organisms.

Soil is made of four basic materials and each of these is required to sustain the life and development of soil. It is made up of **minerals, organic matter, air** and **water.**

Minerals

Minerals make up nearly one half the total volume of soil. These consist of sand, silt and clay, which are classified based on individual particle size. (The proportion of these particles determines whether a soil is a sand, loam or clay.) Sand particles can be seen very easily, but clay particles are visible to the naked eye and can only be seen with a microscope.

Organic Matter

Organic Matter is anything that was once living but is now dead and rotting in the soil. You have probably noticed decaying plant material in your soil samples. There may also be plant roots, leaves, manure and dead animals that break down into organic matter in soil. Decaying organic material also requires worms, insects and very small microscopic bacteria and fungi, which are responsible for eating (decaying) the organic matter and breaking it down into tiny bits. When decay is complete, the dead plant has been changed into organic matter. Since soil organic matter is derived mainly from plant decay, it contains all of the essential plant nutrients, which are used as food by living plants.

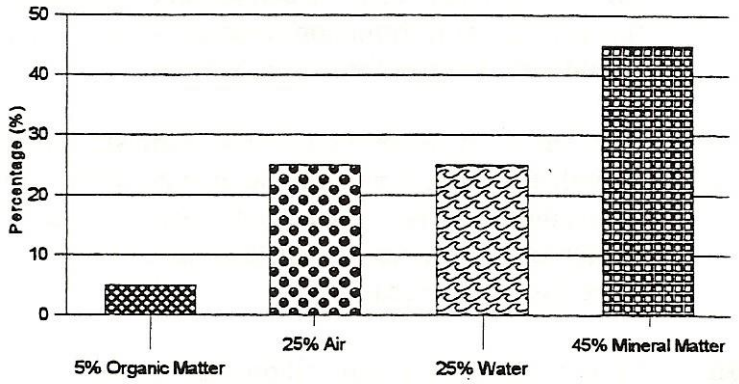
Air

Air is found in spaces between the mineral particles and helps the plant roots to grow and breathe. Air is also important to bacteria and other microorganisms, which are responsible for decomposing organic material. Plants also require air to assist with nutrient and water absorption.

Water

Plants use **water**, and it dissolves salts and nutrients found in soil. Water is important for helping move food in soil to plant roots.

What is soil made of?



How is Soil Made?

Soil is composed of ground-up granite rock, shale, limestone and other kinds of rock. These are called the mineral portion of soil and are formed by the breaking down of rocks.

The glaciers that shaped our prairies over 10,000 years ago were sheets of ice almost one kilometer thick. Rocks and gravel picked up by these moving sheets of ice were broken up and crushed. These smaller rocks were worked down even more by the action of wind, water, heat and cold.

This action is called weathering and happens slowly. The worked down rock forms the mineral matter that makes up nearly half the total volume of soil. It takes hundreds of years for freezing, thawing, air and sunshine to break down rock and turn it into soil particles.

What affects the Formation of Soil?

Not all soil is the same. Soils formed under different conditions develop unique characteristics. Four conditions that affect soil development in Saskatchewan are:

1. **Climate** The climate of an area will help determine many of the soils qualities. Some soils are formed where there is a lot of rain and generally cool temperatures. Others are formed where there is no rain and very hot temperatures. Climate influences the rate and type of soil that is formed. Climate includes **Temperature**, **Wind**, **Evaporation** and **Precipitation**.

   - **Temperature:** Affects which plants can be grown and the rate of plant matter decay. Extreme temperatures, both hot and cold, limit the soil formation process.
   - **Wind:** Will limit soil formation and plant growth. Brisk winds blow bare soil away, destroying many years of soil development.
   - **Evaporation:** Moisture is taken from the soil surface through evaporation from the hot sun. Soil formation requires water so an extreme loss of moisture would limit the soil formation process.
   - **Precipitation:** Rain and snow are prime sources of moisture for plant growth. Plant growth affects how much organic material is returned to the soil when the plants die. (Dry soils have sparse vegetation and therefore low organic matter levels, whereas moist soils have more vegetation and therefore more soil organic matter.)

2. **Vegetation** Most of the agricultural soil on the prairies was formed under grass. Grass produces many small rootlets that die and decay. Soil formed under grass is very black, full of organic matter, fertile and with good texture. Some of the soil is formed under trees. This soil does not contain as many roots and any organic matter is from decaying leaves and needles that tend to remain in a separate layer on top of the soil.

3. **Parent Material** Parent material is the name given to the loose mineral and organic material above the bedrock from which soils develop. It largely determines the soil texture and the supply of natural plant nutrients. Soil conditions such as acidity, alkalinity and salinity are due to properties of the parent material.

4. **The Shape of the Land** The shape of the land is called relief. It controls the drainage of an area and this affects the soil type.

Activity Research

What kind of climate would you find in a desert?

How is soil formation limited by this climate?

What kind of climate would you find in the Arctic?

Will this speed up or slow down soil formation?

What is the climate like in your area?

How might the soil in your project area be affected by climate?

Soils of Saskatchewan

The soils of Saskatchewan are divided into colour types based on the amount of organic matter they contain. They are brown, dark brown, black and gray. Each type has its own special characteristics and they are all different because they are all formed under different conditions.

Brown Soil Zone: The brown soil zone in south central Saskatchewan covers about 15 million acres. Soil in this zone was formed under short grass vegetation. About 70% of this soil zone is cultivated. Hot summer weather, frequent wind, low rainfall and lower organic matter in this region limit crops mostly to cereals and grass for livestock.

Dark Brown Soil Zone: The dark brown soil zone covers 17 million acres in a band mostly north and east of the brown soil zone. Soil in this zone was formed under mostly grassland vegetation. About 82% of this zone is cultivated. Crops are more diversified in this zone due to improved moisture and cooler temperatures.

Black Soil: The black soil zone lies north and east of the dark brown soil zone. About 70% of the 17 million acres is cultivated. Soil was formed under tall grass and aspen trees, resulting in a higher organic matter. The growing period in the black soil zone is somewhat shorter, temperatures average lower but moisture is usually better than the other soil zones.

Gray Soil Zone: This soil zone is the most northern and covers 10 million acres. The Gray, Dark Gray and Gray wooded soils have a short growing season with high moisture but productivity is limited by the fertility of the soil. A considerable amount of land in this zone is used for livestock production.

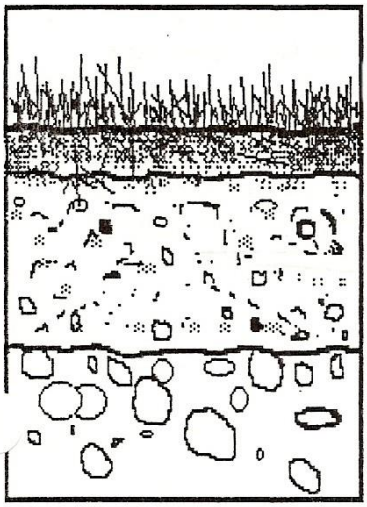
What is the colour-type of soil in your area? _____

Activity

Place one layer of moist soil (1-2 cm) into a small jar. Above place similar layers of sand and then peat moss. On top of the peat place a few green leaves and two or three earthworms. Make several holes in the jar lid for air and place jar in a brown grocery bag for shade. Leave at room temperature for about five days. After this time the worms will have mixed the materials together. This shows how earthworms help the decay of plant material and mix the soil.

Soil Profile Tells a Story

Soil develops a number of different layers as it is formed. If you were to dig a pit in your field, you would be able to see layers. These layers all together are called the soil profile. Each soil profile tells a special story of the life of that soil.



The thin, dark, top layer is called the **TOPSOIL**. This is the most productive soil. This is because it contains the most food for plants, can hold more moisture and can be cultivated easily. This is where most of the organic matter is found and the colour of topsoil may be black, brown or gray.

The middle layer (**SUBSOIL**) is just beneath the topsoil. It is not a productive soil. It absorbs water poorly and is often difficult to work.

The **PARENT MATERIAL** is the unaltered, loose, mineral layer found underneath the topsoil and subsoil layers. It is called the parent material because it is what most of the soil was originally made from.

Soil takes many years to form from organic matter, mineral matter and parent matter.

Soil Facts

- Soil makes up the outermost layer of our planet.
- Natural processes can take 300 years to form one inch of topsoil.
- Fungi and bacteria help break down organic matter in soil.
- Roots loosen soil and allow oxygen to penetrate. This is beneficial to animals living in the soil.
- 5-10 tons of animal life can live in an acre of soil.
- Soil is made of different sized mineral particles that are sand, silt and clay.
- 5 tons of topsoil spread over an acre is as thick as a dime.

Activity

To show the layers found in soil, you may wish to dig a hole about one metre deep that will expose the soil profile. An excavated basement or hill cut along a highway could be substituted. Explore the colour, texture, depth and moisture found in the different exposed layers. Compare these qualities with another site.

The Soil Sample

One way to find out what is in your soil is to do a soil test. Sampling supplies are available through fertilizer dealers. Contact your local fertilizer retailer or elevator company to find out about soil testing labs in your area.

Soil tests can only be as good as the sample you collect. Time and care spent in sampling will ensure that you get accurate information. All the sampling should be done in the normal soil area. Observe variations in yields and crop growth, soil texture and colour, slope, erosion, drainage and past fertilizing, manuring or cropping. Avoid unusual areas such as back furrows, stack bottoms, waterways, alkali spots, etc.

To gather a soil sample for testing, first look over the area to be tested and choose 15-20 representative sites.

For a general soil test, take individual samples at a depth of 15 cm, from each site.

More accurate soils tests are achieved by collecting from a variety of sample depths. This may be useful for getting a more accurate nitrogen evaluation or for finding out what is wrong in problem areas. Separate samples should be taken from the 0-15, 15-30 and 30-60 cm depths at each of the 15-20 representative sites. Place all of the soil from 0-15 cm in one bucket, 15-30 cm in another bucket and 30-60 cm in the last bucket. Mix the samples in each bucket, crushing lumps in the process.

Air dry the samples by spreading them thinly on clean paper. Once dried, remove 500 g (one pound) of each sample depth and place in plastic bags. Provide complete information on the sheet as required by the testing lab.

Activity

- **Choose 15-20 representative sites**
- **Use a soil auger, gardening trowel or spade to take your samples**
- **Keep the samples from different depths separate from each other**
- **Air Dry**

Activity Test Your Knowledge

Which adds more organic matter to the soil, a tree or grass? Why?

How is soil on the tops or sides of hills different from soil in lower lying areas?

List some things that are in organic matter:

What are the three categories of mineral matter?

1.

2.

3.

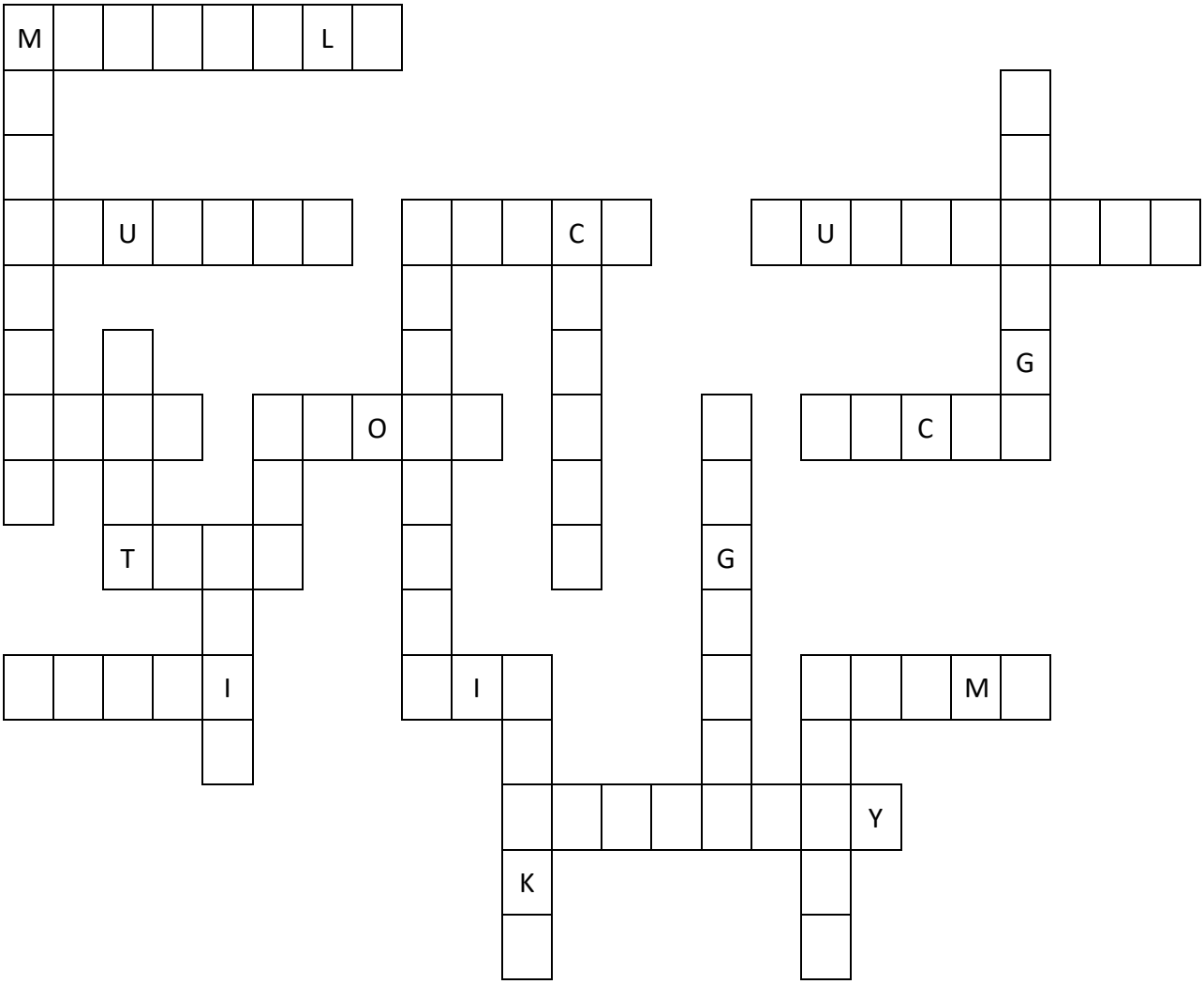
Why does soil need air?

What is so important about water in soil?

Activity

Fill in the crossword below using the following words related to soil:

Air	Energy	Rain	Stubble
Bacteria	Fungi	Rocks	Test
Black	Minerals	Roots	Water
Capacity	Moisture	Rot	Worms
Colour	Nutrients	Silt	
Decay	Organic	Soil	



TILLAGE

Roll Call Name something involved in the preparation of a seedbed.

A Good Seedbed One of the main purposes of tillage is to prepare a good seedbed. A good seed will provide the right environment for seeds to germinate and plants to grow into a high yielding crop. Following are some ways that tillage affects the seedbed:

Moisture: Seeds need water to germinate and begin growing, so they must be planted into moist soil. Fine particles of soil (like clay) will hold moisture. The moisture is needed to help seeds germinate. The smaller the seeds, the finer and shallower the seedbed should be. Tillage will break large clumps of soil into smaller ones. This gives more "pore space" for air, water and room for roots to grow quickly and easily. However, working the soil with machinery such as cultivators and disks tend to dry out the soil. A farmer must be careful that spring tillage does not remove too much moisture from the soil.

Free of Weeds: Weeds compete with young crop plants for water, nutrients and sunlight. If there are a large number of weeds, the yield of the crop can be reduced. Pre-plant herbicides are applied to the soil and evenly mixed in with two passes of tillage equipment such as harrows, disks or vibra shank cultivators. This fall tillage can bury stubble and leave the soil prone to erosion over the winter. In the spring, this work can dry out the soil.

Free of Stones and Roots: Stones and roots on the surface of soil prevent the emergence of the germinating plants and can damage machinery. They can be removed by hand or specialized equipment.

Proper Nutrients: The correct balance of nutrients in soil is necessary to produce a high yielding crop. Soil tests will tell the grower what nutrients are lacking in the soil, and how much fertilizer to add. Fertilizer can be placed in the soil at the same time as the seed, or in a separate operation in the spring or fall. Adding fertilizer usually involves a tillage operation, which can dry soil or bury stubble.

Fine: Untilled soil will tend to settle into a blocky soil structure after the spring thaw. Without some tillage action beforehand, most planters cannot loosen the soil enough to get a fine soil mixture around the seed. This may result in delayed germination.

Firm: A firm seedbed is important because loose soil will dry out. Harrows, a rod weeder or packers should be used to firm the soil, after it is tilled or seeded. A seedbed is firm if you sink no deeper than 1 cm when walking across it.

Tillage Systems

Tillage systems and equipment can be grouped into two categories - primary and secondary tillage

Primary Tillage is usually the first tillage operation after a crop and may be done in the fall, spring or summer. The main purpose of primary tillage is to break up hard soil and bury heavy crop residues. The soil is cut and shattered by primary tillage. The trash may be buried, mixed with the tilled layer or left relatively undisturbed. It usually leaves the surface rough.

This equipment causes a lot of soil movement. These implements cut and shatter the soil and leave the soil surface rough. They are worked relatively deep.

- **Uses**: Bury residues, weed control, break up forage and pasture land, incorporate herbicides, air seeding.
- **Examples**: Moldboard Plow, Heavy Duty Cultivator (Chisel Plow), Disk Implements and Wide Blade Cultivator.

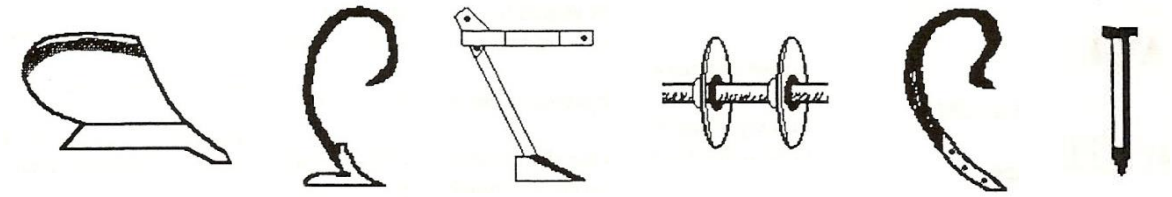
Secondary Tillage is the follow-up to the primary tillage, and is used for seedbed preparation and weed control. It provides additional fine soil tilth, levels and firms the soil, closes air pockets, kills weeds and helps conserve moisture. This equipment causes less soil movement than primary tillage. Secondary tillage is relatively shallow and should be no more than 3 inches deep. Moisture is conserved and clods are more easily broken when secondary tillage immediately follows primary tillage.

- **Uses**: seedbed preparation, firming and leveling the soil, closing air pockets, breaking clods, weed control, incorporation of herbicides, air seeding.
- **Examples**: vibra shank (field cultivator), rod weeder, harrows

The equipment you choose for tillage depends on the operation to be done and the trash cover, soil moisture, soil type, weeds to be controlled, time of the year and time availability.

Depth of Tillage

The depth to which land is tilled varies with the particular operation. Generally, maximum depth of cultivation is 10-13 centimetres (4-5 inches), even when breaking grass or legume stands. Deeper tillage may be used to open up fine textured soils, like clays or clay loams, to allow snow to melt or rainfall moisture penetration. Cultivation deeper than 15 to 18 centimetres (6-7 inches) is of little value and requires considerably more power.



A. **B.** **C.** **D.** **E.** **F.**

What piece of tillage equipment is each of the above parts from?

A. _____ D. _____

B. _____ E. _____

C. _____ F. _____

Which are used for primary tillage? _____

Which are used for secondary tillage? _____

Dealing With Crop Residues

Crop residues are the standing stubble, straw and chaff left in the field after the grain is removed. When left on the surface of the soil, the residues protect the soil from wind and water erosion. However, the residues, especially if the crop was heavy, can interfere with the operation of the seeder.

How a grower handles the crop residues depends on several factors including:

- **The type of seeder the grower uses** - Some disk drills will not cut through a large amount of trash and therefore more tillage is required to bury the crop residues. Hoe drills, air seeders and diskers can seed through more straw than disk drills, but they can plug up on large amounts of straw.

- **How prone the soil is to erosion** - If the soil is very prone to erosion, more residues should be left on the surface in the fall. Sandy soils should have at least 65% of the soil surface covered by residues. Clay soils are less prone to erosion, but still need 50% cover.

- **Desire to trap snow** - Standing stubble will trap snow during the winter. This moisture will be available to the growing crop in the spring. Snow trapping is especially important in areas of lower precipitation.

- **The yield of previous crop** – A heavy crop will produce more residue than a light one. A good straw chopper/spreader on the combine will help distribute heavy straw and chaff. Harrowing or chiseling in the fall will help distribute trash.

Activity Tillage Terminology

In this word find puzzle are words that relate to tillage. The words are in a straight line – forwards, backwards, up, down or on a diagonal. Find as many words as you can.

COVER	MOIST	SEEDBED
CULTIVATOR	PLOW	STUBBLE
DISKING	PRIMARY	TILLAGE
FINE	RESIDUE	TRASH
FIRM	SECONDARY	WEED CONTROL
HARROWS		

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

EQUIPMENT

Roll Call

Be prepared to share how many lubrication points there are on one of the pieces of equipment used in the production of your crop project. List the name of the pieces of equipment being used, the number of lubrication points to check before using the equipment, and indicate whether you know where to find them all.

Equipment	Number of Lubrication Points	Do you know where they all are? (Please Circle)	
Power Unit (Tractors)			
_____	_____	YES	NO
_____	_____	YES	NO
_____	_____	YES	NO
Tillage Equipment			
_____	_____	YES	NO
_____	_____	YES	NO
_____	_____	YES	NO
Seeding Equipment			
_____	_____	YES	NO
_____	_____	YES	NO
_____	_____	YES	NO
Applicators(s)			
_____	_____	YES	NO
_____	_____	YES	NO
_____	_____	YES	NO
Harvesting			
_____	_____	YES	NO
_____	_____	YES	NO
_____	_____	YES	NO
Transportation			
_____	_____	YES	NO
_____	_____	YES	NO
_____	_____	YES	NO

Make it a goal that by the end of this unit you will have found all the grease nipples that require attention on any of the equipment you use with your project.

Equipment Used in Field Crops

Producing a successful crop requires many pieces of equipment. To have an understanding of good crop production practices, it is necessary to have some knowledge of what each piece of equipment is used for and how it works.

Farm equipment can be grouped into a number of sections:

1. **Power units** – tractors
2. **Tillage equipment** – cultivators, disks, harrows, plows, packers
3. **Seeding equipment** – drills, diskers, air seeders, row crop
4. **Applicators** – sprayers, granular spreaders, manure spreaders
5. **Harvesting equipment** – swathers, combines, balers, forage harvesters
6. **Freight transportation** – trucks, trailers, augers, bale wagons, forage wagons

The following section of this chapter will briefly describe the implements listed above, what they are used for and how they work. It should be remembered that all of the above implements come in many sizes and with many different modifications, just like cars or trucks. However, by recognizing some basic components, you should be able to classify a piece of equipment you encounter into one of the categories.

1. Power Units

Tractors: The basic power unit on a farm is a tractor. Tractors all have the same basic use, no matter their size - to power, push or pull another implement. Unless a piece of equipment is self-propelled and therefore has its own power supply, tractors are needed to provide power to the implements.

Tractors may be 2 or 4 wheel drive, which refers to the number of wheels receiving power from the engine. The main drive wheels will be the largest ones on the tractor, and usually have very deep grips or **LUGS** to prevent the drive wheel from slipping when pulling heavy loads.

A tractor can power other implements by pulling from the drawbar, or by pushing or pulling it by its 3-point hitch arms. It can also power them by its **PTO** (POWER-TAKE-OFF) shaft. The PTO is a small ribbed or splined stub on the rear end of a tractor. An implement with moving parts can be attached to this stub by a PTO shaft. The stub, which is powered or turned by the tractor's engine, turns the PTO shaft that then turns the moving units on the implements.

A tractor can also power implements by its **HYDRAULICS**. Hydraulic means being operated by a liquid in motion. In the case of tractors, the liquid is oil. An implement with moving parts can be powered by connecting it by its hoses to the tractor's oil supply. The tractor then pumps the oil through the implement. The flowing oil may be used to move a piston (hydraulic cylinder) or turn a hydraulic moor, which will in turn power the implement.

An example of something that is powered by a tractor's hydraulic system would be a loader.

2. Tillage Equipment

Moldboard Plow: The purpose of a plow is to invert or turn the soil layer upside down. It is used to bury plants and plant residue and leaves the soil surface completely bare of plant cover. It does this by first cutting the topsoil layer and then turning it over. A moldboard plow cuts, lifts and turns slices of soil called furrows. The soil is turned over completely and all crop residues are buried. The action of the plow loosens and aerates the soil.

The moldboard plow is used to prepare land for crops, such as potatoes, that need deep, loose soil. The plow is also used for breaking hay and pastureland. Plowing creates the possibility of erosion because no crop residues remain on the surface to protect the soil. Plowing also consumes a large amount of energy.

Disk Implements: consist of a series of curved metal blades (disks) mounted on a shaft. The disks cut through the ground and turn over the soil. Tandem and offset disks are two common types of disks.

Disks have a wide variety of uses:

- Breaking forage and pasture land
- Cutting and burying heavy crop residues
- Incorporating herbicides
- Seedbed preparation, weed control, chop and mix residues

Disk implements mix soil and are useful for incorporating herbicides. However disks also bury crop residue and may leave the soil prone to erosion.

Cultivators: are made up of curved springy shanks that are attached to the main frame with a heavy set of coiled springs. Shovels are attached at the bottom of the shanks. Shovels come in a variety of shapes and widths depending on the amount of soil mixing that are desired.

The amount of soil disturbance and residue buried depends on the type of attachment used. Narrow spikes and points penetrate the soil, but leave most of the crop residue in place. Wider sweeps stir the soil more, giving better weed control, but burying more of the residues.

The variety of cultivators and attachments make this implement able to perform many tasks:

- Chisel stubble in fall to break up hard soil and bury weed seeds, but leave most of the stubble standing.
- Seedbed preparation, bury residues and control weeds.
- Deep banding fertilizer.
- Planting with an air seeder.

Cultivators work by cutting through the soil layer then lifting it slightly and allowing it to fall over the back of the shovels. Cultivators are an excellent means of weed control because they cut the roots of plants and then leave the roots on, or near the surface in loose soil where they are subject to drying out.

Cultivators can be grouped into 3 categories: Heavy-Duty, Medium-Duty and Light-Duty.

- **Heavy-Duty Cultivators** (also called the **Chisel Plow**) are usually used for primary tillage. Their shanks are spaced fairly wide apart to allow the cultivator to be pulled through previously unworked soil. Shovels used on a heavy-duty cultivator may be spikes if operating in a heavy or sod covered soil, or very wide sweeps if operating in unworked crop stubble.

- **Wide Blade Cultivator** consists of one or more flat, horizontal blades. The blades are pulled through the ground 75-100 mm under the soil surface. The blade cuts off weeds at the roots and loosens the soil, while keeping most of crop residues on the soil surface. The wide blade is most often used in areas where crop residues are light and wind erosion is a problem.

- **Light-Duty Cultivators** (also called **Field Cultivators** or **Vibrashank**). The vibrashank is a modification of the chisel plow. The construction is lighter and the shanks are spaced closer together than on the chisel plow. They are used in fields with a minimum of plant residues because their shanks are usually spaced no more than 6 inches apart. Shovels used on these cultivators may be duck-feet or narrow sweeps. It is usually operated at depth of 50-75 mm because of its vibrating action and closely spaced shanks; this cultivator does a good job of weed control and herbicide incorporation. It is also used for airseeding.

Rod Weeder: The basis of this implement is a rotating rod that is drawn through the soil. The rod pulls out weeds by the roots and works them into the soil surface. The rod weeder maintains about 90% of the crop residue on the soil surface, so it is a valuable implement for weed control on summerfallow. It is also used for packing the soil after seeding with a disker or airseeder.

Harrows: Harrows are dragged across the soil surface for leveling, breaking up soil clods and spreading plant residue on the soil surface and packing. Harrows are usually the last implement used before seeding. They leave a level and firm seedbed allowing for more uniform seeding depth. They may also be used after seeding to pack soil around the seed and cover up the seed furrow.

Packers: Packers come in a variety of shapes. Their main purpose is as their name suggests, packing or firming the soil. They do this by their weight. Packing makes the soil less subject to wind erosion. By packing soil, the soil particles are also moved closer together and the air pores are made smaller. This allows soil water to move upwards through the soil easily. If a seedbed is packed after seeding, moisture will move to the seed zone and germination will occur faster.

3. Seeding Equipment

Seeders: distribute seed in or on the soil. They all have the same basic parts:

- A seedbox or tank for holding seed.
- A seed metering mechanism, which allows even removal of seed from the seedbox or tank.
- Tubes that allow seed to travel to the ground.
- The furrow opener and/or boot, which makes an opening in the ground and buries the seeds.

The five main types of seeders are:

1. **Broadcast Seeders** spread the seed on top of the soil. They are used mainly for seeding small seeds such as grasses and legumes. The seeds must then be worked or pressed into the soil surface with harrows or packers.

2. **Grain Drills** are used for seeding crops such as wheat, oats, barley, peas or canola. There are two types of grain drills: **disk drills** and **hoe drills**. Disk drills have two offset flat disks under the seed hoses to make a furrow for the seed to drop into. Hoe drills have a narrow metal tube that penetrates the surface to allow seed to fall directly into the soil. Some drills are equipped with rollers or press wheels immediately behind the hoes or disks. Most seeders have fertilizer boxes alongside the seedbox so fertilizer may be added with the seed.

3. **Disker Seeders** are occasionally used in heavy textured soils. Disker seeders only use one way disks with a seedbox and tubes that allows seeds to drop between the disks and is immediately covered with soil. Disker seeding eliminates one tillage operation. Diskers tend to provide uneven seeding depth, and since there is no packing system, harrowing or packing are necessary after seeding.

4. **Air Seeders** are light or medium duty cultivators in which seed is placed below the shovels. Seed is transported from the seed tank by a stream of air generated by a fan. Air seeders are generally wider than disk drills. Consequently, more acres per hour may be seeded using an air seeder. Air seeders may provide uneven seeding depth, harrowing or packing after seeding may be necessary.

5. **Row Crop Seeders or Planters** are the machines used to plant con, soybeans, and other crops that grow best in more widely spaced rows. The seeder has several seeding unites, one for each row.

4. Applicators

Granular Applicators, as the name implies, are used to apply granular products such as fertilizer to a crop. Applicators have a holding tank with an opening at the bottom. The granules fall out of this opening and either fall onto a spinner or are blown through a tube the width of the applicator. The spinning style broadcasts (throws) the granules to both sides and behind the applicator in a relatively uniform manner. The air (pneumatic) style distributes the granules across the width of the applicator by means of an air stream and then releases them from the machine to drop to the ground.

Spraying Equipment is used to apply pesticides such as herbicides, insecticides and fungicides. They are also used to apply liquid fertilizers. The applicators consist of a solution tank to hold the chemicals, a simple pump to move the chemical solution to the hoses with nozzles that distribute the solution over the soil or plant surface. The main function of a sprayer is to break the liquid into droplets of effective size and distribute them uniformly over the surface or space to be treated. Another function is to regulate the amount of chemicals being applied to the solution, and force it through the nozzles, which break up the liquids into droplets and

spray it out. The tank should have an agitator that constantly stirs the solution in the tank to keep it properly mixed.

5. Harvesting Equipment

Swathers are machines used to cut down the standing crop and lay them in rows for easy pick-up. The knife on the swather moves back and forth in a side-ways direction, cutting the stem of the plants. The reel rotates and pushes the plants into the knife and then knocks the cut plants down onto the canvas. The canvas then moves the plants and drops them through a narrow opening and they fall onto the ground in a swath.

Combines separate the seed from the crop. They are equipped with a pick-up that lifts the swaths off the ground and into the threshing cylinder that breaks up the straw and heads of the crop, releasing the seeds. From the cylinder, the seeds and chaff drops onto the chaffer and sieves where the seed is separated from the chaff. Another type of threshing uses a single or double rotor to remove the grain from the head. The material is then dropped on the straw walkers. Finally, the seeds are lifted into a large storage tank (hopper) and the straw and chaff is released out onto the ground. Once the hopper is full, it is augured into a truck for transportation.

The pick-up may also have rows of teeth like a swather, and can be used to cut the grain down immediately before threshing it. This eliminates the need to swath the crop ahead of the combine and is called **Straight-Combining**.

Balers are used to compress dried straw or hay from a swath, and pack it into tightly tied bales. This makes it much easier to handle.

Forage Harvesters are used to make silage out of high moisture forage crops that are chopped into small bits and stored in a silo. They are equipped with a pick-up and chopper that blows the chopped crop into a wagon.

6. Trans-portation

Trailers and **Grain Truck**s are used to transport grain from the field to storage and from storage to market. Unloading and reloading trucks requires a **Grain Auger**, which is a long hollow tube with a metal spiral running through the centre. As the spiral turns, the grain is pushed ahead until it is dropped out at the top of the auger and into the truck or storage bin. The larger the tube and engine on the auger, the faster it is able to move grain. Augers are either powered by their own gas engine or by the PTO of a tractor.

Bale Wagons or **Trailers** are used to haul bales off of fields to a storage area or to market. Some are automatic and have some way of lifting bales from the field and unloading them in stacks or rows. Some require a tractor with a loader to pick up the bales and unload them.

Equipment Safety

Farming has a very high ratio of accidents for the number of people actively involved in it. Many of the accidents are farm machinery related, but human error is usually the cause. The best defense against farm accidents is having the right attitude, being aware of dangers, and taking no risks. It takes less time to take the necessary precautions than it does to recover from a careless accident.

When operating any piece of farm equipment, it is important to recognize possible hazards, and take steps to avoid them. Ensure that shields and guards are in place over dangerous fast moving parts such as power-take-off (PTO) shafts, chains, pulleys, sprockets, gears and rollers. Even though these shields and guards are in place, **NEVER** go near the moving parts.

Not only do accidents happen with farm machinery, but also with tools used to fix farm machinery. When it comes to handling tools, most people do it very casually, and without thinking of the dangers involved. Improper use of tools often leads to hand and arm injuries or serious injuries to the eyes.

When using tools, be sure that you:

- Use the right tool for the job.
- Use the tool properly.
- Keep edged tools sharp. Using dull edges means using the tool improperly.
- Replace worn or defective tools.
- Store tools safely and out of reach of young children. A tool left lying around is a sign of sloppy work habits and sloppy safety sense.
- Have the electrical switch within reach of the operator, and use an electrically grounded cord (three pronged) when using power tools.
- Wear protective equipment and clothing (goggles, masks, gloves, aprons, helmets, etc.) whenever needed.

Activity

Match the right answers to the statements:

1. An operator should wear this when operating a tractor without a soundproof cab.
2. At excessive speeds, rollovers are common on these.
3. Front-end loaders are left in this position when they are not in use.
4. It is unsafe to use this tool as a wedge or chisel.
5. The rabbit and turtle shown on a lever in many machines indicate this.
6. These make a fun swing for children, but if left leaning against a wall, could fall on them and cause serious injuries.
7. This tool is always operated with an open palm, so fingers will not be injured if the tool slips.
8. This unsafe practice results in the most child fatalities on farms.
9. You must be at least this age to operate a self-propelled farm implement on public roads.

a) A wrench

b) A tractor tire

c) A screw driver

d) Down

e) Ear plugs, acoustical earmuffs or some other hearing protection

f) Fourteen

g) Having an extra rider in the tractor. “One seat, one person” should be a rule on your farm

h) Speed range

i) Tractors

FERTILIZER

Roll Call

Name something that affects the nutrients supplied to a crop:

_____

_____

_____

Nutrient Requirements of Plants

Plants, like people, require several nutrients for growth. Within soil particles there are various nutrients and food needed for plant growth. These nutrients are generally dissolved in the water a plant absorbs through its roots.

The most important of nutrients are nitrogen (N), phosphorus (P) potassium (K) and sulfur (S).

- Nitrogen promotes lush growth and dark green colour.
- Phosphorus promotes root growth, flower and seed development and early maturity.
- Potassium (also know as potash) promotes strong stems, good root systems and resistance to diseases.
- Sulfur helps to form chlorophyll in the plant and works in combination with nitrogen, to make protein.

The Supply of Nutrients to Soil

Under natural conditions, there is a continuous cycle of nutrient uptake from the soil by plants, and nutrient released into the soil by the decay of plant and animal tissue. When a crop is harvested from a field, all the nutrients used up by the plants are removed from the land. If the crop were not harvested most of the nutrients in the decaying plant material would be returned to the soil for other plants to use. Therefore, when the harvesting of crops etc. breaks this cycle, the fertility (capability to grow or produce) of the soil is reduced. Plants raised on this soil will not be as healthy as they could be. Therefore, the nutrients must be replaced.

Nutrient Deficiencies

Symptoms of nutrient deficiencies can include:

- Stunted Growth
- Pale Leaves
- Low Seed Yield
- Lack of Disease Resistance
- Premature Plant Death

Saskatchewan soils are most commonly deficient in two major nutrients, nitrogen and phosphorus. Plants that do not receive enough nitrogen are stunted in growth, and have yellowing leaves. Plants that do not receive enough phosphorus are stunted with dark green leaves.

Growers can get an accurate list of the available levels of plant nutrients in each field by doing soil tests. Based on this test, recommendations can be made as to what nutrients are required and when, how and at what rates they should be applied. A soil test can save a farmer several dollars because it reduces the risk of under-fertilizing (which means lower yields) or over-fertilizing (which means wasted fertilizer) a crop.

Adding proper amounts of fertilizers will ensure healthy, lush plants that grow larger and produce higher crop yields.

Sources of Fertilizers

Organic Fertilizers come from plant materials that were once living. While they were growing, they absorbed nutrients from the soil, and stored them in their own structure. Once they die and begin to break up, they release nutrients back into the soil. Sources of organic fertilizers include:

- **Green manure** crops such as fall rye, clover and buckwheat act as organic fertilizers when they are planted as a cover crop, grown to a certain stage and then plowed into the soil.

- **Livestock manure** and composts are an economical organic fertilizer for crops. They are an excellent source of nutrients and can improve the structure and tilth of the soil.

- L**egume crops**, such as clover, alfalfa and peas, are especially valuable because they can take nitrogen from the air, change it into a useable form, and add it to the soil by a process known as NITROGEN FIXATION. They also add organic matter, and improve the structure of the soil when plowed down.

Inorganic Fertilizers are plant nutrients made from chemicals. Two or more nutrients are often combined in a predetermined mix. This mix must meet government standards and be clearly labeled.

- Chemical fertilizers are named according to the amount of nitrogen (N), available phosphorus (P), potassium (K) and sulfur (S) they contain. 11-48-0 has 11% nitrogen, 48% phosphorus and no potassium. 10-34-5 has 10% nitrogen, 34% phosphorus and 5% potassium.

Activity

Circle the Correct Answer

1. Does 21-0-0 fertilizers contain any potassium?	**YES**	**NO**
2. What percentage of phosphorus is there is 10-30-10	**10**	**30**
3. Is there any phosphorus in 16-20-0 fertilizers?	**YES**	**NO**
4. What percentage of potassium is there in 8-24-24 fertilizers?	**8**	**24**
5. Does 0-0-60 fertilizers have any nitrogen in it?	**YES**	**NO**

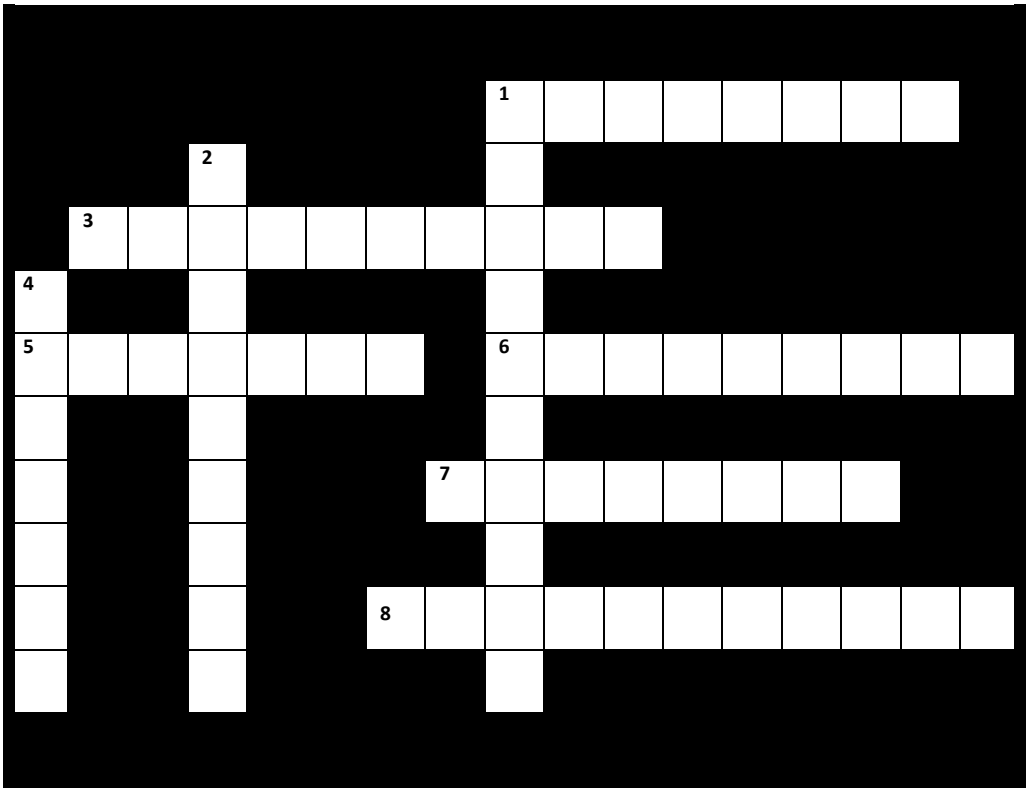
Activity Crossword Puzzle

Across

1) Legumes take nitrogen from the air and change it to a form used by plants through a process called nitrogen _____.
3) This nutrient promotes root growth.
5) Decaying plant material in the soil is an example of _____ fertilizer.
6) Chemicals used to make plant nutrients called _____ fertilizers.
7) Plants that do not have enough of this are stunted in growth and have yellowing leaves.
8) Growing a crop and plowing it under before it matures is a source of fertilizer called _____ _____,

Down

1) A material that is added to the soil to supply nutrients to growing plants.
2) This nutrient helps plants to resist disease.
4) An economical organic fertilizer for crops.



SEED

Roll Call

Name something that seeds provide us with to eat.

_____

_____

The Amazing Seed

Seeds are very fascinating things. They come in all sizes, shapes and colours. A seed is a very compact package containing a tiny plant (**embryo**) and some stored food, covered by a hard protective coating. Within this package lies the ability to germinate and grow into a full-sized plant when conditions are right.

Seeds are the way that plants survive droughts, floods, harsh winters and hot dry weather. To make sure that the seedling has a good chance of survival, the seed has built-in mechanisms that prevent the seed from sprouting until conditions are right. They can be alive but **dormant** for many years.

When seeds on a plant are mature, it is important that they spread out and away (**dispersed**) from the plant on which they have been produced. Seeds disperse in some interesting ways. Burrs stick to animal hair and are either pulled off by the animal or drop off. Berries and fruit are often eaten by birds or animals, which pass through their digestive tract to be deposited in different locations. The wind carries many seeds, like dandelion seeds. Still other seeds float on water.

Once the seed has traveled to, or is planted in the soil, it will germinate if it has moisture, oxygen and the right temperature. Once the seedling has sprouted, it has an immediate supply of food for the initial development of roots, stem and leaves.

Germination

When a living seed is given the right conditions, it will begin to grow. This is called **germination**. In order for this to happen, the seed must be alive and have moisture, oxygen and warmth. If the seed germinates and has enough food for a good start, the plant will grow.

A seed germinates when the embryo begins to grow and emerges from the seed. The root begins to grow and pushes through the seed coat. It grows down into the soil and holds the plant in place. The root grows quickly and starts taking water and nutrients from the soil.

Each seed contains enough plant food to support growth for several days. However, the larger the seed, the more food and energy it can supply to the young seedling. Large seeds germinate faster, emerge from greater seeding depths and produce stronger seedlings than do smaller seeds. Early seedling vigor and rapid growth give the new plant better competition against weed and seedling diseases.

Germination Testing:

A high germination rate (when most of the seeds germinate) is important in producing a high yielding crop. When a grower is planting, there is always some seed that will not germinate. Some seeds are dead or they may be damaged, and just barely able to sprout before dying. It is impossible to tell by looking at a seed whether it will germinate or not. If a large percentage of seeds that are planted fail to sprout, the crop will be thin and unable to compete with weeds growing in the field.

Therefore, knowing the percentage of seeds in a sample that will grow is important. Doing a germination test reveals these qualities of the seed.

Activity

To do a germination test, you will need:

- Several sheets of newspaper or paper towel
- 100 seeds
- A shallow pan with a lid or plastic wrap
- Water

Moisten a double thickness of paper and lay it in a shallow pan. Space the seeds in rows. Cover the seeds with another double thickness of moist paper and place a cover on the pan.

Place the pan where the temperature remains around 20^0C. Keep the covering moist, but not too wet. Many species germinate in seven days. Others take longer. After seven days, uncover the tests. Count only strong sprouts having both a root and a shoot. With 100 seeds, the number of strong sprouts equals the percentage of germination.

For greater accuracy, make four tests of 100 seeds each and average the results. With 400 seeds, total the number of strong sprouts and divide by 400 (the number of seeds tested). This will give you the percentage.

Types of Field Crops

The ability of plants to make sugars and starches makes them so important to the food chain of the world. A plant can store this food in its various parts. Food can be stored in roots (carrots, turnips, potatoes), leaves and stems (alfalfa, grass, lettuce, cabbage), fruit (apples, raspberries, cherries) and seeds (wheat, peas, corn).

The food stored in the seed that would supply the germinating embryo with food for its initial growth, also supplies us with food and nutrients. Seed crops such as wheat, corn, rice, barley and oats are important sources of food to people all over the world. Any seeds from these crops that are of poorer quality are important as animal feed. The main crops grown in Western Canada are classified into four general field crop types:

1. **Cereals**: Cereal crops (wheat, barley, oats and rye) are all bunch grasses. They all have many buds at the base of the stem and a bunch of stems all come from the same spot at soil level.

2. **Oilseeds**: Sunflower, Mustard, Canola, Flax

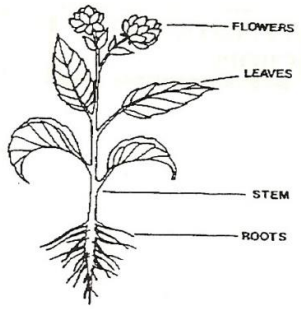
3. **Pulses**: A pulse is a large seeded legume in which the seed is eaten. Pulses can fix nitrogen from the air. Lentils, peas and fababeans are three examples. Legume seeds are second only to the cereals as a source of animal and human food. The protein content of pulses is usually twice that of cereals.

4. **Forages**: All the common cultivated forages belong to one of two groups of plants – the **grass** or **legume** family.

   - **Grasses** – Plants that have fibrous roots (see diagram on page 36). This makes them excellent soil binders. The stems of grasses are jointed and the long leaves have parallel veins.

   - **Legumes** – Legumes can fix nitrogen from the air; the plants add nitrogen to soil as they grow. The growing points of these plants are at the top. The leaves have high amounts of nutrients. The flowers have five petals and the seeds are in a pod.

Plant breeders have developed many varieties of cereal, oilseed, pulse and forage crops that suit Saskatchewan's climate. Some varieties have a special characteristic (such as drought tolerance) that suits them to the climate in some parts of the province.



Activity

Break open two canola seeds and two wheat seeds. Try to make greasy marks on unglazed newspaper with the broken edges. Apply a drop of iodine to each spot and look for a dark colour (starch test).

Test other seeds such as field beans, flax, oats, barley, sunflower, etc. Record which are oilseeds and which are starchy. Oilseeds will make a greasy mark on the paper. Carbohydrates (starch) give a blue colour when iodine is applied.

The Parts of a Plant

Plants are composed of roots, stems, leaves and flowers. All plants need these parts if they are going to grow and reproduce themselves. Some plants may have short stems rather than long ones. Some have small flowers that are difficult to see, rather than large colourful ones. Nonetheless, every plant must have every part, because each has a job to do in keeping the plant alive, growing and producing new seed.

The **STEM** holds the leaves upward to catch the sunlight. Stems also transport water and food between the roots and leaves. The stem can be very short, like a dandelion or very long, like a Douglas Fir (30 metres long!).

LEAVES are the most important factories of a plant. With the help of chlorophyll (green-coloured bodies which give leaves their green colour), sunlight changes water, carbon dioxide and other nutrients into food. This is the basis for life on this earth. Leaves come in various sizes and shapes.

The **FLOWER** is the area where seeds are produced. Plants need the production of seeds to make sure that the particular plant species will survive. Like leaves of plants, flowers come in all sizes, shapes and colours. Those plants, which produce colourful flowers often, do so to attract insects that are necessary to help pollinate and produce seed. Other crops produce flowers that are not so visible. These crops are self-pollinated, meaning that they do not need bees and other insects to help plants pollinate.

ROOTS hold a plant upright in soil and acts as an anchor against the wind and rain. The roots also absorb water and necessary nutrients from soil to be used by the plant in its production of food.

Seed Judging

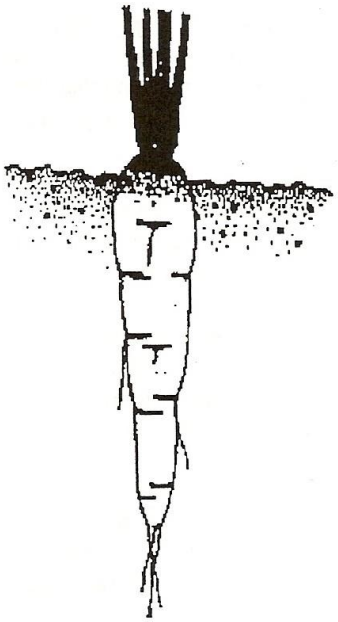
Round, well ripened and mature seeds are essential for producing vigorous, rapid growing plants. The criteria to use when purchasing seed, evaluating the quality of your product, or judging a class include:

- **SOUNDNESS** – Refers to freedom from injury, such as broken, cracked, hulled, frosted, sprouted, moldy, or in any way damaged seeds. Defects in soundness will reduce germination, seedling vigor and disease resistance.

- **PLUMPNESS** – Plumpness shows that the seed contains food for germination and seedling development. Evaluate the general plumpness and uniformity of the sample, plus the weight per bushel. An evenly plump sample would score above another that has slightly larger but unevenly filled kernels. Shrunken or shriveled seeds usually produce weak seedlings.

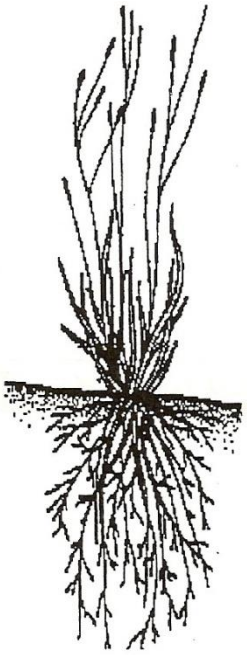
- **COLOUR** – Colour refers to the luster, brightness and shine of the kernels. A uniform bright colour shows that the sample has been harvested under favourable weather conditions. Seed with a dull, faded or bleached appearance is frequently low in vigour.

- **PURITY** – The purity of seeds refers to the presence of other grain seeds, useless matter, weed seeds or disease present in the sample. Samples containing any of the prohibited noxious weed seeds listed in the **Canada Seed Act** should be disqualified. Other crop seeds mean lower yields, higher dockage and lower grades. Some diseases cause diskolouration. Other signs of disease are moldy seeds and the presence of sooty-looking spores in the seed.



Taproot

A fleshy root with a few root hairs. Some examples include carrots, beets, thistles and alfalfa.



Fibrous Roots

This root system is made up of many similar slender roots. Most field crops have this type of root system.

Seeding

Putting seeds into the ground involves four steps:

1. A furrow (row) is opened in the soil.
2. The seed drill places the seeds in the furrow.
   - All the same depth.
   - At the desired number of seeds per metre (density).
3. The seed is covered with soil.
4. The soil is packed.

Once the seed is in the ground and conditions are right (i.e. the temperature of the soil is warm enough and there is enough moisture), the seed will germinate and grow.

Measuring Soil Temperature

Soil temperature is a useful guide for timing spring seeding operations. Once the seed in planted, it is important that germination continue uniformly and without delay. If the soil is too cool, germination is delayed. This can result in seed damage and uneven or inadequate seedling emergence. It may even be necessary to reseed. If the soil is unusually warm in the spring, it may be advantageous to seed earlier than normal. In any case, the soil temperature at seeding depth can serve as a practical guide.

The most accurate way to know your soil temperature is to measure it with a thermometer. Any thermometer that will measure temperature at a specific depth can be used, provided they are long enough to permit reading the temperature when the bulb is inserted to the required depth.

Care must be taken to avoid breaking glass thermometers. Before inserting the thermometer, it is a good precaution to make a pilot hole in the soil using a rod or screwdriver of a similar diameter.

Sites selected for temperature measurement should represent the field to be seeded in terms of the following factors:

- **Soil Cover** – Soil warms from the top down and bare soil warms most quickly. A heavy trash cover, such as a lot of straw or manure, insulates the soil from the warm air and delays soil warming.

- **Slope** (amount and direction of slope) – South-facing slopes receive the most direct sunlight in a day. Therefore, they warm more quickly than north-facing slopes or level land. Snow also melts earlier on these slopes.

- **Soil Moisture** – Dry soil warms faster than wet soil. Moisture content is strongly related to soil cover, slope, texture and drainage. A stubble field that was covered with snow will be wetter, and consequently will warm more slowly, than a bare field.

Activity

Measuring Soil Temperature

- Place the bulb of the thermometer at the intended seeding depth for the crop to be seeded. The bulb should be in firm contact with the surrounding soil.

- Allow a minute or two for the thermometer to become the same temperature as the soil, before taking a reading.

- Record the temperature in a couple of spots in the field at 8:30 a.m. and again at 4:30 p.m. The average of readings from these two times will tell you the soil temperature.

How a Plant Works

A plant is like a candy factory: it is always making sugar. The ingredients it uses are minerals from the soil, water and different gasses in the air. Its source of energy is the sun and the magical ingredient that makes it all happen is the "green machine," chlorophyll. The sugar made is used to help the plant grow, repair itself and reproduce. Extra sugar is stored in the form of starch. It can be stored in the roots (potatoes) or in new seeds (grains of cereal crops).

The Life Cycle of Plants

Not all plants grow from a seed to maturity and die in one year.

ANNUALS – Plants that normally grow to maturity, produce seed and live only one year (e.g., wheat, canola, corn).

BIENNIALS – Plants that grow from the same root system for two years. They usually only flower in the first year and make seed the second year (e.g. raspberries).

PERENNIALS – Plants that grow from the same root system for three or more years (e.g. alfalfa).

WEEDS

Roll Call

Name a way that weeds cost money.

_____

_____

_____

What is a Weed?

A weed is a plant growing where it is not wanted. Thus, canola would be considered a weed when found growing in a field of barley and conversely, barley would be a weed when growing in a field of canola.

Weeds are the most common plants found growing in the settled areas of the province. They may grow in crops, gardens, shelterbelts, fence rows, or waste areas. They are almost all a problem because of their competition with the growing crop, or because they are an unacceptable contaminant. Some plants are considered weeds because they are classed as poisonous plants that may be toxic to animals when consumed.

Some of the problems caused by weeds include the following:

- Can reduce crop yields by competing with crop for water, food (nutrients) and sunlight. In a field there is limited room, water, food and sunlight to go around. Over-crowding can destroy a crop.
- Some release poisons that can affect crop growth.
- Some are the homes of insects and diseases that attack crops.
- They can get in the way of harvesting operations. They can plug up equipment and make it very difficult to harvest crop.
- Weed seeds or other weed plant parts in a harvested crop may make that crop less valuable or unfit for market. (Grains coming in to the elevator are graded lower if they contain a lot of weed seed.)
- In feed grains, some types of weed seeds may cause animals to become sick.

For these and other reasons, growers spend much time working the land to control weeds and spend large amounts of money on herbicides (chemicals that kill weeds).

It Pays to Know Your Enemies

Weeds have evolved to be very tough plants so they can be difficult competition for crop seedlings. They have surprisingly complex methods of survival.

- Some weeds have brittle roots that break off easily when the weed is pulled; leaving a piece of root in the ground that regenerates and quickly begins to grow again.
- Some weed seeds are very easily knocked off the plant making them difficult to get rid of.

- The seeds of any one plant can mature at different intervals and often drop off as they mature. This means that cutting weeds down at harvest time is already too late, as many seeds are already on the ground.
- Some weed seeds can remain dormant in soil for very long periods of time. They begin to grow again when conditions are favourable.

Weeds are usually very hard to get rid of because they have evolved to survive the most adverse conditions. For that reason, they often are very successful competitors when found in field crops.

Weed Classification

In order to practice weed control, it is necessary to be able to identify weeds at different growth stages. Understanding how they work, including how they survive and spread, is essential to develop efficient and effective methods of control. Weeds may conveniently be classified based on their life cycle.

ANNUAL WEEDS are those that complete their life cycle in less than 12 months. There are two types of annual weeds.

- **Summer Annuals** are plants whose seeds germinate in the spring and complete their life cycle by fall. In Saskatchewan, summer annuals survive for less than six months.
- **Winter Annuals** are plants whose seeds germinate in late summer or early fall, and form a low flat rosette of leaves before freeze-up. They overwinter as rosettes, and continue growth the following spring, flower and mature seed by early summer after which time the plant dies, but the seeds produce and germinate.

BIENNIAL WEEDS are those that require more than 12 months but not more than 24 months to complete their life cycle. They flower and have seeds only in the second year.

PERENNIAL WEEDS are those that survive for several years (at least for more than two years). Many will flower every year and die back to the ground, but their roots, or underground stems, live on and grow more with every year. Perennials may be further classified as:

- **Non-Creeping Types** are those that spread mainly by seed since they have no normal means of spreading vegetatively.
- **Creeping Types** spread by seed and also by creeping roots.

An understanding of the life history of a plant is essential for efficient and economical weed control. For instance, annual weeds are generally fairly easy to control in crops while they are young, either by tillage or by

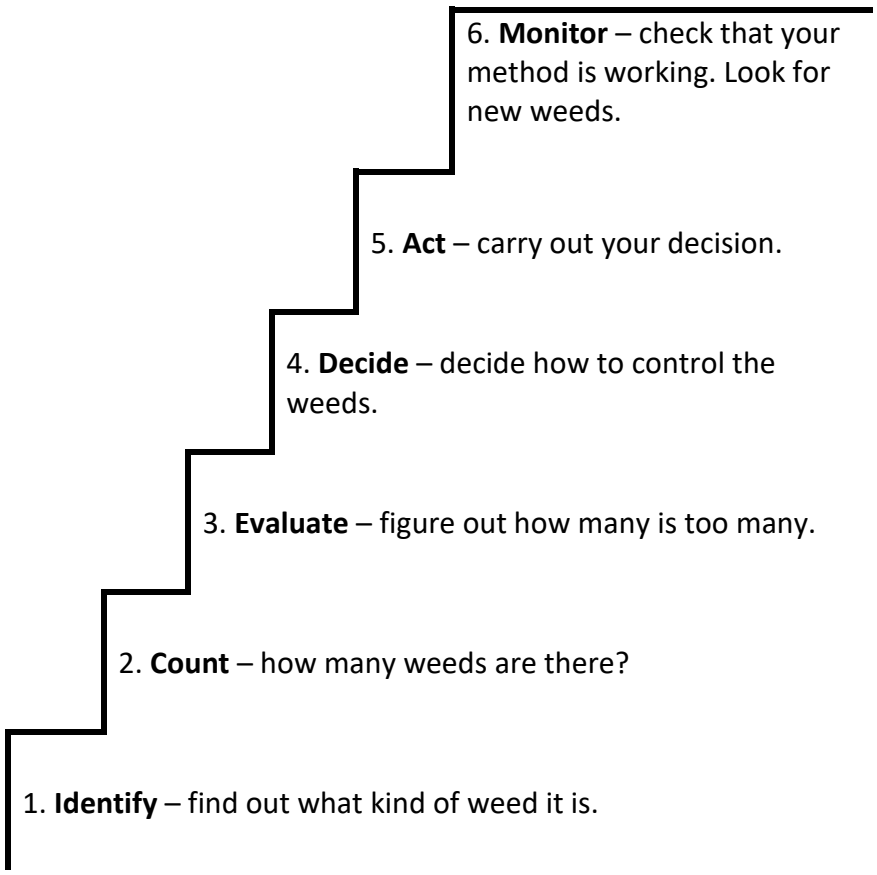
chemicals. However, any surviving plants produce an abundance of seeds, which are often persistent in the soil, and this makes eradication very difficult.

Efficient weed control is dependent upon proper identification of the plant and an awareness of the life cycle of that plant. Sometime in the life cycle of any weed, a weak point is present and at that time control methods are most effective.

Controlling Weeds

Growers recognize weeds as the single most important limiting factor in crop production. Weeds compete with crop plants for minerals, nutrients, soil moisture and sunlight. There are many ways to control weeds. The problem is to find the best way.

One suggestion is to use the **"Six Steps to Better Pest Control"**.



Step 1 - Identify

To control weeds, you must first find out what kind of weed it is. You can identify weeds by asking someone who might know, or by using a picture guide book on weeds. You might ask your Saskatchewan Agriculture Representative about a good resource, which would provide pictures and descriptions of weeds as well as a statement of the agricultural concern of the weeds.

Step 2 - Count It would be impossible to count all the weeds in a field. The best way to figure out how many weeds you have in a field is to look at a sample of the crop and count the weeds in that sample. You select a small sample area (1 metre x 1 metre). Count the weeds in that area. This will give you what is called the "density" of the weed. If you have a large field, it would be good to take more than one sample.

Step 3 - Evaluate Once you know the density, figure out if this is a lot (a high density), or a few (a low density). The density at which significant damage to crop will occur is different for every weed. To figure out the density, you must know your weed and your crop. Weed guides will help you to evaluate this.

Step 4 - Decide Now that you have all the facts, you will decide what to do. To make this decision, you will need some tools, or methods of control. Because there are perennials, biennials, broad-leaved weeds and grasses, parasitic plants, shrubs and even some trees, there is no one method of control that is effective for all these.

There are four basic ways that weeds can be controlled:

- **Biological** – using another living plant or animal to choke out the weeds. (Example - choosing crop varieties that are hardy in weedy fields.)

- **Cultural** – changing the environment to make it unsuitable for weeds to grow. (Example - Crop rotation.)

- **Mechanical** – physically removing the weeds from the field. In field crops, it could be cultivating or pulling weeds out from between rows by using a machine

- **Chemical** – this is the use of pesticides to control weeds. Pesticides used to control weeds are called herbicides.

Step 5 - Act Once you have made your decision you must act on it. Carrying out your plan at the right time can help make your decision more effective!

Step 6 - Monitor Once you've carried out your plan, and used a form of weed control, it is important to walk your fields to see if your plan worked. If it worked, how well did it work? If it didn't work, why not? It is also important to continue to monitor for other weed problems.

INSECTS and DISEASES

Roll Call Name an insect or a disease that might affect your crop from growing.

_____

Insects

Insects are animals whose favourite numbers are three! They have three pairs of legs, and their body is divided into three parts. There are more different types of insects in the world than all other living things (plants and animals) put together. There are many types of insects that have not been identified yet, and there are still many new types to be found.

Insects are probably the most successful of all living things. They made their appearance around the same time as the first dinosaur, more than 200 million years ago. They have adapted to every living condition imaginable. They can live on people, animals and plants, in the ground, in water, in cold climates, in hot climates, in wet areas and in dry areas.

Most insects are very beneficial. If you have more than 100 different insects in a jar, only one of them would be harmful. Without insects, the quality of our life would not be as good. We would have to do without many things.

However, it is estimated that harmful insects can destroy billions of dollars worth of crops every year. Different insects come out at different times of the year. The number of insects that can cause damage will vary from one type of insect to another. Watching fields for insect damage is therefore important.

Pest control manuals will help you to know what insects to watch. Once you have identified the potential pests, learning about their habits, food needs, food preferences, life cycle and habitat requirements is helpful.

The Biology of Insects

Most harmful insects are harmful because the crops you grow are a source of food for them. Some insects will attack the roots, others the leaves, some the stem, and some can even suck the plant's nutritious juices from its leaves and stems.

Insects have a life cycle. During this life cycle, most insects change shape and eat different foods. Therefore, insects may be harmful to a crop only during part of its life (one stage in its life cycle). For some insects, only the larva or adult is harmful. For others, the insect at different stages will affect different parts of the plant.

Insect control may be necessary in one circumstance and not in another. The number of insects in a field varies from season to season. Some things that affect the numbers are:

- Weather
- Natural enemies
- Species of crop
- The stage of growth of the crop

Each factor is a variable and the number of insects will change from one year to the next, as the factors change.

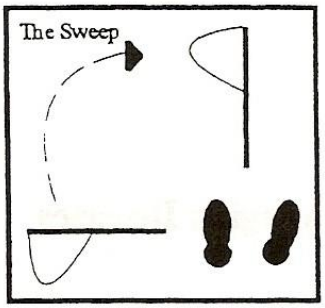
To learn more about specific insects that may affect your crop, refer to the "Guide to Crop Protection" available through Saskatchewan Agriculture. You can download the PDF file at their website: www.agr.gov.sk.ca/Docs/crops/cropguide00.asp

Activity — Collecting Insect Samples

Samples of insects can be collected using:

- A sweep net
- A plastic bag or jar

Since many insects are very mobile, or small and difficult to see, sweeping samples into a net is very useful. A sweep is made by swinging the net at arm's length through the crop canopy so the top of the net is at crop height.



- Hold the net at arm's length to one side.
- Sweep it through the crop canopy directly in front of you.
- Quickly lift the net up into the air and swing it back and forth to force insects to the bottom of the net.
- Immediately grab the net about 15 to 20 cm from the bottom to confine the insects and prevent escape.
- Empty the insects into your plastic bag or jar to identify and count the number of specimens.

Each time you sweep a sample, be sure to step away from where you have already collected so the sweeping activity does not influence the catch in your next sweep.

Diseases

Plants, like people, are affected by some diseases. Infectious crop diseases on the prairies are caused by:

Fungi: Disease develops when fungi infect and grow on a healthy plant.
Bacteria: Invisible, single-celled organisms that invade plants through natural openings or wounds.
Viruses: Tiny infections, visible only under very powerful electron microscopes that are found in all parts of infected plants.
Nematodes: Tiny worm-like creatures that either feed directly on the plant or feed on organic matter in soil, stealing nutrients away from growing plants.

These fungi, bacteria, viruses and nematodes feed on plants and kill parts of the plant. They can cause much damage by:

- Destroying roots
- Attacking leaves and stems
- Attacking seeds

They can live for a long time in soil, in seeds, or in rotting organic matter in the field and they are difficult to eliminate.

Managing Diseases

To better understand how to manage plant diseases, think about the following questions regarding the common cold:

- Have you ever had a cold?
- Have you ever taken medicine for your cold?
- Did the medicine cure your cold?
- If no, why did you take the medicine?
- Is there a cure for a cold?
- Is there anything you can do to prevent catching a cold?

A lot of plant diseases are just like colds. A plant gets a disease but there is little that can be done to cure it. It is possible that by improving the conditions, you might stop the plant from getting any sicker but it is doubtful that you will be able to cure it. This is why the main weapon against plant diseases is prevention.

Disease Prevention

There are many methods used to prevent disease:

- Just as you may take vitamin C to prevent a cold, farmers will treat their seeds with substances to make them more resistant to disease.

- When you get tired and do too much, you find that you might catch a cold easier. Plants are the same. If they are weak, do not have enough food, or too much water, they will be more susceptible to diseases.

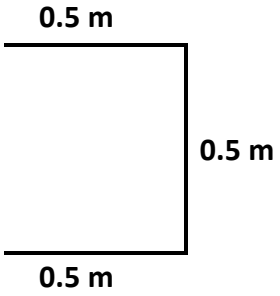
- Some people catch fewer colds than others. The same is true of plants. For example, some varieties of wheat get fewer diseases than others. These wheat varieties are more resistant to disease.

- You may find that if one person in your family gets a cold, eventually everyone gets it. The same thing applies to plants. If you have a diseased crop, this disease will grow and stay in the soil over the winter. If you plant the same crop next year, the disease will seriously affect it. If you plant a crop that is not affected by the disease, you will get more production out of that field and the disease may be eliminated.

- Most diseases are host specific, meaning that they will infect and grow only on certain plants. By eliminating the host, you can help get rid of the disease.

Field Scouting

Field scouting is the regular examination of fields, in a prescribed fashion, to detect and measure the infestation level of pests. It provides an evaluation so action can be taken to control or prevent pests from becoming an economic concern. Regular scouting is the only way to collect the information needed to make timely management decisions. Regular scouting also prevents unnecessary treatments, where damage is insignificant. Early detection can help make eradication possible and reduce the uncertainty associated with pest management.



Sampling Square

A sampling square is used to mark out a 0.25 m^2 area of a crop for sampling. It can be made from a 1.5 m length of ¼" iron rod, bent to form the three sides of a 0.25m^2 square. Only three sides of the square are made so that it can be slipped into a standing crop at eye level, rather than dropped down through the canopy. The rod should be painted a bright colour and marked with flagging tape, so that finding it is easy if placed or dropped in a crop. To convert your findings in 0.25m^2 to the number of pests per m^2, multiply by 4.

In project areas of 30 acres, scout in at least two locations. In fields less than 80 acres, scout in at least five locations. In fields greater than 80 acres, scout in at least ten locations.

Begin scouting when the crop emerges in the spring and continue until freeze-up.

What to Scout for

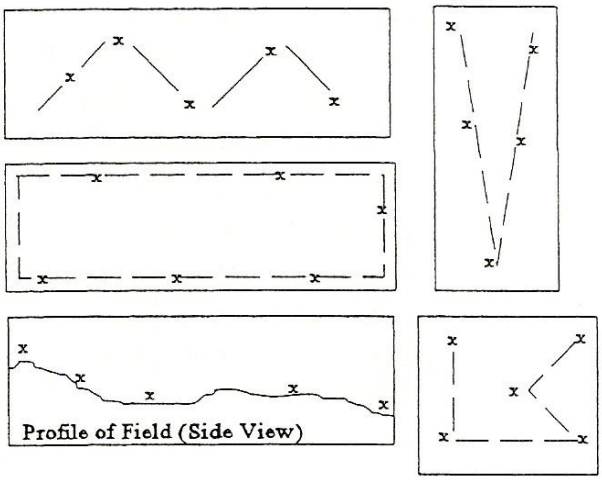
Before scouting your field, it is a good idea to refer to a pest manual to find out what pests are common to your crop. Learn about these pests and how to identify them.

For weeds, examine the sample areas carefully and record stages of growth of both broadleaved and grassy weeds. Count the numbers per square metre of each weed.

For insects, you will need to collect samples of insects and examine plants for damage caused by them. Each time you scout your field, collect samples of insects in each sample area. To allow you to compare your results with samples collected from other scouting sessions, always take a consistent number of sweeps per sample.

When scouting for damage to plants, assess the overall appearance of the field and examine the sample areas. Check all parts of any damaged plants carefully, including:

The Sample Areas should be carefully selected. Take a close look at your field and map out a pattern that will ensure that different areas of the crop are included in your examination. The following are some examples of patterns that can be used when scouting a field. A combination of these patterns will help to ensure that all areas of your field are covered.



- **Seed heads**: Examine the surface of the head or pod, and open the seedpods to examine damage to the seeds.
- **Stems**: Examine the stem surface, and then split the stem from top to bottom to look for insects.
- **Leaves**: Leaves damaged by insects should be individually examined, especially the top ones for any presence of insects and to assess the damage. Examine leaves and sheaths damaged by disease to determine the amount of leaf infection.

- **Roots**: Always dig up roots that appear unhealthy. Clean away the soil and look for insects and damage caused by insects. If there are signs of damage, but no insects present, sieve the soil around the plant to find the cause of the damage. Cut into the root to examine for internal infections.

The following list of symptoms will make it easier for you to recognize that something may be wrong in your field. Watch for:

Overall Field	Leaves	Stems	Roots
• Spotty Growth • Browning • Stunted Growth • Lodging • Yellowing • Loss of Vigour • Thin Stand • Kinked • Poor Germination	• Unusual Colour • Loss of Leaves • Crinkled • Chewing Signs • Stripped • Cupped • Rolled Leaves • Feathered • Spotted • Blotched	• Twisted • Broken • Shortened • Spotted • Abnormal Tillers • Rotten • Kinked • Elongated • Cracked • Swollen • Punctured	• Inhibited • Rotten • Chewed • Tunneled • Swollen

When scouting, you can also monitor whether your management strategies are working or causing any problems.

Be aware that symptoms of plant disease problems may be caused by weather, fertilizers, deficiencies, herbicides and soil problems. Often a laboratory analysis is required to determine if damage to plants was caused by disease or one of the many other factors that can affect the plant in similar ways.

Activity

Put the following in the correct order:

A. _____ Walk to the first sampling sight and identify any pests (weeds, insects or diseases) and evidence of pests found in the sampling area.

B. _____ Convert your finding from 0.25 m^2 into finding for 1 m^2 by multiplying by 4.

C. _____ Look at the field and make a map of carefully selected representative sampling sights.

D. _____ Record your findings on your Field Scouting form.

E. _____ Count the number of pests or plants affected by pests in the sampling area.

F. _____ Move on to the next sampling sight on your map.

G. _____ Place your sampling square on the ground or into the canopy of the crop.

PESTICIDES

Roll Call

Name something that should be done for correct and safe handling of chemicals.

_____

_____

_____

Warning Symbols

On all pesticide labels, there are warning symbols that identify the kind of harm that can result from pesticide misuse or mishandling.

The picture indicates specific types of hazards. The shape or border around the picture alerts us to the degree of hazard. The more lines in the shape of the border, the more severe the hazard.

It is important that you know and understand the following symbols:

An octagon means definite danger.

The diamond indicates a moderate warning.

The triangle indicates a caution of possible danger.

	The **"fire"** symbol is a warning that the pesticide is flammable or may easily catch fire. Keep the pesticide away from heat, sparks and open flames. Make sure no one is smoking while mixing or applying the product.
	The **"exploding grenade"** symbol indicates that the pesticide can explode. This symbol is commonly found on pesticides in pressurized cans.
	The **"corroded hand"** symbol indicates that the pesticide is corrosive to the skin and eyes. The chemical is either acid or alkali and can burn the skin. Be extra careful to protect the skin and eyes when using products with this symbol.
	The **"skull and cross bones"** symbol warns that the chemical is poisonous if taken into the body. Keep the product out of reach of children. Be extra cautious with containers showing this symbol.

Pesticides may enter the body through the skin, mouth or nose. Reducing the risk of exposure is possible through careful selection and use of protective clothing and safety equipment. The minimum level of protection required when working with less toxic pesticides includes:

- ✓ A **hard hat** (wide brimmed, no liner)
- ✓ **Coveralls** (cloth or disposable, worn over long-sleeved shirt and full-length pants, and closed at the neck)
- ✓ Unlined nitrile **gloves** (cuff gloves or wear sleeves over gloves)
- ✓ Neoprene or rubber **boots** (wear pants outside boots)

Extra protection is required for mixing, loading and handling pesticide concentrates, especially when working with highly toxic pesticides. Extra protection required includes:

- ✓ **Goggles** or **face shield** (Eyes are very sensitive to pesticides. They can easily be exposed to vapour or fumes, dust, spray drift, or accidental spills and splashes. Do not wear contact lenses when mixing or applying pesticides.)
- ✓ **Ear plugs** (to protect the ear canal)
- ✓ **Respirator** (check label for required use with less toxic pesticides)
- ✓ Chemically resistant **coveralls**
- ✓ Waterproof **apron**

Avoid wearing the following materials. They either absorb chemicals, prolonging chemical exposure to the wearer, or are not resistant to pesticides, meaning that they do not stop the pesticide from coming into contact with skin they cover. They are also not easily cleaned and should not be worn while handling pesticides.

- ✗ Fabric baseball caps
- ✗ Cloth or leather gloves, shoes or boots
- ✗ Natural rubber or plastic gloves
- ✗ Leather belts or watch bands
- ✗ Contact lenses

Activity Protective Clothing

Match the following symbols with their correct description:

I.	**Danger Poison**	**A.**	
II.	**Warning Explosive**	**B.**	
III.	**Caution Flammable**	**C.**	
IV.	**Caution Corrosive**	**D.**	
V.	**Warning Flammable**	**E.**	

Pesticide Container Disposal

Triple rinsing of pesticide containers is recommended and reduces pesticide residues in containers (metal, plastic, glass) by 99%. To properly triple rinse used pesticide containers follow the steps:

Step 1. Empty contents of the container into the spray tank and drain in a vertical position for 30 seconds.

Step 2. Add water to the container to about 1/5 full.

Step 3. Shake the container thoroughly and empty into the spray tank.

Step 4. Repeat the procedure two more times. This process should take only about 5 minutes.

Once containers have been triple rinsed, they should be punctured or broken to render them non-reusable and to identify them as being triple rinsed. Dispose of all containers in an approved pesticide disposal site.

Pesticide Spill Cleanup

In the event of a pesticide spill, wear protective clothing and make sure that the area is well ventilated. Prevent the pesticide from entering into sewers or water supply. Absorb the spill with paper or sand and dispose of absorbent materials in an approved landfill. **Do not burn**. Wash the site with detergent, or if the spill is large, evacuate the area and notify safety personnel through your local police and fire stations.

All pesticides available for sale in Canada must be registered. To obtain registration, a product must be tested for many years under different environment conditions, on different soil types, crops, weeds, diseases and pests to determine its effectiveness. The product must also be tested for its effect on people and the environment. Questions that must be answered include:

- What happens to the chemical once it is sprayed on the crop?
- Does it break down?
- Is it possible to find any toxic residues within the grain or straw?
- How does it affect animals and birds in the area?
- How does it affect the user of the treated crops?

Only once all these questions have been answered and the product is found to be safe, is the pesticide given registration. However, they still have limitations such as: the product may not be sprayed on a crop less than x number of days before harvest, it may be sprayed only on certain crop species, or it may be sprayed only at rates less than x kg/acre. It may or may not be applied by aircraft, and may be limited to areas that are not near waterways.

Chemicals are tested to determine what type of equipment would provide adequate protection to the users, and recommendations are made on the basis of all these tests as to specific areas of use, and in what context a specific chemical will perform safely and effectively. It should be remembered that even though a chemical is registered, it is still a dangerous product. Safety equipment should be worn when handling them and all instructions pertaining to the chemical should be followed closely.

The 4-H's for Pesticides

HEAD – *Use Your Head*

- Never use pesticides without an adult's help.
- Use a pesticide only when it is needed. Be sure you have identified your weed problem properly, and have the correct chemical to control it.
- The entire label on a pesticide container should be carefully read each time the chemical is used.

HEART – *Have a Heart*

- Never spray or dust on a windy day.
- Store chemicals out of reach of children, and where there is no chance of contact with food or livestock feed.
- Cover birdbaths and animal dishes before spraying.
- Keep pets and farm animals out of the way while spraying.

HANDS – *Handle Pesticides Carefully*

- Do not mix pesticides yourself. This is a job for an adult.
- Apply pesticides only as specified, and only to pests listed on the label.
- Store chemicals in their original containers, never in unmarked containers or bottles used for food or drink.
- Wash hands and face with soap and water after using pesticides, especially before handling food.

HEALTH – *Protect Your Health*

- If the label says to avoid skin contact, wear proper clothing. Wear long-sleeved clothing and gloves when mixing or applying pesticides.
- Avoid breathing in chemical fumes, mists or dusts. Wear a protective mask and stay where the spray or dust will drift away from you.
- If you accidentally spill a pesticide on yourself, STOP. Remove the soiled clothes and wash the exposed skin thoroughly with soap and water.
- After working with chemicals, have a bath or shower and change to clean clothing. Wash clothing before wearing them again.

Activity

Match the right statement with the left answers

I. This is found in pesticide masks to filter out hazardous particles	A. Fumigation (applying chemicals in the open air in a gaseous form)
II. After working with pesticides, do this before you go to the toilet	B. A Pesticide Applicator's Permit, available through Saskatchewan Agriculture, Food and Rural Revitalization
III. The most hazardous pesticide application technique	C. The skull and crossbones
IV. Something that should never be stored in the house	D. Wash your hands
V. You must have one of these before you are allowed to purchase fumigants	E. Charcoal
VI. Do not wash these with the rest of the family's clothes	F. The entire family could be exposed to harmful pesticide residues if contaminated clothes are washed with the rest of the family's clothes
VII. This symbol indicates a danger	G. Pesticides

Why do Herbicides Affect Weeds and Not the Crop?

This is what research is all about. Scientists have been able to develop herbicides that affect only weeds and not crop. They have done this by studying the biology of both the weed and crop and finding chemicals that react to things that are present only in the biology of the weed.

HARVEST

Roll Call

Name something that happens at the busy time of harvest.

_____

_____

_____

Harvest is the time when crops are collected from fields and prepared for sale or for storage. Most field crops in Saskatchewan require a combine, which is so named because it "combines" harvesting (collection of crop) and threshing (removing seeds from plants) operations into one machine.

Determining Best Time for Combining start-up:

As the crop begins to ripen, you should continue scouting your field and collecting samples to check for crop readiness. Crop maturity and moisture content are the main factors that determine when combining should begin. Procedures which can be used to determine the maturity of a crop include:

Moisture Testers: Tests the percentage of moisture in seeds.

Maximum Moisture Content for Safe Storage

For safe storage, harvested grain should not have more moisture than the following:

Crop	% Moisture	Crop	% Moisture
Fababeans	16.0%	Oats	14.0%
Lentils	16.0%	Rye	14.0%
Field Peas	16.0%	Flax	10.5%
Barley	14.8%	Canola	10.5%
Durum Wheat	14.8%	Dry Beans	18.0%
Wheat	14.5%		

Hand Threshing

Take a few heads of your crop and thrash them in your hands to release the seeds. Remove the chaff by sifting the seeds from one hand to the other. This will give you an opportunity to closely examine the seeds. Check for plumpness, ripeness, moisture and colour. Try pressing a fingernail into the kernels to see how soft they are. Squeeze a kernel to check for moisture. Break a kernel to check for colour and ripeness as well.

There are other factors that may affect the timing of harvest operations. These include:

- Climate and soil climates
- Labour and equipment availability
- Specialized equipment needs (driers, etc.)
- Availability of storage

When to Cut

Harvesting should be done at the time when the greatest return will be obtained. For example, the swathing of wheat should be started when the kernel moisture content is such that the kernel is firm, but can still be dented with the thumbnail. However, earlier swathing may be advisable if there is danger of frost.

Given a frost forecast, available time before frost occurrence can be used in harvesting crops that are sufficiently mature. If the warning comes far enough in advance, savings can be considerable. Hastening the maturity of cereal grains by timely swathing is a means of reducing the risk of frost. Wheat and barley can be swathed at a kernel moisture content of up to 35% without seriously affecting volume or weight.

How a Combine Works

The operation of a combine can be divided into the following five basic functions:

1. **Cutting and Feeding:** Field crops are most often swathed and left for a few days to dry. The combine has a pick-up reel that lifts up the swath and feeds it to the combine's platform auger. When the crop is ripe enough for straight combining, a header is attached to the combine that cuts the crop and feeds it into the combine.

2. **Threshing**: This is where the seeds are removed from the heads or pods. The crop is fed into the space between a cylinder and a concave. The impact of rotating cylinder bars shatters the seeds from the heads or pods. The action of the crop material rubbing against itself also threshes out the seeds. Many combines now use single or double rotors as part of the threshing system.

3. **Separating**: Most of the separation of grain from straw occurs through concave openings. The beater, finer grate and straw walkers do the remaining of the separation. The beater deflects the material coming out of the concave down onto the front of the straw walkers. The finger grate prevents straw from falling down into the cleaning shoe. The agitating motion of the straw walkers shakes the grain out of the straw, and moves the straw out the rear of the combine. The loose grain falls through openings in the walker and is delivered to the cleaning unit. Rotary combines use a spinning rotor for threshing prior to the straw walkers.

4. **Cleaning**: The cleaning unit removes chaff and straw remaining in the grain. A chaffer and a sieve are located together in a unit called the cleaning shoe. A fan is mounted in front of this cleaning shoe to remove most of the chaff and straw from the grain.

   The fan speed is adjusted according to the type and dryness of the crop being combined. The fan lifts the lighter particles of chaff into the air and they are carried out of the combine. The heavier particles land on the chaffer, where smaller heavy particles are sifted onto the sieve and lighter particles are moved along the chaffer until they fall out onto the ground. The air stream from the fan continues to help separate the grain from the unthreshed heads. The grain falls through the openings in the sieve to the clean grain auger, and is carried to the grain tank. The unthreshed grain falls off the end of the sieve into the tailings to be returned to the threshing unit.

5. **Handling**: This component of the combine moves the clean grain from the cleaning shoe to the grain tank, and then out into the truck. Also, the unthreshed grain is returned to the separating unit to be threshed. The cleaned grain is moved from the shoe to the clean grain elevator by the clean grain auger. The elevator lifts the grain up to the grain tank loading auger, which deposits it in the centre of the grain tank. When the tank is full, a large auger in the bottom of the grain tank channels the grain into the unloading auger, which transfers the grain into the truck.

Determining Yield

When your crop project is harvested, the yield is the weight of product per acre of crop harvested. The weight yield is most accurately determined by weighing the product as it is taken off the field. Then, knowing the area harvested (i.e. how many acres your crop was grown on) and the weight of the final product, the yield is calculated as:

$$\textbf{Yield} = \frac{\textbf{weight of product (lbs or kg)}}{\textbf{\# of acres}}$$

The Bushel

A bushel is a volume measure that is also used to determine yield. It is not as accurate as actually weighing the crop produced, but it is a commonly used measure. The reason that it is less accurate is because it is a measure of volume rather than a measure of weight. Because of differences in the quality of grains, and the density of each kernel, a bushel of a high quality crop would weigh more (have a greater yield) than a bushel of poorer quality crop. The weight of each kernel may be greater in a higher quality crop, which means that the overall weight and yield of this crop is higher than that of a crop with lighter kernels.

Since 1977, all business transactions of the Grains Industry in Canada have used metric units. The use of metric units improves the measures and pricing used in the industry. The base units used include:

Physical Quantity	Metric Unit	Symbol
Weight (mass)	kilogram	kg
Unit of Trade	tonne	t
Length	metre	m
Area	hectare	ha
Yield	kilograms per hectare	kg/ha
Quota	kilograms per hectare	kg/ha
Total Production	tonne (1000 kg)	t
Test Weight	kilograms per hectoliter	kg/hl
Volume	cubic metre	m^3

Storage

Once grain is removed from the field it is either sold or placed in storage. If it is to be stored, it must be protected from moisture, insects and rodent damage. The quality of the grain must be retained during storage. Improper storage can lead to spoilage.

Spoilage of stored grain can occur because of heating, which means that the grain was too moist to have been stored. Bins must have proper ventilation to allow the grain to “breathe” and should be adequately sealed to prevent rodents from entering. Some granaries are equipped with aeration fans to help dry grain, and to maintain an even temperature throughout the grain, which can prevent spoilage. Grain bins can be made of wood, cement or steel as long as they are properly constructed and maintained.

Grain that is removed from the field before it is completely dry must be brought to an appropriate level of moisture content before being put in storage, or spoilage will occur. Grain may have to be harvested at a high moisture content if it is a wet or late season, and harvesting cannot wait. In order to reduce the moisture content, a machine known as a **Grain Dryer** may be used that blows hot, dry air through the grain to lower its moisture content. Most are very simple in design. They have a big drum that has agitators inside to stir the grain, and a set of chambers with fans that blow hot air through the grain, cool it off and let it flow out the bottom. Grain is augured into the top section where drying occurs before being cooled. It is then ready for storage. Dryers are usually powered with a tractor's PTO to move the grain. Heat is supplied by electricity or propane.

Reducing Stored Grain Losses

The following steps will help to avoid storage losses:

- Periodically take samples from different parts of the bin to determine moisture content, temperature and insect activity.

- In barley, if the moisture content is above 15%, it should be aerated as soon as possible. No germ or heat damage will occur with a moisture content below 13%.

- The temperature should be between 4.44^{0}C and 10^{0}C throughout the bin (for barley).

- If even a slight rise in temperature is detected, damage is being done either by vigorously feeding insects or rapidly growing storage fungi.

- In wheat, moisture content should be below 13% because with moisture content of 13.5% or 14.5%, slow invasion by storage fungi can cause germ damage without a rise in temperature.

- Wheat that is heating, even when insects are not present, has a moisture content of greater than 14.5% and should be aerated as soon as possible to get the temperature below 4.44^{0}C throughout the bin.

Activity

Put the following harvest operations in the correct order:

- [ ] An auger moves the grain from the truck to a bin for storage.
- [ ] The crop is cut.
- [ ] The grain that has been threshed is cleaned with a fan, chaffer and sieve.
- [ ] The grain is transferred from the grain tank in the combine to a truck to be transported.
- [ ] The moisture content of the crop is tested.
- [ ] The crop is fed into the combine with a pick-up reel.
- [ ] The grain is separated from the straw.
- [ ] The grain is threshed to remove the seeds from the heads or pods.

Marketing

Roll Call

Name a product that is grown, processed and sold in Saskatchewan.

_____

_____

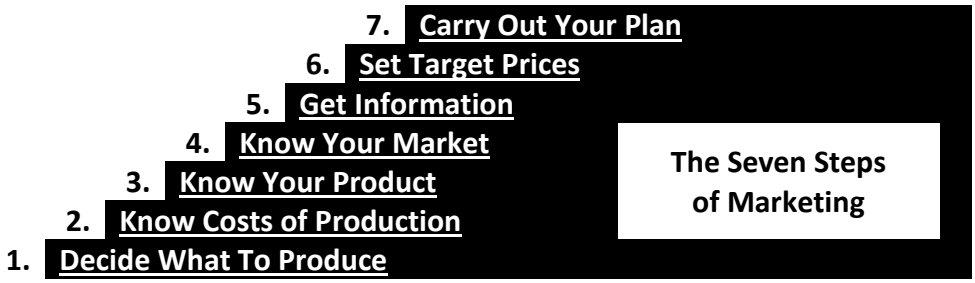
What is Marketing?

Marketing is the activities involved with getting a product from the person who grows the product (the **producer**) to the person who buys the product (the **consumer**).

There is more to marketing field crops than simply selling the crop to the nearest buyer. Producers must decide **what** they will grow, **how** they will sell their product, **who** they will sell their product to, **when** they will sell their product, and at **what price** they will sell it for. When a producer decides what **commodities** (products) to grow, he has an idea of who will buy the commodities he produced and at what price.

The Seven Steps of Marketing

Successful marketing can be thought of as having the right product, at the right place, at the right price, and at the right time. In order for all of these to happen, it is helpful to use the following seven steps:



1. No producer would decide to grow anything without knowing that people will want to buy what they grow.
2. Knowing how much it will cost to produce a commodity can help the producer to set target prices to cover the costs.
3. Once a crop is in the bin, a sample should be submitted for a proper grading assessment.
4. Know what products are wanted on the market.
5. Information about the market, potential buyers, prices, etc., should be collected on regular basis.
6. Set the target price you hope to receive for your crop to cover the costs of production. This helps you to know when to sell.
7. Watch the market for opportunities to make sales at your target price.

Understanding the Market

Supply and demand are the two central ingredients of the market that determines the price for products grown by producers.

Supply: Supply is the producing and selling of a product. Supply describes the behaviour of producers in the relationship between how much of a commodity producers grow, and the price for the commodity. As more producers grow more of a commodity, the price for that commodity falls.

Demand: Demand is considered to be the most important force in determining what is produced, and how much is produced. Demand means how much of a product people want to purchase at what price. If the price is low, consumers will want to buy more, and if the price is high, they will want to buy less.

SUPPLY	DEMAND
Choices *producers* make about what and how much to grow.	**Choices *consumers* make about what to buy at what price.**

Things That Affect Supply

The supply of a product is affected by:

- **The price producers receive for their products.** If a producer is going to get more money for their grain, they will want to sell more of it at the higher price.
- **The number of producers growing the product.** More producers growing canola means there will be more canola available on the market. This also relates to the amount of land that canola is being grown on. The number of producers may be few, but if a few producers are growing a large number of acres of one product, supply is still high.
- **Technology.** Technology has contributed to the ability of producers to grow more. Technology has improved everything involved in agricultural production, from the quality of seeds to the mechanical power of equipment.
- **The costs involved in producing the product.** If the cost of inputs (seed, fertilizer, fuel, chemicals, etc.) decrease, it is possible to grow more products for less cost. If the cost of inputs increases, either fewer inputs will be used (reducing the yield), or it will cost more to grow the same quantity of product as when the costs were lower.
- **The costs involved in producing other products.** If it costs less to produce barley than it does canola, then more producers may choose to grow barley.
- **Unpredictable things like weather.**

Changes in the supply of a product can be a result of any one of these factors.

Things That Affect Demand

People make choices when they are purchasing agricultural products. It is helpful to understand consumer behaviour, and things that affect the choices consumers make.

Consumer factors that affect demand include

Consumer factors that affect demand include:

- **Population**. Extra stomachs to satisfy can be expected to result in increased demand for food at any given price.
- **Income and Income Distribution** represents the ability for individuals to purchase a commodity. As income levels increase (people have more money), the demand for some products (such as meat) often increase faster than the demand for more staple products (such as potatoes or flour).
- **Tastes and Preferences** are the choices consumers are influenced by,including their attitudes relating to health, lifestyles, religion and demographics (age, sex, family size, etc.). Some examples include: retired people tend to eat less than adolescents; some people are restricted from eating certain food based on their religious beliefs.
- **Price of Similar Products.** Products that are similar are often reasonable substitutes for each other. When the price of one product changes, the demand for the other changes with it. For example, when the price of beef increases, pork, at a lower price is a good substitute, so the demand for pork will be higher.
- **Price of Complementary Products.** Some products complement each other, so that a change in price of an item that complements another item, will affect the demand of both items. For example, bacon and eggs are complimentary products, and when the price of bacon increases, the demand for both bacon and eggs will decrease.

The products themselves may also affect the demand for agricultural products.

Product factors that affect demand include

- **Form.** The form of the product might be the quality, grade and the use to which it will be put. For example, there will be a different demand for milling wheat than feed wheat.
- **Location.** The distance to the market and the characteristics of that market. For example, the demand for Canadian canola exported to Japan is high. Producers who are closer to the west coast benefit from this because they can get their product to the port for shipping easier and faster.
- **Time.** The season that the product is most popular. Examples include, turkey at Christmas, feed barley through the winter, or hamburger and steaks in the summer.

Grain Storage as a Marketing Strategy

Deciding how long to store grain on the farm depends upon a number of factors. Long-term storage is profitable if prices rise enough to cover storage and interest costs.

Storage Costs

Unless a producer is paying to store their grain in someone else's bin, the storage cost is limited to the investment cost of bins, the depreciation of these bins, and the opportunity cost of interest.

The Opportunity Cost of Interest

The opportunity cost is the cost associated with not being able to use the money that is tied up in grain being stored. If the producer sold this grain, he may use it to do something more profitable than waiting for grain prices to rise.

Something the producer may want to use this money for is to pay down debts to reduce interest costs. When you borrow money from the bank, the bank charges you a percentage of the amount borrowed. This amount is called **interest**. Therefore, it costs you money to borrow money. As you pay back the amount of money borrowed, the interest payments are reduced.

When deciding how long to store grain, it is important to consider the amount of interest being charged on a loan (that could be paid off, or down if the producer sold the grain). If the interest costs on a loan are higher than the price that he would get for the grain after a period of storage, it would be better for the producer to sell now, and reduce interest payments. If the producer has less debt, he may be able to store the grain to wait for a better price, without accumulating a lot more interest to have to pay in the end.

In years when the supply of a commodity is high, the price will be lower, and it will probably pay to store the grain until the price goes up. On the other hand, when supplies are relatively low, grain buyers will want to attract producers to sell their grain by raising the price they will pay, and storage may not be the best alternative.

Spoilage Risks When Storing Grain

- Be sure your bin is in a well-drained site.
- Sheltered areas help prevent snowdrifts around bins.
- Be sure the bin is well sealed.
- Take samples from different parts of the bin to determine moisture content, temperature and insect activity.
- A slight rise in temperature can indicate vigorously feeding insects or rapidly growing fungi.
- If a rise in temperature is detected, the bin should be emptied or aerated as soon as possible.
- If theft is a concern, it is a good idea to put padlocks on bins.

Other Marketing Strategies

Crop Insurance. Managing risk is an important part of managing farm operations and marketing. Crop insurance provides one way to manage risk. It helps to guarantee some income for producers in the event of a poor or damaged crop.

Diversification. To diversify means to produce several commodities to help guard against loss. It is the opposite of specialization, which is concentrating on growing one commodity. When diversifying, it is important to consider:

- What crops can be reliably grown in your area?
- Does the crop grow in similar areas in another part of the world?
- Can you obtain good quality seed?

Some diversified crops that are now being grown in Saskatchewan include: field peas, greenhouse crops, market gardens, carrots, sunflowers, strawberries, saskatoons, caraway, coriander, mint, etc.

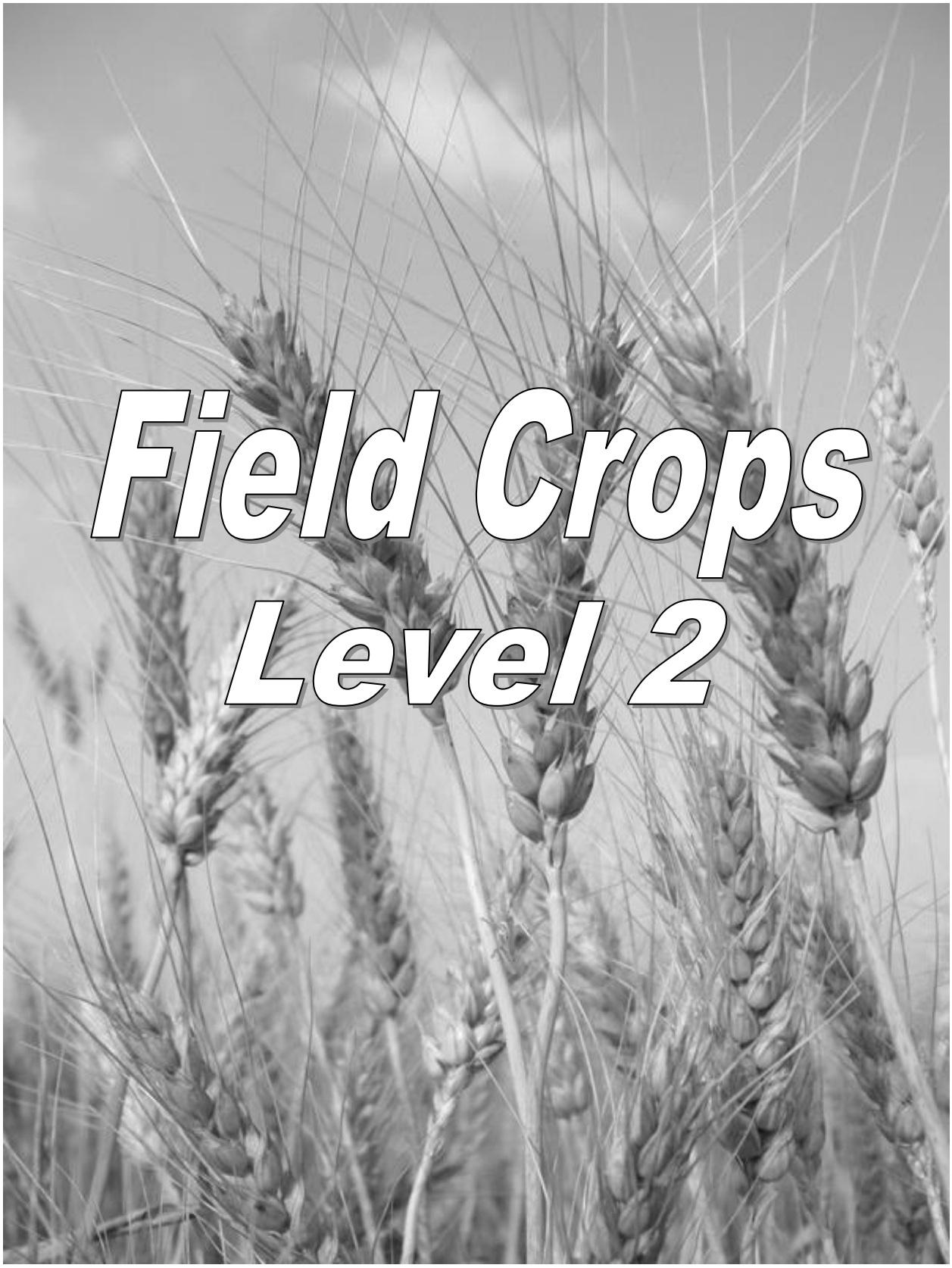
Value-Added Processing. This means to add value to a product by further processing. It may mean producing a processed feed grain, milling grain for flour, packaging market garden produce for sale in stores, rolling oats for baking, etc. Some important questions to ask about value-added processing include:

- Is there a market for your processed product?
- Can your product sell in a number of different markets?
- Can you process enough of your product to make it worthwhile?
- What government regulations might affect your processing (inspection, sanitation, labeling, waste, job site safety, consistency of product, etc.)?

Activity

Answer the following questions by circling the correct response.

1. When you go hiking with your friends, you take with you a granola bar. You are the only one that has brought food along, and everyone is hungry.	What would be the **supply** of granola bar on the hike? **HIGH** **LOW** What would be the **demand** for the granola bar? **HIGH** **LOW** What would happen to the "**value**" of that bar? **INCREASE** **DECREASE**
2. One year, producers in Saskatchewan grow a lot of wheat. Another country that grows wheat has bad weather that year, and they are not able to harvest their crops.	Would the **supply** of wheat in the other country be high or low? **HIGH** **LOW** Would this raise or reduce the **demand** for Saskatchewan wheat? **RAISE** **REDUCE** How would this affect the **price**? **INCREASE** **DECREASE**
3. One year, a certain commodity is very popular, and a lot of producers grow a large amount of this one commodity. Everyone has a good crop and they successfully harvest it.	What is the resulting **supply** of that commodity? **HIGH** **LOW** What does this supply do to the **demand** of that commodity? **HIGH** **LOW** **NOTHING** How does this affect the **price**? **INCREASE** **DECREASE**



Field Crops
Level 2

SOIL

Roll Call

Name something that is found in soil.

Keep a list of what other members mention.

Soils – A Storehouse of Nutrients

Nutrients are elements needed for growth of plants. There are many known storehouse of nutrients. Three of these – carbon (C), hydrogen (H), and oxygen (O), are in nutrients, the air or water. Other nutrients come from soil. There are many essential nutrients that plants get from soil. You may recognize the names of some of them. They are nitrogen, phosphorus, potassium, sulfur, calcium, magnesium, iron, manganese, boron, copper, zinc, molybdenum and chlorine. Luckily, there are enough of them naturally present in the soil. However, Saskatchewan soils are usually deficient in one or two of them, especially nitrogen and phosphorus.

The nutrients that plants need in the largest amount are: nitrogen, (N), phosphorus, (P), potassium (K), and sulfur (S). In growing field crops, we are concerned mainly with three major elements.

Nitrogen (N)

Nitrogen, a building block of protein, is a very important plant nutrient and plants use a lot of it to grow. Soils that have grown a crop other than a legume the previous year are usually deficient in nitrogen. It is important to test your soil, so you know how much nitrogen is needed to give the crop enough nitrogen to ensure good growth. Adding too little nitrogen will result in poor growth, and adding too much will increase costs and may encourage lodging.

Nitrogen is always present in the organic matter in soil, but not in a form plants can use. Bacteria are required to release it in a useable form. The useable form can be stored in soil until needed. During fallow, bacteria grow and release large amounts of nitrogen. This is the reason why fallow land often doesn't require any nitrogen fertilizer. However, nitrogen is also easily lost to the soil, water and air, so it is still important to test to ensure there is an adequate supply.

Phosphorus (P)

Phosphorus promotes root growth, flower and seed development and early maturity. Saskatchewan soils are often phosphate deficient, and this will cause a reduction in a crop yield by slowing plant growth in almost all stages. A soil test is necessary to determine how much phosphorus is needed to obtain maximum crop yield.

Potassium (K)

Potassium promotes strong stems, good root systems, and resistance to disease. Most Saskatchewan soils have enough potassium for maximum crop production, but deficiencies do occur, mainly on sandy and peat (organic) soils.

Some soils may need extra potassium or sulfur, and less commonly, manganese, iron, zinc or copper.

Sulfur (S)

Sulfur is required for chlorophyll production. It helps to increase seed size and weight. Sulfur is an important part of making protein from nitrogen.

Understanding the Soil Test

Any deficiency in any nutrient will cause a reduction in crop yield. Soil testing can be useful for determining nutrient requirements of crops to be grown in a certain soil. It can help for planning a fertilizer program, and identifying reasons for poor crop growth. Yearly soil tests provide a working record of soil characteristics of a field with a particular crop rotation history. The soil test results will tell you what nutrients your crop needs.

Managing Soils of Saskatchewan

The crop rotation, tillage operations, amount and kind of fertilizer that you and your family use on your farm are related to the kind of soil you have, the amount of precipitation and sunshine your farm gets, and the kind of vegetation that grows wild in your area. All of these are a direct result of your geographical location or where you live within the province of Saskatchewan.

The Processes of Soil Formation

The active processes of soil formation are: additions, losses, translocation (movement) and transformation. These processes are controlled by temperature, precipitation, plants and animals, topography and time.

Additions: Most additions such as water, organic matter and the sun's energy occur at the surface.

Losses: Losses occur both at the surface and in the subsoil. Surface losses include water, carbon dioxide and nitrogen. Erosion can also physically remove large amounts of surface soil layers. Subsoil losses occur mainly as materials suspended or dissolved in that they are leached out of the soil.

Translocation: Soil components such as clay and organic matter move down from the surface layer to subsurface layers.

Transformation: These changes take place without any physical movement. Chemical changes, weathering by wind and water and organic matter decomposition are examples.

Just as climate influences the formation of soils, it also influences the type of vegetation able to grow in the region. There are three distinct vegetation regions in Saskatchewan.

The Grasslands Region

The grasslands region of southern Saskatchewan is an area where the dominant type of natural vegetation is a mixture of short and tall prairie grasses, plus shrubs and a few trees. Soils formed in this environment are typically brown in colour.

Parkland Region

Occur north of the grasslands and consist mostly of mixtures of trees such as birch, poplar, spruce, pine and tamarack. Soils formed under these conditions are organic soils made up of leaves and decaying stems. These organic soils build up in layers above the mineral soil surface. Soils formed in this environment are typically black in colour.

The Tundra Region

These regions are areas where the lower layers of the soil remain frozen all year round. This leaves a very narrow layer of soil for plants to grow and anchor themselves in, and for that reason plants growing in this region are very low growing. There are no trees in this region, only shrubs, lichens, and flowering moss. Soils in this region are affected more by the climate conditions of freezing and thawing than they are by the vegetative influence on soil formation.

Soil Structure

Soil structure refers to the physical arrangement of mineral and organic particles into clumps (aggregates) of different shapes and sizes. It is important because it affects the movement of air and water in soil.

Soil structure is affected by a number of physical forces that involve movement within soil. Some of these forces are:

- Expanding roots
- The movement of earthworms and other soil organisms
- Shrinking and swelling from moisture variation
- Freezing and thawing

It is also affected by the amount of organic matter, and can be improved by increasing the organic matter in the soil. This will improve the porosity and water-holding capacity of the soil.

Good soil structure provides a growing environment where crops can obtain the proper amount of air and water. It improves the water-holding capacity and makes the soil easier to cultivate.

Managing Soil Organic Matter

Organic matter improves the soil tillage, structure, moisture holding capacity and resistance to erosion. It contains “glues” that hold the mineral matter together. Increasing soil organic matter will generally result in increased soil productivity. Organic matter can be increased by returning stubble and crop residues to the soil, adding animal manure, and by plowing crops into the soil (green manure).

Soil organic matter cannot be increased quickly even when management practices that conserve soil organic matter are adopted. However, by adding more organic matter, the soil will be able to support the production of higher crop yields. Higher crop yields mean more crop residues will return to the soil, and there will be more decomposition of organic matter.

Activity

Test Your Knowledge

1. Which of the following is not a method of preventing and controlling salir soil?
    a) The use of deep rooted forage crops such as alfalfa
    b) Summer fallowing
    c) Continuous cropping
    d) Application of barnyard manure

2. Which of the following practices help to add organic matter to soil?
    a) Add manure
    b) Add green manure
    c) Return stubble and crop residues to the soil
    d) All of the above

3. Which of the following practices help in controlling wind erosion?
    a) Maintaining crop cover
    b) Strip cropping
    c) Shelterbelts
    d) All of the above

4. Which of the following statements is true?
    a) K stands for **potassium**
    b) P stands for **potassium**
    c) Ph stands for **phosphate**
    d) K stands for **phosphate**

Collect a litre of clay soil and a litre of sawdust. Moisten 250ml of soil until you can form a mud cake. Place this mud cake on a plate labeled “no sawdust”.

Moisten and mix thoroughly 125ml of soil and about 60ml of sawdust until they form a mud cake. Place this mud cake on a plate labeled “sawdust”.

Place both plates in the sun and let the mud cakes dry. When they are both completely dry, break the mud cakes with your hands.

Which cake crumbled easier? How would you explain this?

Activity

Match up the statements on the left with the terms on the right.

I. The finest particles in a soil.	a) Organic matter
II. What physical property in a soil affects water capacity and workability of the soil?	b) Pore space
III. Affect movement in the soil.	c) Nitrogen, Phosphorus, Potassium and Sulfur
IV. The part of the soil occupied by water and air.	d) Roots, earthworms, soil organisms, moisture and temperature variation
V. Returning stubble and plant residue to the soil helps to increase the _____ in the soil.	e) Clay
VI. The primary nutrients required by plans.	f) Soil structure

TILLAGE

Roll Call

Name something involved in the preparation of a seedbed.

_____

The Objectives of Tillage

The tillage system required for your field crop project will depend on soil, moisture, weeds, previous crop, trash cover, insects and diseases, soil erodibility, fertilizer placement and machinery availability. There is no one best system, as each specific situation will require its own special treatment. A successful practice in one location may be a disaster in another. The results of your tillage system should be:

- Placement of seed in a proper environment for germination, emergence, root and crop growth.
- A soil structure that facilitates intake, storage and movement of water.
- Control of weeds or volunteer crop growth with no green vegetation on the field at either planting or emergence.
- Placement of agricultural chemicals at the proper depth.
- Crop residues that will not interfere with cultivation, herbicide or fertilizer practices planned for the field.
- No soil erosion.

Many of these objectives conflict with one another. Growers must use tillage for good seedbeds and weed control, but that tillage breaks down soil structure, reduces organic matter, brings previously buried weed seeds to the surface, and often leaves the soil susceptible to erosion. A wide choice of machinery and chemical weed control offers enormous scope in the extent of tillage operations. The grower's task is to find the right combination to maximize yields, and minimize costs and soil damage.

Tillage Options in Saskatchewan Soils

A number of terms exist to describe the different types of tillage systems used in Saskatchewan. The following is a summary:

Conventional Tillage –used for seedbed preparation and weed control. Both pre-plant and in-crop herbicides are used for chemical weed control. With conventional tillage, primary tillage (plowing) is generally done in the fall. This is then followed in the spring with two or three secondary tillage operations (disking, cultivating, and harrowing).

Reduced Tillage - the number of tillage operations is reduced, or equipment is changed so that there is less soil disturbance and more crop residues remain on the soil surface.

Minimum Tillage – the number of tillage operations are kept to a minimum. Herbicides are used to replace some of the tillage operations. Crop residues must be evenly spread, and seeding equipment must have good straw clearance.

No Tillage (zero-till) – because of soil erosion concerns, many farmers have become interested in zero tillage practices. Zero tillage is when the crop is planted with no tillage being done at all. Herbicides alone are used to control weeds. Seeding equipment must have good straw clearance and be able to penetrate soils that have not been loosened by tillage.

Conservation Tillage – tillage that has the goal of retaining crop residues, reducing erosion and conserving moisture. Conservation tillage is a general term that can apply to reduced, minimum and zero tillage systems.

Which soil type requires more tillage?

When the sandy loam was disked and harrowed (conventional tillage), the yield was reduced. What might be a reason for this?

_____

_____

_____

_____

Activity

Match the words used to describe tillage on the left with the statement on the right.

1. Summerfallow	A. Reduces water loss in the soil.
2. Reduced Tillage	B. Both primary and secondary tillage is used.
3. Conservation Tillage	C. Changing equipment so there is less soil disturbance and more crop residue remains on the top of the soil.
4. Packing	D. Herbicides are used to replace some tillage operations.
5. Tillage	E. No tillage is done to the soil.
6. Conventional Tillage	F. Reduced, minimum and zero tillage systems.
7. Minimum Tillage	G. Should be avoided.
8. Zero-till	H. Decreases organic matter, buries crop residues and loosens soil.

Effects of Tillage on Soil

1. **Decreases Organic Matter**

   - Organic matter decomposes more quickly when the soil is stirred up by tillage.

2. **Buries Crop Residues**

   - Without cover, the soil must absorb rainfall energy, which causes the breakdown of soil structure and crusting of the surface.
   - Without cover, the soil is prone to erosion.
   - Sandy soils need 65% cover.
   - Clay soils need 50% cover.
   - Residues decrease evaporation from the soil surface. This is especially important in the soil zones where evaporation levels are the highest.

3. **Tillage Loosens Soil**

   - **If weather in spring has been cool, tillage will help the soil warm and dry out. However, if the seedbed is not packed, it may dry out excessively. A common belief is that without tillage, the soil will become very hard. However, producers who practice zero-till often find that after a few years the soil becomes softer because of increased organic matter.**

Another common belief is that fall tillage increases the amount of winter precipitation stored in the soil. Many feel that tillage opens up the soil and roughens the surface allowing water to more freely enter the soil. However, research has shown that fall tillage does not necessarily increase soil water storage.

Seedbed Firmness

A firm, well-packed seedbed provides excellent soil moisture and oxygen contact with the seed. Prior to seeding, the seedbed should be firm enough so that heel marks are barely visible. You should sink no deeper than the thickness of the sole on a normal work boot. This will also provide better depth control with the seed drill. Packing the soil reduces the size of the pores in the soil surface. The more packed the soil, the greater the proportion of small pores relative to the number of large pores. Packing compresses the soil surface, reduces soil surface, and reduces soil moisture vapour loss from the large pores of the soil. However, the soil granules should not be pulverized or packed so tightly that the supply of oxygen to the seed or seedling roots is restricted. A soil with fine or small granules holds water more strongly and may have less air than a soil with larger granules, which has larger pores.

The volume of soil from which moisture moves to the seeds extends only about 2.5 centimetres (1”) or so away from the seeds. Therefore, seeding on a firm, well-packed seedbed using a drill with press wheels that pack the soil over the seeds, will improve seed germination by reducing the proportion of large soil pores. This reduces water vapour losses and provides better moisture for seed germination.

Loose, cloddy seedbeds dry out because water vapour is lost to the atmosphere from the many large pores. A rough, cloddy surface will also result in bouncing of the seed openers, and dropping of seed on the soil surface, causing uneven germination and emergence. Large soil clods also physically prevent the emergence of seedlings. On the other hand, a finely powdered surface should be avoided because of the danger of wind erosion and surface crusting.

The soil surface should be slightly lumpy to provide the seedling with protection, and to reduce the risk of wind erosion. Operators of large tractors and equipment may travel too fast. This can cause shallow and uneven penetration, excessive pulverization of the soil and burying of trash. Excessive spring cultivation can also dry out the surface soil to the depth of tillage, preventing shallow seeding to moisture. A field with a slightly lumpy structure does not puddle and crust after a heavy rain as readily as a powdery seedbed, and it does not dry out as quickly as a very lumpy, cloddy seedbed. A dry pulverized soil surface can blow and cut seedlings off as they emerge. Unnecessary tillage with heavy implements or traffic from hauling manure or silage on land with wet subsoils can also cause deterioration of the soil structure.

Activity

Word Scramble: Unscramble the following words used when preparing and describing a good seedbed.

SENSRIMF	☐	☐	☐	☐	☐	☐	☐	☐	
STORMIEU	☐	☐	☐	☐	☐	☐	☐	☐	
DEWONES	☐	☐		☐	☐	☐	☐	☐	
THEPD	☐	☐	☐	☐	☐	☐	☐	☐	
ILSO RECTUSRUT	☐	☐	☐	☐					
	☐	☐	☐	☐	☐	☐	☐	☐	☐
AGLETIL	☐	☐	☐	☐	☐	☐	☐		

EQUIPMENT

Roll Call

How many lubrication points are there on the different equipment used in the production of your crop? List the name of the pieces of equipment being used, the number of lubrication points to check before using the equipment, and indicate whether you know where to find them all.

_____

_____

Equipment	Number of Lubrication Points	Do you know where they all are? (Please Circle)	
Power Unit (Tractors):			
_____	_____	YES	NO
_____	_____	YES	NO
_____	_____	YES	NO
Tillage Equipment			
_____	_____	YES	NO
_____	_____	YES	NO
_____	_____	YES	NO
Seeding Equipment			
_____	_____	YES	NO
_____	_____	YES	NO
_____	_____	YES	NO
Applicator(s)			
_____	_____	YES	NO
_____	_____	YES	NO
_____	_____	YES	NO
Harvesting Equipment			
_____	_____	YES	NO
_____	_____	YES	NO
_____	_____	YES	NO
Transportation			
_____	_____	YES	NO
_____	_____	YES	NO
_____	_____	YES	NO

Make it a goal that by the end of this unit you will have found all the grease nipples that require attention before using any of the equipment in your project.

Working around Equipment

Many accidents occur with jacks, hitches and lifts. Arms, legs or the whole body can be crushed when someone is caught between two objects (like the hitch of a tractor and an implement), or if a piece of equipment is not correctly blocked when it is lifted and it falls on the person working under it. It is important to be aware of situations that may result in a crushing injury:

- When helping to hook up machinery to a tractor, be sure the operator knows where you are, and do not take chances by placing your body or hands in between the implement and the tractor hitch.

- Never climb under anything that is held up by only the lift or jack. It takes only a few extra minutes to place blocks or struts under the machine before placing your body under a heavy machine.

  Before working on any equipment it is important that you:
  - Take the mechanism out of gear
  - Shut off power supply
  - Properly park and block the equipment
  - Check the operators manual

- If you are asked to help someone working on a machine, do not assume that the machine has been properly blocked. **Check that it has!**

- When using a jack, be sure that the ground beneath it is stable. A piece of plywood under the jack base will give added stability.

- When moving only one end of a machine off the ground, be sure to place blocks behind all other wheels to prevent the machine from rolling off the jack.

- Be aware of the hazard presented by projectiles flying off any machine that cuts, chops or grinds such as mowers, swathers and combines.

- Keep debris and dirt out. Accumulation of debris signals sloppy work habits, and perhaps sloppy safety precautions. Get into the habit of cleaning up around your farm, and you will reduce the risks of injury due to falls caused by carelessly discarded machine parts and tools.

Servicing Machines

Most maintenance should take place before or after the day's work, but many machines require frequent lubrication during the day. Such maintenance cannot be neglected. It is far better to use extra time for complete and thorough machine servicing than to have field breakdowns costing hours, or even days.

It is impossible to predict when some part of a machine will fail, but many machine breakdowns in the field can be avoided by making thorough inspections before and during operation. Watch for signs that will help avoid breakdowns. To help eliminate or reduce breakdowns, follow these rules:

- Inspect and repair machines well ahead of the use season. Proper care and maintenance plays an important role in extending the life of farm machinery.
- Practice preventative maintenance. The manual for each piece of equipment will have guidelines for regular maintenance and recommended service intervals.
- Avoid rocks, holes and obstructions.
- Drive cautiously in rough fields.
- Don't overload the equipment.
- Check out strange sounds, vibrations or smells.
- Make small repairs when needed.
- Use periodic checkups to locate potential trouble
- Keep all power transmitting members adjusted, aligned and lubricated.

Learning How to Operate Farm Equipment

Common sense and good judgment by the machine operator is very important. Machinery operators should know the capabilities of their equipment and follow recommendations for usage. Machines often do not allow a second chance to inexperienced operators who make mistakes.

When learning how to operate farm machinery, the **"One seat, one person"** rule is suspended with the following guidelines:

- It is preferred that youth learn to operate machinery in a tractor with a cab. This protects the teacher (passenger) from falling out. Extra caution is required, as the passenger is not protected in the event of a rollover.

- No one should be allowed to operate a machine without first being instructed on the proper operating procedures, and the possible hazards in each procedure. Basic instruction must be given prior to the youth operating a moving piece of equipment. This means pointing out where the brakes are, where the throttle is, where the PTO shut-off lever is, etc. Many accidents occur when an inexperienced operator does not respond correctly to a dangerous situation.

It is recognized that the only way to learn how to operate equipment properly is by observation and by "learning to do by doing". Gaining experience operating equipment with the help of an adult is important. Be sure to use extra caution in these situations.

Operating Farm Machinery

- Before starting any piece of equipment, make a brief safety inspection, and be sure no one is standing too close.

- Read the owner's manual before you start work with an unfamiliar piece of equipment. Know the machine's limitations.

- When using augers, be aware that loose clothing could become entangled in the moving parts and never try to unclog the machine while it is running.

- Front-end loaders can be very dangerous. Operating a tractor with a front-end loader calls for extra precautions. Don't carry loads raised above the tractor, and never travel up a steep hill with a loaded bucket. Be extra cautious because the tractor with a loaded bucket is especially susceptible to rollovers. Never allow anyone to ride in the bucket.

Activity

Match the statements on the left with the right answers

1. Children are often run over by farm machinery because farmers fail to do this.
2. Farm implement upsets have occurred because operators do not check this.
3. Grain truck fires have resulted when stubble is caught around it.
4. On a tractor, towed loads should be hitched to this.
5. Operators should do this before unplugging, adjusting or repairing equipment.
6. Protects you during a tractor rollover.
7. Road travel requires that they use a SMV sign.
8. Rubber-tired farm tractors, if they are not pulling a trailer, are exempt from these.
9. This farm machine has been involved in the largest number of accidents resulting in injury to farmers.
10. Welding around painted surfaced of farm machinery may result in these dangerous fumes.

a) Check/walk around the vehicle.

b) Disengage power and place blocks under the wheels.

c) Proper inflation of the tires.

d) Road bans.

e) A tractor designed with a Roll Over Protection Structure and a seatbelt.

f) Slow moving vehicles.

g) The muffler. Grain trucks should have an ABC multi-purpose dry chemical fire extinguisher in it.

h) The drawbar. Loads hitched any higher could flip the tractor.

i) Toxic.

j) Tractors account for 64% of fatalities in machinery accidents.

FERTILIZER

Roll Call

Name something that affects the nutrients supplied to a crop:

_____

_____

_____

Elements Required for Plant Growth

Gases:
Oxygen, Carbon and Hydrogen

Macro-Nutrients:
Nitrogen, Phosphorus, Potassium and Sulfur

Micro-Nutrients:
Iron, Manganese, Boron, Copper, Zinc, Molybdenum and Chlorine

- These seven "micro-nutrients" are required only in very small amounts. Fertilizers that contain micro-nutrients are only recommended when there is proof, from a soil test, of a deficiency.

Fertilizer Recommendations (the soil test)

The following three things are used when making fertilizer recommendations from a soil test:

1. Identification of the nutrient or nutrients that are deficient and the degree of deficiency.

2. Estimation of the response to a given level of fertilization of the crop to be planted.

3. Assessment of economic returns from fertilizer.

The more accurately these three factors can be determined, the more likely you will have profitable returns from fertilizer. "Net Returns" are the value of the increased yield minus the cost of the fertilizer. Comparing these returns based on present and past fertilizer and crop prices can be a useful tool when choosing your fertilizer program.

Assessment of Economic Returns

An important factor when choosing fertilizer rates is the effect of annual changes in fertilizer and crop prices on net returns. Comparisons from year to year can be made by using an estimate of the increase in yield from fertilizer, applying the current fertilizer costs and crop prices. For example:

Crop and Year	Price (tonne)	Price (bu)	Increase in Yield From Fertilizer (bu/acre)	Value of Increased yield A	Fertilizer Cost B	Net Returns A-B	$ Return $ Invested A÷B
Wheat							
Year 1	$139.63	$3.80	20.2	$76.76	$20.90	$55.86	$3.67
Year 2	$110.23	$3.00	20.2	$60.60	$21.00	$39.60	$2.88
Year 3	$165.35	$4.50	20.2	$90.90	$23.70	$67.20	$3.84
Barley							
Year 1	$105.64	$2.30	32.3	$74.29	$20.90	$53.39	$3.55
Year 2	$82.67	$1.80	32.3	$58.14	$21.00	$37.14	$2.77
Year 3	$114.82	$2.50	32.3	$80.75	$23.70	$57.05	$3.41
Canola							
Year 1	$268.96	$6.10	16.0	$97.60	$20.90	$76.70	$4.67
Year 2	$275.58	$6.25	16.0	$100.00	$21.00	$79.00	$4.76
Year 3	$352.74	$8.00	16.0	$128.00	$23.70	$104.30	$5.40

Fertilizer Prices used =	Year 1	Nitrogen $0.24/lb	Phosphate $0.26/lb
	Year 2	Nitrogen $0.25/lb	Phosphate $0.24/lb
	Year 3	Nitrogen $0.27/lb	Phosphate $0.30/lb

Using an estimate in yield from fertilizer over a range of applications, and then comparing the marginal costs and marginal returns, helps to establish the best rate of fertilizer to apply. The **marginal cost** is the cost of the additional fertilizer, and is different each year as the cost of fertilizer changes. The **marginal return** is the value of the increase in yield from the additional fertilizer. Changes in crop prices have had a much greater effect on net returns than fertilizer costs. In the example above, the net returns range from $37.14/ac to $104.30/ac.

This method determining fertilizer rates uses an economic decision rule, which states:

Add another unit of fertilizer as long as the value of crop produced by that unit is greater than the cost of the fertilizer.

If you add additional fertilizer beyond the point where the marginal costs equal marginal returns, it will cost more than the value of the increased yield. Maximum net returns per acre can be achieved when marginal costs equal marginal return, however, because of the risks and uncertainties involved in crop production, it may be wise to choose a lower level of fertilization. Another thing to consider if you are short of operating capital (money) is that additional dollars spent on fertilizer may return you less than if the money were spent on other production inputs such as weed control.

Calculating Fertilizer Application Rates

Fertilizer application rate depends on the results of soil tests, and the requirements of different crops. Soil test recommendations are given in kilograms per acre (pounds per acre) of nutrients. To determine the fertilizer rate for a particular nutrient, multiply the rate of the nutrient desired by 100 and divide by the percent of the nutrient in the fertilizer. (Remember, fertilizers are named giving the grade of nutrients in the order of – **Nitrogen: Phosphorus: Potassium**.

<u>Example 1: Rate of nitrogen (N) recommended is 80 kg/ha (71 lbs/acre)</u>

Using 34-0-0 the rate of fertilizer required is $\frac{80 \times 100}{34} = 235$ kg/ha

Therefore, you would need to supply 235 kg of 34-0-0 fertilizer over every acre to provide 80 kg of nitrogen to each acre.

Example 2: Rate of Phosphate (P_20_5) recommended is 40 kg/ha (36 lbs/acre)

Using 11-55-0 the rate of fertilizer required is $\frac{40 \times 100}{55}$ = 73 kg/ha

Therefore, you would need to apply 11-55-0 fertilizer at a rate of 73 kg/ha in order to supply each acre with the 40 kg recommended.

Example 3: Rate of potash recommended is 15 kg/ha (13 lbs/acre)

Using 0-0-60 the rate of fertilizer required is $\frac{15 \times 100}{60}$ = 25 kg/ha

Therefore, you would need 25 kg of 0-0-60 fertilizer for each acre in order to supply each acre with the 15 kg recommended.

Forms of Inorganic Fertilizers

Inorganic fertilizers are most commonly available in three forms: granules, liquids and gases. Each form of fertilizer has its advantages and disadvantages.

Gases such as anhydrous ammonia must be placed beneath the surface of the soil, helping to prevent loss to the air. Therefore, they are banded into the soil through special applicators, which are often modified cultivators. When the gas is injected into the soil, it is attracted to the soil water particles and bonds to them. For this reason, anhydrous ammonia must be banded deep enough to allow for binding to the water particles before the gas escapes back to the surface. The depth of banding necessary (usually 8-15 cm) will depend upon the soil moisture content.

Advantages:

1. Highly concentrated (82%), therefore it is less bulky.
2. Cheapest form of nitrogen.

Disadvantages:

1. Safety – highly poisonous and very corrosive.
2. Requires specialized equipment for application and storage.
3. Very susceptible to nutrient loss if improperly applied.
4. Must be banded deep into the subsoil and away from plant roots or seeds.
5. Bulk purchases are usually an option for only very large growers because of the specialized storage facilities required.

Liquid fertilizers can be either broadcast or sprayed on the ground surface, or banded beneath the soil surface. Solutions being broadcast are applied through modified field sprayers capable of handling the heavy, corrosive product.

Advantages:

1. Easy to blend.
2. Easy to handle once specialized equipment has been acquired.
3. Safer than gas because of low pressures.
4. Can be mixed with some soil incorporated herbicides for once-over application.
5. Can be banded, broadcast, mixed with seed or applied directly onto the plants.
6. Bulk purchases are an option only if a farmer has his own bulk liquid storage tank.

Disadvantages:

1. More expensive than gas or granules.
2. Requires special equipment.
3. Has a low percent content and therefore it is bulky to handle.

Granules are a common form of fertilizer used in Western Canada. Several types and blends are available in granule form. Other blends besides nitrogen, phosphorus and potassium are available, as are micro-nutrient blends.

Advantages:

1. Most readily available from dealers.
2. Can be purchased in small bags or in bulk.
3. Safe and easy to handle and store.
4. Can be broadcast, banded, mixed with seed, or can be applied to soil during tillage operation for post emergence.
5. There is a large selection of types and blends available.
6. No specialized equipment is necessary – most seed drills have fertilizer boxes.
7. No special storage structures are required if bulk purchases are made.

Disadvantages:

1. More labourious to handle.
2. High volume with low volume percent of active ingredient, therefore it is bulky.
3. Under wet conditions or high humidity, caking can be a problem.

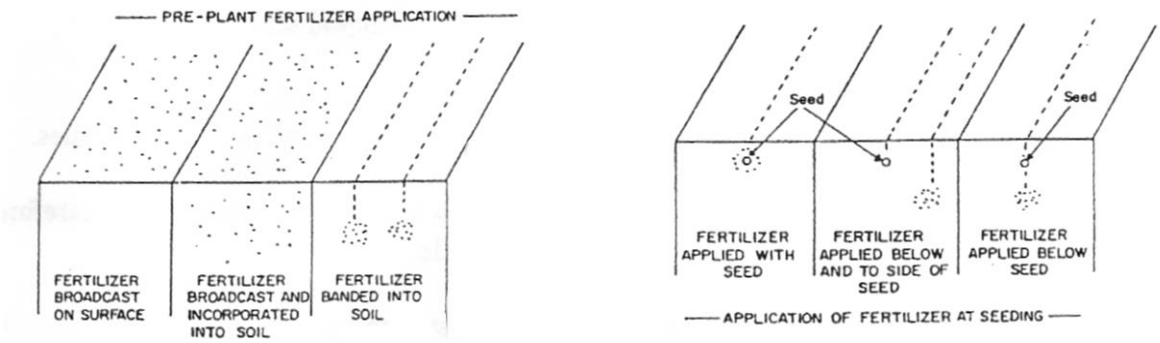
Methods of Applying Fertilizer

When fertilizers are placed into the soil there are two primary methods of product placement: **Banding** and **Broadcasting**.

Banding refers to the placement of a product in a narrow row or band. This may be done on the soil surface or beneath it. Fertilizer placed with seed in the seed row is also referred to a banded placement.

Broadcasting refers to uniform application across the entire soil area (usually on the surface). Broadcast fertilizers can be left on the soil surface to seep into the soil with rainwater or it may be incorporated with the tillage operation.

Phosphorus Application For Annual Crops



In Western Canada, banding fertilizer below the soil surface is often found to be the most effective method, because of the low rainfall common in some areas. More fertilizer remains beneath the soil surface, and is closer to plant roots even during periods of low rainfall. Less fertilizer is wasted when the soil surface dries out early in the season, preventing plant roots from being able to reach any nutrients on or near the soil surface. Even some of the broadcast fertilizer that is incorporated will end up on or near the soil surface, and out of reach to the plants. Therefore, sub-surface banded fertilizer stays beneath the soil surface, and if banded deep enough, is available to plant roots even during periods of low rainfall.

SEED

Roll Call

Name something that seeds provide us to eat.

_____

_____

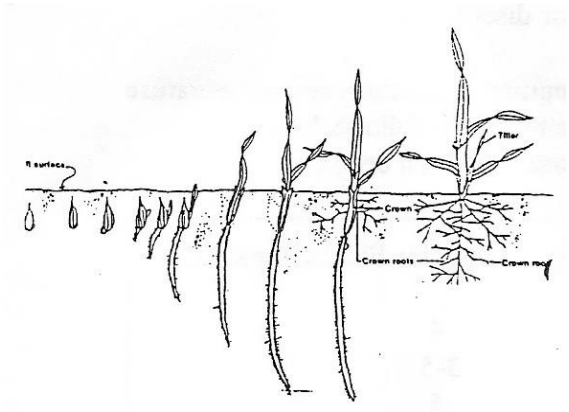
Classification of Plants

There are two classes of plants. One class is called **monocots** (one [mono] leaved [cotyledons]). The seeds of these plants have one seed leaf (cotyledon) that is full of food for the growing embryo.

The other class of plants is called **dicots** (which means two [di] leaved [cotyledons]). The seeds of these plants have two seed leaves (cotyledons) that are full of food for the growing embryo.

Germination of Monocots

Monocot plants contain one cotyledon and when the seed germinates, the cotyledon remains below the soil and a single leaf emerges on the surface.



When the plant begins to grow in a monocot seed, the root pushes through the seed coat and grows down into the soil to hold the plant in place. The root will quickly grow and start taking up water and nutrients.

The next part that begins to develop is called the **coleoptile**, which is like a hollow tube with a sharp, pointy end. With this sharp end the seedling can push up through the soil.

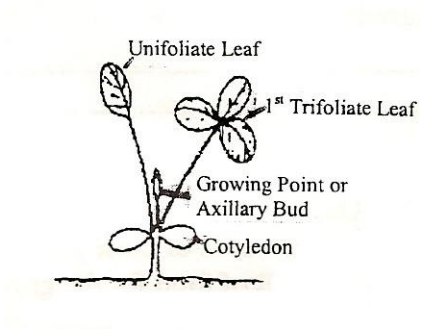
Then the leaves, which are weak and unable to push themselves through the soil, grow up through the coleoptile. The coleoptile will only grow about 8 cm long so if the seeds are planted deeper than this, the leaves will not reach the soil surface and the seedling will die.

Examples of monocots: corn, wheat, barley, rye and oats

Germination of Dicots

Dicot plants have two cotyledons. When the seed germinates, it sends both cotyledons above the soil surface and leaves on these plants are produced in a pairs.

Alfalfa and Clover



Second Trifoliate Leaf State

Growth Stages of Dicots:

1. **The Seedling**: refers to the young plant between emergence and the tillering stage. In this stage, seedlings are usually identified by their leaf stage (e.g. a cotyledon-leaf stage, a two-leaf stage, a four-leaf stage). In legumes, they are identified as **Unifoliate Leaves** (the first true leaves that have expanded above the cotyledons) and **Trifoliate Leaves** (all leaves above the unifoliate leaves have three leaflets per petiole).
2. **Bud or Prebloom**: Flower clusters are developing from auxiliary buds, no flowers are open yet.
3. **Bloom or Flowering**: The flower buds open so the petals are visible.
4. **Seed Formation**: Development of seeds after fertilization.
5. **Maturity**: Seeds are ready for harvest.

Factors that Affect Germination and Emergence

Seed Viability: A seed is viable if it is capable of germinating and producing a new plant. If the mother plant was diseased or frozen before the seeds were mature, the embryo might have been killed. If the seeds sprouted while they were in the swath or granary, the embryo will be dead. Large, plump grain seeds will usually germinate and emerge faster and produce more vigorous seedlings than smaller seeds. Avoid planting seeds that are small, shriveled or discoloured.

Time of Seeding: Seeds require a minimum soil temperature before they will germinate. The table that follows lists the germination temperatures for some common crops.

Minimum Germination Temperatures for Field Crops (^{0}C)

Wheat	4
Barley	3-5
Oats	5
Canola	8
Corn	10

Although they will sprout at the minimum temperature, the seeds will germinate and emerge faster if the soil is warmer. However, in Saskatchewan, because of the short growing season, it is important that crops be seeded as early as possible. By delaying the seeding, the grower risks having crop damaged by drought during the summer or frost in the fall. Although the germination is slower, the highest yields are usually obtained on early seeded crops.

Soil Moisture: Germination cannot begin without water. The seed absorbs water, using it to transform starch stored in the seed into simple sugars that the growing roots and shoots can use. Water softens the seed coat allowing the roots to emerge from the seed. The seed must be placed into a moist soil. Spring tillage should be kept to a minimum, and the seedbed should be packed after seeding to reduce moisture loss.

Seeding Depth: Each seed has a limited amount of stored food. If the seed is planted too deep, the food reserve will be used up before the seedling emerges. This will result in poor emergence and a thin crop. Also plants may be weakened and not grow as quickly, or yield as much as they should. If the seed is planted too shallowly, it may fail to germinate or die if the soil surface dries out. A general rule is to plant just deep enough to place the seed into moist soil. For cereal crops this is 25-50 mm. In sandy soils that dry out quickly, the grain can be planted up to 75 mm deep. The smaller sized seeds are planted shallower than grain seeds. Canola should be planted at a depth of 12-25 mm.

Soil Characteristics: In some areas of Saskatchewan, soil crusting can reduce seed emergence. Because of specific characteristics of the soil, a crust forms on the surface after it rains. This crust can be so tough that it will prevent seedlings from emerging. It can also stop rainfall from entering soil and seedlings will die.

WEEDS

Roll Call

Name a way that weeds cost money.

_____

_____

_____

Collecting Weeds

A plant collection is a fun way to gain experience in locating and identifying several types of weeds. Your plant collection should be started early in the spring so all the growth stages of the weed can be collected.

Weed control is often done very early in the spring, so you must be able to identify weeds at early stages of development. This section has the added advantage of showing you how and why weeds are considered a problem. You will be able to see how they force out crop plants in their search for food and light, and it will help you identify the same plant at different growth stages.

When collecting weeds, always collect the whole plant, including roots. Always dig the root up rather than pulling it up from the soil. Make note at the time of collecting including:

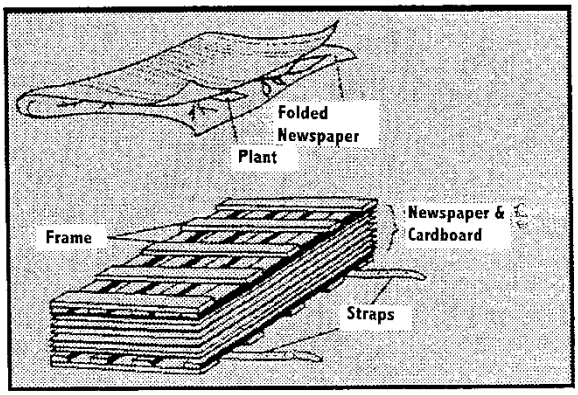
- **Place**: Geographical location (Legal land description, if available)
- **Habitat**: Where was it growing (i.e. in a pasture, wheat crop, canola crop, etc.)?
- **Date**: Month, day and year.
- **Density**: How many other plants were found in a square metre area?

Place each plant in a separate plastic bag. Blow a bit of air in the bag and tie. You want to protect the plant from wilting, drying and from being crushed.

Activity

The Plant Press: To preserve the collection you will need to press the plants. To build a plant press, you will need:

- 10 lathes or similar strips of wood about 0.5 x 4 x 30 cm
- 8 lathes or similar strips of wood about 0.5 x 4 x 40 cm
- Six or eight sheets of corrugated cardboard 30 x 40 cm
- Several newspapers folded in half and paper blotters 30 x 40 cm
- 2 straps 85-90 cm long
- Small bolts, rivets or wire nails



1. Assemble the lathes as shown into two frames.
2. Lay a sheet of cardboard on the bottom frame with the longer lathes up.
3. Cover cardboard with a blotter.
4. Cover the blotter with a folded newspaper.
5. Label plants and spread flat on newspaper.
6. Cover plants with folded newspaper.
7. Place a blotter on top.
8. Add second cardboard placing corrugations in the same direction.
9. Repeat with as many layers as desired, ending with a new piece of cardboard.
10. Fix straps around the whole press and tighten
11. Set in a warm site on wooden strips with corrugations pointed upward to allow air circulation.
12. Open press and inspect specimens twice daily at start and replace damp newspapers each time. The newspapers must be changed frequently or mold will develop and spoil your plant collection.

Straightening out plants that are bent can be done when plants are relaxed but not yet brittle. If plants are too large, cut them into two or three smaller sections and dry separately.

Mounting Once the plants are dry and ready for mounting:

- Arrange the dried specimens attractively on mounting sheet.
- Fasten down with strips of clear tape.
- Label specimens, including their stage in development.
- The plastic protectors used to hold paper in notebooks make excellent displays and are easy to work with.
- Plastic wrap can be taped over the large specimens.

Means of Controlling Weeds

Weeds can be controlled in a number of ways by

- **Cultural** methods, with biological control, or with
- **Chemicals**

Cultural and Mechanical Methods

Mowing weeds off close to the ground is a method of control, but it is necessary to repeat the procedure every time new growth appears, and before seeds develop. Low growing weeds will escape control by mowing.

Tillage such as harrowing, disking or cultivating can help control weeds by breaking off the plants, exposing their roots or covering them with soil, so the weeds die. Before seeding, cultivation is important to control as many weeds as possible so that the crop gets a head start. This form of control can be used to control weeds between rows of row crops.

Mowing and tillage are limited to areas that do not have crops because you want to remove only the weeds, not crop plants.

Cropping practices are another cultural way weeds can be controlled. Planting perennial grasses and legumes with crops seems to be a very good method of keeping land relatively weed free. Applying fertilizer to a crop also helps, as young seedlings compete more favourably with weeds. Early planted, vigorous crops can out compete weeds by “shading” or using up the majority of the available light. As well, some crops compete with weeds better than other crops so they can be planted where a known weed problem exists.

Crops that are excellent competitors include fall-sown crops such as fall rye and winter wheat, and crops that form very dense canopies early in the season, such as canola and barley. Crops that are poor weed competitors are those that have open canopies, and allow lots of light through to the soil, or are short and grow slowly during the early stages, like flax.

Seeding at rates 25% greater than normal will also help crops compete with weeds by providing a lush crop canopy. Heavier seeding rates of cereals allow a margin for crop damage from post-seeding tillage. However, under extremely dry conditions, heavier seeding rates cause the crop to compete with itself for moisture. For this reason, heavy seeding should not be practiced in very dry areas.

Biological Control

A biological method of weed control includes the practice of using **animals**, **insects** and **plant diseases** to cut down weed population. Using sheep and goats to graze weeds and shrubs, and grazing cattle in areas with quack grass before weed seeds are produced, are a couple of examples. Work is also being done to find plant diseases and selective insect pests to introduce onto specific weeds.

Chemical

By far the most common method of weed control is the use of chemical herbicides. Chemical weed control products are called herbicides (herb [plant] + cide [to kill]). Herbicides can be applied to weeds in row crops where cultivation would be impossible. As well, late season cultivation in row crops often injures the roots of the crop, as well as the weeds.

Herbicides thus reduce the destructive effects of excessive cultivation. Herbicides have made it practical for farmers to use land that would previously have been too erosion prone to be used effectively. As well, farmers have been able to use zero-tillage methods that help protect land. Herbicides help reduce labour-intensive methods of weed control. Many perennial weeds and bush species cannot be effectively controlled by cutting them down, but are responsive to herbicide control. Although herbicides can be used instead of tillage, most are used in conjunction with tillage practices.

Types of Herbicides

Herbicides are either **selective** (killing only a certain plant species) or **non-selective** (killing all plants onto which it is applied).

- **Selective herbicides** can be used within recommended crops, but application rates must be accurate in order to kill the weeds and not damage the crop. The selectiveness of the chemical may depend upon different growth habits, product rates and plant types (monocots or dicots).

- **Non-selective herbicides** are usually used before a crop emerges, or after it has matured, because it can kill any plant with which it has contact.

No herbicide belongs rigidly to either group. Under some conditions, non-selective herbicides may react selectively, and if the dosage is high enough, a selective herbicide will destroy all plants. It is therefore important that the directions and recommendations for usage be followed exactly.

How Herbicides Work

Contact Herbicides: Some herbicides kill plants by having "contact" with plant parts. These contact herbicides work best on annual weeds. Some products kill only the plant parts to which they are applied, but if a high enough percentage of the plant tissue is contacted, the whole plant will die.

Systemic Herbicides are absorbed into the plant by the roots, leaves or stems, and are then transported throughout the plant tissue to areas of active growth. They often take more time to kill weeds, but are necessary to control perennial weeds such as quack grass and Canada Thistle.

Some herbicides have both **Contact** and **Systemic** activity.

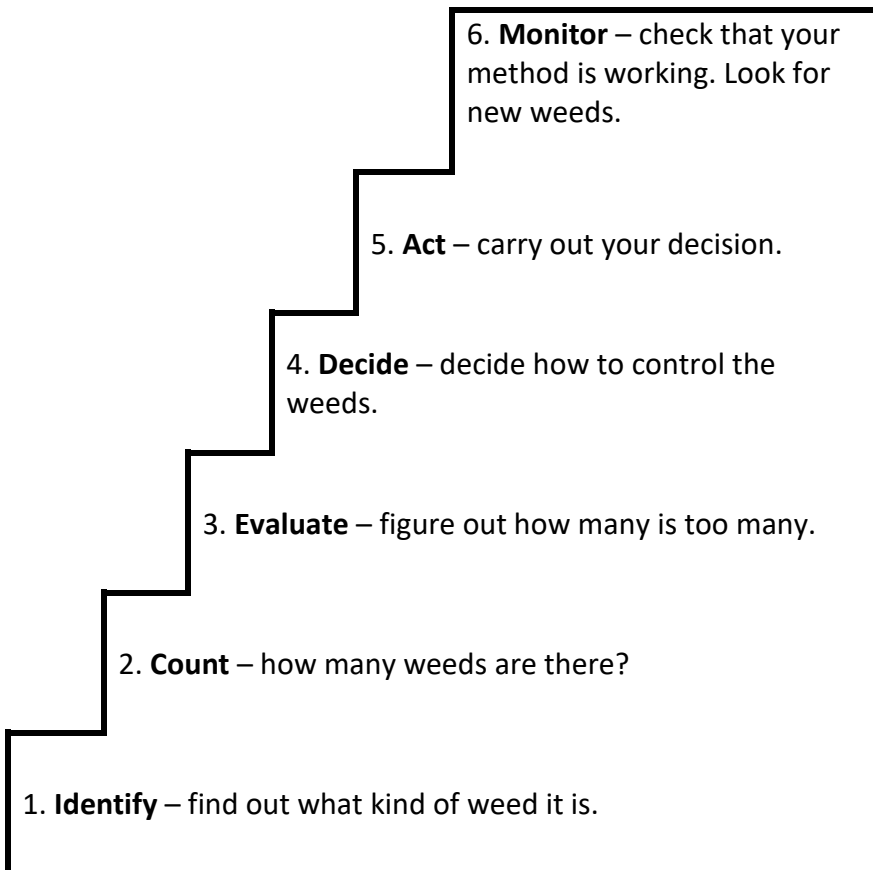
Activity

Once your weed collection is completed, take it to a 4-H meeting and share it with the rest of your club members. See how many other members can identify the weeds you have collected!

INSECTS AND DISEASES

Roll Call Name an insect or a disease that might affect the crop(s) you are growing.

Six Steps to Better Pest Control



Step 1 To control insect and disease problems, you must first find out what the problem is. You can identify insects and diseases by:

- Asking someone who might know.
- Using a picture identification book on pests.
- Using an identification key. This uses a series of questions to narrow down the identification of your pest.

Step 2 Counting all the insects or all the plants affected by insects and disease in a field would be impossible. The best way to figure out how many plants have been affected in a field is to look at a sample of the crop, and count the insects or plants affected in the sample. You select a small sample area (using your field scouting sample square). Count the effects of your pest problem in that area. This will give you what is called the “density” of the

problem. If you have a large field, it would be good to take more than one sample.

Step 3 Once you know the density, figure out if this is a lot (a high density), or a few (a low density). The density at which significant damage to the crop will occur is different for every insect and disease. To figure out the density, you must know your pest and your crop. Pest guides will help you evaluate this.

Step 4 Now that you have all the facts, you will decide what to do. To make this decision, you need some tools or methods of control. Because of the variety of insects and diseases that can infest your crop, no one method of control is effective for all of them. You can choose from four basic ways that pests can be controlled.

1. **Biological**: Using another living plant or animal to choke out the insect or disease. Like the house cat that catches mice, this might mean using crop varieties that are resistant to certain diseases or that do not attract certain insects.
2. **Cultural**: Changing the environment to make it unsuitable for insects or diseases to live in. For example, we use the cultural method of controlling molds when we wash dishes right after supper. In a field, you may rotate crops or plant different crops every few years.
   This reduces the chance of a disease, which attack and lives on only one crop growing in numbers over the years, and becoming a big problem.
3. **Mechanical**: Physically removing the insects or diseased plants from the field. This might mean pulling out affected plants and burning them, or cleaning equipment between fields to prevent the spreading of pests that may be caught in clods of dirt.
4. **Chemical**: This is the use of pesticides to control pests. Insecticides control insects and fungicides control diseases.

Step 5 Once you have decided, you must act on it. Carrying out your plan at the right time can help make your decision more effective!

Step 6 Once you have carried out your plan, walking your field is important to see if your plan worked. If it worked, how well did it work? If it didn't work, why not? It is also important to continue to monitor for other pest problems.

Integrated Pest Management Integrated means using more than one method of pest management at the same time, which can be very effective. One aspect of the IPM program is ***prevention***. When you know what crop you are going to plant, you should do some research to find out what type of pests might affect it, and what you can do about them ahead of time.

Types of Diseases Just as different things cause different human diseases, different things also cause plant diseases. For example, colds are caused by viruses, athlete's foot by fungi and ear infections by bacteria.

Disease	Description	Examples
Fungus	• Threadlike "roots" enter the plant's cell walls to take food. • Take food and water from living seeds or plants causing plants to decay and die. • Fungi spread by spores (seeds), which get carried by wind and water.	• The fluffy growth on rotting food • Powdery mildew
Bacteria	• Invisible single-celled organisms. • Invade plants through natural openings or wounds. • Are spread by wind, water, insects and farm implements. • Can multiply quickly, and are most destructive under moist warm conditions.	• Bacterial Blight
Virus	• Very tiny, much small than bacteria. • One virus usually works on only one cell, but the virus will be found in all parts of the infected plant. • Spread by insects and weeds. • Viruses cannot survive outside a host.	• The common cold • Barley Stripe Mosaic Virus
Nematodes	• Tiny worm-like creatures. • May live on organic matter in soil or as parasites on plants. • Survive in soil as eggs that hatch when a suitable host is present. • Are spread by humans, wind, water or animals.	• The Golden Nematode of potatoes

The most effective way to control crop disease is by using several methods (integrated pest management). Relying on only one method is usually unwise, as many diseases can evolve and overcome resistant strains of crop or chemical controls.

Activity

The following is a list of available methods for controlling diseases. Identify whether each one is an example of biological, cultural, mechanical or chemical in the blank space.

1. _____ RESISTANT VARIETIES – possibly one of the most effective ways of controlling diseases is to develop strains of crops that are resistant to disease. This procedure involves the breeding of plants for their resistant qualities. This is done in a laboratory, where people control the pollination of plants. This procedure can sometimes take as long as 10 years. Researchers are kept very busy developing new varieties of seeds that are resistant to the many new diseases that develop.

2. _____ SEED TREATMENT – seeds are often treated to help make them more resistant to certain diseases. The need for seed treatment depends on the crop and the area. In the dry harvest areas of the prairie provinces, only 10-20% of cereal grains are treated. In humid eastern Canada, 70-80% of seeds are treated.

3. _____ SEED SELECTION – the seeds selected can affect how susceptible your crop will be to disease. Cracks in the seed coat will make it easier for diseases to enter the seed. Seeds from disease affected crops should not be used.

4. _____ FOLIAR OR LEAF TREATMENT – the foliage or leaves of plants can be sprayed with a fungicide to protect them from diseases. This procedure is often only worthwhile in very humid seasons, when diseases are a problem.

5. _____ DISEASE AVOIDANCE – for many diseases to have a serious effect on a crop, they need the right temperature and humidity. Planting crops earlier may be one way of avoiding the peak disease conditions.

6. _____ CLEANING EQUIPMENT – between fields to prevent any possible spread of disease.

7. _____ CROP ROTATION – if a disease shows up in a field, changing the crop (crop rotation) can often be the solution to disease problems.

Identifying Diseases and Insects

Diseases are very difficult to identify and usually require a lab analysis. Along with the sample, the lab will require the following information:

- Where it was found.
- When it was found (the date).
- What type of crop it was found in.
- The growing stage of the crop when the pest was found.
- The damage that it was causing to plants.

This information is also useful for accurately identifying insects. When you collect samples, be sure to record this information and tag it to the sample.

How to Control Insects

Controlling insects can be expensive, and so it is often not worth doing. The best cure is usually prevention. Looking for insects is very important so that in the following year measures can be taken to prevent them, or at least reduce their numbers. The following are some methods used to control insects.

Biological

- Introducing a parasite that will live off and eventually destroy the insect.
- Introducing an insect or another animal that eats the damaging insect.

Cultural

- A weed free crop will often reduce the number of insects.
- For an insect that prefers canola, changing the crop rotation, and planting wheat may stop the insect from eating into your profits.

Chemical

- When using an insecticide, knowing the effects it will have on helpful insects (such as bees) is important. For example, if there is an alfalfa crop beside the field that depends on bees for pollinating its plants, some insecticides could kill the bees and ruin the alfalfa crop.

Mechanical

- Tillage may destroy the eggs of some insects, or it may interrupt some insects' overwinter stages of growth.

Activity

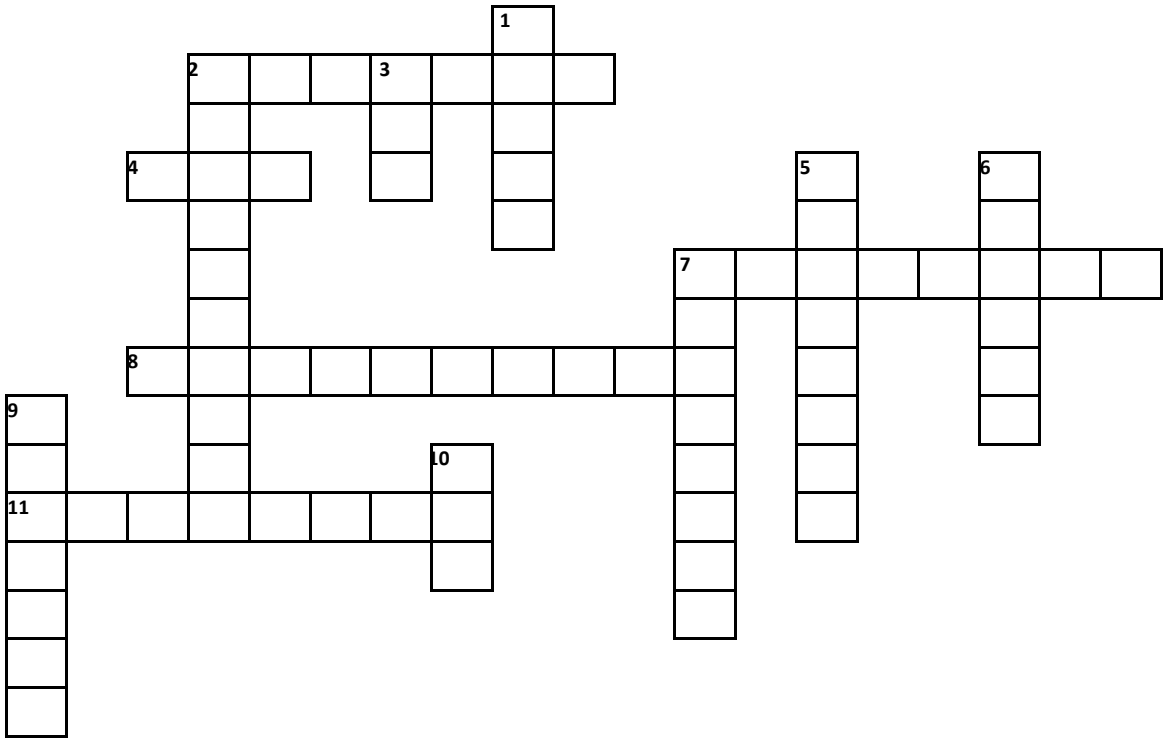
Use the information above to fill in this crossword puzzle.

DOWN

1. When you want to know how many pests you have, you _____ them in a sample area.
2. Killing a fly with a fly swatter is an example of this form of pest control.
3. Abbreviation for Integrated Pest Management.
5. The first step in figuring out how to control a pest.
6. Once you've identified your pest, and you've studied the situation it is time to _____ what to do.
7. Washing your hands before eating in an example of this method of controlling pests.
9. When you don't want something to happen you try to _____ it.
10. An identification _____ uses a series of questions to help identify pests.

ACROSS

2. Once you have decided how to control a pest, you must make sure your decision worked or your must _____ it.
4. What you do once you have made your decision.
7. Something you can apply to crops to control pests.
8. A ladybug eating an aphid is an example of this form of pest control.
11. How you determine the severity of an infestation.



PESTICIDES

Roll Call

Name something that should be done for correct and safe handling of chemicals

_____

_____

_____

Pesticides can be classified in a number of ways. The two most common are:

1. By **family**, based on the chemical similarity.
2. By **mode of action** – the process by which the pesticide kills the pest.

In some cases, pesticides from different families have the same mode of action. Repeated use of pesticides with similar modes of action can lead to problems, such as the development of pesticide resistance, increased carry over, or possible crop injury. Pesticide mixtures with different modes of action and knowledge of the chemical family can be useful in selecting suitable products in a pesticide rotation to delay the development of resistance, and avoid such problems.

Choosing the Right Chemical

- Know your problem. Identify the pest. Estimate the infestation level, or probable economic loss, to determine if treatment is required.
- Know the crop variety. Some products are restricted to, or excluded from use on specific crop types or varieties.
- Note the soil type or texture of the area to be treated. Pesticides that are subject to leaching should not be used on soils with a high leaching potential to prevent ground water contamination.
- Check the labels for recommended crops for registered products to be used on, as well as for pests controlled by the product.
- Check the crop and pest for their stage of growth or development. Choose the pesticide that best targets the present growth.
- Check the label for the recommended application time, e.g. spring, summer or fall; time of day).

- Check the label for cropping and/or harvest restrictions.
- Consider the use of land adjacent to the crop to be treated. If there is livestock, bees, shelterbelts and gardens that may be affected by off-target drift, choose a product that might provide the same control and greater compatibility with neighbouring land uses.
- Use the least toxic suitable product.

Keep Records

When a treatment has been chosen, be sure to record wind speeds, rainfall, moisture condition, crop variety, fertility, quantity of material used, acres treated and temperature at time of spraying.

Read the Product Label Carefully for Instructions

- Recommended rate for the particular pest, infestation level, crop and field conditions.
- Method of application.
- Any application restrictions during adverse or extreme weather conditions.
- Any other restriction, cautions or special instructions.
- Refer to charts for weed or insect pests for pesticides available.
- Refer to the appropriate pesticide, and select the product best suited to your operation.
- Apply the pesticide strictly according to instructions given on the label attached to the product container.

Adjuvant

Adjuvant is frequently added to pesticides to enhance the application and/or performance of the pesticide. In most liquid pesticides, these have already been added, while some “dry” products require that an adjuvant be added to the spray tank. If adjuvant is required, use only those products named and recommended on the label. Failure to do so could result in crop injury, reduced pest control, and/or invalidation of the pesticide warranty.

Surfactants are the most common adjuvant used with pesticides. Surfactants added to liquid pesticides change the surface of liquids and are often referred to as surface-active agents.

Surfactants change the surface of liquids, and improve their emulsifying, dispersing, wetting, spreading, sticking and penetrating properties.

Tank mix properties are not necessarily the same as those of individual pesticides applied separately, and may have separate recommendations.

For example, Poast and MCPA amine can be used on several crops; however, a Poast + MCPA amine tank mix can be used only on flax.

What to do if results are unsatisfactory:

- Ensure the choice of pesticide was suitable. Are the crops and pests treated listed on the product label?
- Compare your method of pesticide preparation to the product label instructions.
- Check for equipment malfunction – e.g. plugged screens, nozzles worn or mixed type or size.
- Compare the application techniques with those given on the label – e.g. stage of growth or development of crop and pest, ground speed, pressure and incorporation.
- Consider weather conditions at the time of application - e.g. cold, heat and drought.
- Consider the time since application. Some results are not apparent for several days. Look for early symptoms of the chemical taking effect.
- If the results are unsatisfactory, seek technical help. Gather all relevant data, particularly evidence such as photos or specimens.
- Collect a specimen for diagnosis. Disease or insect damage can resemble herbicide injury.

Pesticide Drift

Pesticide drift is a concern for all pesticide users. Landowners are responsible for ensuring that any pesticide application conducted on their property is conducted in a safe, responsible manner.

All sprayers should be calibrated prior to use, taking into consideration nozzle types, nozzle pressure and boom height. Proper calibration will assure better performance, as well as reduce the risk of chemical drift.

When applying pesticides next to sensitive crops, farmsteads and open water, a buffer strip should be left to reduce the risk of off-target drift. The size of these strips will depend on the chemical used, application method and degree of risk from escaping drift. However, for spraying near open water, it is required by law that the buffer strip be 30 metres from the edge of the water.

Pesticides should not be sprayed when winds are excessive (generally winds over 16 km/hr are considered a drift hazard). Pesticides should only be sprayed when winds are blowing away from farmsteads, sensitive crops or water bodies. Conditions of “dead-calm” or temperature inversions should also be avoided to prevent vapour clouds.

A suitable drift retardant additive to the spray tank may help to reduce potential drifting of pesticides.

Safely Prepare Pesticides for Application

- Use protective clothing and recommended safety equipment. The exposure hazard is greatest during mixing.
- Follow the mixing instructions.
- Use specified amount and quantity of water.
- Use recommended rates (tank mix rates may be different from each pesticide used alone).
- If specified, add adjuvant.
- Record rates used, mix order, pesticides, adjuvant used and water quantity for future reference.

Apply Pesticides Using

- Recommended safety precautions and equipment.
- Proper application equipment.
- Recommended rates of pesticides, adjuvant and water.
- Proper time (e.g. growth stage, time of year, time of day, etc.).
- Recommended techniques (e.g. ground speed, pressure, and incorporation).
- Record weather conditions at time of application, techniques used and growth stage of both the crop and pests for future reference.

Pesticide Toxicity – Hazard and Risk

The terms **“toxicity”**, **“hazard”** and **“risk”** do not all have the same meanings. Users of pesticides should understand the different meanings of these terms.

Pesticides vary in the degree of being poisonous. How poisonous a pesticide is depends on its chemical and physical properties (toxicity).

The relative hazard of a pesticide is dependent upon the toxicity of the pesticide, the dose received, and the length of time exposed. No hazard exists when the container of a pesticide is sealed, but once that seal is broken, and the pesticide is handled, exposure can occur and a hazardous situation is created.

Risk of exposure is a function of how the pesticide is handled by the user. Although the hazard may be the same whenever a pesticide is being poured into the spray tank, a person wearing protective equipment is at a lower risk of exposure than someone wearing no protective equipment. Therefore, the user can have control over the risk of exposure by carefully managing the hazard.

LD_{50} values are used to rate the toxicity of pesticides. The LD_{50} is an abbreviation for the dose (expressed in milligrams per kilogram of body weight of the test animals). For example, if a pesticide has an oral LD_{50} value of 10 mg/kg, and the test animals each weigh 1 kg, 50% of the animals would die of poisoning, if each ate 10 mg of the pesticide. Therefore, the smaller the LD_{50} value, the more toxic the pesticide, because a smaller dose is required to affect test animals. The LD_{50} value usually refers to the active ingredient in the pesticide formulation.

LD_{50} less than 500 mg/kg indicate high toxicity.

LD_{50} 500-1000 mg/kg Indicates moderate toxicity.

LD_{50} 100-2500 mg/kg Indicates low toxicity.

LD_{50} greater than 2500 mg/kg indicates very low toxicity.

Herbicides are a major tool in managing weeds. A variety of products are available for field crops. Most herbicides are used in a selective manner. Specific herbicides are chosen to control one plant without significantly affecting the other plants around it. Herbicides registered for the control of weeds in specific crops have proven their ability to do a specific job. The specific uses of herbicides and the guidelines required to ensure safe application are outlined on the label, and should be strictly followed.

Activity

Match the right statement with the left answers.

I. Herbicide, fungicide, rodenticide and insecticide are all members of this family.

II. This item provides information about first-aid treatment, disposal, limitations or precautions for any pesticides.

III. How many times you should rinse a pesticide container before disposing it.

IV. A substance that contains an acid or caustic that may chemically burn the skin as well as attack the metal parts of equipment.

V. When mixing pesticides, the only way to prevent contamination of your water source.

VI. Storing pesticide containers here is a dangerous practice

VII. The place where you dispose of all rinsed pesticide containers.

A. Always read the label carefully before using chemicals.

B. Pesticides.

C. In the event of a leak or fire, chemicals could pose a serious hazard to the family if stored in the house.

D. Triple-rinsing and draining it into the sprayer tank can reduce the hazards and save you money.

E. A Municipal Pesticide Container Collection Site.

F. A corrosive substance.

G. Haul water to the sprayer unit in a nurse tank to help reduce the hazard in the event of an overflow.

HARVEST

Roll Call

Name something that happens at the busy time of harvest.

_____

_____

_____

Getting Things Ready

As the harvest season approaches, it is important that equipment is prepared. The basic preparation of harvest equipment includes:

- Any repairs that are needed.
- Lubrication as required.
- Tire pressure checked.
- Any chains and belts checked for wear and tear.

Harvesting Losses

Many farmers are able to grow crops that will measure up to nearly all the requirements of a top quality product – until they harvest the crop. Then, because of some faulty harvesting procedure, the top quality product is damaged, and drops to a lower grade. This happens frequently with malting barley crops. Analysis of crop material both before and after passing through the combine will identify problem areas. Potential areas of loss are:

- **Natural losses** – due to unfavourable weather, insects, birds, animals and shattering.
- **Reel and cutter bar losses** - due to the mechanical action of the swather or combine reel and cutting bar.
- **Pick-up loss** – due to the mechanical action of the pick-up of the combine as the swathed crop is being lifted from the windrow into the threshing mechanism.
- **Threshing and separating mechanism loss** – due to improper adjustment of the threshing mechanism, or the separating mechanism, and also due to overloading or underloading the threshing and separating mechanism.

Many combines are now equipped with electronic loss monitors. However, these monitors do not measure loss in actual amounts, and a visual check on losses must accompany a meter reading to correlate losses. Changes in crop conditions will necessitate corresponding check and adjustments of the loss monitor.

Evaluating Yield

The average yield for crops in Saskatchewan is extremely varied. The average yield for crops in your area will depend on the soil type, the number of frost-free days, the moisture content of the soil, rainfall, etc. Knowing the average yield for your area will help you to evaluate the efficiency of your crop project, and the yield you have produced.

Kernels per gram is another way of evaluating the quality of seed that is harvested. This relates to the density of seeds. The yield of the crop may be very high, but the quality of the seed very poor. A comparison of the number of kernels/gram with a kg/acre or a bushel measure reveals the accuracy of this measure. Two crops that seem to be the same yield with a bushel or a kg/acre measure may be quite different when evaluated on the number of kernels per gram.

Storage Capacity

The capacity of bins for storing field crops depends on the density of the seed being stored. Therefore, the following factors are used in the calculations that follow:

Grain	Factor (tonnes per m^3)	Grain	Factor (tonnes per m^3)
Wheat	0.770	Peas	0.770
Oats	0.470	Triticale	0.650
Barley	0.620	Safflower	0.470
Flax	0.650	Pulse	0.770
Rye	0.730	Sunflower	0.300
Canola	0.640	Timothy	0.500
Mustard	0.640	Potatoes	0.600

For a square of rectangular bin – multiply the

Length X Width X Depth X Factor = Tonnes

For a round bin – multiply the

Circumference X Circumference X Depth X 0.7958 X Factor = Tonnes

Forage Conservation

The objective of forage conservation is to produce a stable product, of adequate nutritional value, with minimum loss, at reasonable capital and labour costs. All freshly cut forage crops deteriorate rapidly for two reasons:

- Chemical changes within the crop itself, and
- The action of molds and bacteria.

There are essentially two different methods of conserving forages:

1) Dehydration (haymaking)
2) Preservation (silage making)

Haymaking

Forage crops will "keep" without deterioration if the moisture content is reduced to approximately 10-12% for leafy crops, and approximately 15-18% for more mature crops. This occurs either slowly by air at natural temperatures when hay is dried in the field, or rapidly as in the production of dehydrated alfalfa.

When making hay, the crop is baled at about 18% moisture. It later cures down to about 14-15% moisture, which is due partly to continued slight respirations in the bale, and partly to the consequent heating of the damp hay that sets up air currents through the stack removing the final moisture.

Forage crops of high digestibility are hardest to make into hay because of very high moisture content, and the danger of compaction. You must strike a compromise, and cut the crop at about the heading stage when yield, carbohydrate content, protein content and digestibility are all reasonably high.

The following losses are the disadvantages of haymaking:

- Loss of leaf during handling
- Loss of carotene or Vitamin A due to exposure to sun and rain
- Slight loss of digestibility

Silage Making

Ensilage is a process in which forages are “pickled”. The fermentation of sugars produces enough lactic acid naturally, to prevent harmful organisms from multiplying. The concentration of lactic acid in the silage juice is critical. The wetter the forage at the time of ensiling, the more acid is needed to preserve it. This is because the wet forage has a higher water to sugar ratio, and even though all the sugar is turned to acid, the silage juice will contain a lower percentage of acid. Thus the concentration of lactic acid may not be high enough to prevent harmful bacteria from multiplying. These bacteria may then attack protein, breaking it down to unpleasant smelling compounds such as butyric acid. Prolonged fermentation can then occur, destroying the feed value of the silage.

When making silage, high sugar content in the crop must be ensured by avoiding cutting at an immature, low sugar stage of growth, as well as by avoiding late top dressings of nitrogen that reduce sugar content and increase protein content. Wilting in the field can effectively increase low sugar content. The drier silage produced is stable at a lower concentration of lactic acid in the juice.

Continued respiration of the crop uses up valuable sugar, and can be stopped by cutting off the supply of oxygen. The oxygen trapped in the silage mass is soon used up, and if further air is prevented from entering, respiration losses can be low. However, if air is allowed to enter the mass and continued respiration occurs, heat is produced, and a cycle starts in which heated air rises within the silage mass, and more air is drawn in. if the mass becomes very hot, protein becomes less and less digestible, and the additional respiration increases invisible losses. If the silage mass is carelessly packed, and the silo not sealed properly, over-heating is almost certain to occur.

As with hay making, some compromise has to be made between high digestibility and protein content in young leafy forages, and the ease of ensiling more mature crops containing more sugar and less water. Cutting of silage crops is usually done at a stage intermediate in terms of maturity and protein content between young leafy forages and field cured hay.

The aim of conservation is to create conditions that will halt the process of deterioration, for example, by drying, by acidification or by heating.

Forage Losses Forage losses can be grouped into three categories:

1. **Physical Losses** are those that occur during cutting, crimping, picking up, handling or because of trampling and spoilage. These losses involve leaf material for the most part. They can lead to a serious drop in protein content and digestibility, especially with legumes.

2. **Invisible Losses** are not readily seen, but affect the soluble and most digestible part of the forage. They include:

   - Respiration: as long as a plant contains over 30% moisture, and is exposed to oxygen, it continues to respire or breath even after it is cut. The process of respiration burns up readily available plant material, producing heat that rises, leading to heated brown hay or overheated dark brown silage.

   - Fermentation: is the process of chemical breakdown of plant material carried on by micro-organisms, like bacteria and moulds. This process is essential to silage making, where conditions are created so that bacteria present on the forage ferment the sugars in the forage producing lactic acid, which then pickles the forage and stops further bacterial action. Due to the bacterial activity, fermentation involves some loss, which varies with the type of crop and its moisture content. There is no loss of crop and its moisture content. There is no loss in dry hay and progressively greater loss in wetter crops. Fermentation loss is most serious in silage when the process is prolonged in storage, because there is not enough lactic acid produced to form a stable product.

   - Effluent: once forage is cut, the cell structure can no longer prevent liquid from escaping, so that any liquid in excess of what the mass can hold will run out. The amount depends on the moisture content of the cut forage, the pressure applied, and the amount of soluble material present in the forage crop. Because water is one of the products of fermentation, a high fermentation loss adds to the effluent loss. Effluent contains a high proportion of soluble material from the crop and therefore every effort should be made to avoid these losses.

   - Leaching: is the washing out of soluble material from the crop by rain. Losses will depend on the amount of water (rain) passing through the crop and the amount of soluble material in the crop. It is possible to lose all of the soluble material.

3. **Damage Losses** can reduce nutritive value of the crop in the following ways:

   Over heating during conservation can reduce digestibility of crude protein from about 30-70%, or less. Moulds can cause unpalatability, digestive upsets or actual toxicity in poorly conserved forage. Carotene content of grasses or legumes can be destroyed by excessive sun, rain or over-heating.

The composition of a forage crop varies greatly at different stages of growth. As the crop matures, the protein content rapidly falls, as does the moisture content and the fibre content gradually increases. Sugar or carbohydrate content reaches a peak just before heading, and then drops off. The crop becomes less digestible as it matures. However, the stage just before maturity is also the period of rapid growth. One must try to balance yield of a high quality product. Ideally, one should aim at cutting the highest possible amount of protein per acre.

MARKETING

Roll Call

Name a product that is grown, processed and sold in Saskatchewan.

_____

_____

Getting the Best Price for Your Commodities

Wouldn't it be nice to put seed in the ground knowing what you will sell the final product for a good price once the crop is harvested! This seems difficult because prices for farm products rise and fall due to changes in supply or demand. However, the profit a producer makes from the sale of their products can be influenced using two markets. One market sells agricultural commodities, and the other market sells promises that commodities will be delivered for a set price in the future.

- **The Cash Market** – The physical market where producers sell the products that they have harvested at the current selling price. The producer has no control over the price that they receive for their products, other than to sell or not sell at the given price.
- T**he Commodity Futures Market** – The market where futures contracts that promise a future delivery of a commodity at a specific price are bought and sold. The producer has no control over the price of futures contracts at the time of purchase or sale.

Using these two markets over a period of time, producers are able to influence the profit they will receive for their products through a process called **hedging**.

Hedging

Hedging is the act of taking opposite positions in the two markets to lock in reasonable prices for products. It is a way of locking in the prices that producers will receive for their commodities, or that buyers will pay for commodities.

Grain producers use a "sell hedge" because they want to present the price at which they will later sell their grain. This is how it works:

First, the producer establishes a target price that he wishes to get for the crop he's growing. When the producer plants a crop in the spring, he does so with the idea that the crop will be harvested and sold for a target price that will cover input costs (the seed, fuel, fertilizer, etc.) and provide some profit for the farm.

Once a target price has been established, the producer watches the futures market for his target price. When the futures market price has reached the producer's target price, he sells a futures contract for the same commodity and tonnage of grain he wishes to pre-price for delivery in a month after he

hopes to sell the grain.

So, in the spring, the producer enters a contract that says he will deliver a specific amount of grain in the future (usually set for after the date when the crop will be ready for sale).

After harvest, the producer sells the same amount of crop he hedged, to a local market for the price available at this time. If the price has fallen, the price he will receive for his grain may be less than the target price he hoped for.

To offset the loss, the producer now buys back the futures contract for the current price of futures contracts. Because the price of this commodity on the cash market has decreased, the price for futures contracts of this same commodity will also have decreased. So the producer buys back the contract for less than he sold it in the spring. This simultaneous exchange is called an offset.

Therefore, the producer has lost some money on the cash sale of his crop, but he has made some money on the futures transaction. Because the futures price and cash price are closely linked, the final price received will be very close to the price hedged. If the cash price goes down, futures price goes down and what is "lost" in the cash market is equally made up in the futures market.

Therefore, hedges are used to help control the risk associated with price changes. There is a direct cost associated with using a hedging strategy. This cost is the fee or commission charged by brokers for their services. The fees vary with brokers, the specific instructions in the hedge and the commodity being traded.

An Example

Here is an example of a sell hedge using a barley crop:

Most contracts are based on the equation:

Futures Price – Basis = Cash Price

- In May, a producer wants to use the local cash barley price of $120/tonne as a target price for 20 tonnes of barley he will have on hand to sell in October. To hedge, he sells a December futures contract for 20 tonnes of barley.
- The price of the December futures contract is $140/tonne on this particular May day, when the price is locked in ($20 more than his target pice!).
- In late October, the producer decides to sell the 20 tonnes of barley to a local feedlot for $90/tonne (the highest local price available at this time). To offset the loss in price of the sale, the purchaser calls his broker to buy back the futures contract for $110/tonne. The calculation looks like this:

Date	Cash Market	Basis	Futures Market Action
May	$120 (Target Price)	$20	Buy Dec. $110
October	$ 90 (Cash Received)	$20	Sell Dec. $140
	$ 30 = the difference		Futures Grain = $30
Cash Price Received + Futures Gain = Final Price $90 + $30 = $120			

The barley was sold to the highest local cash price at the time the producer wanted to sell ($90/tonne). The producer made money at only $90/tonne from the cash sale, but he made an additional $30/tonne in profits from the futures contract (that he sold for $140/tonne and bought back for only $110/tonne). The final price totaled $120/tonne, right on the target price rather than just $90/tonne that would have been $30 off the target price!

Hedges Are Not Always Perfect

A perfect hedge is when the final return price matches the original target price, because basis has not changed from the original estimate. However, hedges usually do not work out to exactly the target price because of the difference in the cash market price and the futures market price on a given day. This difference is called **the basis** and can change daily.

The basis is the difference between the price the farmer receives, and the futures contract price upon which the net price is based considering all marketing costs including transportation, handling and risk. It represents the costs of getting grain from the selling point to the point of use, either domestic or export. Grain buyers use basis to attract grain when they need it. When supply is low, buyers will compete by offering higher local cash prices, which narrows the basis. When supplies are high, buyers can lower their price, thus widening the basis, and still find producers willing to sell. Therefore:

A **Narrowing Basis** usually occurs when there are fewer producers selling grain because the competition among buyers is high (buyers want to attract those few producers to sell their grain to them). In general, a narrowing basis is good news to the producer/hedger because they make more money through the narrowing of cash and futures prices.

A **Widening Basis** usually occurs when there is a high level of competition among producers (a lot of producers are selling grain) meaning that the buyers don't need to attract producers. This is not so beneficial for the producer/hedger because the local cash price falls away from the futures price.

Basis Risk

Therefore, there is some risk in hedging because of the variation in the basis. However, the basis risk (the odds that the basis will change) is much less than the price risk. As the example above shows, it was more profitable for the producer to have hedged and received $120/tonne than to have not hedged, and received only $90/tonne. It is better for producers to hedge and take a risk that there may be a variation in the basis, than just hope for the best price at the time they are ready to sell their grain.

Choosing the Right Month

Futures contracts are traded for specific delivery months. These are the months when the actual commodity is to be delivered to the party that has bought the contract. For the majority of hedges, the commodity is not actually delivered on the futures contract. As in the example above, they are entered into, and exited from, to manage the risk of adverse price changes. Choosing which contract month to sell depends on:

- When the cash commodity will be sold
- The amount of buying and selling of a contract month (volume)
- The expected basis between the futures month, and current cash price

The planned delivery time for the cash grain is the main factor considered when selecting a futures contract month. The general rule is to select a delivery month, just after the planned cash delivery date. For example, if delivering barley in February to the local elevator, use a March or July barley futures contract.

Choosing a month close to the actual cash sale ensures the futures price will accurately reflect the cash price at that time (reducing the basis risk). Using a month just after the planned cash will simplify the hedging process, and eliminate the need to buy back the hedge before the cash grain is sold.

Another good guideline is to never hold a futures contract into the delivery month, unless actually delivering against the contract. For example, do not hold a March contract in March. This protects against some of the unpredictable price swings within a delivery month. It provides a buffer against holding a contract on the delivery date, and either not being able to supply the commodity, or having to take delivery. This can be a very expensive mistake.

Rolling Futures Contracts

If a producer sells a futures contract for a November delivery, and he does not buy back that contract before the date of delivery, he is bound to deliver at the price the contract was originally sold for. Getting the product to the futures delivery point may be too costly or impossible for the producer. To avoid this danger, he must roll their futures contract. "**Rolling**" involves buying back the original contract, and at the same time, selling a new contract for a more distant month. This then allows him to maintain the hedge into the future.

For example, in October a producer plans to sell his grain in late March, so he hedges by selling contract for May. As March approaches, the producer finds a widening basis and a lower local cash price. The producer anticipates that later in June, supply of their commodity will be lower, meaning that the basis will narrow. Therefore, the producer decides to put off the selling of his cash grain for a time when the basis has narrowed. In order to protect the price with a hedge, the producer must roll his futures contract. In late March the producer buys back the original May contract and then sells a July contract. When the producer sells the cash grain in June, he then buys back the July contract and the hedge is complete.

Hedging Pitfalls

Done properly, hedging can be an efficient way to favourably hold prices for periods of time. There are a few things hedgers should watch:

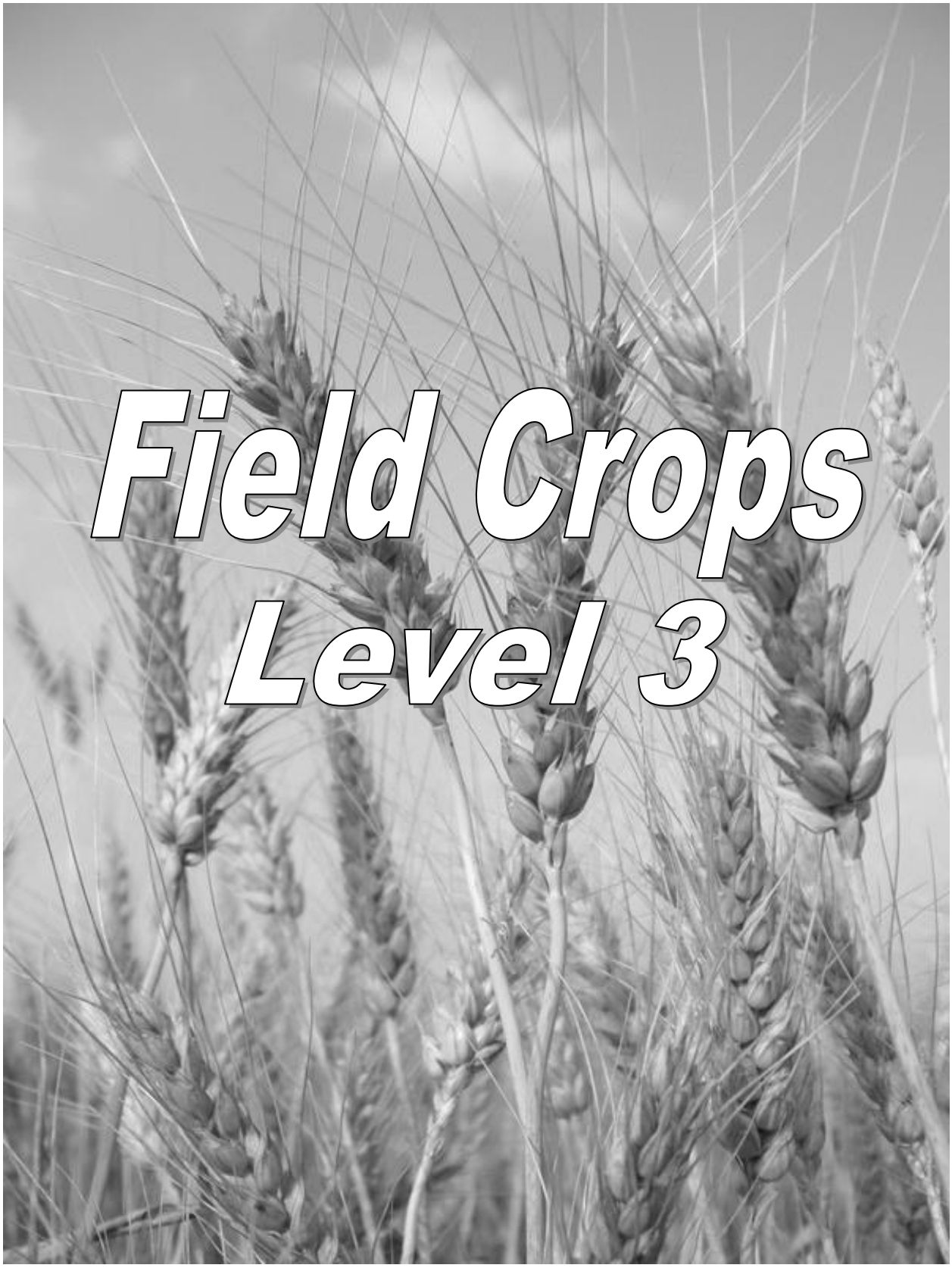
- Do not hold a contract in the futures delivery month unless intending to actually delivery against the contract.
- Do not buy or sell contracts that are too far into the future, or are "thin". In Canada, trading in contracts less than ten months into the future is a good guideline.
- Be sure to take an opposite futures position to the cash market: sell the futures contract when producing the commodity, then buy the futures contract back when selling the commodity.
- Avoid hedging when the basis is narrow, if the crop is in the bin, because it will likely widen and erode the accuracy or effectiveness of the hedge. The hedger must consider today's basis, and what the basis is likely to be when the cash grain is sold.
- Be sure to match the tonnages of the futures contract to the tonnages of the grain to be prepriced.
- Do not jump in and out of the futures market to make quick profits; the goal is to reduce risk and lock in favourable prices.

Hedging, used with common sense, allows a producer to lock in high prices until he can make actual deliveries.

Activity

Match the following words with their correct explanation:

1. Commodity	a) A transaction to minimize the risk of loss due to adverse price fluctuations.
2. Market	b) The difference between the sale of a particular commodity and a specified futures contract price for the same commodity.
3. Futures Contract	c) Buying back an old contract at the same time as selling another for a later delivery date.
4. Hedging	d) A term used to designate the standardized contracts covering the purchase and sale of commodities for future delivery.
5. Basis	e) Where commodities are bought and sold.
6. Rolling	f) It is beneficial to producers when the price difference between the cash market and the futures market is narrow.
7. Narrowing Basis	g) An article of trade.



Field Crops
Level 3

SOIL

Roll Call

Name something that is found in soil.

_____

Keep a list of what other members mention.

_____

_____

_____

_____

Soil Conservation

The earth is a large globe that supports life. The amount of soil on earth that can grow crops is limited. About only 3% of the earth's surface is suitable for productive agriculture. This surface area is limited by a number of factors that can occur naturally or are a result of human activity. 75% of the earth's surface is covered with water. 22% is land that is not accessible for tillage or is located where climate is not suitable for agriculture.

To represent the amount of usable soils on earth, begin with one orange. Remove three quarters of the orange peel to represent the fraction of the earth's surface covered with water. Remove half of the remaining orange peel to show the earth's surface taken up by bogs, deserts, mountains, cities, etc. Peel away three quarters of the remainder to represent areas that are too hot, too cold, or too wet to farm. The remaining section (1/32) represents the earth's arable land.

With so little land available for productive agriculture, it is important to carefully manage the soil you use.

Soil Erosion

Erosion is really a two-step process. First, it involves the **loosening** of soil particles. Then, this loosened soil is **transported** from one location to another. The two types of erosion are **wind erosion** and **water erosion**.

Wind Erosion

Coarse textured soils (sandy loams, loamy sands and sands) are the most susceptible to wind erosion. Wind provides the energy for wind erosion. A strong wind will pick up soil particles and move them long distances.

If a strong wind blows across a bare, dry field then soil erosion will occur. Wind-blown soil will tumble, somersault and bounce along the surface of the ground. The largest particles (sand) may end up beside fences and in ditches. The smallest particles (clay and organic matter) containing nutrients will break away from the soil completely and will be lost as dust. If a lot of soil is blown way, then crops will not grow well, because nutrients for plant growth are lost.

Water Erosion Soils that contain a high proportion of silt-sized particles (silt loam, silty clay loam) are most susceptible to water erosion. In most soils where the land is sloping, a considerable amount of precipitation is likely to be lost by runoff. This loss has two serious consequences. First, crop plants are deprived of this water, which might otherwise have entered the soil; and second, the runoff water carries with it some of the valuable topsoil and can cause serious soil erosion. The surface soil is gradually taken away. This means not only a loss of natural fertility but also of nutrients that have been artificially added. Also, it is the finer, more fertile portion of the soil that is always removed first.

Rainfall provides water for water erosion. An intense rainstorm will break apart soil particles and wash them away. The amount of erosion depends on the amount of rain and its energy, how easily the soil can be broken apart, and the amount of plant material present. Bare soil is easy to wash away, especially when it is on a steep or long hill.

When raindrops fall to the earth, they can explode on the surface just like small bombs. This is called **splash erosion** and is the first stage of water erosion. After it has been raining for a while, the water begins to run down the hill. Water running down a hill will pick up loose pieces of soil and wash them away. This thin layer of running water is called **sheet erosion**. If the water is able to wash down the hill for a while longer, then small paths may be cut into the soil. These paths are like tiny rivers and are called **rills** (**rill erosion**). If the water runs down these rills long enough, gullies may be formed. **Gully erosion** may be identified when the paths cut into the soil interfere with normal tillage operations and cannot be smoothed over by these operations.

Streambank Erosion This occurs in the large channels that carry runoff water for a long time after a rainfall. The flowing stream erodes the banks and may eventually cause the banks to cave into the stream.

Activity

Gather wind-blown soil from a ditch and examine it. How does it look or feel?

Half fill a cardboard box with soil and direct a stream of air from a fan or hair dryer toward the soil surface. Try this with different soils you find on your farm. Place a cardboard barrier in the soil container to represent protection from trees, grass or stubble. Direct the air stream toward the soil surface from a number of different directions. Record your findings.

Take two used aluminum cake pans, cut along the vertical edges of one end of each pan, and fold over to form a flap. Place a small crimp in each flap to allow collecting. Half fill each pan with soil and tilt slightly so that the end with the crimped “spout” is downhill. Lay straw or grass on the surface of the soil in one pan. Place a jar below each crimped area. Pour water from a watering can at a gentle, even rate onto the surface of each pan from a distance of 60-80 cm. Compare runoff, soil conditions and soil losses from each pan.

Which box lost the most soil? Why?

From which box did the water stop flowing first? Why?

Which box lost more water? Why?

Activity

Collect a litre of topsoil and a litre of subsoil from your field. Find four containers, such as the bottoms of cut-off milk cartons or flowerpots. Punch holes in the bottoms for drainage. Label two of the containers "subsoil" and divide the subsoil between the two. Finely crush it before you place it in the containers. Label the other two containers "topsoil" and divide the topsoil between these two. Select some corn, beans or other similar seeds. Plant four seeds in each container, about 3 cm deep. Pour water over the soil until it begins running from drainage holes in the bottom. Add water as needed to keep the surfaces moist. Keep them in a warm, well-lit area. Keep the following record for one month.

	Topsoil	**Subsoil**
Date planted.		
Dates seeds emerged.		
Number of days to germinate		
How many seeds came up?		
Did the plans stay green?		

Was there a difference in the number of seeds germinating in the two soils? _____. If so, how do you account for this?

_____

_____

_____

_____

Was there any difference in the colour or vigour of plants in the topsoil and subsoil? _____

If so, write down the difference with an explanation you have for this difference.

_____

_____

_____

_____

When wind and water erode the land, what kind of soil do they remove?

_____

Will erosion affect yield?

_____

_____

Factors Affecting Erosion

Climate

- Rainfall (frequency and intensity)
- Frost
- Wind

Soil

- Particle size (texture)
- Surface cover and organic matter content
- Condition (structure)

Topography

- Steepness of slopes
- Length of slopes

Management Practices

- Tillage practices
- Cropping practices
- Conservation practices
- Placement of shelter belts

How Can We Reduce Erosion?

Soil erosion is a large problem on the Canadian prairies. It is something that farmers should try to control for the following reasons:

Environmental Reasons: Eroded soil may cause environmental problems. When soil is washed into streams and waterways, the pesticides and nutrients applied to the soil may also be washed in. This sort of run-off may harm fish and birds that live in, or near these waterways.

Economic Reasons: Soil erosion costs farmers money because of lost yields, and increased nutrient and pesticide costs. Soil material can also fill ditches and waterways; therefore there is an additional cost in maintenance.

Stewardship Reasons: Many people believe that soil is a "borrowed resource". What this means is that it is our duty to preserve the soil resource for future generations of farmers.

Aesthetic Reasons: The sight of eroded land is an unpleasant one! Both passers-by and the farmer who must work the land can feel better about the state of agriculture when there are no visible "scars" caused by erosion.

Of all the factors affecting erosion, management practices are the only ones that we can control. Good land management is needed to prevent soil erosion. Factors involved in controlling soil erosion are: maintaining good soil structure and protecting the soil surface. Specific things that can be done to help reduce soil erosion are:

a) **Reduce bare summerfallow**. When a farmer keeps summerfallow bare (without plant cover), the soil can be eroded easily. The best soil covers are straw, stubble, forage or a crop.
b) **Conservation tillage**. The purpose of conservation tillage is to keep as much plant residue on the surface as possible. This means tilling the soil as few times as possible.
c) **Contour farming**. Here tillage and crops run across the slope. The resulting surface roughness conserves soil and water. Contour farming works best on slopes that are not steep.
d) **Strip cropping**. To prevent wind erosion, crop and fallow strips are placed so as to run at right angles to the prevailing winds. Narrow strips are needed on easily eroded soils. Wide strips can be used on land that has a lower possibility of erosion.
e) **Cover crops**. These protect the soil when regular crops are off the land. Fall rye or spring grains seeded on erodible soils during August and September help to control wind erosion. Roots hold soil together and help prevent erosion.
f) We can protect soil from the rain if we **keep it covered** with straw, stubble, forage or a crop. We can protect waterways from excess erosion by planting grass in waterways. These broad, shallow grass-lined channels take run-off away from farmland with minimum erosion. We can also protect soil from running water by planting rows of crops across the slope of a hill rather than up and down the hill.
g) **Windbreaks and Shelterbelts** are used to lower the wind speed. Farmers can get trees for shelterbelt planting, or tall wheatgrass and flax, planted in strips, can also act as a windbreak. Shelterbelts do not completely stop erosion from strong winds and should be used with other soil conservation measures.

Properties of Mineral Matter – Soil Texture

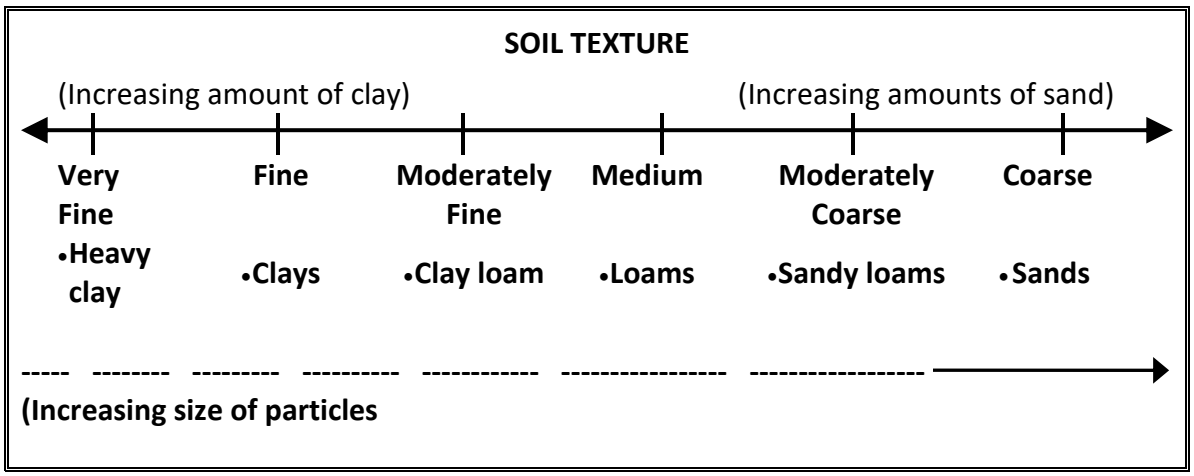
Mineral matters are made up of different sized particles, and are called **separates**. Separates are classified as sand, silt or clay, depending on individual particle size. Soil is rarely composed of only one separate. Soil usually has small quantities of all three separates. The ratio of sand, silt and clay determines the texture of soil. Soil texture is often referred to as the "**feel**" of the soil. Weathering is a constant process and it changes the fraction of the mineral matter of our soils. Each separate has unique qualities. The properties of sand, silt and clay are as follows:

Sand particles are composed dominantly of quartz, and act as individual grains in soil. When sand dominates the soil, it has large soil pores that enhance aeration and infiltration. However, the soil's ability to retain water and nutrients is very low.

Silt particles are too small to be seen without a microscope. Again, quartz is the dominant mineral. Silt particles are non-sticky but soapy when wet and feel like talc powder when dry.

Clay is the smallest particle found in soil, but it is the most important one in terms of physical and chemical properties of soil. While sand and silt are formed from rock, physically weathered into smaller pieces, clay results from chemical and physical reactions on soil minerals to form small particles of new minerals. Because of the resultant relatively large, chemically active surface area, clay is able to bond nutrients to its surfaces. In addition to being a storehouse for plant nutrients, clay is responsible for the stickiness, swelling and shrinking, and water holding capacities of soil. Soils high in clay have such small pore spaces and large internal surface area that they have a low water infiltration rate and are generally less well aerated. Clay can hold water so tightly that it has less water available for plants than silt does. Clay soils drain slowly and are difficult to work, but they may become highly productive if the amount of decomposing organic matter in them is increased to the extent that soil structure is improved.

Loam soils contain a relatively equal amount of sand, silt and clay particles.



Very fine textured soils can be very productive under good management. They have very high moisture and nutrient retention. However, they often exhibit severe structure and drainage problems. Soil compaction and excess surface runoff commonly occur. It also takes more power to work this type of soil.

Fine textured soils are characterized by very good productivity, although they also commonly exhibit structure and aeration problems. They hold a significant quantity of their water content in the available form for plants, but tend to clod badly. Formation of aggregates in these soils can lead to better drainage and aeration. As a result, aggregation can modify the effect of texture on the soil physical properties. Nutrient retention is high in these soils.

Moderately fine textured soils are characterized by very good productivity. They exhibit moderately high moisture holding capacity, and excellent nutrient supply power. The surface structure is commonly strongly aggregated. These soils can be extremely susceptible to water erosion on long steep slopes. On such topography, contour tillage is strongly recommended.

Medium textured soils are usually characterized by good productivity. Moisture holding capacity and nutrient supplying power is better than coarser soils and aeration and tilth is often better than finer soils.

Moderately coarse textured soils can exhibit fair productivity with careful management. They can also be susceptible to wind erosion. Conservation tillage, organic matter and fertility management practices are essential. Moisture and nutrient retention is usually low to medium.

Coarse textured soils are usually characterized by poor productivity. They are very susceptible to wind erosion, but if care is taken to maintain adequate levels of organic matter, they can be greatly improved. Because they are so well aerated, organic matter disappears rapidly, so maintaining water stable aggregates is a challenge. Moisture and nutrient retention is usually low.

Estimating Soil Texture

The texture of soil is important because, along with the amount of organic matter, soil texture determines the pore space available for holding air and water in soil. Because of this, certain crops grow better on different types of soil.

Feel Test

It is possible to estimate soil texture by evaluating the “feel” of the soil, both when it is dry, and when it is wet.

Dominant Separate	Dry Feel	Wet Feel
Clay	Hard	Sticky
Sand	Loose	Gritty
Silt	Powdery (Soft)	Soapy

Dry Consistence Test

Another way to evaluate the dry "feel" of soil material is to test its response to an applied force. Take a lump of dry soil approximately the size of your thumbnail. Squeeze it between your thumb and forefinger. Note the pressure needed to crumble it. Soil with a high level of clay would be so hard that it feels as if you would cut your fingers before the lump breaks. Loam soils with a mixture of clay and sand will be firm but can be broken with difficulty. Soil with more sand than clay is very fragile and breaks easily.

Moist Cast Test

Compress some moist soil by clenching it in your hand. If the soil holds together (forms a cast), then test the strength of the cast by tossing it gently from hand to hand. The better it holds together, the more clay is present.

Ribbon Test

Moist soil is rolled into a pencil shape, and then squeezed out between the thumb and forefinger, to form a ribbon. The longer and thinner the ribbon, the more clay is in the soil.

Activity

Match the soil property with its effect:

I. Soil Texture	a) Amount of water and air
II. Soil Structure (organic matter)	b) Drainage and workability of soil
III. Soil Porosity (space not taken up by soil).	c) Movement of air and water

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Soil Water Capacity

Although bits of soil seem to fit together tightly, there are spaces between them. These spaces are filled with air or water. If all the spaces are filled with air, the plants will die of "drought". Plants need both air and water in soil to grow well.

If drainage is good, there is usually no problem with having too much water in soil. The excess will run away into underground water sources deep in the earth. Sufficient water is retained in soil by physical forces.

Different types of soils will hold different amounts of water. A sand grain is very smooth and doesn't hold water very well. Clay particles are built like stacks of coins. There are lots of nooks and crannies to hold water. The amount of water a soil will hold depends on the amount of sand and clay, and the drainage.

Land Restoration

Soil conservation includes the restoration of damaged land into productive use and not just halting further damage. Stabilizing gullies and reclaiming saline seeps will increase food production, and increase workable land acreages. Controlling flooding also adds to the usable land base. Considering how important it is to maximize crop potential and farm profits, every acre of usable land is a valuable commodity.

Activity

- Select two or more soils that differ in colour or texture. Try to get a sandy soil, and a clay or silty soil.
- Fasten a piece of cloth over one end of two tubes (cans with both ends removed would work), with a rubber band. Fill the containers with equal amounts of different soils.
- Place them over two jars of equal size. You may need to put three nails in each can at equal height to help hold them in the neck of the jar.
- Add equal amounts of water to each container, about ½ the volume of soil. Avoid pouring water into the jar below.

How long between the time when the water was added and water began coming through the soil?

_____

How long after you added the water did water stop coming through the soil?

_____

How can you change a soil's ability to hold water?

_____

_____

_____

_____

_____

TILLAGE

Roll Call Name something involved in the preparation of a seedbed.

Preparing a Seedbed In Saskatchewan, land is sometimes prepared for cropping by a combination of tillage and herbicide application. This work often begins in the fall, and is finished in the spring just before seeding. Some of the main jobs that have to be done before a crop can be planted are:

Crop Residue Management If the straw is not baled, it will have to be evenly spread over the field. A good chopper/spreader on the combine will make this easier. If necessary, harrows will also spread the trash.

Some seeders have difficulty working through a large amount of straw and chaff. Tillage with a cultivator or disk will bury some of the residue, making it easier for the seeder. However, soil needs some standing stubble and trash on the soil surface for erosion protection over the winter and spring. The trash should not be buried.

One pass with a tandem disk, or a couple of passes with a cultivator is all the fall tillage that should be done on a field that will be cropped the next year. The amount of tillage needed will depend on the type and yield of the previous crop. Heavier crops produce more trash, and more tillage may be required to prepare these fields for seeding. Fields that will be summerfallowed the following year should be sprayed or cultivated only.

Weed Control Pre-plant herbicides will control weeds in the next year's crop and can be applied in the spring or fall. Generally these chemicals require two passes with a cultivator or disk for proper mixing in the soil.

Pre-plant liquids should be used only in the spring. Most liquids must be applied on fields that have less than 25% trash cover. After two passes for incorporation, there will be almost no cover left and the soil will be vulnerable to erosion. The producer must decide if applying the granular form in the fall will leave enough surface cover to protect the soil from erosion.

Tillage early in the fall will bury weeds and volunteer grain seeds. These seeds will germinate and start to grow in the fall, and die during the winter. Winter annual weeds, such as stinkweed, germinate in the fall and remain alive during the winter. Fall tillage will uproot and kill these weeds.

Incorporate Fertilizer

Fertilizer that is not placed in the ground at the time of seeding is applied **prior** to seeding. Nitrogen applied in the form of anhydrous ammonia can be chiseled or knifed in with little soil disturbance.

Granular fertilizer can be broadcast on the surface of the soil and harrowed in.

Final Seedbed Preparation

As a general rule, the less tillage that is done, the better. Each tillage operation costs the farmer time and money. Excess fall tillage buries trash, leaving the soil more vulnerable to erosion. Spring tillage can dry out the soil, and rob the growing crop of moisture.

If crop residues are light, the only tillage that may be needed is a shallow cultivation to kill early germinating weeds. Many farmers seed with no prior spring tillage.

Water Hazard

Soil should not be tilled when wet! Heavy equipment on wet soil compacts the soil and subsoil. This results in impaired drainage, increased erosion during heavy rains and reduced root growth. Crop yields will be reduced. An easy method of determining if soil is dry enough for secondary tillage is called the **Worm Test**.

Grab a handful of soil from the top 7.5 cm of the soil. Squeeze the soil into a hard ball with your hands. Do not add water. Roll the ball in your hands to form a worm. If the soil falls apart before the worm is 1 cm in diameter, it is dry enough to till; if the soil can be rolled into a long thin worm less than 1 cm in diameter, it is too wet to till!

How do we Decide What Type of Tillage to Use?

Every farm is different and therefore requires different tillage practices. There are probably other members in your club with the same crop who used different tillage equipment than you used. When should we do tillage? Spring? Fall? Maybe we don't need to tillage. To make these decisions we need to know:

1. Soil texture of the field.
2. The previous crop grown.
3. The crop to be grown.

1. Tillage for Soil Texture

The soil moisture content at the time of tillage determines, to a large extent, whether the right size granules and soil structure will be achieved. Tillage with suitable implements, properly adjusted at the right speed and depth, in soil that is at the right moisture content will provide a seedbed with the desired granular structure rather than a powdery or excessively lumpy structure.

For coarse textured soils, where the sand grains do not usually come together as granules but stay as separate grains, this optimum moisture content occurs when only the small pores are full of water, and excess water has an opportunity to drain from the large pores. Sandy soils offer little resistance to tillage equipment, and are easily worked into a fine or excessively fine condition making them susceptible to erosion.

Very fine textured clay soils generally develop much stronger structured granules (clods) than sandy to medium textured soils, since they contain greater amounts of clay that help bind the soil particles together. The time for tillage on these soils is when the soil is slightly drier than field capacity. At this stage, clay clods will fall apart easily into granules. The granules will not survive for long under a beating rain, but they will be helpful while they last. Clay soils, particularly those low in organic matter, have a very narrow moisture range during which tillage is most effective. Fine textured soils offer more resistance to tillage equipment because clay has a much greater stickiness than sand or silt. Working fine textured soil when too wet can destroy good soil structure and cause the soil to puddle or form a compact mass of large hard lumps that make a poor seedbed. It is difficult to prepare a good seedbed if soil is dry or cloddy. Dry, fine textured soils pulverize easily with the granules, breaking down into a fine powdery surface susceptible to erosion and crusting.

Medium textured soils are best worked when moist. Weak to moderately weak clods may be seen, and may stick to tires and equipment when wet. If these soils are tilled frequently to excessively fine condition, and then exposed to rains, they may become hard, crusted at the surface as they dry, poorly aerated and slow to dry. Medium textured soils with high organic matter content usually have a reasonable granule structure; however, improper management and tillage over a period of years will result in poor structure.

2. Tillage for the Previous Crop Grown

Many crops are beneficial to the soil because they add organic matter. The increased organic matter improves soil structure. Crops such as grasses, legumes, forages and grain may improve soil structure. Tillage practices need not be so intensive following these crops.

3. Tillage for Crop to be Grown

How fine and shallow you work the seedbed depends on the seed size of the crop to be grown. Small seeds such as alfalfa need a finer seedbed and therefore require more tillage.

Contour Tillage

Where land is tilled across the slope of a hill rather than up and down, the land is protected from water erosion caused by water running downhill. Each cultivator furrow acts as a small dam to stop the water from flowing downhill; improper tillage can lead to erosion.

Adjusting Tillage Equipment

Equipment should be properly adjusted and properly maintained. Disks and cultivator shovels should be sharp and set at the proper working positions. The main adjustments that need to be made to tillage equipment include: Speed, Depth, Width of Implement, Spacing of Shanks and Angles of Cut.

When using a piece of equipment, check to see whether it is doing the job you want it to do. Walk over the cultivated areas, observing how deep the machine is penetrating, and whether weed seeds are being buried and to what depth. Soil loosened by tillage appears to be worked deeper than it actually has been. Scrape away the top layer of soil to see how far down your tillage equipment is operating.

Tillage equipment is properly adjusted when it:

- Pulls straight
- Cuts desired width
- Cuts to a uniform depth
- Operates as it was designed to

Adjustments to tillage implements may vary according to soil and field conditions, including the level of moisture in the field, the amount of crop residues, the purpose of the tillage, soil characteristics, etc.

Side draft refers to a machine not pulling “in line”. Causes of this include:

- Improper hitching set-up
- Tractor positioned wrongly to implement
- Implement adjusted wrongly (i.e. toe in on wheels, etc.)

It can be corrected by adjusting the wheel direction, hitch, toe in, etc.

Depth Control

If you double the depth of cultivation, you increase power requirements by approximately four times. Deep cultivation may bring up clay-like subsoil that is not beneficial to crop production. It also brings dormant weed seeds to the surface where they germinate and grow.

While tillage equipment is being used, the implement may need to be readjusted hydraulically, as field conditions vary to maintain a uniform cutting depth. Factors that affect the depth control on tillage equipment include:

- Weight of equipment
- Hardness of soil
- Suction action of loose soils
- Levelness of equipment
- Line of draft
- Operational speed

Speed

The speed of travel is usually critical. Operating tillage equipment too fast can cause the soil to be crushed too fine, shallow and uneven tillage and trash to be buried more than is necessary. These increase the risk of wind erosion, and can make seeding more difficult. Selecting the appropriate speed for the type of implement being used and purpose of the tillage operation is important for the machine to be operated at optimum speed, to get the maximum amount of work done in the minimum amount of time while still maintaining a high quality of tillage. This means reducing time lost, which may mean operating at less than maximum possible speed.

Field efficiency – "amount of work done compared to possible amount of work done if no time were lost". Types of time loss include unplugging, repairing equipment, cornering, etc.

Speed and the size of equipment determine the machine capacity per hour. Speed affects field efficiency because as speed increases, so does the possibility of more plugging and breakage, etc. Increasing the speed may or may not increase field efficiency, if it will ultimately mean more stops, or reduce the quality of the tillage job.

Factors that affect speed selected for tillage:

- Type of implement used
- Effects of speed on capacity (e.g. increased speed may cause more plugging)
- Amount of tractor horsepower available
- Costs of higher speed (e.g. fuel consumption, wear, damage, etc.)
- Operator skill
- Quality of tillage operation (e.g. resulting soil conditions, trash cover, seed control, etc.)

Summer-fallow

Summerfallow has been linked with several soil problems in recent years, including:

- Soil erosion
- Decrease in soil organic matter
- Decrease in nutrients
- Increase in saline seeps

If possible, summerfallow should be avoided. The following are general cropping rules:

- Continuous cropping is recommended for soils in black soil zones.

If summerfallow is used, aggressive tillage should be minimal to maintain surface crop residues. The residues will prevent soil erosion and decrease evaporation from the soil surface. Herbicides can replace some tillage operations. Research comparing chemical fallow with conventional and minimum tillage fallow found the following:

1. The chemical fallow used only herbicides for weed control. The chemical fallow had the highest cost per acre, but also had the highest yield.

2. The minimum tillage plot used a combination of herbicide and tillage. Minimum tillage had the lowest cost per acre.

3. The conventional fallow used tillage alone (four passes with blade and one with cultivation)

Breaking Forage Land

Forage land creates a special tillage problem, because it is difficult to create a good seedbed out of old sod. Usually the breaking of forage land is expensive and time consuming.

Three methods are presently used:

1. <u>Plowing</u>

The old sod is cut into strips and these strips are inverted so that the sod is buried. The plow fractures and loosens the soil under the sod. Subsequent passes with disk implements cut up the sod into small pieces. The final seedbed is produced with additional cultivation and harrowing.

Because plowing buries all residues, the soil may be prone to wind and water erosion during the winter.

2. **Disking**

   The old sod is cut up with a heavy disk implement. This method requires more additional passes to work the sod into a satisfactory seedbed.

3. **Chemical**

   The old sod is killed by an application of herbicide. The seed are placed into the sod with a specialized seed drill.

EQUIPMENT

Roll Call

How many lubrication points are there on the different equipment used in the production of your crop? List the name of the pieces of equipment being used, the number of grease nipples to check before using the equipment, and identify whether you know where to find them all.

Equipment	Number of Lubrication Points	Do you know where they all are? (Please Circle)	
Power Unit (Tractors):			
_____	_____	YES	NO
_____	_____	YES	NO
_____	_____	YES	NO
Tillage Equipment			
_____	_____	YES	NO
_____	_____	YES	NO
_____	_____	YES	NO
Seeding Equipment			
_____	_____	YES	NO
_____	_____	YES	NO
_____	_____	YES	NO
Applicator(s)			
_____	_____	YES	NO
_____	_____	YES	NO
_____	_____	YES	NO
Harvesting Equipment			
_____	_____	YES	NO
_____	_____	YES	NO
_____	_____	YES	NO
Transportation			
_____	_____	YES	NO
_____	_____	YES	NO
_____	_____	YES	NO

Make it a goal that by the end of this unit you will have found all the grease nipples that require attention before using any of the equipment in your project.

Servicing Tractors and Self-Propelled Equipment

When servicing or repairing any equipment, it is important that you always properly and safely block the equipment to keep it from rolling or falling. Identify any possible fire hazards, remove any crop residues, and have water or a fire extinguisher handy.

The Engine:

When taking any tractors or self-propelled equipment out of seasonal storage, be sure to check for bird nests, mouse nests, etc., in the engine and exhaust systems. You may need to recharge the battery and check that any hydraulic systems function properly, and all controls are free to move properly.

Check and change the oil, if needed. Check all fluid levels. Check the cooling system - look for such things as a clean radiator, and that air cooling passages are cleared. Check the fan belt condition and tension. Clear fire hazard areas. Perform minor tune-ups, such as changing plugs and points, as needed. Perform air precleaner service and sediment bowl service.

Running Gear:

Inspect and service the running gear and steering linkages, such as steering clutches (linkage), tires, wheel mounts, counterweights, brakes, etc. Also, check for mud buildup between wheels.

Safety Equipment:

User-guards for machinery at points where accidents frequently occur such as the chains, pulleys, sprockets, gears, rollers and power-take-off (PTO) shafts have made modern farm equipment much safer. However, these devices are of little use if they are not in place. These guards must be put back in place each time the machine is serviced. Accidents often occur when arms, legs, loose clothing or hair is caught in fast moving parts of equipment. A PTO shaft is perhaps the worst machinery hazard, because it moves so quickly, and with such force that anything coming in contact with it will catch and begin to wrap around. Its power is so great that it can pull off a person's arm or leg in a matter of seconds. The PTO on most tractors comes fully shielded; however, accidents usually occur when these shields are not put back in place after servicing.

Speed of Operating Equipment

There is a preferred speed range for each field operation. In some cases, a faster speed is necessary to make an implement work properly. Some calibrated operations require a precise and constant speed. Still others may need to be quite slow.

It is a good idea to make an accurate speed check, because speed indicators may be affected by time, size, field conditions and other factors. Speed is measured in km/hr. The speed of a tractor is calculated by determining how far the machine travels in a given period of time.

$$\textbf{Speed} = \frac{\textbf{Distance}}{\textbf{Time}}$$

Check the speed for one minute. Measure how many metres the equipment traveled and convert to km (1 km = 1000m). In one hour, the distance traveled would e 60 times as far because there are 60 minutes in an hour.

Example: In one minute your equipment traveled 188.5 metres. 188.5 metres = 0.1885 km x 60 minutes = 11.31 km/hr.

When you know the length of the field, you may also calculate speed by measuring the time it takes for the equipment to travel the length of the field at the speed it is set at.

Example: If the field is 280 m long, and it takes you 1 minute and 45 seconds to travel that distance, then the equipment is traveling at a speed of:

280 m – 0.25 km

$$\frac{1.75 \text{ min}}{60 \text{ min/hr}} = 0.029 \text{ hr}$$

$$\text{Speed} = \frac{\text{Distance}}{\text{Time}} \qquad \frac{0.28 \text{ km}}{0.29 \text{ h4}} = 9.7 \text{ km/hr}$$

Farm Equipment Management

Farming operations usually involve several different crops, each one having its own tillage, planting and harvesting requirements. Lack of adequate equipment may mean not getting crops planted or harvested on time. If key operations are delayed, yields may be reduced.

Some suggestions for improving your machine management skills:

1. Keep complete records of fieldwork done by various machines, and the number of working days available for critical field operations.
2. Know the average capacity of machines, and the number of workdays available.
3. Know how to estimate costs for any machine, and how to combine costs of machines to estimate total cost for an entire system.

4. Know how to improve equipment reliability, and work towards eliminating unnecessary downtime.
5. Improve field efficiencies with machines to cut costs, and complete more work in the available time.

Being able to make some calculations is useful for management of machinery, as well as for making decisions about equipment used in crop production. Some helpful calculations to make in evaluating machinery, and operator performance include:

Equipment Capacity

Using full machine width is one important way to more efficiently use labour and equipment. The greater the average width of cut, the greater the capacity. Every machine should be used as close to its full width as possible.

It is important to understand how to estimate capacities of machines. It is also important to know for selecting power units and equipment that can complete important field operations on time. This can help to avoid the added expenses of owning machinery that is larger than necessary.

Equipment Capacity (measured in acres-per-hour) is calculated using:

Speed: The average rate of travel expressed in km/hr.
Width: The distance in metres across the processing portion of the machine.

Larger machines mean lower labour costs. Large tractors, for example, have plenty of power to complete big acreage jobs in a hurry. However, smaller tractors cost less per hour than larger tractors, and this cost is also important to take into consideration.

Theoretical Capacity:

Theoretical capacity is the maximum possible capacity obtainable at a given speed, assuming the machine is using its full width.

Example:

The theoretical capacity of a tractor pulling a disk that is 4.3m wide and traveling at 8 km/hr would be:

- Distance (metres) traveled in 1 hour at 8 km/hr x 1 hr = 8 km = 8000m

Assuming the disk always cuts the full width, every hour it would cover:

- 4.3 m x 8000 m/hr = 34,3400 m^2/hr

Because there are 10,000 m^2 in a acre, the theoretical capacity of the disk is:

- 34,400 m^2/hr = 3.44 acres per hour 10,000 m^2

Theoretical capacity cannot be sustained for long periods of time, because any field operation will be interrupted by turns, filling hoppers and breakdowns. Yet, it is valuable information; it gives the maximum capacity that can be used as a basis for evaluating performance of machines and their operators.

Effective Field Capacity:

The best way to determine the **effective field capacity** of a machine is to make an accurate check of the number of acres actually covered for tonnes handled over a period of time:

Example:
If a 4.3m disk actually covered 28 acres in 10 hours, with no breakdowns, its effective field capacity would be:

$$\frac{28\text{ h}}{10\text{ hr}} = 2.8\text{ acres/hr}$$

Calculating the use of a piece of equipment over a longer period of time can provide a clearer picture of its effective capacity. An average can be calculated for a two to four week period using the total number of acres covered, divided by the total number of hours in the field.

Example:
Total area covered = 194 acres
Total time in the field = 76 hrs

$$\text{Effective Field Capacity} = \frac{194\text{ acres}}{76\text{ hours}} = 2.55\text{ acres/hour}$$

Effective Field Capacity for Forage Equipment:

The effective field capacity for hay and forage equipment is calculated using **Tonnes-per-Acre** as the unit of measure.

For a forage harvester chopping a swath of alfalfa that yields 2.5 tonnes per acre, its effective field capacity would be expressed in tonnes per hour. If 40.5 acres of the alfalfa is chopped in 10 hours with no breakdowns, or other delays, its effective field capacity would be:

$$\frac{2.5\text{ ton/acre} \times 40.5\text{ acres}}{10\text{ hours}} = 10.125\text{ tonnes/hour}$$

Calculating the use of a piece of equipment over a longer period of time can provide a clearer picture of its effective field capacity. An average can be calculated by using the total tonnes harvested divided by the number of hours in the field.

Example:
Total Tonnes Harvested in 1 Month = 1452.5 tonnes
Total Hours in the Field = 192 hours

$$\text{Effective Field Capacity} = \frac{1452.5 \text{ tonnes}}{192 \text{ hours}} = 7.6 \text{ tonnes/hour}$$

Field Efficiency:

Efficiency: The ratio of the effective capacity of the machine to its theoretical capacity. It is an indicator of how much time is spent working, versus turning, filling hopper and other jobs.

Field Efficiency is calculated as a percentage using both the Effective Field Capacity and the Theoretical Field Capacity.

$$\text{Field Efficiency} = \frac{\text{Effective Field Capacity}}{\text{Theoretical Field Capacity}} \times 100$$

A comparison of the one-day and one-week field efficiencies shows a mistake commonly made by farm operators or managers. The mistake is the natural tendency to remember only the best working days, and to use these capacity figures for planning and scheduling purposes. When scheduling operations or sizing machines for the future, use realistic field capacities, as determined over the full season of use.

Fuel Consumption Per Hour:

Dealers and other growers may provide a reasonable estimate of fuel consumption for a machine with which an operator has no direct experience. Information on owned machines may be obtained from the previous year's records. Actual cost per hour will vary with field conditions, load slippage and topography on a particular field.

Equipment Safety

The principal types of farm machinery accidents involve the victim being caught in the machines, or being crushed. Accidents can be avoided with a minimum of effort. Recognizing possible hazards and taking steps to avoid them is the first step in the operation of any piece of farm equipment. An equipment operator with a good safety attitude takes good care of equipment, and operates all machines carefully and correctly.

Driving Farm Equipment

Be aware of how to properly drive a tractor up a hill, how to pull a load up a hill, and what to do if you must operate farm machinery on slopes. Careless handling of large fast-moving equipment is bound to end in tragedy.

Electrical

Most electrical farm accidents are the result of contact with overhead supply lines, or buried power lines. Operators moving high clearance portable equipment must always be aware of the dangers involved in contact with power lines.

Extension cords are also responsible for many electrical accidents each year, because of improper grounding or worn out cords. The cord must not be in the work area where it could be cut or damaged, and it must not be a hazard to people walking over it.

Fire

Each year, fires claim many lives and destroy valuable property. The primary causes of fire include:

- The intentional setting of brush and trash fires that get out of control,
- Improperly disposed matches or cigarettes, and
- Electrical short circuits.

It is essential to have fire extinguishers close by – ones that are matched to the job they are designed for. The four main types of fire extinguishers area:

- Water pumps or pressurized water
- Carbon dioxide
- Liquid gas
- Dry chemical

Activity

Match the left with the answers on the right.

1. Hydraulic fluid is under tremendous pressure, and a small leak could inject fluid into your body tissue causing a serious health problem. Check hydraulic for leaks with this.
2. Farmers are injured while repairing or unplugging farm machines when the machines are left in this condition.
3. Four things you can do to lift an overturned tractor.
4. Serious eye injuries using this power tool is a result of poor housekeeping with excessive build up of metal filings.
5. Statistics indicate that this hand tool is the leader in tool related injuries.
6. The height legally allowed for a vehicle and its load on Saskatchewan highways.
7. This is the third leading cause of farm accidents after machinery and animals.
8. To move a grain bin that is higher than 5.3 metres on any secondary or rural highway, who should you contact?
9. Using a screwdriver to do this "jolts" the user.
10. Without a Dimensional Permit, this is the maximum distance you can move a grain bin on a secondary road.
11. Which tractor would have the highest percent of its annual costs as fixed cost? A large tractor used 400 hrs/yr or a small tractor used 800 hrs/yr?

a) 60 kilometres during daylight.

b) Another tractor, a tow truck, a hydraulic jack or an air bag.

c) Anything higher than 4.5 metres requires an over height permit.

d) Cardboard or wood. Never use your hands.

e) A drill press.

f) Keep going. Don't stop. If a fire starts and you must get out, then hop clear of the machinery and land with your two feet close together. Continue hopping with the two feet together for about 20 metres.

g) Running.

h) Starting the tractor with a screwdriver across the starter posts.

i) The local utility company.

j) The jack-all.

k) Tools. 40% of far accidents occur while doing repairs and maintenance.

FERTILIZER

Roll Call Name something that affects the nutrients supplied to a crop.

Fertilizer Application

Nitrogen Fertilizers:

Nitrogen is the most important element in plant growth. Nitrogen can move in moist soil, and need not be applied near the seed.

Nitrogen can be applied in a band at a depth of 10-15 cm, as in the case of **anhydrous ammonia application**.

It can also be drilled in prior to seeding, with the seed or broadcast on the soil surface and incorporated. Too much nitrogen drilled with the seed can reduce germination. The amount that can be safely drilled with the seed varies with the crop grown, the soil texture, moisture conditions, and the type of nitrogen fertilizer you use. The following ranges can occur in the amount of nitrogen that can be safely drilled in with the seed:

- Wheat – 22 to 44 kg/acre
- Oats or Barley – 16 to 28 kg/acre
- Small Seeded Crops (Canola, mustard, flax, alfalfa, etc.) – no more than 11 kg/acre

Nitrogen fertilizers can be applied in either spring or fall. Fall applications are not recommended on poorly drained sites where soil remains saturated or flooded for longer periods in the spring, because significant losses of nitrogen can occur under these conditions through a process called **denitrification**. Soil temperatures should be below 10^0C before nitrogen is applied in the fall. Top dressing of nitrogen on cereals after emergence can be effective up to the short-blade stage. It should be considered when severe nitrogen deficiency symptoms appear early in the growing season.

Phosphorus Fertilizers:

Since phosphorus fertilizer does not move readily in soil, it must be placed near the seeding roots to get the best results. Phosphate fertilizers should be applied with, or near the seed for annual crops. Broadcast application may cause a delay in response due to the slow movement of phosphorus. Thus, where this method is used, as on established forages, a broadcast application may give response in the year following application. Phosphate fertilizer should be worked into soil prior to seeding perennial forages on soil that is very deficient in phosphorus.

Potassium Fertilizers:

Potassium will move in soil more readily than phosphorus, but for annual crops, better results are obtained from application drilled with or near the seed. The maximum amount that may be safely placed with the seed is 33 kg/acre for small seeded crops.

Broadcast application can be used on either spring or fall at about twice the rate used for applications that are drilled into the soil.

Sulphur Fertilizers:

Sulphur moves readily in moist soils when in the sulphate form. Therefore, soluble sulphate fertilizers provide good results either as broadcast or drilled-in applications.

Preparation and Calibration of Fertilizer Applicators

Granular:

Before using a granular applicator, be sure to check:

- Proper cleaning, no old fertilizer, corrosion, etc.
- Tire inflation.
- Chains and sprockets, including tensions, alignment, lubrication, etc.
- Belts are in good shape.
- Spreading width adjustment mechanism, and that the close off mechanism is in proper working order.
- Shafts are free to rotate, including PTO shaft, joints and shields.

To determine field speed required for the proper rate of application:

- Locate the charts in the operator's manual, or on the machine. Chart settings - refer to specific ground speeds.
- Identify the units of measure (lbs/acre or kg/acre).
- Recognize and understand the fertilizer being used (11-51-0).
- Determine the width of application.
- Calculate the area to be covered.
- Determine the proper setting for desired rate of application based on speed.
- Take into consideration differences in flow rate between different brands and types of fertilizer.

Note: If a fertilizer recommendation is given in kilograms/acre and the machine is calibrated in pounds/acre, set the machine at 10% less than the recommendation, and you will obtain the rate that is required.

Anhydrous Ammonia:

Before using anhydrous ammonia application equipment, be sure to check that:

- Shut off valve is working properly.
- Hoses, fittings, etc. have no leaks, and are tight.
- Make sure all hoses/runs are operating to maintain proper pressure.
- Shank points are in good shape, and nozzles are not plugged.
- Breakaway is working properly.
- Water tanks are filled with no leaks.
- Brakes on tank work for safe transporting.

Note: Never leave the control mechanism operating while machine is stopped.

The operating volume to be applied is determined by the desired lbs/acre and ground speed appropriate to the field conditions.

Operating Fertilizer Equipment

Speed depends on the desired application rate, and terrain conditions. Problems with excessive speed include machine damage and poor spreading patterns. Appropriate speed and spray pattern are selected to apply desired amount of fertilizer. Proper use of gauges and metres on the machine help to ensure that the desired amount of fertilizer is being applied.

Calculating Nutrient Costs and Fertilizer Rates

The Federal Fertilizers Act requires that all fertilizers be labeled with their guaranteed minimum analysis according to the percentage of nitrogen, phosphate and potash. Fertilizer cost is related to its nutrient content. When buying, compare prices on the basis of per kilogram (pound) of nutrient contained, not the price per tonne of material.

Nutrient costs are calculated as follows:

Example:

One tonne (1000 kg) of Urea (46-0-0) contains 46% nitrogen. At a cost of $290/tonne, the cost per kilogram of the nitrogen is:

$$46\% \text{ of } 1000 \text{ kg} = \frac{46}{100} = \frac{X}{1000} = 460 \text{ kg}$$

In one tonne of Urea there is 460 kg of nitrogen. The cost of the nitrogen is $290/460 kg = $0.63/kg.

SEED

Roll Call

Name something that seeds provide us with to eat:

_____

Seed Treatments

There are various seed treatments available that are used for specific purposes. Some reasons for treating seed before seeding may include:

- To increase a stand yield.
- To improve the vitality of the seeds and plants.
- To increase nitrogen fixation.
- To prevent diseases.
- To prevent insect damage to the seed.

Pre-treated seed is available from seed cleaning plants, and seed distributors. Consider the cost/effectiveness of this option. Make sure proper arrangements are made to ensure that treated seed is available when it is needed.

Some seed treatments can be done on the farm. Be sure that you select the correct treatment for your seed, and follow all of the directions carefully. The only way to know if your seed treatment is effective is if it accomplishes the purpose for which it was selected.

Hazards of Seed Treatments

Seed treatments pose a danger to people and livestock. Practices that could reduce dangers when treating seed or handling pre-treated seed include:

- **Read** and follow all label directions.
- Be sure to take all necessary **safety precautions** outlined on the label.
- **Dust inhalation** – wear a mask or respirator.
- **Contact with skin** – wear gloves and cover skin.
- Keep treated seed **securely contained**, away from livestock to avoid the danger of livestock poisoning.
- Stay upwind of pouring grain to **avoid any dust**.

Inoculation of Legume Seed

Inoculation is the addition of nitrogen fixing bacteria to legume seed, to ensure an adequate supply of these bacteria in the soil where the legume is to be grown. Suitable bacteria may be present in certain soils. However, knowing whether inoculation is needed is difficult, and the cost of the inoculums is very small. Bacteria for inoculating legume seed may be purchased from seed sellers, usually with powdered peat moss. Do not use inoculums after the expiry date. Store inoculums or inoculated seed in a

cool, dark place, or in a refrigerator. Inoculation ensures sufficient amounts of the correct strain of bacteria are present in the soil.

When purchasing inoculants, ensure that it is the proper inoculants for the type of seed. Consider the supplier's reputation and ensure proper storage conditions (e.g. cool, dark, dry). Check the expiry date, and use a sticking agent to ensure proper coating of the seed.

The addition of nitrogen-fixing bacteria to legume seed is known as inoculation. After the seed has germinated, the bacteria infect the roots of the seedling, on which small, pinkish nodules are formed. Here the bacteria convert nitrogen from the air into a form that the host plant can use. This association between the plant and bacteria is helpful to both, and takes place only with legumes. The plant provides the bacteria with carbohydrates, and the bacteria fix atmospheric nitrogen for the plants. The atmospheric nitrogen is changed to amino acids that can be used by the legume plants to manufacture protein.

There are differences between strains of legume bacteria. You must apply the right kind of inoculums to the seed you wish to treat, or the bacteria will not infect the seedlings. The legume bacteria are classified into the following groups, and each group requires a special strain of bacteria:

1. Alfalfa, white sweet clover, yellow sweet clover
2. Red clover, alsike clover, white clover
3. Birdsfoot trefoil
4. Sainfoin
5. Crownvetch

The inoculants should be applied with a sticky liquid so that it will stick to the seed. Two tablespoons of corn syrup in a litre of warm water will help the bacteria stick to the seed. Use just enough to dampen all seeds. The inoculums powder is then sprinkled over the seed and mixed with it. Seed should be planted as soon as possible after it is treated, careful not to expose the inoculated seed to direct sunlight. Do not mix inoculated seed with fertilizers or chemicals.

When sowing inoculated seed, ensure that the seedbed has been properly prepared (e.g. firm and moist). Ensure that the equipment has been properly calibrated, and the seeder is appropriate for seeding small seed. Make sure that the seeds are adequately covered with soil, and not left exposed to sunlight.

Seeding Equipment Preseason Inspection

Before seeding, your equipment should be carefully inspected, paying close attention to the following components:

- Bolts and fasteners – is loose or missing, use proper replacements
- Disks – Damage, replacement, proper spacing
- Condition of chains, gears, sprockets, etc.
- Missing, broken or plugged grain tubes, fertilizer tubes
- Tension springs, seed cups, metering mechanisms
- Packers
- Tires, including pressure, condition and wheel bearings
- Remove rust, residues, etc.

For all equipment, lubrication is very important. Ensure that you have an operator's manual for all equipment to help you identify all the preseason lubrication needs, select the proper lubricants and complete any needed service.

- Inspect and change where necessary, oil and grease, e.g. gearboxes, wheel hubs, etc.
- Inspect any seals or glands.
- Watch for any missing nipples, and replace them as necessary.
- Be sure to use the proper lubricants in proper places.

Key points of inspection of drive mechanisms:

- Gears, sprockets, bushings in gears
- Gear alignment
- Chains, including condition, tension, alignment, etc.
- Shafts, including alignment, couplings between boxes, no bends, etc.
- Shear pins
- Drive wheels, including slippage, proper inflation, etc.

Worn or damaged parts should be replaced with proper replacement parts. Ensure that your equipment has been properly reassembled and is in proper working order after any repairs.

Seeding Rate

The rate at which you wish to seed your crop depends on the type of crop you are seeding, the climate, moisture content of the soil, soil nutrients, soil carrying capacity, etc. The recommended rate of seeding for each crop will vary from area to area, and from year to year. Rates of seeding should be lighter in the drier areas, and heavier where moisture is more abundant.

Calibrating the Seed Implement to Establish the Desired Seeding Rate

How much seed per acre you want to plant depends on the seed size.

1. Find the **Flow Rate Chart** in the operator's manual or on the hopper lid.
2. **Identify** the units of measure used (lbs/acre or kg/acre).
3. **Set** the flow rate mechanism to the appropriate seeding for your seed type.

Variations in the actual output, from the table seeding rate settings, may be due to:

- Improper tire inflation
- Drive wheel slippage
- Differences in seed (e.g. weight, size type, moisture content)

Check the actual output by digging down where the drill has already passed. Check for a uniform seeding depth. Count the number of seeds in a small area, and convert to the units of measure used in the setting of the drills. Readjust as necessary to obtain desired output.

Factors Affecting the Flow Rate of Seed

- Seed variety, including size and weight.
- Type of seed treatment used (some are sticky).
- The speed of the drive shaft that drives the metering device.

Depth of Seeding

Determining appropriate depth and seeding rate for different crops and conditions is important. Each seed contains enough plant food to support growth for several days. However, the larger the seed, the more food and energy it can supply to the young seedling. Large seeds germinate faster, emerge from greater seeding depths, and produce stronger seedlings than do smaller seeds. Cereals should be seeded at a depth of 25-50 mm. On lighter soils that tend to dry out quickly, the grain can be seeded down to 75 mm. Canola should be planted at 12-25 mm.

WEEDS

Roll Call

Name a way that weeds cost money.

_____

_____

_____

Timing of Herbicide Treatments

Different herbicides must be applied at different times.

Pre-plant incorporated herbicides are applied to the soil surface and cultivated (incorporated) into the soil before the crop is planted. This type of herbicide application is done in the fall or spring, just before planting.

Pre-emergence products are applied to the planted field before the plants have emerged.

Post-emergence products are applied to the field after the crop has emerged.

How to Identify Crop and Weed Leaf Stages

Recognition of plant growth stages is essential for effective weed and disease control. Many herbicides and fungicides are safe on a crop only when applied at a specific growth stage. Similarly, weeds are controlled only when they are at certain growth stages.

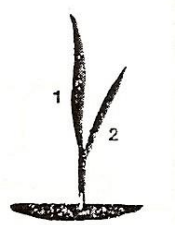
For most post-emergent products, growth stages are described by the number of leaves. The following is a description of how to count leaves for staging.

Cereals and Annual Grass Weeds

Leaves are counted, starting at one for the first leaf, and progressing up the primary shoot. Tillers are important, but not counted as leaves. A leaf should be counted as soon as it emerges, but may be labeled as early, mid or full leaf. The early stage is when it begins to emerge. The full stage is just before the next leaf emerges.

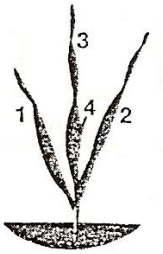
Tillers or stools are the secondary shoots of a grass plant. The first tiller emerges from the axle of the first leaf, the second just above the second leaf, and so on. Tillers generally appear at the 3 to 4 leaf stage. Be sure to identify tillers, and count only leaves on the primary shoot. As well, do not remove any leaves from the main shoot when separating tillers.

1. Leaf Stage

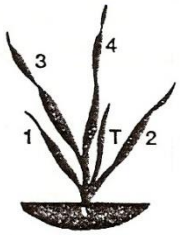


2. Leaf Stage

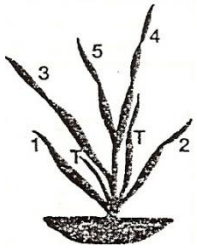
3. Leaf Stage



4. Leaf Stage



4. Leaf Stage (Tillering)

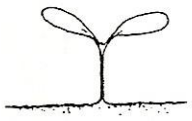


5. Leaf Stage

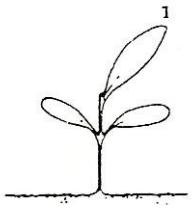
Broadleaf Weeds

<u>Cotyledons</u> – These are the seed leaves that usually emerge above ground. On some plants, such as fababeans, lentils and peas, they stay below the soil surface. Cotyledons are not true leaves, and are not counted when determining leaf number. They are a different shape than the true leaves and may dry up and disappear at an early stage.

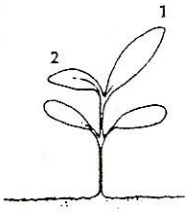
<u>Alternate Leaves</u> – Some plants have one leaf at each node on the stem. The next leaf emerges at the next higher node, and extends away from the stem in the opposite direction. These plants (lamb's quarters and wild mustard are good examples) are said to have alternate leaves. To determine the leaf stage, simply count the number of leaves present.



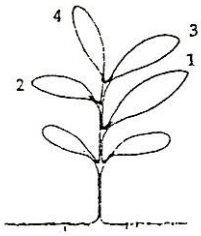
Cotyledon Stage



1 Leaf Stage

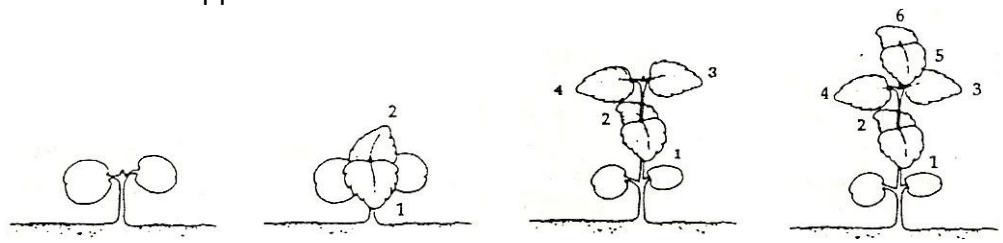


2 Leaf Stage



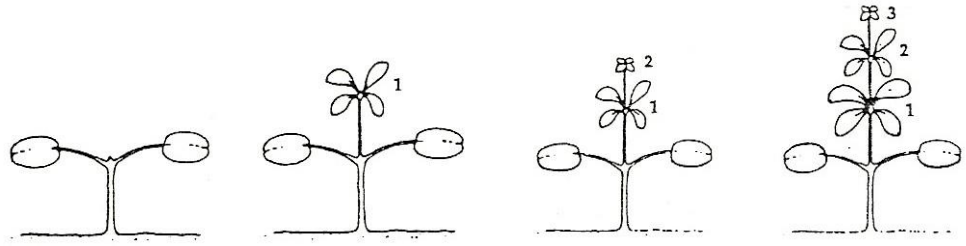
4 Leaf Stage

<u>Opposite Leaves</u> – Plants with two leaves at each node, one on each side of the stem, are said to have opposite leaves. The next pair of leaves on the next node are rotated about 45^0 so that they are not directly over the previous pair. Plants with opposite leaves have even-leaf numbers only. When counting, the leaf number progresses from cotyledons to two leaf, four leaf, etc. These plants generally appear shorter than plants with alternate leaves at a similar leaf stage. Be sure to count each pair as two leaves. Hemp nettle is a weed that has opposite leaves.



Cotyledon Stage **2 Leaf Stage** **4 Leaf Stage** **6 Leaf Stage**

Whorled Leaves – More complex plants like cleavers may have whorled leaves. These plants have three or more leaves at each node on the stem. The leaf number in each whorl may vary, so be sure to count each individual leaf unless the guide or label recommendation refers to the number of leaf whorls.



Cotyledon Stage **1 Whorl Stage** **2 Whorl Stage** **3 Whorl Stage**

Noxious Weeds

Noxious weeds are those that are difficult to control, and may be easily spread. Every responsible citizen should be aware and familiar with the provisions of the **Saskatchewan Noxious Weed Act.**

This law lays out guidelines to people about their duties in keeping their property free from weeds.

- Landowners are responsible in both rural and urban areas. The law says that the landowner is responsible for the destruction of any noxious weeds as often as necessary to prevent the production of seeds.

- The landowners of any rural property are responsible for the portion of any road allowance that adjoins their property. In urban areas, the city assumes responsibility for the roads, streets, boulevards and lanes.

- Other requirements of the law include the safe handling of weed seeds or material containing weed seeds, plus the moving of machinery and other things containing weed seeds.

The purpose of the law is to prevent the introduction of new weeds into clean areas, and also to help farmers cope with costly weed control programs by reducing the chances for weeds to grow and spread seeds onto crop areas.

Preventative Control Measures

Preventative control measures to avoid weed problems include:

Clean Seed: Use only clean seed for planting. This eliminates the introduction of weeds that are foreign to your farm. Be sure to obtain a seed analysis certificate from the seller to determine actual weed content. Species and numbers are listed on the certificate.

Clean Machinery: Check for, and remove all weedy material before moving equipment from a field so that you do not spread weeds to other fields. Seeding equipment should be thoroughly cleaned. Have shovels or disks on tillage equipment cleaned to remove plant parts. Thoroughly clean all harvesting equipment parts that convey grain, hay or straw.

Grain Transportation: Since it is impossible to transport open grain loads without some loss due to wind, weed seeds will be blown onto roadways and adjacent fields. Cover loaded grain trucks to prevent the loss of valuable grain, and to avoid roadside weed infestations.

General Sanitation: Keep populations in check on roadsides, fence lines, shelterbelts and waste areas. Watch for the spread of any new weeds. Contact your local weed supervisor, or weed inspector if new weed problems develop, particularly on roadsides. If screenings are being fed to livestock, be sure to finely grind them for weed seed contaminated grain before feeding. Unground weed seeds can pass through livestock digestive systems unharmed, and the manure may act as a source of weeds in the field. Pile manure for several months so that heating action can destroy weed seeds. Also, keep pastures clean of weeds as livestock movement spreads weed seeds.

Crop Management: A crop must be managed to provide maximum competition to weeds. Rotate crops frequently to prevent crop related weeds from multiplying, and to allow a variety of control measures to be used. Plant crops that successfully compete with weeds.

INSECTS and DISEASES

Roll Call

Name an insect or a disease that might affect the crop you are growing.

_____

There are thousands of species of plants and animals in Saskatchewan. Most are beneficial, some are occasional pests, and a few are always in conflict with human interests.

Destroying plants and animals is not desirable unless they are causing or likely to cause damage. However, most pest control operations (including tillage, pesticides and crop rotations) kill many non-target organisms, as any habitat change will kill or displace many species.

Insects: Some insects are very important as pollinators of many plants. Insects are also an important food source. They are often at the bottom of the food cycle and their presence makes the existence of many other animals possible.

Disease: What is the purpose of having diseases, whether it is in plants or people? Survival of the fittest! Diseases usually affect only the weaker members of a population, leaving the strong to reproduce and populate.

Therefore, we need to be careful about what we kill accidentally. Fortunately many practices decrease the killing of non-targeted species. We can use less pesticide, be careful to apply the pesticides at times when beneficial organisms are less vulnerable, use more specific pesticides and apply pesticides only when necessary. Integrating the use of pesticides with cultural, biological and mechanical controls will also save money and delay the development of resistant pests.

Killing desirable species includes destruction of allies in our competition with unwanted pests. These allies are the predators and parasites of our pests, and accidentally killing them can cause a resurgence of the pest in numbers, even greater numbers than before.

The Pesticide Treadmill

Application of broad-spectrum pesticides has been described as a **pesticide treadmill**. This term refers to the treatment of pests, and the accidental mortality of their predators. The pest population usually recovers faster than its predators, and another pesticide application is required. This may cause a recurring need to apply pesticides to the point where the pest eventually develops a resistance to the pesticide.

Resistance

Resistance is not a unique response to pesticides. Pests develop either resistance or partial resistance to a control measure after repeated exposure to it, because naturally resistant pests are left to repopulate the area each time a control is used. After many generations the entire pest population can become resistant. In other cases, natural or induced changes within the pest can occur (mutations), in which the changed pest (mutant) is entirely or partly resistant to the control. This type of resistance is difficult to predict because it occurs at random. In all cases, however, resistance in pests can be combated through a variety of practices.

Undesirable Pests

If pests (including weeds, insects and disease) are natural, why are they such a problem?

1. **Introduced**: Some pests have been brought in (introduced) to one area from another. It could be from one country to another, or from a forest to a meadow. Problems can arise because these pests have not evolved with the other plants and animals of the area. Sometimes the intruder will not survive. Unfortunately, some times the intruder finds no natural enemies in the new area, and can do extensive damage as it flourishes.

2. **Changing the Environment**: When humans change the environment, pests can become a problem. For example, a meadow has a variety of plants, and is lush and healthy. When the meadow is changed into a one-crop field, problems will occur. Plants that existed in the meadow will compete with the crop. Insects that feasted on the plants in the meadow will now seriously affect the crop. Diseases that may have affected some plants may not be a serious problem. However, diseases in a field with only one crop can be devastating.

3. **Diversity**: The more variety you have, the better chance that things will survive. For example, in a meadow you have a variety of plants. If that meadow is infected with an insect that destroys all of one plant, it will not be as devastating as if only that plant was growing there. All other plants still survive. However, in a field of barley, if you get an insect that feeds off barley roots, the problem will be noticeable and serious.

Know Your Pests

To know how to control pests, knowing as much about them as possible is essential. They are living organisms that are continually reproducing and evolving, and often they evolve in a way that becomes resistant to controls. Important and interesting information can be found in books on pest control, including things such as:

- **How insects survive the winter**: Winters are a problem to insects, but they have evolved methods of overcoming the cold and surviving. In the winter, most insects are dormant. You may find that some dormant

insects are covered with frost crystals, or even frozen stiff. This ought to kill them, but it does not, because some insects can produce their very own "antifreeze" that prevents them from really "freezing." Where an insect spends the winter also affects its ability to survive the cold weather. Just as groundhogs seek the shelter of their underground hole, many insects will seek the shelter of residue, litter and soil. Tillage may be useful for destroying the wintering habitat for some insects.

- **Some insects have natural enemies:** You may see dead or diseased insects infected with viruses, fungi or other pathogens. These are signs of natural pest control. If you know the natural enemies of your pests, you may be able to judge whether they will contribute significantly to killing off the pest so that you don't have to. You can avoid harming beneficial insects during pest control, therefore preventing the pesticide treadmill.

- **Soil pH may affect some diseases**: Certain diseases tend to be associated with alkaline and acid soils. Changing the pH of the soil may be one way to get rid of a disease.

Threshold Populations

The presence of a pest in a crop does not necessarily mean economic damage. Not panicking when you find a pest is important because plants usually compensate for injury caused by small numbers of pests. To gauge when a pest will start having a negative economic impact on a crop, you can find the threshold population.

- This is a measure of the pest density at which control methods should be used, to prevent an increasing pest population from causing economic injury. This density may be the number of pests per plant, pests per square metre, pests per sweep of an insect, percentage of plants damaged in a square metre, or another suitable measure.

This measure is different for every pest, and can be found in pest management publications, such as the following publications:

- Guide to Crop Protection
- Weeds of the Prairies
- Field Scouting Guides

For many pests, this measure is only estimate measure, but it is a useful tool for helping producers decide when pests have increased to a level where control measures are needed. Using population threshold measures as a guide can help to eliminate unnecessary measures.

Activity

Do some research about the pests that may affect your crop. Find out as much about these pests as you can and prepare a presentation for the rest of the club. Include information such as:

- What pests might affect your crops production?
- How to identify them.
- The life cycles of the pests.
- Any interesting characteristics or habits of these pests that you might take advantage of for preventing or controlling them.
- What the threshold population of this pest is for your crop.
- Different methods available for controlling these pests.
- The method of control that you would recommend and why.

Recognizing Herbicide Injury

Many fungal, bacterial and viral infections, as well as insects, can produce plant disorders similar to those produced by herbicides. When using herbicides in field crops, there may be occasions when drift, improper timing, improper rates or unusual weather conditions result in undesirable effects on crops sprayed or on neighbouring crops. Sometimes, what looks like a disease affecting a crop, may actually be herbicide injury. Herbicide injury in a field often displays a distinct pattern. Herbicides may affect leaves, stems, flowers and roots.

Look for alike symptoms:

- Nutrient deficiencies
- Fertilizer burns
- Insect or disease damage
- Weather related injury
- Air pollutant injury

The Use of Insecticides

The infestation and the severity of insect damage vary drastically from area to area, and season to season. Some pests require control during periods of abundance that may last from one to several years. Other pests are perennial, and require control measures each year, such as the sugar beet root maggot, controlled by the application of a granular insecticide with the seed at planting time.

Insecticides will kill the pest insect if applied properly at a stage when the pest is susceptible. An application made too early or too late in the life cycle may not provide adequate control and would be wasteful. To ensure proper use of insecticides identify the pest, learn its habits, food needs, food preferences, reproductive cycle and habitat requirements. Obtain information on pending pest problems and check your records for the

previous years' problems so you are prepared for changes in insect population levels.

Honeybees and other pollinators are susceptible to most insecticides. If applications are made to weeds or crops in bloom, you may kill many bees. To reduce this risk, apply insecticides in late evening when bees are not flying. Advise beekeepers in the area to be sprayed at least 48 hours before application. Never allow insecticide spray to drift directly onto an apiary site. Do not apply insecticide to water bodies.

When using insecticides, be sure to:

- Follow label instructions for proper application.
- Learn the biology of the pest.
- Base control decisions on the amount of foliage, weather conditions, age and size of the insect, and the required dosage.
- Most insecticides have limited residual control properties when applied to foliage. If insects are moving into crops, or emerging over an extended period, several applications in the same season may be necessary.

The Use of Fungicides

Fungal diseases of some field crops may be subject to direct chemical control by fungicides. The control of most other field crop diseases requires alternate methods. The major use of fungicides is the treatment of seeds. Many excellent products are available for effective control of seed-related diseases.

PESTICIDES

Roll Call

Name something that should be done for correct and safe handling of pesticides.

_____

_____

_____

Resistance

Agricultural pests can develop resistance to fungicides, herbicides or insecticides. Resistance is the result of repeated use of one or more similar pesticides over a number of years. Growers should use management practices that prevent or minimize the development of resistance, and prevent the spread of existing resistant populations.

Pests resistant to one or more chemical pesticides occur naturally. Repeated use of one pesticide or of pesticides with a similar mode of action can result in a buildup of resistance, and a loss of control. It is extremely difficult to observe the progression of resistance until a loss of control is observed.

Identifying Resistance

- Loss of control is observed. One pest may escape control while other species are controlled.
- Ensure that the pesticide performance was not adversely affected by weather conditions or misapplication.
- Check field records for evidence of repeated use of one or more pesticides with a similar mode of action.
- Check whether the pest infestation occurred before or after the pesticide application.
- Collect samples of the pest suspected of being resistant and them tested.

Management Strategies to Avoid Chemical Resistance

- Keep accurate records of crop rotation and pesticide use.
- Rotate both crops and pesticides. When rotating pesticides, use products with different modes of action. Avoid repeated use of one or more similar pesticides.
- Use clean seed.
- Use pest resistant crop varieties.
- Use cultural pest controls, including tillage where practical.
- Avoid pesticides with long residual activity.

- Follow label directions regarding management practices.
- Use good sanitation practices. Avoid spreading crop seed, weed seed, crop residues or manure from suspicious fields.
- Use mixtures or split applications of pesticides with different modes of action.
- Follow all label directions and restrictions carefully.

Getting the Sprayer Ready

- Clean, prepare and maintain chemical application equipment. Preliminary maintenance, adjustments and settings must be made according to the operator's manual. The entire sprayer system should be cleaned and rinsed. Lubricate and repair equipment to get best possible performance.
- Ensure that all nozzles are the same size and spray angle by checking the code number on the nozzle tip. Clean, calibrate, and if necessary, replace spray nozzles. **Never use your mouth to blow a tip clean.**
- Partially fill sprayer tank with clean water.
- Check pump and pressure system. Ensure the pump has adequate output. If the desired spray pressure can be achieved with the agitator and boom valves open, the pump output is okay.
- Check accuracy of main sprayer gauge by installing a new gauge on the boom end temporarily and compare the pressure readings. The reading should be identical.
- Inspect spray patterns and replace tips that have streaky patterns. Flat fan nozzles should be aligned so the patterns do not interfere with each other.

Nozzle Tip Calibration

The output of individual nozzles must be within 5% of the average nozzle output to provide an even volume over the width of the spray swath. Nozzles with outputs either above or below this value must be replaced.

With the sprayer operating at the recommended spraying pressure (275 kPa), collect, measure and record the output from each nozzle on the boom for one minute. (Note: if nozzle strainers are equipped with ball-check valves, increase pressure by 35 kPa).

Calculate the average output.

Replace nozzles with output 5% greater than average. Clean and recheck nozzles with output 5% less than average.

Ground Speed Determination

Actual ground speed can be confirmed by noting the time it takes to travel a measured distance. The following ground speed chart is based on the time required to travel 800 metres.

Speed (Km/h)	Travel Time for 800 m (min:sec)
7	6:48
8	6:00
9	5:20
10	4:48
11	4:22
12	4:00

Steps for Sprayer Calibration

Step 1. Determine the number of acres to spray using your field records. *(Example: 30 acres)*

Step 2. Know the sprayer tank capacity, which is marked on the sprayer tank. *(Example: 2000 litres)*

Step 3. Determine spray volume needed per acre, which can be obtained from the pesticide label. *(Example: 40 litres per acre recommended)*

Step 4. Select nozzles for 40 litres per acre from the manufacturers chart. *(Example: Nozzle No. 11002@275 kPa and 9 km/h = 40 L/acre)*

Step 5. Check nozzle output. *(Example: Nozzle flow between 0.71 to 0.79 litres per min per nozzle is okay)*

Step 6. Calculate total spray solution needed by multiplying the number of acres x the recommended rate. *(Example: 30 acres x 40 litres acre = 1200 litres)*

Step 7. Calculate the total amount of pesticide needed from the pesticide label by multiplying the litres of pesticide per acre x the number of acres. *(Example: 0.60 L/acre x 30 acre = 18 L of pesticide needed)*

Step 8. Mix with the required amount of water as indicated on the label.

Step 9. Set sprayer to travel at desired speed according to the nozzle chosen in Step 4.

Activity

Proper Mixing of Pesticides – put the following in the correct order.

	Triple rinse empty containers and add rinsate to the tank.
	Shake pesticide container vigorously while still closed and sealed.
	Fill the sprayer with half the required amount of clean water.
	Add remaining amount of water and spray at once.
	Slowly add pesticide to sprayer with agitator operating.

Standard Benchmarks

Application Volume	*40 litres per acre (L/ac) = 100 litres per acre*
Spraying Pressure	*275 kilopascals (kPa) = 40 pounds per square inch (psi)*
Speed for Spraying	*9 kilometres per hour (km/h) = 5.4 miles per hour (mph)*
Nozzle Spacing on Spray Boom	*0.5 metres (m) = 20 inches (in.)*
Height above target for 80^0 and 110^0 nozzle tips	*45 centimetres (cm) = 18 inches (in.)*
Nozzle tips	*8002 or 11002*

A standard nozzle puts out 0.75 litres/minute at 275 kPa

At 9 km/h these nozzles apply 40L/ac of spray

Notes*

If tank mixing more than one pesticide, add pesticides in the order recommended on the label. Generally, the following order will reduce the possibility of the formation of precipitates or gums that may clog nozzles and filters:

1st Soluable powders
2nd Wettable powers and flowable liquids
3rd Solutions (amines and salts)
4th Adjuvant (surfactant)
5th Emulsifiable concentrates (esters)

Always agitate the mixed tank vigorously if sprayer has been standing for a time after mixing.

Cleaning the Sprayer

Reasons for Sprayer Cleanout:

- To prevent crop injury by leftover residues.
- To avoid loss of activity of the next pesticide by leftover residues.
- To stop chemicals from corroding or plugging spray equipment. Clean the sprayer thoroughly when changing chemicals. Even a small amount of some pesticides left in the sprayer can create serious damage to subsequently sprayed crops.

Cleaning at Day's End:

Refer to product labels for further recommendations for sprayer cleanout.

Step 1. Reduce waste by mixing only the required volume of spray solution, and by spraying or re-using as much of the leftover residue as possible. Select a special site for flushing and cleaning the sprayer. Do not clean sprayers near creeks, dugouts, sloughs, wells or any other water sources. Ensure that wash water does not come into contact with any desirable vegetation or its roots. Make sure discharged wash water (especially from insecticides) will not be accessible to children or animals.

Step 2. Wash the outside of the sprayer, and then drain the tank completely. Clean all parts. Remove and clean all strainers and nozzle tips. Plugged nozzle tips should be cleaned with a soft bristle brush or compressed air. **Never use your mouth to blow a tip clean.**

Step 3. Open the boom-ends. Partially fill the sprayer tank with clean water, circulate and flush through the booms for at least 10 minutes, then drain. If any visible residue remains, repeat this clean water rinse step.

Step 4. Fill the sprayer with clean water and add one litre of household ammonia for every 100 litres of water. Circulate the solution through the agitator and bypass for at least 15 minutes. Spray out and drain completely.

Step 5. Repeat the ammonia wash cycle.

Step 6. Rinse twice more with clean water and drain.

Step 7. At the end of the spraying season, add light oil, or automobile antifreeze during the final stage of the last rinsing procedure. Remove the pump and store it indoors. Close all openings into the sprayer to prevent entry of debris or rodents. Protect plastic tanks from direct sunlight during storage to ensure longevity.

Activity

Match the left statements with the answers on the right.

I. This is one of the first things to be done before mixing pesticides, if you want to avoid poisoning.

II. Farmers should use it when handling chemicals.

III. This measurement determines the toxicity of a chemical.

IV. When hauling bulk chemicals on public highways the truck is required to have placards indicating this.

V. Chemicals on the farm should be stored in this.

VI. Bulk Chemicals should not be stacked higher than.

A. In a locked storage shed with warning signs.

B. Protective equipment.

C. Read the label. If you have any questions, contact the supplier.

D. Dangerous Goods.

E. 4 feet or 1.21 metres.

F. The Lethal Dose (LD). The smaller the number on the label, the more toxic the substance is.

HARVEST

Roll Call

Name something that happens at the busy time of harvest.

_____

_____

_____

Bringing the Swather Out of Storage

When bringing the swather out of storage, ensure you use the proper draw pin (pull type).

- Install canvasses and check their condition for any tears or thin areas.
- Check:
  - All fluid levels
  - Drive train:
    - PTO
    - Chains
    - Belts: condition and tension
    - Gears
    - Sprockets
    - Bearings, to make sure they are free to move
    - Clutches, control linkage and steering clutches
  - Running gear: tires, wheels, nuts, wheel bearings, etc.
  - Battery condition (self-propelled)
  - Hydraulics
  - Structural: bolts tight, welds secure, frame not bent, etc.
  - Sheet metal: holes, tears, popped rivets, bends, etc.
  - Knives: proper working order, not gummed up

Identify all of the pre-season lubrication needs, select the proper lubricants, and perform any needed service. Remove any rust and residues on the knife. Inspect all the oil and grease (gear hoses, wheel hubs, etc.) and change where necessary. Inspect seals and glands for damage and watch for missing nipples.

Swathing or Straight Cutting

- The cutterbar should be adjusted just low enough to cut off the grain heads and leave most of the straw standing. This will reduce the amount of straw that has to pass through the machine.

- Reel speed is adjusted according to the ground speed. Reel speed has to be fast enough to push the crop against the cutterbar, but not so fast that is shatters the grain or pushes down the crop.

Servicing and Repairing a Combine

Follow the manual directives to identify all preseason lubrication needs, being careful to select the proper lubricants. Remove any rust and residue. Check and change, when necessary, oil and grease in such parts as the engine, hydraulics, gearboxes, wheel hubs, etc. Inspect seals and glands. Watch for, and replace any missing nipples.

When replacing chains, belts, sprockets and tightener blocks, be sure to watch for:

- Proper tensions
- Proper alignments and direction of travel
- Proper removal and installation procedures
- Signs of wear on belts and chains, lubrication and cleaning of chains
- Sprocket wear
- Chain repair (installing connecting links, etc.)

The Walk Around Inspection

It is important to periodically walk around your machine to inspect that it is properly working. Things to watch for include:

General:

- Belts and chains (conditions, tension, alignment)
- Loose parts, broken supports
- Bearings
- Hydraulic leaks
- Wheel bolts
- Tire pressure

Pick Up and Table Components:

- Pick up teeth (wear bends, missing, loose, etc.)
- Pick up belt (frays, tears, tension, etc.)
- Roller bearing
- Auger flighting (bent, broken, running uneven, etc.)
- Bent, broken auger fingers
- Holes in sheet metal (table bottom)

Cylinder Rasp Bars and Concaves:

- Watch for loose cap screws, nuts, bends, rasp bar wear in centre of bar, unequal clearance along concave, levelness of cylinder and concave, etc.

Grain Augers and Elevators:

- Check housings for breaks or weak spots
- Check for trash and dirt, broken or missing paddles, etc. through inspection doors
- Check for loose or bent flighting
- Check chain tension and slip clutches

Setting a Combine

Setting a combine has sometimes been described as more an "art" than a "science". This may be partially true, however the process of adjusting a combine should result from an analysis of combine performance and crop conditions. Most producers realize that setting a combine for optimum performance in one condition does not guarantee satisfactory performance in all conditions. Weather and harvest conditions constantly change. A good combine operator recognizes these changes, and makes adjustments as necessary.

Always refer to the operator's manual for the particular combine you will be using. The manual will set out basic settings for every crop. Use these as a starting point, and make fine tunings to the settings as needed, depending on performance, crop and weather conditions, and machine type. A good operator must recognize when performance is limited by machine design, and when it is a result of settings, adjustments or operating techniques. Considerable operator care and skill is required to balance combine capacity, performance and efficiency to maintain optimum overall productivity.

What Requires Adjustment?

Pickup:

- The speed of the pickup is correct if it appears that the swath is just lifted up as the pick-up goes underneath it. The swath should move in an unbroken, even flow. Excessive speeds will tear the swath apart, and cause uneven feeding and shattering.
- The pick-up height is adjusted so that the teeth are able to pick up the entire swath, and still clear the ground.

Threshing:

The combine should be adjusted so the grain is removed from the heads or pods, without having the grain damaged, the straw shredded or excess chaff created.

- Cylinder Speed (Settings = High, Medium and Low)
- Concave Clearance (Settings = High, Medium and Low)
- Fan Speed (Settings = High, Medium and Low)
- Chaffer (Settings = a distance measure in mm)
- Cleaning Sieve (Settings = a distance measure in mm)

Check for threshing problems in these locations:

- Straw at the rear of the combine – broken or chewed straw indicates overthreshing and can overload the shoe. Unthreshed grain is a sign of underthreshing.

- Grain in the tank – very few cracked kernels should be found. Cracked kernels can be a result of overthreshing or too many tailings being returned for rethreshing.

- Tailing return – there should be very few unthreshed heads returned.

- Straw walkers – the straw walkers will be overloaded if under-threshing is occurring at high speeds. The grain cannot be separated from the mass of straw, and the grain is carried out of the machine with the straw.

- Cleaning shoe – if the shoe is overloaded with excessively broken straw, this is a sign that overthreshing is occurring.

Overthreshing is Indicated by:	**To Correct Overthreshing:**
• Cracked grain • Broken and chewed straw that overloads the shoe • Grain losses over the shoe	• Slow the cylinder by 5% at each adjustment • Open the concave slightly if reducing cylinder speed • Reduce the ground speed slightly if the above do not help

Underthreshing is Indicated by:	**To Correct Underthreshing:**
• Unthreshed heads and excessive tailings • Overloaded straw walkers • Grain loss over the straw walkers	• Increase the cylinder speed by 5% at each adjustment • Reduce concave space slightly • Increase the ground speed slightly if the above adjustments do not help

Cleaning Unit:

Too little fan blast, or too small chaffer openings will cause grain losses in the cleaning unit. Overthreshing can also cause this problem. Check the condition of the straw; if it is excessively broken, the problem is overthreshing. If the straw is whole, then either more air is needed or the chaffer openings must be larger.

Too much fan blast will blow grain over the shoe. There will be very little straw and chaff on the shoe, and the fan speed should be reduced.

Operating Combines

General guidelines for operating combines are:

1. Adjust the ground speed as needed to prevent overloading the combine.

2. Use engine speed recommended by the manufacturer. Changes will upset the balance in the rest of the combine.

3. Check frequently for proper threshing and grain losses.

MARKETING

Roll Call

Name a product that is grown, processed and sold in Saskatchewan.

_____

_____

Grain Marketing Alternatives

Commodity contracts are highly standardized, legally binding documents. Contracts are standardized to simplify trading. Contracts specify the commodity bought or sold, the quantity, grade, delivery point, delivery period and terms.

Most contracts are based on the equation:

Futures Price – Basics = Cash Price

Identifying the commodity and quantity contracted is straightforward. Most contracts call for delivery of one grade of the commodity. Often, however, other specified grades are allowed to be delivered at a premium or discount to the contract price. Price differentials are established based on those usually found in the case market.

There are a number of different commodity contracts that can be used by producers when marketing their commodities. They include:

Spot Sales are used by producers when they deliver grain, and are paid based on the day's prices. With spot sales, producers receive payment right away. The current futures price and basis are used to calculate the cash price.

Deferred Delivery Contract sets the price and basis for grain that the producer will deliver at a later date. An example of this would be when the price is high and expected to go down, and the basis is narrow. The producer has not yet harvested the crop, but wants to take advantage of the favourable price and basis. Producers receive payment when the product is delivered. In this case, a futures contract in the future, and an expected basis is used to calculate the cash price for delivery in the future.

Deferred Pricing Contract is a contract whereby a producer can deliver grain right away, but be allowed 90 days to agree on the cash price they will receive for that grain. If no agreement is made within 90 days, the producer will receive the market price for the grain on the 90th day. This contract would be used when the price is low and expected to rise. Both the futures price and basis are allowed to change until the cash price is set.

Basis Contract is a contract that sets the basis cost for a commodity to be delivered at a later date. It does not set the futures price the producer will receive for their grain, and allows this price to be set up to the delivery date. This would be used when the basis is narrow, and the futures price is low. It allows the producer to take advantage of a narrow basis, while hoping for higher prices between now and the date of delivery. If no agreement is made before delivery, the producer will receive the price available on the day of delivery. Producers receive their money upon delivery.

Open Basis Contract. With an open basis contract, producers can lock in the futures price they will receive for their grain (which will be delivered at a later date), but wait to establish the basis cost. This would be used when the price is wide, and the basis is high. It allows the producer to lock in the current price, and have until delivery to watch for a narrower basis to lock into. If no agreement is made before delivery, the basis will be the one available on the day of delivery. Producers receive their money upon delivery.

Floor Contracts provide a bottom (floor) price that a producer will receive for their grain while also giving them an opportunity to take advantage of rising prices by selling them a *"Call Option"*. This may be done with a spot sale (especially with old stored grain) or a Deferred Delivery Contract (with new crop not yet harvested).

A **call option** gives the producer the right to buy a futures contract at a specific price when the call option was purchased, for the period of time that the option is made out for (30 days, 60 days, 90 days, etc.). Anytime after the producer has sold their grain and until the final date for the call option:

- If the price of futures goes up, the value of the call option will also go up, and then it can be sold for the higher price.

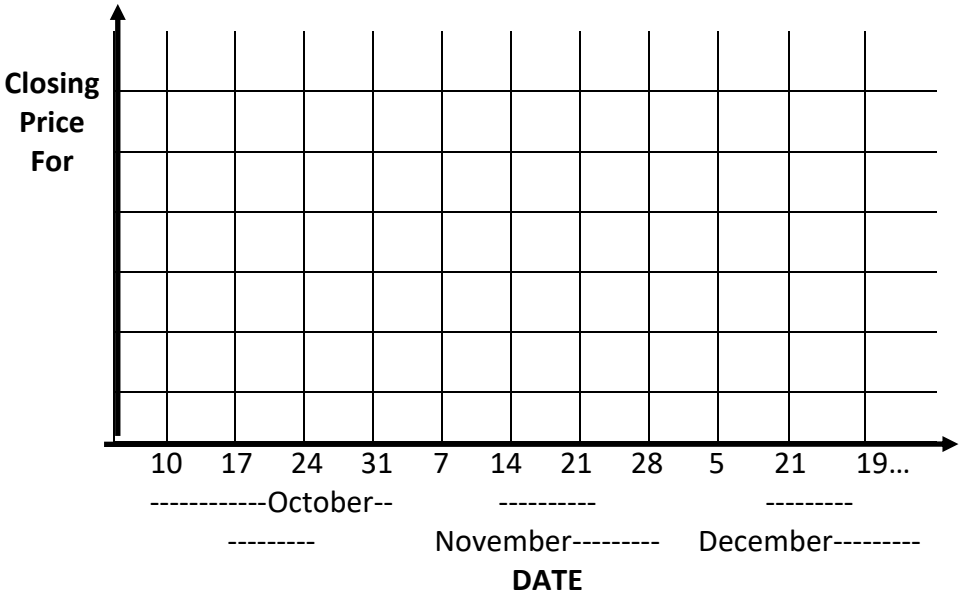
- If the price for futures contracts does not go up, the producer is still guaranteed to get the floor price for his grain that has been sold.

The cost for a floor contract with a call option is often taken off the initial price for the grain. Therefore, one company may be buying grain for $10/tonne less than another, but with a call option. If the lower price still matches the target price the producer wants, and the prices are rising, this opportunity to make more may be the marketing choice to make.

Watching the Market

On the radio, TV or in agricultural publications you will often come across market reports. When you first look at one, it is difficult to understand what they mean. Understanding cash markets and futures markets can help you recognize some figures, but it is still difficult to know what they mean. The best way to figure it all out is to talk to other people. Listening carefully to market reports, and then asking a lot of questions about what the items mean can help to put into perspective what the market is doing.

Another helpful activity is to chart the market. With a piece of graph paper, draw a chart like the one below. On the X-axis, put the date at weekly (7-day) intervals.



The Y-axis will represent the closing price for the commodity that you wish to track (use the commodity that you are growing for your fields crop project).

Find out what the closing market price (in the futures market) was for your commodity today. You may find this information by listening to the radio, calling someone who would have this information (perhaps a grain buyer at a local elevator), or on the Internet. On the chart, about halfway up, place a dot above today's date and on the y-axis, write the price per tonne on the line where the dot has been placed. Now, complete the Y-axis by writing in prices higher and lower than today's price in equal increments of about $5/tonne.

Over the next few months, find out the closing market price for your commodity each week. As you chart the market, watch for issues that affect the grain market, and continue to talk with other producers, grain buyers, and any other people involved with grain markets, to help interpret what you record.

Reports that provide information about the markets can be heard on the radio, read in a newspaper (Saturday editions of the Financial Post or the Globe and Mail always have Fridays' future prices), or on the Internet. These reports may provide daily, weekly or monthly updates on what the markets are doing. In order to understand market reports, it is important to review and understand how markets function over a period of time.

Reading the Markets – Making Marketing Choices

By now you should have a basic understanding of how markets work, and the tools that producers have when marketing their products. The next most important thing to be able to do is to read markets, and make decisions about the marketing tools to use.

The key to making marketing decisions is staying **informed**. Being in tune with the market means knowing what is considered a strong or a weak price in the current market.

Reading market news isn't enough to give a producer the full picture of what the market is doing, and whether prices will rise or fall. It also helps to talk to a variety of information sources, such as:

- An elevator manager
- A feedlot operator
- A grain dealer
- A commodity broker
- A market analyst

Keeping a list of people you can speak with at least once a month can help you get a range of opinions about the market. A variety of opinions is helpful to obtain a well-rounded view of the market. Producers who stay in touch with market contacts each month have a better idea of realistic price expectations, and can spot marketing opportunities.

Activity

Make a list of contacts that you could talk to over the next few months as you chart the market.

Description	Name	Phone Number	Date Spoken With
A grain elevator manager			
A feedlot operator			
A grain dealer			
A commodity broker			
Other:			

Each month, after marking the weekly closing prices for that month, give one of these people a call and ask them:

1. What do you see the market doing?

2. What sorts of things are affecting the market right now?

3. Do you think the prices will rise or fall over the next few months?

4. What are the factors that will affect the market over the next few months?

As you gather a variety of opinions, and chart the market for yourself, you will develop your own opinions about what the market is doing, and how it will affect the marketing of your own harvested field crop project!

Activity

What type of contract would you use if…

Use each of the following options only once to answer the following scenarios.

- Hedge
- Spot Sale
- Basis Contract
- Deferred Delivery Contract
- Deferred Pricing Contract
- Open Basis Contract
- Floor Contract (Options)

1. You plant wheat in the spring, expecting to sell it for a high price when it is harvested. A month after you plant it, you see that the local cash prices for wheat are falling more than expected. Reports from the USA indicate that they are expecting a bumper crop of wheat this year. The price of a December contract for wheat remains high on the futures market and you know that you have a space to store your crop and sell it in November. _____

2. At harvest you run out of storage space. The current price is low but is expected to rise in the next couple of months.
   _____

3. In watching the markets, you see that the price for the grain you have in storage is high, and you expect it will go down. However, the basis is also currently wide so you don't want to deliver right away.
   _____

4. You see that the price for your crop, which you haven't yet harvested, is high and expected to go down. The current basis is narrow. Your crop will be ready for delivery in three months.
   _____

5. You have grain that you need to get rid of right away, and the market price has been high, and recently started to go down. The basis is narrow. _____

6. A local buyer offers you your target price for your grain through a Deferred Delivery Contract. You expect that prices will rise in the next little while, but you want to guarantee you will get your target price in case the market drops. _____

7. This year's harvest of canola is poorer than expected due to low rainfall and low yields. Buyers in your area are competing for a low supply of canola, and the local basis for canola is narrow. In watching the markets, you expect that the price for canola will go up in the next two months, and you are able to store your crop for this period of time.
   _____

CANADA
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