Unit D: Agricultural Equipment Systems

Lesson 7: Operating, Calibrating, and Maintaining Grain Harvesting and Handling Systems

Student Learning Objectives:

Instruction in this lesson should result in students achieving the following objectives:

1. Explain the operating principles of grain harvesting equipment.
2. Explain the calibration of grain harvesting equipment.
3. Identify proper maintenance procedures for grain harvesting equipment.
4. Explain the principles of operating grain drying and handling equipment.
5. Explain the calibration of grain drying and handling equipment.
6. Identify proper maintenance procedures for grain drying and handling equipment.

Recommended Teaching Time: 2 hours

Recommended Resources: The following resources may be useful in teaching this lesson:

Combines-Reducing Harvesting Losses (VAS 3049). University of Illinois, Urbana, Illinois: ITCS Instructional Materials.

Combines-Selecting and Servicing (VAS 3048). University of Illinois, Urbana, Illinois: ITCS Instructional Materials.

Grain Drying, Handling and Storage Handbook (MWPS-13). Iowa State University, Ames, Iowa, 1988.

Griffin, George A. *Combine Harvesting*. Moline, Illinois: Deere & Company, 1991.

GROWMARK. *FS Grain Drying Guide*. FS Supplies Division, Bloomington, Illinois.

Introduction to Combines (VAS 3047). University of Illinois, Urbana, Illinois: ITCS Instructional Materials.

USDA. *Official United States Standards for Grain*. Federal Grain Inspection Service, USDA, Washington, D.C., 1995.

List of Equipment, Tools, Supplies, and Facilities:

- Writing surface
- PowerPoint Projector
- PowerPoint Slides
- Transparency Masters
- Copies of student worksheets
- Combine parts
- Rope to make 1 square meter
- Crop seeds (wheat or another cereal crop)
- Moisture tester

Terms: The following terms are presented in this lesson (shown in bold italics and on PowerPoint Slide 2):

- Allowable storage time
- Cleaning
- Drying front
- Drying zone

- Equilibrium moisture content
- Feeding
- Handling
- Lodging
- Tailings
- Threshing

Interest Approach:

Display to the class the pictures of grain being threshed and the two types of grain threshers that have been used in Afghanistan (PowerPoint Slides 3, 4, 5, 6, 7, 8, and 9). Ask the students the processes the pictures are showing and what the machines are used for in agriculture. Lead a discussion about common threshing practices. This lesson is going to look at other types of grain harvesting equipment that is used when there are large hectares of land used for growing a grain crop.

SUMMARY OF CONTENT AND TEACHING STRATEGIES

Objective 1: Explain the operating principles of grain harvesting equipment.

Anticipated Problem: What are the operating principles of grain harvesting equipment?

(PowerPoint Slide 10)

I. Early combines were known as “harvester-threshers”, machines that were pulled through the fields by teams of horses or mules. Some machines were known only as “threshers” since the grain was first cut and then brought to a thresher for threshing and separating the grain from the straw.
   A. Today the combine is a complex machine used to harvest and thresh all kinds of grain in a variety of crop and field conditions. The name “combine” developed when the harvesting and threshing operations were “combined” into one complete machine.
   B. To understand the operation of a combine, look closely at each function of the machine. Once the operation of each of these components is understood, it becomes easier to understand how they relate to each other and to the operation of the entire machine.

(PowerPoint Slides 11, 12, and 13)

   C. All combines perform six basic functions.
      1. The gathering of the standing crop is referred to as the ***cutting*** function. Parts of the combine involved include the platform, cutter bar and reel, corn head, snapping unit (gathering chains, snapping rolls, and stripper plates).
      2. Delivering the cut crop material to the threshing unit in a steady, uniform flow is called the ***feeding*** function. Parts involved include the header or platform auger (table auger), feeder house (feeder conveyor, paddle conveyor or feeder chain).

(PowerPoint Slide 14)

      3. The ***threshing*** function involves the removal of grain from the head, seedpod or cob, by either a flailing or a rubbing action, or a combination of both. Parts involved include the cylinder or rotor, and concave.

4. Separating the loose grain from the straw is referred to as the ***separation*** function. The parts involved include the grates, straw walkers, beater or rotary deflector.

(PowerPoint Slide 15)

5. The ***cleaning*** function removes the grain from the trash. Parts involved include the cleaning shoe (sieves, chaffer, and fan).
6. Moving the grain throughout the machine is the ***handling*** function. Parts involved include the clean grain (augers, elevators, and grain tank), tailings (augers and elevators), grain holding (grain tank), and unloading (augers).

Use TM: 7-1 (PowerPoint Slide 16) to illustrate a combine harvesting wheat in a field. TM: 7-2 (PowerPoint Slide 17) illustrates a cotton picker harvesting cotton. Use TM: 7-3 (PowerPoint Slide 18) to discuss how grain flows through a combine. Have students complete LS: 7-1 to strengthen student understanding.

Objective 2: Explain the calibration of grain harvesting equipment.

Anticipated Problem: How is grain harvesting equipment calibrated?

(PowerPoint Slide 19)

II. Unless the operator knows the source of grain losses, he or she cannot calibrate the machine to reduce the losses. Some losses are due to improper operation and others are caused by improper adjustment.

A. Harvesting losses occur in different areas of the harvesting process.

(PowerPoint Slide 20)

1. Pre-harvest losses are those which occur in the field before combining. Such losses show up as grain on the ground, the result of wind shatter, lodging, down crop, or weather conditions. The inability of the crop to stand is known as ***lodging***.
2. Header losses occur when the header is operated improperly or when the crop tends to shatter easily. Each type of header: cutting platforms, corn heads, and windrow pickup units has operating characteristics which can cause losses.

(PowerPoint Slide 21)

3. Threshing losses are caused by unthreshed grain carried over straw walkers, cracked grain due to overthreshing, or cracked grain due to excessive tailings. Material that is not completely threshed or separated is called ***tailings***.
4. Straw walkers or separator losses are usually caused by feeding too much material over them at slow cylinder speeds and wide concave spacing when the combine is operating at excessive ground speeds. Too much material prevents the grain from falling through the walkers and onto the cleaning shoe.

(PowerPoint Slide 22)

5. Cleaning shoe losses may be caused by too much air from the fan, too much material on the chaffer, or improperly adjusted chaffer and sieve.
6. Leakage losses can occur almost anywhere on the combine. To guard against leakage, inspect the combine to see that all inspection doors, cleaning doors, and drainage doors are in the proper position and closed securely. Also check for torn seals, damaged sheet metal, or holes.

B. The areas of combine (cutting, feeding, threshing, separating and cleaning) may be responsible for harvesting loss. Determining losses varies with the type of grain harvested.

(PowerPoint Slides 23)

1. Cotton harvesting difficulties deal with moisture removal, ejecting valuable fiber, and cleaning lint

(PowerPoint Slide 24)

2. Corn harvesting losses can occur as ear losses and kernel loss. The largest corn loss usually is in ears left in the field.

(PowerPoint Slide 25)

C. Precision agriculture equipment, global positioning systems, and yield and moisture monitors are calibrated by following the directions in the owner/operator manual. Vibration, load weights, and temperature are some of the calibrations that need to be made in order for the equipment to be accurate.

Use TM: 7-2 and TM: 7-4 (PowerPoint Slides17 and 23) to reinforce difficulties with cotton harvest. Discuss how this will affect crop production and profits.

Objective 3: Identify proper maintenance procedures for grain harvesting equipment.

Anticipated Problem: What maintenance procedures should be followed for grain harvesting equipment?

(PowerPoint Slides 26 and 27)

III. Proper maintenance and service adjustments are necessary to assure efficient, safe operation of the combine. Costly repairs, premature wear, loss of field time, and accidents can be reduced if the combine is properly maintained and adjusted.

(PowerPoint Slide 28)

A. The operator's manual for the machine should be used in reference to specific maintenance intervals, location of service points, and instructions for the performance of maintenance and service adjustments.

(PowerPoint Slide 29)

B. The following are general maintenance practices that a good machine operator should always follow in order to make operating and maintaining the combine much easier and safer.
    1. Before starting the harvest season, preliminary inspections and adjustments should be made following the guidelines in the operator's/owner's manual.
    2. Always keep the machine clean. Before starting the combine, clean all field trash, mud, and excess grease and oil from the machine.
    3. Make sure that nuts, cap screws, shields, and sheet metal parts are tight. A loose shield can vibrate, produce excess heat, produce irritating noise, and cause a machine to fail if it falls in the way of moving parts.
    4. Inspect the combine every day before starting. A brief look at all areas of the combine can help you spot potential machine failures and safety hazards.
    5. Keep maintenance records. A simple chart showing when lubrication and service adjustments were made can help insure that all needed maintenance has been performed.
    6. Do not abuse the machine. Proper lubrication and adjustment is of little help if the operator abuses the machine.

(PowerPoint Slide 30)

    7. Check all fluid levels daily prior to starting.
    8. Lubricate bearings and chains as called for in the operator's/service manual.
    9. Check tire air pressures periodically throughout the harvesting season.
    10. Check belts frequently for correct tension, excessive wear, tearing, cracking, swelling, and unraveling.

(PowerPoint Slide 31)

        a. When replacing a belt never pry it over the rim of a sheave.
        b. Wipe off oil and grease as soon as they are spilled and then clean the belt with suitable cleaner that will not soak into it.
        c. Clean belts periodically in mild soap and water, do not use strong detergents.
        d. Use of belt dressings is not recommended because they may deteriorate the belt.
        e. Check pulleys for misalignment, excessive wear, damage, distortion, and accumulation of dirt and debris in the bottom of grooves.
    11. Maintain correct chain tension, 1 centimeter of sag per 30 centimeters, between shaft centers.

(PowerPoint Slide 32)

        a. Chains should be removed from the combine for cleaning and lubrication at the end of every season.
        b. Add or remove offset links (half links) to ensure correct length and tension.
        c. Do not add new links to an old chain or old links to a new chain, this will change the bite of the chain as it enters and leaves the sprocket.

d. Check alignment of all sprockets in drive and correct misalignment when necessary.
e. Do not put a new chain on worn sprockets, as its life will be shortened.

Use TM: 7-5 (PowerPoint Slide 33) to provide examples of the servicing of combine belts and chains.

Objective 4: Explain the principles of operating grain drying and handling equipment.

Anticipated Problem: What are the principles for operating grain drying and handling equipment?

(PowerPoint Slides 34 and 35)

IV. The principles involved in the operation of grain drying and handling equipment involve factors relating to system design and the removal of moisture.

(PowerPoint Slide 36)

A. Goals of a well designed drying system include:
   1. Timely harvest of top quality grain.
   2. Safe and pleasant working conditions.
   3. Ability to do important drying jobs efficiently such as:
      a. Holding wet grain to be dried.
      b. Drying wet grain.
      c. Cooling dried grain.
   4. Capacity to handle grain at the harvesting rate.
   5. Provisions for easy expansion in the future due to increased volume and harvesting rate.

(PowerPoint Slides 37 and 38)

B. Grain dries due to the removal of water, leaving dry matter.
   1. Grain is harvested at high moisture contents to minimize field losses.
   2. Grain that is harvested is too wet for safe storage is usually dried for maximum marketing potential and storage flexibility. Grain must be artificially dried to reduce the moisture content to a safe storage level to prevent spoilage.
      a. A fan picks up air, carries it over an energy source (gas, electric, solar, etc.) to improve its moisture-holding capability, pushes the air through the grain mass to absorb the moisture from the grain and then carries it outside the system.
      b. The layer being dried is referred to as the ***drying zone***—only the grain in this zone is drying. The grain above this zone remains wet while the layer below is dry.
      c. The leading edge of the drying zone is called the ***drying front***.

(PowerPoint Slide 39)

   3. ***Equilibrium moisture content*** is the point when continued contact with the drying air results in no further moisture reduction. Drying system capacity should be sufficient to receive and handle the daily harvest rate and allow for increasing capacity in the future.

4. Length of time grain can be stored at a given moisture content and temperature is known as ***allowable storage time (AST)***.
    a. Drying and storage systems are designed around the allowable storage time.
    b. A combination of high moisture content and high temperature leads to fast mold growth and rapid spoilage.
    c. Factors that affect the condition of stored grain are insects, rodents, and bacteria.

Use TM: 7-6 (PowerPoint Slide 39) to illustrate the principles of grain drying. TM: 7-7 and TM: 7-8 will be helpful in reinforcing the concepts of storage life and moisture content in grains. Ask students about the general practices with common grains are. How long do we store wheat? Cotton? Other grains?

Objective 5: Explain the calibration of grain drying and handling equipment.

Anticipated Problem: How is grain drying and handling equipment calibrated?

(PowerPoint Slides 40 and 41)

V. Calibration of grain drying equipment is important to attain the proper moisture content for stored grain. There are several factors that are taken into consideration when calibrating grain drying equipment. They include:
    A. Initial moisture content of the grain.
    B. Temperature of the grain.
    C. Relative humidity of the outside air.
    D. Desired final moisture content of the grain, which is affected by the use of the grain.

Again, TM: 7-7 and TM: 7-8 will help students in understanding this objective.

Objective 6: Identify proper maintenance procedures for grain drying and handling equipment.

Anticipated Problem: What maintenance procedures should be followed for grain drying and handling equipment?

(PowerPoint Slide 42)

VI. Proper maintenance and service adjustments are necessary to assure efficient, safe operation of the drying and handling equipment.

(PowerPoint Slide 43)

A. Costly repairs, premature wear, loss of harvesting time and accidents can be reduced if the drying and handling systems are properly maintained and adjusted. The operator's manual for the equipment should be used in reference to specific maintenance intervals, location of service points, and instructions for the performance of maintenance and service adjustments.

(PowerPoint Slide 44)

B. There are general maintenance practices to follow in order to make operating and maintaining the drying and handling systems much easier and safer.
    1. Thoroughly clean all grain drying and handling equipment prior to use. Always keep machinery and equipment clean. Excessive build-up of trash, debris, and fine dirt can cause heat build-up, part fatigue and failure, and/or fires.
    2. Inspect all bearing and friction surfaces for excessive wear.
    3. Make sure that shields and other safety equipment are in place at all times.
    4. Keep up-to-date maintenance records. A simple chart showing when lubrication and service adjustments were performed can help to insure that all needed maintenance has been performed.
    5. Inspect the equipment every day. A brief inspection of all areas can help you spot potential machine failures and safety hazards.
    6. Check all fluid levels daily.

(PowerPoint Slide 45)

    7. Lubricate bearings and chains as called for in the operator's/service manual.
    8. Check belts frequently for correct tension, excessive wear, tearing, cracking, swelling, and unraveling.
    9. Maintain correct chain tension, 1 centimeter of sag per 30 centimeters, between shaft centers.
    10. Check all electrical equipment prior to use.
    11. Insure that all fire extinguishers are properly charged and in working order.

Discuss how proper maintenance can extend the life of a machine and improve efficiency. Relate those practices for grain drying and handling with practices for other equipment.

Review/Summary: Use the student learning objectives to summarize the lesson. **(PowerPoint Slide 46 and 47)** Have students explain the content associated with each objective. Student responses can be used in determining which objectives need to be reviewed or taught from a different angle.

Application: Use the accompanying lab sheets to help students in applying the lesson's content.

LS: 7-1 Grain Harvesting and Handling Systems

Evaluation: Evaluation should focus on student achievement of the objectives for the lesson. Various techniques can be used, such as student performance, on the application activities. A sample written test is attached.

Answers to Sample Test:

Matching

1. C
2. I
3. A
4. B
5. E
6. F
7. H
8. J
9. G
10. D

Fill-in-the-blank

1. handling
2. non-grade, grade, special
3. 1
4. field losses
5. repairs, wear, time, accidents
6. harvesting, threshing
7. allowable storage time
8. insects, rodents, bacteria

Short Answer

1. Timely harvest of top quality grain, safer and pleasant working conditions, ability to do important drying jobs efficiently, capacity to handle grain at the harvesting rate, provisions for easy expansion to future, due to increase volume and harvesting rate.
2. Cutting, feeding, threshing, separating, cleaning, handling.

Sample Test

Operating, Calibrating, and Maintaining Grain Harvesting and Handling Systems

Name: _____

Matching: *Match each word with the correct definition.*

a. tailings	e. drying zone	i. allowable storage time
b. cleaning	f. threshing	j. equilibrium moisture content
c. cutting	g. feeding	
d. drying front	h. lodging	

_____ 1. Cutting or gathering the crop.

_____ 2. Length of time grain can be stored at a given moisture content and temperature.

_____ 3. Material that is not completely threshed or separated.

_____ 4. Removing the grain from the trash.

_____ 5. Layer of grain being dried.

_____ 6. Removal of the grain from the head, seedpod, or cob.

_____ 7. Inability of the crop to stand.

_____ 8. Point when continued contact with the drying air results in no further moisture reduction.

_____ 9. Delivering the crop material to the threshing unit in a steady, uniform flow.

_____ 10. Leading edge of the drying zone.

Fill-in-the-blank*: Complete the following statements*.

1. Moving the grain throughout the combine is referred to as the _____ function.
2. Grade quality measurements are categorized as _____, _____ and _____ grades.
3. A chain in correct tension would have _____ centimeter of sag per 30 centimeters, between shaft centers.
4. Grain is harvested at high moisture contents to minimize _____ _____.

5. If the drying and handling system is properly maintained and adjusted costly _____, premature _____, loss of harvesting _____ and _____, can be reduced.
6. The name combine developed when the _____ and _____ operations were combined into one complete machine.
7. Drying and storage systems are designed around the _____ _____ _____.
8. Factors that affect the condition of stored grain are _____, _____ and _____.

***Short Answer**: Answer the following question*.

1. What are the five goals of a well designed drying system?

2. What are the six basic functions that a combine performs?

TM: 7-1

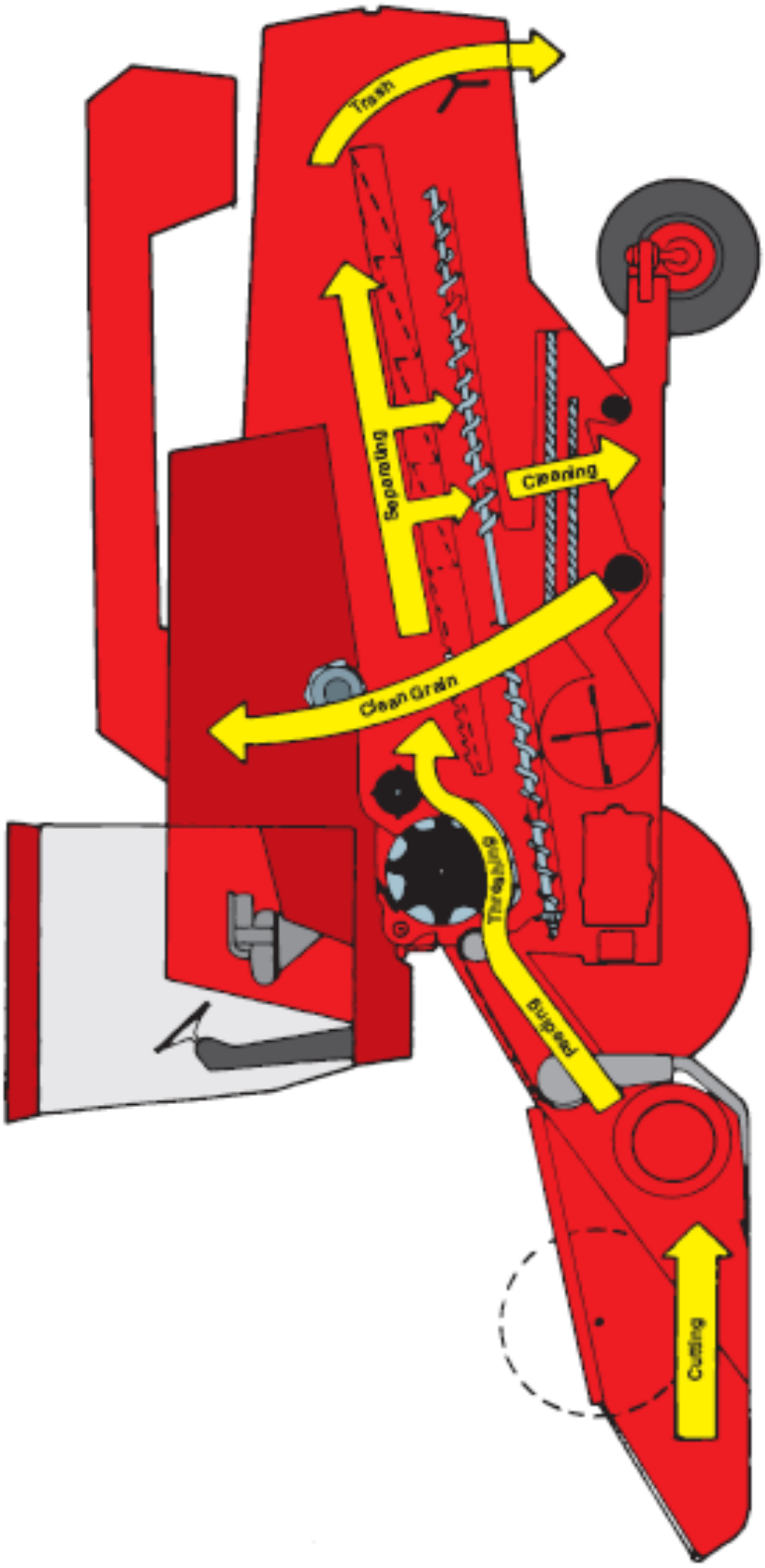
COMBINE HARVESTING WHEAT

TM: 7-2

Two Machines Harvesting Cotton

TM: 7-3

HOW GRAIN FLOWS THROUGH A COMBINE



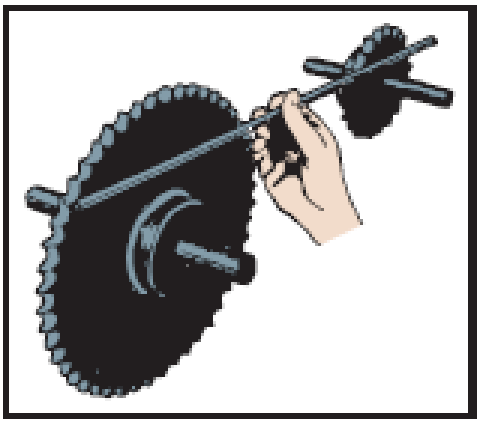
TM: 7-4

DIFFICULTIES WITH COTTON HARVEST

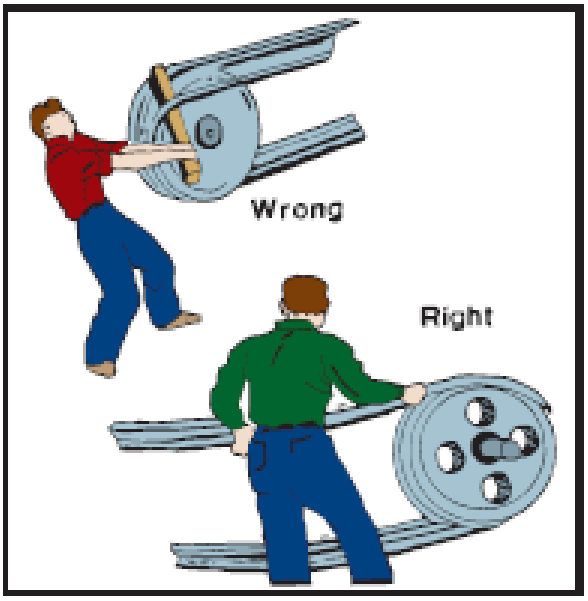
- **Moisture removal**
- **Valuable fiber ejection**
- **Cleaning lint**

TM: 7-5

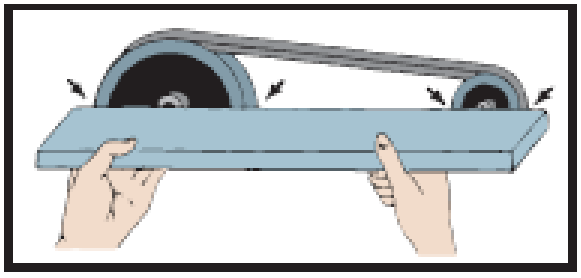
COMBINE SERVICING—BELTS, CHAINS



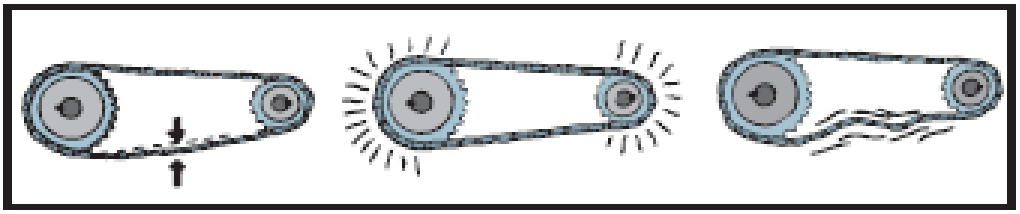
Check sprocket alignment with a straight edge or string. Misalignment will cause rapid wear of sprockets and chains.



Never pry a belt over a pulley. This breaks the cords in the belt and will result in belt roll-over and early belt failure.



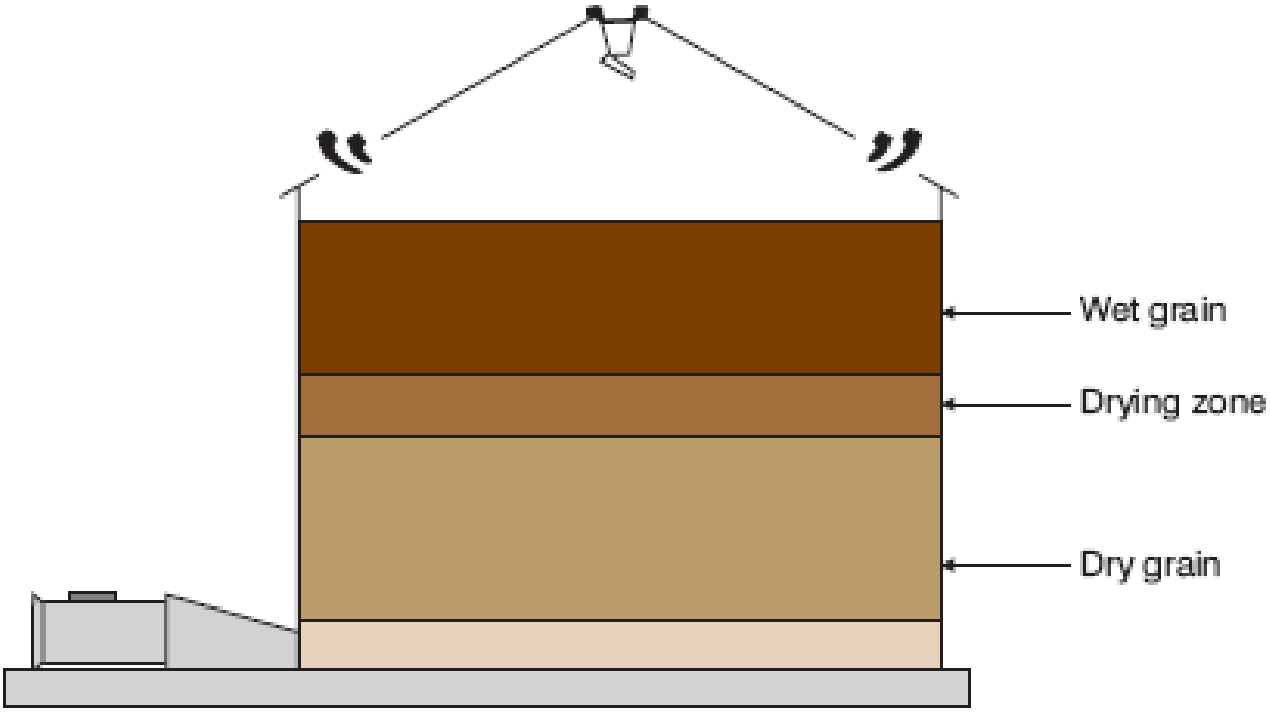
Check pulley alignment. Pulley misalignment will result in distortion of belts which results in excessive wear and damage.



Keep chains adjusted to ¼" sag per foot between shaft centers. Over tightening produces rapid chain and sprocket wear. Loose chains "whip" and can cause chain and sprocket damage.

TM: 7-6

GRAIN DRYING PRINCIPLES



The drying zone starts at the bottom. When it reaches the top, drying is completed. Spoilage will occur if the drying zone doesn't reach the top within the allowable storage time.

TM: 7-7

MAXIMUM STORAGE LIFE FOR SHELLED CORN

Grain temperature (Celsius)	Moisture Content (% wet basis)							
	15.5	18	20	22	24	26	28	30
-1	2276	648	321	190	127	94	74	61
2	1517	432	214	126	85	62	49	40
4	1012	288	142	84	56	41	32	27
7	674	192	95	56	37	27	21	18
10	450	128	63	37	25	18	14	12
13	299	85	42	25	16	12	9	8
16	197	56	28	17	11	8	7	5
18	148	42	21	13	8	6	5	3
21	109	31	16	9	6	5	4	3
24	81	23	12	7	5	4	3	2
27	60	17	9	5	4	3	2	2

TM: 7-8

STORAGE MOISTURE CONTENTS

Grain Drying Tables								
	Equilibrium Moisture Contents							
Relative Humidity %	20	30	40	50	60	70	80	90
Corn %	7	8	10	11	13	14	16	18

Maximum Moisture Contents for Grain Harvest and Safe Storage		
Grain Type and Storage Time	Maximum Moisture Content	
	For Harvesting (%)	For Safe Storage (%)
Shelled corn and sorghum		
Sold as # grain by spring	30	15
Stored 6–12 months	30	14
Stored more than 1 year	30	13
Soybeans		
Sold by spring	18	14
Stored up to 1 year	18	12
Stored more than 1 year	18	11
Wheat, oats, barley		
Stored up to 6 months	20	14
Stored more than 6 months	20	13
Sunflower		
Stored up to 6 months	22	10
Stored more than 6 months	22	8
Flaxseed		
Stored up to 6 months	15	9
Stored more than 6 months	15	7
Edible beans		
Stored up to 6 months	20	16
Stored more than 6 months	20	14

LS: 7-1

Grain Harvesting and Handling Systems

Using a search engine on the internet, find three different types of grain harvesting or handling equipment. Prepare a five to eight minute presentation about the information you explored. A visual aid must be created using PowerPoint.

Complete the following information on the grain harvesting or handling equipment you explored.

1. Picture
2. Brand
3. Make
4. Key features
5. Tire size
6. Types of heads/attachments
7. Other interesting information
8. Sources of information