1986

4-H 210 4-H Tractor Operation and Safety Manual

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4-H TRACTOR
OPERATION AND
SAFETY MANUAL

Issued in furtherance of Cooperative Extension work, Acts of May 8 and June 30, 1914, in cooperation with the
U.S. Department of Agriculture. Leo E. Lucas, Director of Cooperative Extension, University of Nebraska,
Institute of Agriculture and Natural Resources.

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4-H TRACTOR OPERATION AND SAFETY MANUAL

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INTRODUCTION

The material in this manual has been compiled for use in training programs for the 4-H Exemption of the Hazardous Occupations in Agriculture Order. The lessons or units included meet the requirements for 4-H tractor material designated by the Order for 10 hours of instruction to qualify for exemption from Order No. 1, Operation of Tractors over 20-belt hp.

These units provide a good base for instruction on safety awareness, understanding of controls and safety checks, and safe tractor operation. If this material is covered in discussions and understood, the student should have little trouble with a tractor safety quiz. However, supplementary material from 4-H Tractor Program material or other sources may be used for better understanding of tractor make-up, capabilities and maintenance. Exemption from Order No. 2 requires an additional 10 hours on safe use of machinery.

TABLE OF CONTENTS

First Year* CO 675 Learning How to Be Safe
Unit 1 ................................................... Page 3
The Instrument Panel
Unit 4 .................................................... Page 12
Controls for Your Tractor
Unit 5 .................................................... Page 18
Daily Maintenance and Safety Check
Unit 6 ........................................................ Page 24
Starting and Stopping Your Tractor
Unit 7 ..................................................... Page 30
Second Year* CO 676 Tractor Safety on the Farm
Unit 1 ..................................................... Page 35
Third Year* CO 677 Tractor Safety on the Highway
Unit 1 ................................................... Page 42
Hitches, Power Take-Off, and Hydraulic Controls
Unit 3 .................................................... Page 48

*Refers to 4-H Tractor Program Manuals

ACKNOWLEDGEMENTS

The author would like to acknowledge Pat Stockley, and Agricultural Engineering Staff for their input into this manual. Also, PWS Publishers, American Publishing Company, National 4-H Council and John Deere Manufacturing are gratefully acknowledged.

First Year - Unit 1

LEARNING HOW TO BE SAFE

Did you know that just 100 years ago a one-year old child had only a 50 - 50 chance of reaching adulthood? Scarlet fever, diphtheria, smallpox and other diseases took the lives of many children. Thanks to modern medicine, these diseases can now be controlled by vaccinations and "miracle drugs." Today a one-year-old child has an excellent chance of growing up—if he or she does not have a bad accident. In fact, accidents cause more deaths to persons between the ages of 15 and 24 than all other causes added together. Out of these death-causing accidents almost 3/4 are caused by motor vehicles.

You cannot be vaccinated against an accident, but you can greatly reduce your chances of having an accident by developing good safety habits. One of the main purposes of the 4-H Tractor Program is to help form good safety habits, and thus reduce the number of accidents with farm tractors and machinery.

AGE OF TRACTOR ACCIDENT VICTIMS

Tractor accidents cause more than 600 deaths each year in the United States. However, many more are seriously injured in tractor-related accidents. Figure 2 shows how tractor accidents are divided among the different age groups. Almost half of the victims are under 20 years old. This is a good reason for you to be careful as you "grow up" with a tractor. Listen to your leader and your parents when they tell you how to be a safe operator.

Even after you think you have learned how to operate a tractor safely, you can't relax for a minute—an accident has no respect for age or experience. Look at Figure 2 again. Notice that many accidents happened in all age groups.

One more thing. Many accidents happened to children under 10 years old. How do these happen to children who were too young to operate a tractor? The National Safety Council tells us that most of these (68 percent) were "extra" riders on the tractor or on the implement the tractor was pulling. This points to the need for you to follow one very important rule — no extra riders. Keep young children off tractors and away from areas where machinery is working.

Operating a tractor is serious business and a full-time job. Make up your mind that you are going to be a safe tractor operator. Start right now by obeying the rules that could keep you from hurting or killing yourself, a family member or a friend.

Because you cannot predict exactly when an accident will occur, you must learn to think about safety at all times. Thinking and practicing safety are up to you and all others who work around tractors and implements. As you work through the tractor project, learn to anticipate dangerous situations, then avoid them. Here are some important safety rules that should be followed to avoid accidents.

\[\text{Fig. 1. Among persons between the ages of 15 and 24, accidents cause more deaths than all other causes added together.}\]

\[\begin{array}{|c|c|c|c|}
\hline
\text{AGE} & \text{TRACTOR ACCIDENT VICTIMS} \\
\hline
\text{1} & \text{2.5} \\
\text{5-14} & \text{24.6} \\
\text{15-24} & \text{22.5} \\
\text{25-44} & \text{17.5} \\
\text{45-64} & \text{16.2} \\
\text{>65} & \text{17.6} \\
\hline
\end{array}\]

\[\text{Fig. 2. Operators under 15 have the highest tractor accident rates.}\]

\[\text{ACCIDENTS FACTS 1983}\]

\[\begin{array}{|c|c|c|}
\hline
\text{OPERATOR AGE} & \text{FREQUENCY (ACCIDENTS PER MILLION HOURS OF USE)} \\
\hline
\text{5-14} & 24.6 \\
\text{15-24} & 22.5 \\
\text{25-44} & 17.5 \\
\text{45-64} & 16.2 \\
\text{>65} & 17.6 \\
\hline
\end{array}\]

\[\text{BASE ON 4,700 CASES IN 25 STATES}\]
THE OPERATOR MUST BE THE ONLY PERSON ON THE TRACTOR

The safest place to ride on a tractor is in the operator's seat. Generally, a tractor has only one seat, therefore it should have only one rider—the operator. No matter where the extra person rides he may lose his balance and be thrown off, if the operator has to stop suddenly or make a quick turn to avoid a hazard.

This rule also applies to riding on equipment hitched to the tractor. One of the most dangerous practices is to give children a ride on mounted equipment such as a front-end loader. Remember the study by the National Safety Council. Many of the fatalities to children under 10 are caused when a front-end loader trips and the children are run over by the tractor.

The operator must be the only person on the tractor and there must be no riders on the equipment hitched to the tractor. The operator has a full-time job keeping the tractor under control. He has no time to look out for the safety of extra riders.

ALWAYS OPERATE THE TRACTOR AT A SAFE SPEED

Unsafe speeds may cause a tractor to upset. Since a tractor can turn over in three-fourths of a second or less, the operator cannot possibly get off the tractor in time to avoid the chance of getting injured or killed. (Ask your leader to demonstrate some of the causes of upsets by using a model tractor.)

Unsafe speeds vary with the situation so be extra careful when going back and forth to the fields. Records show that one-third of the tractor accidents happen under these conditions. You can upset a tractor going in a straight line at even 8 mph, if the wheels hit an object or drop into a hole. Eight mph is about twice as fast as you can walk. The same thing could happen at 6 mph or less while the tractor is turning. When speed is doubled, the chance of upsetting is four times as great.

SHUT OFF THE ENGINE BEFORE REFUELLING

Fuel vapor, which is invisible, can collect around the tractor engine and may cause a fire. This is most likely to happen when refuelling the tractor fuel tank, even though liquid fuel is not spilled. Fuel vapor is three times heavier than air, and will flow downward and collect around the engine. Refuelling when the engine is hot or while it is running may cause the vapor to ignite from a hot manifold or a "loose" spark. To avoid starting a fire, shut off the engine and wait until it has cooled before refuelling. Refuelling during the late evening. Not only is it safer but it reduces moisture build-up in your fuel tank.

Check the fuel system for leaks; they can cause fires. You can't be too careful in making sure a tractor is safe.

OPEN THE SHED DOOR BEFORE STARTING THE TRACTOR

Exhaust gases from an engine contain carbon monoxide. When you breathe too much, it is a deadly poison. You can't see it or smell it, so you have no way of knowing when this deadly gas is present. To be safe, always fasten the shed door open before starting the tractor. This allows the fresh air to mix with the carbon monoxide and carry it away. One other possibility is to vent the exhaust outside through a ventilation system. As an added precaution keep an approved 5 to 10 lb. dry chemical fire extinguisher in the shed and another one on the tractor.

HITCH ONLY TO THE DRAWBAR WHEN PULLING A LOAD

The drawbar hitch is the safest place on the tractor for pulling a load. Hitching to the axle or seat bracket, for example, can cause the tractor to upset backwards. The higher above the ground a load is hitched to the tractor, the easier it is for the tractor to be pulled over backward. (Ask your leader to demonstrate some of the causes of upsets by using a model tractor.)

A tractor has enough speed and power to upset backward in three-fourths of a second or less if it is improperly controlled or hitched. This means the operator has little chance to escape from being involved in an accident, since it would take two or three seconds to get clear of the tractor once it starts to upset.

For safe hitching, the drawbar should be from 13 to 17 inches above the ground (hitch no higher than recommended by the operations manual). On tractors with an adjustable drawbar, the drawbar should be kept low when pulling a load. Raising the drawbar to get better traction is a dangerous practice that can also cause the tractor to upset backward. Loose chains dangling from the drawbar are a hidden hazard because they might catch on a stump or rock and give the tractor a sudden jolt, causing the tractor to upset.

To be safe, always use the drawbar when pulling a load, keep it low, and don't overpowered or speed when starting the pull. Remember: Keep the drawbar low, and pull it slow.

KEEP POWER-TAKE-OFF SHAFTS PROPERLY SHIELDED

A rotating power-take-off (PTO) shaft can be a deadly killer unless protected by shields. Modern tractors have PTO shafts that run either 540 or 1,000 rpm. At either of these speeds an unguarded shaft can quickly grab clothes should they brush against it. Your clothes can be wrapped around the turning shaft at the rate of 8 feet a second. Once caught, catastrophic results are very likely. A person is no match for the speed and power of the turning shaft, since today's tractors are 500 times more powerful than the average human.

All rotating shafts should be protected. To help prevent PTO accidents, tractors have three different guards, or shields: (1) A shield that covers the PTO stub when it is not in use. (2) A master PTO shield, which should remain on the tractor at all times. (3) A shield that covers the rotating shaft when the tractor is connected to an implement. All of the shielding must be used properly to give protection from the rotating shaft. Manufacturers have made this shielding so that it can be used with all combinations of tractors and equipment.

USE CAUTION WHEN MOUNTING OR DISMOUNTING FROM THE TRACTOR

Many accidents occur when the tractor is not running. Many of these accidents involve falls. A safe tractor operator doesn't jump on or off a tractor. Use the steps and handholds that are provided and watch your step. Being in a hurry always increases your chance for an accident. Remember, a clean tractor is safer than one cluttered with dirt and grease. Don't use the tractor platform for storing tools. They belong in the tool box. Keep the work areas clear of items that can cause you to trip and fall.
Before getting off the tractor, make certain that it is left in a safe condition. This means shutting off the engine, setting the brakes (or parking brake), disengaging the PTO shaft, and leaving the tractor in low or reverse gear. On some tractors the gearshift should be placed in the "Park" position instead of being left in gear.

**REDUCE SPEED BEFORE MAKING A TURN OR APPLYING BRAKES**

Separate tractor brakes are provided for the main purpose of helping to make short turns at slow speeds. They can also be used for making quick stops in case of an emergency. Such might be the case when traveling in high gear on the highway. In this case the brakes should be locked together and adjusted to equal pressure. The brakes need frequent checking since brakes tend to wear unevenly.

To help prevent upsets, leave the tractor in gear and slow the engine down with the throttle. Then the inside brake can be applied to help make the turn.

**KEEP YOUR TRACTOR UNDER CONTROL AT ALL TIMES**

The best thing you can do to prevent an accident is to always keep the tractor under control. A tractor is an inhuman machine and, as such, is not responsible for anything it does. The way a tractor acts depends on the operator's attitude, and skill in operation.

**THINK AND PRACTICE SAFETY**

Always remember that a tractor is faster and more powerful than you are and that an accident can only happen under two conditions: When you do something that is unsafe, or when you allow an unsafe condition to exist. You can be in control over the power and speed of a tractor with your ability to think. Learn to correct unsafe conditions and guard yourself, your family and friends against potential hazards. **Think ahead and avoid hazardous situations.**

Practice being a safe tractor operator at all times. Remember that safety cannot be acquired by rules alone. And you can't be vaccinated by a doctor to keep from having an accident. You must develop safety as a habit and always be alert to prevent accidents.

**SAFETY REGULATIONS**

Agricultural workers make up about 4 percent of our nation's total work force. Workers in agriculture have suffered 9 percent of the disabling injuries and 16 percent of the occupational deaths in our nation. Agriculture is one of the top two most dangerous occupations. It is obvious that agricultural workers have had more than their share of accidents.

As our society has become concerned about the quality of life, major safety regulations have been established or are being considered to improve working conditions of employees and to reduce accidents among all agricultural workers.

The regulations most related to youth are included in the Fair Labor Standards Act, the Occupational Safety and Health Act (OSHA) and the Workmen's Compensation laws. A brief summary of these regulations is included for general information. Publications, including excerpts from the Federal Register, are available to provide complete copies and interpretation of the regulations. A thorough understanding of the current laws and subsequent revisions is essential.

**FAIR LABOR STANDARDS ACT**

The purpose of this act is to prohibit the employment of children under 16, without special permission, in occupations declared particularly hazardous by the Secretary of Labor.

**Employment not permitted:** No minor under 16 may work during school hours except on the home farm for parents. No minor under 16 may work at any time in occupations declared particularly hazardous without special permission.

**Employment permitted:** Minors over 16 may be employed on a farm at any time in any farm job. Minors under 16 may work for parents at any time in any job. Minors under 16 may work outside school hours in farm jobs not declared particularly hazardous. Minors 14 and 15, trained under the 4-H Federal Extension Service program or the U.S. Office of Education Vocational Agriculture Training Program, may work outside school hours on farm equipment on which they have been trained.

**Exemptions** allow employment of minors 14 and 15 in farm jobs declared particularly hazardous: Minors under 16 may be employed if—

a. They have successfully completed one or more of the following training programs:
   (1) 4-H tractor operation,
   (2) 4-H machine operation,
   (3) Tractor and machine operation.

b. They have been instructed by employers on safe and proper operation of the specific equipment to be used.

c. They are continuously and closely supervised or are checked by an employer at least at midmorning, noon and midafternoon.

Minimal qualifications for employment of youth under age 16 in hazardous occupations include:

a. 14 years of age.
b. Completion of a 10-hour course of familiarization with hazards related to use of tractors.
c. Completion of a 20-hour training program on safety operation of tractors and farm machinery.
d. Pass a written examination on tractor and farm machinery safety.
e. Demonstrate ability to operate a tractor with a 2-wheeled trailed implement on a course similar to the 4-H Tractor Operator's Contest and operate machinery safely.

An employer must have on file a copy of a signed training certificate which certifies all requirements have been met.
THE TRAINING CERTIFICATE

The training certificate is not a driver's license. It consists of trainee personal data, certificate number, certification by instructor and certifying authority, employer's information regarding trainee qualification and responsibilities of the employer and a list of hazardous occupations.

NON-HAZARDOUS JOBS

Not all farm jobs are considered to be hazardous by the Department of Labor under the Fair Labor Standards Act. Examples of farm jobs permitted are: loading and unloading trucks; operating small tractors (under 20 hp); picking vegetables and berries, and placing them on conveyors or in containers; clearing brush and harvesting trees up to 6 inches in butt diameter; working with farm animals on the farm and at fairs, etc. (except specified breeding stock in confined areas); raising and caring for poultry; milking cows; processing and storing milk and dairy products; detasseling corn; cleaning barns, equipment storage buildings, chicken coops, etc.; mowing lawns; riding, driving or exercising horses (except for stud horses); picking cotton; handling irrigation pipes; harvesting and storing tobacco; riding on transplanters.


Penalties for violation of the Child-Labor Requirements of the Fair Labor Standards Act:

1. First offense—up to $10,000 for willful violation.
2. Second offense—not more than $10,000 fine and/or not more than 6 months imprisonment.

TYPICAL SAFETY FEATURES AVAILABLE ON MOST NORTH AMERICAN MANUFACTURED TRACTORS

1. By now you have read and discussed some rules for operating a tractor safely. If you believe that these rules will help prevent accidents, sign your name here as a pledge that you will always do your best to follow them and to be a safe tractor operator.

Signed ________________________________ Member

Show the rules to your parents. Have them sign their names below, both as a pledge to help you become a safe operator, and to always practice safety themselves.

Signed ________________________________ Parent

2. During this course, you will be using tractor operator's manuals. Begin the use of a tractor operator's manual and complete the following:

A. Make and Model of tractor: ______________________________

B. Page number of table of contents: ______________________________

C. Speed of tractor in fastest gear: ______________________________

D. Are safety precautions listed throughout the manual or grouped on one or more pages? ______________________________

E. Look through the operator's manual carefully and see how many additional safety rules you can find. What precautions listed in the operator's manual are not in Unit 1 of this manual?

a. ______________________________
b. ______________________________
c. ______________________________
d. ______________________________
e. ______________________________
f. ______________________________
g. ______________________________
h. ______________________________
i. ______________________________
j. ______________________________
k. ______________________________
l. ______________________________
m. ______________________________
n. ______________________________
o. ______________________________
p. ______________________________
q. ______________________________
3. Check the drawbar. Height from drawbar to ground. _____ inches. What should it be? _____ inches. Is it a safe drawbar? _____ Does the tractor have a brace for locking the drawbar in position when pulling a load? _____  

4. Are all PTO shields in the proper place? _____ If not, which shields are missing? _____ Don’t wait, replace shields immediately.  

5. Can you tell by looking at the power-take-off lever if it is engaged? How?  

6. How many adjustments does the seat have? What are they?  

Is the seat loose? _____ If so, tighten all bolts and make proper repairs. See if you can adjust the seat so you can reach all of the controls on the tractor from a comfortable sitting position. If not, you may be too young to operate the tractor safely. Check with your leader to see what he or she thinks.  

7. Give the tractor a complete safety check. List below anything you find that is unsafe. For example, have trash or tools been left on the platform? Is there a leak in the fuel system? How about the tires and wheels? Correct any items that are unsafe. Your parents will be glad to give you some help. Tell what you did to correct any items that were unsafe.  

a. __________________________________________________________________________________ _  

b. _________________________________________________________________________________ _  

c. _________________________________________________________________________________ _  

d. _________________________________________________________________________________ _  

e. _________________________________________________________________________________ _  

f. _________________________________________________________________________________ _  

g. _________________________________________________________________________________ _  

h. _________________________________________________________________________________ _  

i. _________________________________________________________________________________ _  

j. _________________________________________________________________________________ _  

Note: Fill out this work unit using a tractor at home. Be ready to discuss your experiences with the other 4-H members at the next meeting.
Pilots of spacecrafts and airplanes use an instrument panel to tell them if all of the systems are working properly. Your tractor has an instrument panel for the same purpose. The dials and gauges on the instrument panel will warn you of trouble in any of the different parts of the tractor system. Study the instrument panel carefully so that you will understand what each of the dials or gauges tells you. The operator's manual for a tractor will explain the function for these instruments. The manual will give correct readings for all the instruments and tell you what to do if trouble is indicated. Let's examine the instrument panel more closely.

**OIL PRESSURE INDICATOR**

An oil pressure gauge is used on some tractors to show the amount of pressure in the engine lubrication system when the engine is running. Instead of a gauge, some tractors have a red warning light that comes on or flashes to indicate low oil pressure.

This gauge or warning light shows you if the oil pump in the crankcase is working. It does not always mean that oil is circulating properly through the engine and does not show the oil level. If, for example, an oil line is plugged, the proper pressure will still be shown by the gauge, but some part of the engine may not be getting sufficient lubrication.

When a tractor engine is first started, it takes a while for the circulating pump to build up the oil pressure. That's why low pressure may be indicated every time you start the tractor. If the correct pressure is not indicated within a few seconds after starting, shut off the tractor and see if you can locate and correct the problem. Start with the gauge. It may not be working properly. Check the oil level in the crankcase. The oil level may be too low for the pump to work properly. If the oil level is correct, then too much oil is escaping in the system, which usually means the engine needs to be repaired. Some tractors have a similar light or gauge for the transmission oil.

**CHARGE INDICATOR**

This gauge is sometimes called an "ammeter" and will let you know whether the generator or alternator is charging the battery properly. There are two common types of ammeters used on tractors. One of these will actually indicate the rate at which the battery is being charged, or discharged. The other is a red light that comes on or flashes when the generator or alternator is not properly charging. Like the oil indicators, the charge indicator may not show the actual electrical charge stored in the battery. When the amount of electrical energy supplied to the battery from the generator or alternator exceeds the amount supplied by the battery to the electrical system, a charge will be indicated. Discharge will be indicated when the output supplied by the battery is greater than the amount received. Both types of indicators are connected to the switch and will normally show discharge after the switch is turned on and before the engine is started. Discharge may also show when the engine is running at a slow idle speed. You should shut off the engine at once when trouble is indicated by this gauge. There may be a short in the electrical system which could lead to a fire. A loose or broken connection may be the cause of the trouble, or there may be a faulty generator or alternator.
Use of Colored Lights with Individual Symbols

AMMETER or GENERATOR LIGHT

Red when insufficient charge rate

FUEL LEVEL

Red when temperature is too high

ENGINE OIL PRESSURE

Red when pressure is insufficient

WATER TEMPERATURE

Red when temperature is insufficient

TRANSMISSION OIL TEMPERATURE

Amber Zone (Caution)

ENGINE R.P.M.

Red Zone

Fig. 3. Typical illustrations of the use of color with universal symbols.
COOLING SYSTEM GAUGE

This gauge shows the temperature of the engine coolant. When the engine has warmed up sufficiently, the gauge will indicate "normal" or "run," or the dial may show the actual coolant temperature. For gasoline and LPG (Liquified Petroleum Gas) engines, the operating temperature should be from 165°F to 185°F. For diesel tractors the normal operating temperature is usually 180°F, and higher.

If the temperature is too cool, the engine is not developing its full power. It will have poor fuel efficiency, sludge will form in the oil, and rapid wear of the moving parts will occur. A faulty thermostat is usually the cause of low operating temperatures. A thermostat keeps the engine at the proper temperature in the same way that it controls the temperature in your house.

When the engine is running too hot, serious internal damage can occur. There are several possible causes so you must shut off the engine and locate the trouble. It may be nothing more than a clogged radiator or hose or perhaps the fan belt is loose or broken. If you cannot find the trouble right away, call your local dealer.

TRANSMISSION TEMPERATURE

Many tractors also have a temperature and pressure gauge for the transmission. The transmission fluid is often used as hydraulic fluid, so the temperature may depend on the amount of hydraulic usage, as well as how hard the tractor is pulling. Many tractors have a cooler for the transmission-hydraulic fluid, and high temperature could be a sign that the cooler is clogged or it may be quite helpful for operations such as spraying, where proper ground speed is important.

ENGINE SPEED INDICATOR

All tractors built today have an instrument called a tachometer to show how fast the engine is running. The tachometer is marked in revolutions per minute (rpm) and tells you how fast the crankshaft of the engine is turning. A special mark on the tachometer dial indicates where the standard PTO speeds (540 or 1,000 rpm) can be attained. The tractor may be equipped with a speedometer which gives the speed in miles per hour (mph). This will be quite helpful for operations such as spraying, where proper ground speed is important.

HOUR METER OR PROOFMETER

The number of hours the engine has operated is a useful gauge. This is an essential instrument to record length of tractor operations as well as a helpful reminder to perform periodic maintenance.

PYROMETER

A few tractors are equipped with a pyrometer to measure exhaust temperature. These are used primarily on turbocharged diesels. The pyrometer can warn the operator when the temperature gets too high from overloading, and it also gives a reliable indication of when the engine is cool enough to turn off the engine without turbocharger or valve damage.
FUEL GAUGE

Most modern tractors have a gauge that indicates how much fuel remains in the tank. A good tractor operator never lets the tank run dry. This is particularly important if the tractor burns diesel fuel or LPG. Every time a diesel engine runs out of fuel, time is lost because the fuel system must be vented of air before re-starting the engine. If you run out of fuel with an LPG tractor, you may be a long way from the fuel storage tank. Since LPG has to be stored under high pressure you need special equipment for refueling.

Keeping the fuel clean is a problem with diesels, thus many have elaborate filtering systems for the fuel. Some diesel tractors have a fuel pressure gauge to indicate when these fuel filters become plugged.

WORK UNIT
First Year Unit 4

THE INSTRUMENT PANEL

1. Draw a diagram of the instrument panel on a tractor. Show the location of (a) oil pressure indicator, (b) charge indicator, (c) water temperature gauge, (d) engine speed indicator, and (e) fuel gauge. Draw a small circle in the proper location to indicate each of these dials. Inside the circles place the letters a, b, c, d and e to indicate which gauge properly matches those listed. Hint: The owner's manual may help identify these gauges.

2. Look at the engine speed indicator. What is the rated engine speed _______ rpm. What is the rated power-take-off speed? _______ rpm.

   Does the indicator tell you how many hours the tractor has been run? __________

   Does this dial tell you how fast you would be going in the various gears? __________

3. There may be other gauges or dials on your tractor. Look over a tractor carefully and list them below. Also indicate the normal reading.

   __________

   __________

   __________

   __________

   __________

4. What do gauges show that is not shown by indicator lights?

Members' Check-up
First Year Unit 4

THE INSTRUMENT PANEL

Draw a line under the right word or words and put the letter for the correct answer at right of page.

1. The oil pressure gauge (A-will) (B-will not) tell you when you need to add oil. _____

2. Operating a tractor engine with a low radiator temperature will result in (A-more power) (B-less power) than when the temperature is normal. _____

3. A charge indicator is sometimes called an (A-ammeter) (B-thermostat). _____

4. Low operating temperature of a tractor engine is usually the result of (A-full throttle operation which causes the fan to over-cool the engine) (B-a faulty thermostat). _____

5. A tractor engine speed indicator (or tachometer) tells you (A-the number of revolutions per minute the engine is turning) (B-the number of feet per second the tractor is traveling). _____

6. If a diesel engine runs out of fuel (A-the fuel system has to be vented) (B-the engine can be restarted immediately). _____

7. The same fuel gauge (A-can) (B-cannot) be used for both a gasoline and LPG tractor. _____

8. If a tractor is pulling a plow and the red light comes on, indicating low oil pressure the operator should (A-leave the tractor engine running and go for help) (B-increase the throttle setting to see if the light will go out) (C-shut the engine off at once and check the oil level). _____

9. The ammeter or charge indicator light will show a discharge of the battery if (A-the generator or alternator is not charging properly) (B-there is a broken spark plug wire) (C-the engine is running very slowly). _____

10. Most tractors (A-do) (B-do not) have a warning light to tell you when to change oil. _____

Note: This Check-Up Sheet is intended to test what you have learned and to stimulate discussion with the other 4-H members. The more you discuss these questions with your leader and the other members the more you learn and understand.
CONTROLS FOR YOUR TRACTOR

The controls on a tractor enable you to "tell" the tractor what to do. To become a safe and skilled tractor operator, you must know the function of each control. You will also have to be able to find and use these controls quickly, so you can react when necessary to perform tractor operations or react in an emergency to avoid an accident.

SEAT ADJUSTMENT

Let's start with the seat on your tractor. It should be adjusted to the position that permits you to operate all of the controls from a comfortable sitting position. Most tractors have seats that can be raised or lowered, moved forward or backward, as well as adjusted to the weight of the operator. If, after the seat is adjusted, you can't reach the controls easily from a comfortable sitting position, you may be too young to start operating a tractor. If you are not sure, ask your leader to help you determine whether you can reach all of the controls safely and use them effectively.

CONTROLS FOR STARTING THE TRACTOR

Controls for starting the engine vary somewhat between models. The most common controls are: (1) A key to turn on the ignition and provide power to the starting systems. On some tractors the key also operates a switch to open and close a fuel supply valve. (2) A starter button that completes the electrical connection to the starter motor. Sometimes the key also serves as the starter button. In either case an electrical impulse is supplied to a solenoid (a kind of electromagnet), which engages the starter gear first, and then closes a switch to operate the starter motor. Some tractors will not start unless the gearshift lever is in "neutral" or "park" position and/or the clutch is disengaged. This is a safety feature to keep from starting the tractor in gear and possibly causing an accident.

CLUTCHES AND SHIFTING LEVERS

A clutch is a device for disengaging or disconnecting a rotating shaft. Several different types of clutches may be found on tractors. The main clutch is called an engine clutch and is used to disconnect power to the transmission when you want to stop or change gears. When disengaged, the gearshift lever can be moved to the desired position. When the clutch is engaged - that is, when the pedal is released - the tractor will start moving. To be safe, always engage a clutch gradually after checking to the front, rear and both sides of the tractor. Gradual release means less wear and tear on the engine and drive train.

This same type of clutching mechanism is also used to control power at the PTO shaft or belt pulley. In most cases these clutches can be used when the tractor is moving. With some tractors, the engine must be running before the PTO can be engaged. The operator's manual will describe which types of clutches are on your tractor. There may be only one or several gear-shifting levers on a tractor. Large tractors often have several power and speed ranges available. Shifting between these ranges is done with different levers and often it is possible to change ranges and directions without using the clutch.

BRAKES FOR TURNING AND SAFETY

Unlike a car or truck, the brakes on a tractor are used for more than slowing down or stopping. Tractor brakes have three functions: (1) to assist the tractor in making short turns in field operations; (2) for emergency stops; and, (3) for parking. Your tractor is equipped with two brake pedals; each one controls the brake on one side of the tractor. If only one brake pedal is engaged, pressure is applied to the brake drum or disc for the wheel on that side of the tractor. This slows down or stops movement of that wheel and causes the tractor to turn in a circle, until the brake is released. This explains why braking the rear wheel on the side towards the turn will actually make it easier to turn shorter. Most four-wheel drive tractors have only one brake pedal so there is no brake assistance when turning. If you hit only one brake hard with the tractor going at a high rate of speed, the tractor may upset. For traveling in "road gear," both brakes must be locked together in case an emergency situation makes it necessary to come to a sudden stop. Always keep both brakes adjusted equally.

Most modern tractors have power or hydraulic brakes. These require less foot pressure, so you need to be very careful in operating them until you are thoroughly familiar with how they work.

STEERING

A steering wheel is used to transmit turning effort to the front tractor wheels. Turning effort may be transmitted by shafts, linkage and gears, or it may be transmitted by oil under pressure. Most new tractors are equipped with the latter system called "hydraulic power steering." Less effort is required to turn the steering wheel, which helps to make it less tiring to operate the tractor on rough ground or for extended periods. If the engine stalls, it may be extremely difficult to turn the steering wheel.

Four-wheel drive tractors may steer by angling the wheels (crab steering) or by pivoting the tractor in the center (articulated steering). Caution is needed when operating an articulated steer tractor since one can easily crush a person standing near the pivot point. Also, articulated steering moves the center of gravity during a turn.
TRANSMISSIONS

A tractor is equipped with a gearshift and transmission. This is a device for changing tractor speeds to match the operation you are performing. On some tractors speed can be changed with the tractor in motion. On others the tractor must be stopped and the clutch disengaged before the gears can be changed. Tractors formerly had only one reverse and three forward speeds. Modern tractors have many more speeds to select from than older models.

HYDRAULIC CONTROLS

The hydraulic system may have several different levers. These levers control various remote cylinders and a 3-point hitch. In most cases, the levers are located to the right of the driver, but consult the operator's manual to determine the exact location and function of the levers on a tractor.

UNIVERSAL SYMBOLS AND SIGNS

Several universal symbols are likely to be found on your tractor. Learn these symbols and typical hand signals so you will know and communicate with them effectively.

The "Safety Alert Symbol" is commonly used on safety signs found on agricultural equipment. The symbol means Attention! Be alert! Your safety is involved! Alone it is a white exclamation point with a red triangle; when printed (in an operator's manual, for example) the triangle is black.

The CAUTION sign (BE CAREFUL on some machines) is a general reminder to tell the operator that certain safety practices must be observed. It also identifies some of the less serious hazards. These signs are black and yellow.

A WARNING sign alerts the operator that a greater risk is involved for a specific potential hazard. This sign is also black and yellow.

DANGER means that one of the most serious potential hazards is present. Unsafe operating techniques or bad work habits in this area could lead to serious accidents and personal injury. The DANGER sign is red and white.

The universal Slow Moving Vehicle (SMV) symbol is required to be mounted on farm machinery and other vehicles traveling at less than 25 miles per hour on public roads.

Fig. 5. Safety symbols and signs.

HAND SIGNALS

Use when noise or distance does not allow normal voice communication.

SLOW IT DOWN - DECREASE SPEED
THIS FAR TO GO
MOVE OUT - TAKE OFF
RAISE EQUIPMENT
MOVE TOWARD ME - FOLLOW ME
STOP
STOP THE ENGINE
START THE ENGINE
COME TO ME
SPEED IT UP - INCREASE SPEED
LOWER EQUIPMENT

Fig. 6. Hand signals, properly used and understood makes tractor operations safer and easier.

WORK UNIT
First Year Unit 5

CONTROLS FOR YOUR TRACTOR

1. Try the seat on a tractor. How many adjustments does it have? ________
What are they? __________________________________________________________

2. Sit in an operating position with your hands on the steering wheel. Can you reach and operate all of the hand and foot controls? ________ If not, which ones can't you reach? ____________________
3. Draw a diagram of the gearshift pattern from a tractor. Use the numbers to show the various gearshift positions.

4. Can you shift gears without using the clutch? (Read the owner's manual carefully to find the answer.) If the answer to the last question was yes, tell which gears can be shifted without a clutch.

5. Does your tractor have an additional clutch to vary the forward speed of your tractor "on the go"?

What is it called?

6. Take a look at the engine speed control lever on a tractor. While the tractor is not running, have another member move this lever back and forth. Can you tell how it controls speed. Draw a diagram of the speed control lever, showing the direction of movement of the various parts as speed is increased.

7. Where are the brakes located? Can they be locked together? How do you set the brakes so the tractor will not roll away when you leave it on a slope?

Are the brakes mechanically operated? Hydraulically operated?

8. Does the tractor have power steering? If so, does the power steering work when the engine is not running? Why?

9. Make a list of controls on your tractor. Tell what each one does.

<table>
<thead>
<tr>
<th>Control</th>
<th>What It Does</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>What It Does</td>
</tr>
<tr>
<td>Control</td>
<td>What It Does</td>
</tr>
<tr>
<td>Control</td>
<td>What It Does</td>
</tr>
</tbody>
</table>

Note: This Check-Up Sheet is intended to test what you have learned and to stimulate discussion with the other 4-H members. The more you discuss these questions with your leader and the other members the more you learn and understand.
DAILY MAINTENANCE AND SAFETY CHECK

For scientists to launch a space vehicle, a careful inspection and countdown must be made to ensure the proper function of all the various parts. While a tractor is not nearly as complicated as a rocket, it still must be mechanically fit and safe for the day's work. In this unit you will learn how to develop your own "countdown" so your tractor will operate properly once it is started for the day's work.

The purpose of preventive maintenance is to promote optimum performance and prevent costly repairs. Keep a careful record of all maintenance performed on your tractor. Many operators' manuals have pages where you can record many of the periodic procedures. If the operator's manual does not contain these pages, you can easily make up sheets. List each maintenance job performed and the date it was done.

AIR CLEANER ASSEMBLY

Every gallon of fuel burned in an engine requires from 6,000 to 9,000 gallons of clean air. The air cleaner must remove dirt and dust from the incoming air so it will not get into the engine where it could cause rapid wear and extensive damage. Without an air cleaner, an engine can be completely ruined in one day's time. If the air cleaner is clogged with dirt and restricts air flow, engine performance will suffer. Most modern tractors use a two-stage air filter, while some of the older models use an oil bath. Remember, under dusty conditions air filters will have to be changed more frequently than in normal conditions. Consult the operator's manual to find out how to service your air cleaner properly.

COOLING SYSTEM

The cooling system is really a "heat control" to keep the engine at the proper temperature. When the fuel-air mixture burns inside the cylinder, a great amount of heat is created. Temperatures often reach 3,000 to 4,000°F. Part of this heat must be carried away by the cooling system. It is also possible to keep the engine too cool. A cold engine uses more fuel, wears faster and will not develop full power. To maintain proper engine temperature, a control called a thermostat is used in the cooling passage between the engine and radiator. This device opens when hot and closes when cold.

Maintenance of the cooling system includes checking the coolant level and the level in the crankcase. The level of the oil should be checked daily. Add oil if the dipstick shows too low a level. If the dipstick indicates an increase in the level, check for dilution from the fuel or cooling systems.

60 HOUR GASOLINE ENGINE TEST

OPERATING TEMPERATURE:

FUEL CONSUMPTION:

POWER:

OIL IN THE CRANKCASE

The oil in the crankcase helps keep the engine clean, reduces friction of moving parts and carries away some of the heat produced in the cylinder. It also acts as a cushion between moving parts to reduce shock and to form a seal between the piston and cylinder wall. If an engine does not have enough oil in the crankcase it will soon overheat. This will result in oil breakdown and cause extensive damage from excessive engine wear.

Tractor engines are equipped with a dipstick or plug to show the amount of oil in the crankcase. The level of the oil should be checked daily. Add oil if the dipstick shows too low a level. If the dipstick indicates an increase in oil level, check for dilution from the fuel or cooling systems.
Follow oil-changing instructions given in the operator's manual. Use the proper grade of oil for the climatic condition the tractor is experiencing. Change oil on time; you cannot tell from the oil's appearance that it needs changing. Change oil soon after the engine has been run and is hot while the oil and filter, check the oil level. Then start the engine and check for proper grade of oil for the climatic condition the tractor is experiencing.

FUEL SYSTEM

Make it a habit to check the fuel supply each time before starting an engine. Include the sediment bowl, fuel line and carburetor in your inspection. Whenever possible, refuel in the evening, but never refuel the tractor when it is still hot.

Keep the fuel supply clean and avoid contamination by water. This is particularly necessary with diesel tractors. They have close-fitting parts that can be quickly ruined with even minute particles of dirt. Use a trap or filter on diesel storage tank and keep the traps and filters on the tractor clean. Some diesel tractors have a sediment pump in the fuel tank that needs periodic draining.

LPG fuel is stored under high pressure and can't be checked by looking in the tank. Most LPG tractors have either a direct reading sight gauge or a rotary tube that indicates the fuel level. Caution - direct contact of LPG fuel with fingers, face or any part of the body can cause a severe "frostbite." Be careful when checking fuel level or transferring fuel.

LEVEL OF LIQUID IN THE BATTERY

The battery provides electrical energy for starting the tractor and for operating the lights and other accessories. The life of a battery depends on (1) keeping the battery fully charged at all times, (2) keeping the liquid level above the plates and (3) keeping the battery clean. Permitting the plates to remain exposed to air for any length of time will cause deposits to form on them and shorten battery life.

If the liquid level is too low, refill with distilled water or with rainwater caught in a non-metal container. It is better to use clean tap water even though it may contain harmful minerals, than to let the battery run dry. Take care not to touch the battery with your hands or clothes. The sulfuric acid solution from the battery will quickly burn flesh or eat holes in cloth.

When you check the battery for liquid level look at the clamps on the posts. Tighten them if they are loose, being careful not to ground the "hot" terminal. Grounding the "hot" terminal could cause sparks that might explode the vapor on top of the liquid in the cells. Battery vapor is an explosive mixture of hydrogen and oxygen.

Currently, most of the batteries are low- or no-maintenance batteries. These batteries contain a special chemical that reduces the production of gas during normal charging voltages. Thus, water never needs to be added. These batteries are completely sealed, except for a small vent hole in the side. Most are equipped with a test indicator in the top cover. If this indicator is light yellow, do not charge, or jump start. In this case the integral charging system has malfunctioned and battery needs replacing.

SERVICING THE HYDRAULIC SYSTEM

Preventive maintenance to the hydraulic system involves making sure the oil level is always at the specified level. It also involves changing the fluid and filters when required and keeping the system free of leaks. Be especially cautious when checking for leaks in the hydraulic system. Many hydraulic systems develop pressures over 2,000 psi, which is three times the pressure needed for oil to penetrate skin. Pinhole leaks are often invisible and especially dangerous. Pinhole leaks should be located by moving a piece of cardboard or glass past the suspected leak area. A magnifying glass can help find the leak.

If high-pressure oil penetrates the skin, see a doctor at once. Serious infection or reaction can develop if medical attention is not administered immediately.

MAKE SAFETY A DAILY HABIT

Safety must become a daily habit. Before a tractor is used, it should be examined carefully for any unsafe conditions that might cause an accident. This inspection can be made at the same time you make the daily maintenance check. There is almost no limit to the number of items that should be checked. The steering mechanism must be properly adjusted. Other items that should be checked include the fan belt, brakes, clutch, seat and shields. Make sure there are no leaks in the fuel system. Keep the tractor clean. Keep tools in the tool box where they belong and not on the platform.

Always keep tires properly inflated. Watch the pattern the tires make in the soil while under load. Most operator's manuals will show what the tire footprint should look like and the proper inflation pressure. Improper inflation not only causes rapid tire wear but also influences traction.

Remember to check for loose fittings, bolts and nuts. If two pieces are no longer held together or loosely held, wear can be accelerated or bolts can be bent or sheared off. In either case, the results mean money for costly repairs.

This is only a partial list. Space to develop a safety check of a tractor is included in the work unit.
In this unit you learned about important daily maintenance needs of a tractor. Review the operator's manual and see if you can find more inspection checks that should be added. How about the hydraulic system? The fuel sediment bowl? The pre-cleaner on the air cleaner stack? In the operator's manual, the Daily Maintenance check may be listed as "10-hour service."

1. Use the blanks below and make up a checklist for a Safety Inspection of a tractor. Then ask your parents to help give the list a trial. If you find anything that isn't safe, correct it right away. Report what was done to correct the unsafe item in the right-hand column below.

<table>
<thead>
<tr>
<th>Daily Safety Check Points</th>
<th>Unsafe Items Corrected</th>
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</thead>
<tbody>
<tr>
<td>1.</td>
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<td>2.</td>
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<td>3.</td>
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<td>4.</td>
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<td>5.</td>
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</tbody>
</table>

Note: This Check-Up Sheet is intended to test what you have learned and to stimulate discussion with the other 4-H members. The more you discuss these questions with your leader and the other members the more you learn and understand.
First Year - Unit 7

STARTING AND STOPPING YOUR TRACTOR

Learning the proper way to start and stop a tractor is an important first step toward becoming a safe, skilled tractor operator. The best place to start is—you guessed it—by reading the operator’s manual. Study the manual carefully to learn the exact procedures for your tractor.

GENERAL STARTING PROCEDURE

Not all tractors use the same starting procedure. This is particularly true for diesels or LPG tractors. Here are some rules that should be included in the procedure for starting any tractor safely: (1) Make a daily maintenance and safety check as outlined in the previous unit. (2) Take your position in the operator’s seat. Adjust the seat so you can reach and operate all of the controls. (3) Place the gearshift in “Neutral” or “Park.” This is necessary on some tractors to make the starter work. (4) Make sure the power-take-off and hydraulic lift levers are in the “Neutral” position. (5) Look out for the safety of others. Check carefully; make sure any persons who may be in the vicinity are well out of the way of the tractor and any equipment that may be attached. (6) Put your foot on the clutch and depress it. This reduces the load on the starter and is a good safety precaution in case the tractor is started, let it run at half throttle for a few seconds to let the oil pressure stabilize. Avoid pulling heavy loads for the first few minutes of engine operation.

STARTING A GASOLINE ENGINE

For a gasoline engine to start and run, the mixture of fuel and air delivered to the cylinders must be in the proper ratio. It takes about 13.5 pounds of air to provide enough oxygen to burn one pound of fuel for full-load operation. However, an engine with the carburetor adjusted properly for full-load operation may not start without “chocking.” The engine must be chocked to start properly in cold weather.

The choke is a valve in the carburetor that cuts air intake for starting a cold engine. When the choke valve restricts the air, more fuel is pulled into the cylinder and surrounding parts, diesels need some kind of help in starting. Diesel tractors do not use a spark for ignition. Instead, the incoming air is heated by the compression stroke to a temperature high enough to cause the fuel to start burning as soon as it is injected. Due to the cold temperature of the cylinder and surrounding parts, diesels need a special device for injecting a small quantity of ether gas with the first few turns of the engine by the starter. All devices are used to help heat the engine block so the compressed air in the cylinders will be hot enough to start the engine and keep it running. Diesels do not have a choke. In cold weather, excess fuel is supplied by adjusting the throttle or with an excess fuel button.

STARTING A DIESEL ENGINE

The choke is a valve in the carburetor that cuts air intake for starting a cold engine. When the choke valve restricts the air, more fuel is pulled into the cylinder and surrounding parts, diesels need some kind of help in starting. Diesel tractors do not use a spark for ignition. Instead, the incoming air is heated by the compression stroke to a temperature high enough to cause the fuel to start burning as soon as it is injected. Due to the cold temperature of the cylinder and surrounding parts, diesels need some kind of help in starting.

STARTING AN LPG TRACTOR

LPG tractors are started in almost the same way as a gasoline tractor. A special fuel tank is required on the LPG tractor since the fuel will completely vaporize at ordinary temperatures if exposed to atmospheric pressure. Most LPG tractors are designed to start the engine on vapor, while the fuel is stored as a liquid under high pressure.

Normally the vapor valve is opened for starting, and the liquid valve is left closed. The vapor valve should be opened slowly, permitting vapor from the top of the fuel tank to become available for starting. If this valve is opened too quickly the sudden rush of gas will cause another valve, called the excess flow valve, to close. You will then have to wait a few minutes for the excess flow valve to reopen. The purpose of the excess flow valve is to provide an instant shut-off in case a leak develops in the fuel line from the tank. There are excess flow valves on both liquid and vapor outlets.

Once the LPG engine has started and warmed up to the proper operating temperature, the liquid withdrawal valve should be opened and the vapor valve closed.

IF THE ENGINE DOESN'T START

If the engine, whatever its type, fails to start on the first try, wait until the engine stops rotating before trying again. If the starter is engaged while the engine is turning, there is a chance of damage to the starter or to the ring gear of the engine. While trying to start a tractor, remember not to engage the starter for periods longer than 15 seconds at a time. This will prevent the battery from overheating or running down and will protect the starter motor. Don't keep grinding on the starter, because failure to start may be due to something seriously wrong with the tractor.

When the engine fails to start, you have to become a "trouble shooter." Perhaps you forgot to turn on the fuel supply, or there might be a loose or broken ignition wire. Also, the engine may be flooded by excessive choking, or perhaps you did not have the choke out at all. If you cannot find the trouble right away, then check with someone who is familiar with the tractor.

On a diesel tractor, the fuel shut-off control must be moved to the RUN position before the engine can be started.

If the tractor does not start due to a dead battery then the battery should be removed and charged or jump-started with another tractor of equal capacity. Remember that batteries can explode so if you are jump-starting a tractor; keep the spark and battery gases from getting together. Here's how: (1) Make sure both tractors are parked and brakes locked. (2) Check the two batteries and make sure they are the same voltage. (3) Make sure both batteries are grounded with the same pole-usually the negative terminal is connected directly to the engine block. (4) Add water to battery cells that are charged.

IF THE ENGINE DOESN'T START
low. Never jump-start a battery with frozen liquid. (5) Connect the red-clamp jumper cables to the positive terminals of the two batteries. Wiggle each clamp so it makes good contact with the terminal and will not spark. (6) Connect the black clamp to negative terminal of the good battery. (7) The final connection is the one that sparks, so place it as far from the battery as possible. The last black clamp should be attached to the dead tractor frame or engine block. (8) Keep cables from fans and belts and do not touch black clamps to red ones. (9) Try to start the dead tractor. If it will not turn over, start the booster tractor and let it charge for a few minutes. Then try starting again. (10) After starting the dead tractor remove clamps in exact reverse order. Remember the first one disconnected will cause a spark, so first remove the one farthest from the battery. If you have protective glasses, wear them. For your safety and others around you, never attach your cables to the dead tractor's starter. If the tractor is in gear it could run over someone when cables are connected.

WEIGHTS TO INCREASE STABILITY AND PERFORMANCE

Add front-end chassis weights to counterbalance rear-mounted implements and heavy vertical drawbar loads like two-wheeled trailers, manure spreaders, rear mounted loaders and scrapers. Adding front-end weights for pulling heavy loads uphill will help offset the loss of stability. Add rear-wheel weights or tire ballast to counterbalance front-end attachments like spray tanks or front-end loaders. The reason for these weights is to keep about 70 percent of the total weight on the rear wheels during tractor operation.

Ballast is weight added to provide efficient tractor performance and maximum drawbar power. Ten to 15 percent slippage is considered ideal in field operations. For first adjustment, consult the operator's manual or equipment dealer to determine the amount of weights needed for a given operation and soil condition. Correct ballast may be gained by observing the tire pattern and making weight corrections, as needed. Too little weight results in excess slippage, tire wear and fuel consumption. Excessive weight results in a sharp, distinct pattern with no evidence of slippage which will create excess wear on the drive train and additional soil compaction.

When more ballast is required, do not exceed the maximum carrying capacity of the tires. When extra ballast is added, adjust the tire pressure to maintain correct support of the sidewalls. Keep in mind that a towed implement requires more ballast than a mounted implement. Mounted implements provide weight transfer to the tractor that acts as additional ballast.

STOPPING A TRACTOR

Just as it is important to know how to start the tractor, there are some rules that must be followed when the engine is shut off. The following procedure is suggested. Other suggestions may be listed in the operator's manual. (1) Reduce engine speed with the throttle and let the engine idle for a few minutes. This cools the engine down and helps prevent warped valves and damaged turbochargers. It also will help keep the engine from backfiring. (2) Shut off the engine. This is done with a switch on a gasoline or LPG tractor. Diesels usually have a fuel shut-off valve, either separate or included with the throttle. (3) When the engine is completely stopped, put the gearshift lever in "Park" or low gear. Putting the transmission in gear or "Park" will prevent the tractor from rolling away if it must be parked on a slope. (4) Stop the brakes. This will also help to make sure the tractor will not accidentally roll downhill. (5) Finally, use caution when dismounting from the tractor. A safe tractor operator doesn't jump on or off a tractor. Use the steps and handholds that are provided and watch your step!
5. List, in proper order, the steps you would take in stopping a moving tractor and shutting it off for the night.

6. How would you stop a tractor engine if the ignition key fails? ____________

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**Members' Check-up**

**First Year Unit 7**

**STARTING AND STOPPING A TRACTOR**

**Drawing a line under the correct word or words, and putting the letter for the correct answer at right of page.**

1. In choking a tractor engine for cold-weather starting the operator (A-makes the air-fuel mixture richer) (B-makes the air-fuel mixture lean). ____________

2. (A-Diesel) (B-Propane) tractors require heated air in the cylinders for quick starting in cold weather. ____________

3. In cold weather a tractor engine should not be placed under a load until (A-it will run smoothly without being choked) (B-the heat gauge is in the normal operating position). ____________

4. Propane is a fuel that (A-vaporizes) (B-liquifies) at ordinary temperatures. ____________

5. Diesel engines (A-do not) (B-do) require a warm-up period before being loaded. ____________

6. Shutting off an engine before letting it idle for a few minutes (A-makes it hard to start the next time) (B-may cause warped valves due to uneven cooling). ____________

7. When driving a tractor downhill make certain the clutch is always (A-engaged) (B-disengaged). ____________

8. It is a good idea always to (A-leave the ignition key in the tractor) (B-remove and place the ignition key where it is not available to children). ____________

9. The first step in starting any tractor is (A-turn on the ignition) (B-check the gearshift lever) (C-make certain the area is clear of other people). ____________

10. A sign of excess tractor weight is (A-excess tread wear on the edge of the tire) (B-no slippage) (C-excessive slippage). ____________

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**Second Year - Unit 1**

**TRACTOR SAFETY ON THE FARM**

The tractor is involved in more fatal and non-fatal accidents than any other farm machine. In fact, studies show that four out of every 10 operators will have a serious accident with a tractor during the time they are actively engaged in farming. As a member of the 4-H Tractor Program, do your part to help reduce tractor accidents.

**PLAN AHEAD—AVOID ACCIDENTS**

"I was in a hurry." "I just got careless." "I thought I could get out of the way in time." How many times have you heard these excuses from persons who have had an accident? We all know that carelessness and being in a hurry can cause accidents. But why do we hurry or get careless? The answer is simply that we are trying to do more in a given amount of time than can be done safely. Or we continue to work after we get tired. When we get behind with our work, we take too many chances, and that results in accidents.

You have the ability to think. That's something a machine doesn't have. That's also why it is better to plan your work so that you don't need to hurry or take chances. By thinking ahead you can learn to eliminate hazards before they cause an accident.

Be a safe tractor operator by forming two important safety habits: (1) be sure the equipment you operate is safe, and (2) be sure you have the proper attitude—one that gives you sufficient time to think ahead so a hazardous situation can be avoided.

**REACTION TIME**

How long does it take to make a simple reaction, for example, putting your foot on both brakes to make a sudden stop, or turning off the ignition? The minimum time needed to make these reactions is one-half a second. Average reaction time is three quarters of a second. It may take two or three times that long if you panic or make the wrong move first. A lot can happen in the fraction of a second it takes for you to make a simple move. The tractor could upset or you could be caught in the PTO shaft.

Your natural reaction in an accident situation is either to freeze and do nothing at all, or to make the wrong move. Here's an easy way to demonstrate this fact: Hold one end of a broomhandle and ask another person to hold one end of a broomhandle and ask another person to hold the other end of the broom. The person who is holding the broom handle is told to give a quick jerk on the broom. Chances are, your friend will tighten the hold and could not let go. Your natural reaction is to tighten your grip and hold on. This is why people get caught when they try to unclog a machine while it is running. The machine suddenly unclogs itself and the operator can't let go, so his or her hand goes into the machine.

The simplest and easiest way to avoid accidents is to think ahead and avoid accident situations. When you are having trouble with a tractor or machine, always shut off the motor before leaving the seat to work on it.
Every time you get ready to start your tractor, make sure it is mechanically safe to operate. That goes for all other machines, too.

With a little practice, you can give a tractor a complete daily maintenance and safety check in less than five minutes. Use a method that lets you start at one place on the tractor, and move completely around it so that you don't miss anything. Include the seat, steering, brakes, clutch, platform, wheels, tires, hitch, and PTO in your check. You can add several other items to the list for your tractor.

**SEAT**

Seats on modern tractors have several adjustments. Adjust the seat to your size and weight. You need to be able to reach and operate all controls from a comfortable sitting position. Check all of the bolts and screws. If any are loose or missing, make repairs immediately.

**BRAKES**

Good brakes are important. Keep them evenly adjusted whether they are the kind that can be locked together, or are both operated with one foot. Newer tractors with power or hydraulic brakes need special care. Check your operator's manual. If you turn in one direction more often than the other, brakes will not wear evenly. For this reason they must be checked frequently. Form a habit of stopping your tractor by slowing down the engine. Don't jam on the brakes to make a stop unless it is necessary to avoid an accident.

**HITCHES**

Any time you pull a load with your tractor, the load is trying to pull the tractor over backwards. The tractor tries to pivot around the rear axle. You may have noticed how the front end of your tractor seems to be lighter when a very heavy load is attached. The hitch on a tractor is designed to let you pull very heavy loads without fear that the tractor will upset backwards, provided the loads are hitched properly. So always hitch to the drawbar, and keep the hitch low. When the hitch point on the tractor is raised, the chance for a backward upset is greatly increased. Always use a safety-hitch pin for fastening a pulled implement to the drawbar of a tractor. This pin will not bounce out and cause the implement to get loose and possibly cause an accident.

**TRACTOR UPSET**

A tractor has the power to rotate around the rear axles should the rear wheels be held fast. In this situation, if the tractor is in a forward gear, the front end will come up, resulting in a backward upset. This might be the case if you get stuck in a ditch and fasten a plank or something else to the wheels to get traction. Always back out, if stuck. Or get someone to pull the stuck tractor out with another tractor.

A tractor can tip over sideways at a speed of 8 miles an hour if the wheels drop into a hole or hit an obstruction. (Eight miles an hour is about twice as fast as you can walk.) It will tip at a much slower speed if you are turning. Slow down and be very careful to avoid obstructions or holes. The chances of upsetting are four times greater when speed is doubled.

**ROLL-OVER PROTECTIVE STRUCTURES (ROPS) AND SEAT BELTS**

The development of rollover protective structures (ROPS) received a lot of attention from tractor manufacturers during the 1960's. The National Safety Council reported in 1973 that 53 percent of all farm tractor fatalities which occurred from 1969 to 1972 were caused by tractor overturns where a ROPS was not used. Due to these findings and the protective advantages of ROPS, OSHA in 1976 required all tractors operated by employees to be equipped with ROPS and seat belts. In 1985, all tractors were constructed with mandatory ROPS and seat belts.

Correctly designed ROPS are constructed to provide operator protection during a single rollover. During an accidental overturn, ROPS protects the tractor operator by absorbing energy and buckling without endangering an operator within the critical zone. To keep the operator in the critical zone seat belts must be worn. A suitable ROPS is designed to withstand forces from an 180-degree overturn or the total weight of the tractor. Check the ROPS label attached to the cab or frame to make sure that the ROPS can withstand additional weight from ballasting and duals.

**POWER-TAKE-OFF**

The power-take-off (PTO) shaft on the tractor is an easy way to drive some machines, such as combines, mowers, or forage choppers. The standard speed for a PTO shaft is either 540 or 1,000 rpm. An unguarded shaft is dangerous at any speed when it is turning. The PTO can quickly grab clothes if they brush against it. Once caught, a person is helpless against this shaft. Against the power of a tractor, no matter how big he or she is. Never operate a machine unless the PTO is covered with a standard shield. One type of shield covers the top and sides of the shaft. Another type is a loose shield fastened to the PTO with anti-friction bearings. It will rotate slowly when the PTO is in use but will stop when touched. Caution— you can't always tell whether a PTO shaft is guarded by a loose shield while it is running. To be safe, treat it as an unguarded shaft and stay away from it. The PTO stub should be protected when the PTO is not in use. This can be done with a stub shield that completely covers the shaft. If you don't have one for your tractor, it is not difficult to make one. A master shield covers the top of the stub shaft and is standard equipment to allow all tractors to be connected to any power-driven equipment. It should always be in place. Some newer tractors also have a front PTO shaft under the tractor. It should be given the same protection with shields as a rear PTO.

**SAFE HANDLING AND STORING OF FUELS**

If hilly or sloping fields are crossed, be especially careful to avoid conditions that may lead to an upset. The chance of a tractor upsetting backward increases if the front end is higher than the back end. This means that you should be very careful when driving or pulling a load up a hill. Let the clutch out very slowly when starting up a slope. Adjust the rear wheels to a wide position when working along the slope, to help protect from a sideways upset.
Liquid fuel cannot burn. It must be vaporized and mixed with air. You can demonstrate this with a candle. Light the candle and watch it burn for a few seconds. Notice how the paraffin first melts from a solid to a liquid and then is vaporized by the heat from the flame. When the candle is snuffed, the vapors that continue for a few seconds can be re-lighted some distance from the wick.

An underground tank provides the safest storage for petroleum fuels, other than liquefied petroleum gas (LPG). Where underground storage is not feasible, safe fuel storage may be provided by a good above-ground tank. Locate it as far as practical from buildings. Forty feet is considered a minimum. You can get specific suggestions for safe fuel storage from your fuel supplier. A shut-off valve between the hose and the tank is a must. It should be the kind that will stop flow of fuel in case of fire. Keep the area around the storage tanks clean of weeds and trash. Keep the tank shaded; the heat of the sun. Storage containers of 55 gallons or less must be painted vermilion red.

If flammable liquids must be used indoors, always keep them in a safety can with a spring-closed cover to prevent the escape of vapors.

Do not use gasoline for cleaning purposes. Gasoline gives off flammable vapors at temperatures down to 45 degrees below zero. Use a solvent for cleaning. It is much safer and will clean as well as, or better than gasoline. Never refuel a tractor while it is running or even while the engine is hot. Fuel vapors are heavier than air and may collect around the tractor and be approved for use on petroleum fires. Two examples of approved extinguishers.

Exhaust gases contain carbon monoxide (CO), which is a deadly poison. You can’t smell it or see it so you have no way of knowing when a deadly amount is present. If you must run an engine inside, keep the doors open and air circulating.

SAFETY AND YOUR RADIATOR

If the radiator has a pressure cooling system, let it cool for awhile before removing the radiator cap. The water in a pressure cooling system quickly turns to steam when the pressure is suddenly released. Always place a dry cloth over the cap and remove the cap slowly as an added precaution against being burned by the steam.

EXHAUST GASES CAN KILL

Exhaust gases contain carbon monoxide (CO), which is a deadly poison. You can’t smell it or see it so you have no way of knowing when a deadly amount is present. If you must run an engine inside, keep the doors open and air circulating.

To help you learn how to avoid accident situations, let’s start with a discussion of some accidents that have actually happened. Read the stories of the accidents. Discuss them with other members and your leader. Then use the blanks to tell how the accident could have been prevented. Be on your toes; the answer may not be as simple as you think.

Situation 1 - Farmer A was pulling a large drag harrow in a field crossed by a small ditch. Due to constant plugging of trash under the harrow, Farmer A took the stay bars off the hydraulic hitch of the tractor and raised the hitch as high as it would go. This stopped the plugging, but the harrow caught on an old stump as he crossed the ditch. The tractor tipped over backward. Gasoline spilled from the tank and started a fire. Farmer A was pinned under the tractor and suffered a broken leg and severe burns before being rescued by a neighbor. The tractor was a total loss.

How could this accident have been prevented?

Situation 2 - A new tractor had just been delivered by the local dealer to Farmer B, whose son was 10 years old. A few days after the tractor was delivered, the boy was showing off the new tractor to his 9-year-old friend. He had watched his father start the tractor, so he decided to start it, too. It started right away, but the PTO started and the boy was run through the baler and instantly killed.

How could this accident have been prevented?

Situation 3 - Farmer C tried to start a tractor but found the starter locked. To loosen the locked starter, he put the PTO switch. The first tractor started and crawled up the rear tires of the second tractor. Farmer C was knocked off the seat and suffered severe bruises.

How could this accident have been prevented?

Situation 4 - A 7-year-old boy was sent by his mother to take a jug of water to his father's baling crew in a nearby field. On the way back to the house he got tired and lay down in a windrow to take a rest. He went to sleep and didn’t hear the baler coming. No one in the baler crew saw him and he was run through the baler and instantly killed.

How could this accident have been prevented?
LETS GO TO WORK
The best way to prevent an accident is to eliminate hazards that might cause an accident. Ask your parents to give a hand. Use this work sheet to list hazards found on your farm and tell what can be done to eliminate them.

1. Roadways, farmstead, and lanes. Look for obstructions and holes that might cause an upset.

<table>
<thead>
<tr>
<th>Hazards found</th>
<th>How they were eliminated</th>
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2. Tractor. Give a tractor a complete safety inspection. Look for low tires, fuel leaks, loose seat, missing shields, etc.

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<thead>
<tr>
<th>Hazards found</th>
<th>How they were eliminated</th>
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3. Fuel storage. Check location of tanks from nearest building. Check for shutoff valves, safety cans, relief valves for LPG tanks, etc.

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<tr>
<th>Hazards found</th>
<th>How they were eliminated</th>
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4. Shipping area and storage shed. Are flammable petroleum or chemical products stored where they might cause a fire? Are there fire extinguishers? Are the tools and pesticides where they belong? There may be other hazards.

<table>
<thead>
<tr>
<th>Hazards found</th>
<th>How they were eliminated</th>
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Note: Fill out this work unit, using your own farm site. Be ready to discuss your experiences with the other 4-H members at the next club meeting.

Members' Check-up
Second Year Unit 1

TRACTOR SAFETY ON THE FARM

Place the letter for the correct answer at the right of the page.

1. PTO shields (A-can) (B-cannot) be used when the tractor is a different make than the attached equipment.

2. When pulling a heavy load up a slope, keep the hitch (A-as low as possible) (B-as high as possible).

3. Vapor from fuel is (A-lighter) (B-heavier) than air.

4. It is better to (A-back out) (B-drive out) of a ditch when the rear wheels start to spin.

5. Raising the hitch on the tractor (A-decreases) (B-increases) traction and (A-increases) (B-decreases) the possibility of tipping backward when hitched to a heavy load.

6. A tractor is about (A-5) (B-500) (C-5,000) times more powerful than you are.

7. It is the (A-carbon monoxide) (B-carbon dioxide) in exhaust gases that can kill.

8. Raising the hitch on the tractor (A-decreases) (B-increases) the chance for a backward upset.

9. When speed is doubled the chance for an upset is (A-doubled) (B-quadrupled) (C-the same).

10. List three rules that you believe should be followed by every tractor operator.

I. 
II. 
III. 

11. A jump cable for booster battery use is correctly connected when (A-each cable connects a positive and a negative terminal) (B-each cable connects positive or negative terminals and the last connection is made away from the batteries on the frame or engine block) (C-the red cable connects to starters, the black cable connects to generators).

Note: This Check-Up Sheet is intended to test what you have learned and to stimulate discussion with the other 4-H members. The more you discuss these questions with your leader and the other members the more you learn and understand.
TRACTOR SAFETY ON THE HIGHWAY

About one-half of all fatal tractor accidents occur on highways, county roads and other roadways. Collisions with other motor vehicles are an important cause of death, but a large number of the fatal tractor accidents involve only the tractor.

Inexperienced operators, unsafe operation, not watching the road, and excessive speed are common causes of tractor accidents on roadways.

TRACTORS ARE NOT BUILT FOR HIGHWAYS

Your tractor was not designed for use on highways and public roads. The road speed of a tractor is much slower that of an automobile or truck. A tractor traveling at less than 20 mph is a "sitting duck" for an automobile or truck traveling at 55 mph.

Tractors also have a high center of gravity which makes them easier to overturn if turned sharply at excessive speed, if an obstruction is hit or when accidentally driven into a road ditch.

The quick-acting power steering on tractors requires full attention of the driver while traveling at higher speeds. The tractor is designed for rapid maneuverability at low speed, not high speeds. Many accidents have occurred when the driver looked to the rear and accidentally turned the steering wheel slightly as he or she looked back, thus causing the tractor to swerve into the ditch.

Tractors are not made to carry passengers. Carrying passengers on the tractor is a dangerous practice. Other arrangements should be made to give rides to extra persons.

Tractors are being used to pull larger and longer loads on highways. Wagons and trailers capable of carrying up to 12 tons of hay or grain are frequently being pulled by farm tractors. These heavy loads are dangerous when traveling on slick or gravel roads, especially when the tractor is towing heavy wagons up or down inclines. Be careful; if excessive slippage occurs, stop the tractor and get additional slowing or pulling power from another tractor. To be safe, equip the wagons and trailers with their own brakes.

Heavy loads hitched to a tractor traveling at road gear speeds easily create steering and braking problems. Remember the two-wheel drive tractor has only two brakes, one for each rear wheel; and the heavy machine or wagon being pulled often has no brakes at all.

STATE LAW RELATING TO FARM EQUIPMENT

There are certain state laws that apply to the operation of farm equipment on public roads. These laws cover the operation, lighting, and identification of farm equipment on public roads and these regulations vary from one state to the next. To obtain the information on the laws that apply to your state, check with your local state police. They can furnish a copy of the traffic laws for farm equipment. This information would make a good report for your next club meeting.

SAFE DAYTIME DRIVING

Avoid the use of busy highways even if it means you must drive somewhat out of your way. While using a two-lane highway, drive on the shoulder if possible and go slowly enough to see obstructions or holes that could cause an upset. Sometimes you have no choice but to use the highway surface. When you do, avoid the dangerous practice of driving with one wheel on the pavement and the other on the shoulder. This practice encourages faster traffic to try to pass when there isn't enough room. If oncoming traffic doesn't yield part of its lane, the car attempting to pass will crowd the tractor off the highway or side-sweep it, catching the left rear wheel. In these situations, it is better to occupy one full lane the same as if you were driving a car. At least this will help to keep cars from passing without first making sure there is no oncoming traffic.

Hilly, winding roads are especially hazardous because the driver of an oncoming vehicle cannot see you and you cannot see him or her. As a result there may be a collision or someone has to take to the ditch.

The best way to avoid highway accidents is to stay off the road as much as possible. If you must use the highway, use it when traffic is the lightest, and make the equipment as easy to identify as possible.

All states now require that a slow-moving vehicle (SMV) identification emblem be placed on the rear of any tractor, tractor with towed equipment or self propelled machine traveling 25 mph or slower.

The SMV emblem consists of a fluorescent yellow-orange triangle with a dark, red reflective border. The yellow-orange triangle is for daylight identification and the red border is for night identification. The emblem should be attached to the center of the equipment between 2 to 6 feet (0.61 to 1.83m) above the ground measured from the lower edge of the emblem. The SMV emblem may be permanently attached or be portable for use with several implements. The SMV emblem should not replace such warning devices as tail lamps, reflectors, flashing light, or warning flags, and it is not to be used as a clearance marker for wide equipment.

The SMV emblem needs to be replaced as it begins to fade or it will not offer the protection for the tractor operator or the motor vehicle driver from an accident.

PRACTICE COURTESY

Safety on the highway begins with courtesy. When traffic piles up behind you, pull off the road at the first opportunity and let it pass. Remember that it is a privilege for you to operate your tractor and equipment on a highway. Don't abuse this privilege. Practice courtesy. Know and obey the rules of the road as they apply to the tractor and other slow-moving equipment in your state.

SAFE DRIVING AT NIGHT

Operating farm equipment on a highway at night presents a serious problem since it is difficult for motorists to know of your presence. The best rule is to stay off the highway at night with slow-moving equipment. Plan your work so that farm equipment is moved during daylight hours and at a time when traffic is lightest.
If you must travel at night, be sure the tractor is provided with adequate lights, and that supplemental lighting is provided for the towed equipment. Local state laws should be followed in the lighting of your equipment. Similar laws are suggested by the Uniform Vehicle Code. This code states that tractors should have one or two white lights visible 500 feet forward, and one red light visible 500 feet to the rear.

It is dangerous to use a white light to the rear because it might cause a motorist to think the light is the headlight of an oncoming car or motorcycle. It is also dangerous, and sometimes illegal, to use a flashing red light. In many localities, a flashing red light is reserved for use on emergency vehicles such as ambulances and police cars.

In addition, there should be a light on the farthest projection to the left of any part of the equipment to the side of traffic, whether the light be on the tractor or the towed equipment. The clearance light should show red to the rear and amber to the front and be visible for 500 feet to the rear. Red tail-lights or reflective tape can be applied to the extreme right and left corners of the towed equipment. Lights, electrical connections, and mounting brackets for lighting farm equipment have been standardized so they can be used on all combinations of tractors and equipment.

**BLIND CORNERS**

One of the major hazards in rural areas is blind intersections and drive-way entrances that have crops or shrubbery restricting vision toward the other lanes of traffic. Check with your leader. Perhaps your club could make a project of clearing some of the blind corners in your community. Be sure you first obtain permission from the landowners and tenants. Clear your driveway so that visibility is extended to at least 700 feet in both directions.

**SAFE EQUIPMENT**

In the First and Second Year projects you learned about the importance of keeping farm equipment in safe operating condition. It is even more important to have farm equipment in safe condition when it is taken onto the highway.

When traveling on highways or public roads, you are traveling at speeds much faster than used for field work. This means that the mechanical condition of a tractor must be perfect. A routine daily safety inspection is the best way to find and eliminate hazards before they can cause trouble. Be alert for loose or missing bolts and nuts in the wheels, and check for cracks in the wheel casings. Look at the tires to make sure they are suitable for use on the highway. Check the tire pressure. Inspect the steering mechanism for loose play. You may not have noticed it in the field, but it doesn't take much looseness to cause trouble on the highway.

In normal field use, brakes do not always wear evenly. This is because the tractor is usually turned more in one direction than the other. If the brakes are not adjusted evenly, applying both brakes in a sudden stop could cause the tractor to upset. The brake pedals should be locked together for highway travel. Tractors can pull far more weight than they can safely stop in an emergency. Over-estimating the braking ability of tractor brakes is a common error made by many operators.

For safe braking, never pull a load that is heavier than the tractor. A tractor weighing 18,000 lbs (8200 kg) will safely pull and stop a load weighing 18,000 lbs (8200 kg).

To maintain safe steering it is also important not to overload the drawbar on a tractor. Excessive weight on the drawbar will cause the front of the tractor to become lighter due to the rearward shift in weight. A tractor is designed to carry approximately 30 percent of its weight on the front wheels or 3,000 pounds (1500 kg) for a 10,000 pound (4500 kg) tractor. When loading a 2-wheel trailer, try to center the load just ahead of the trailer axle so the trailer carries the weight instead of the tractor drawbar. Weights can also be added to the front of the tractor to counter-balance the effects of a heavily loaded drawbar.

While pulling a heavy load behind your tractor, drive slower and allow plenty of distance for stopping when approaching an intersection or stop sign. As a safety precaution, start slowing down far enough ahead so that a complete stop can be made without brakes. Use great care when stopping a tractor pulling a heavy load. It takes only a little braking pressure on the load to cause the hitch to jackknife and upset your tractor.

Safety hitch pins should always be used when pulling a load with the tractor drawbar. The locking feature of the safety hitch pin will prevent the pin from bouncing out and unhooking the trailer or implement from the tractor. Tractor tires usually contain a liquid or other heavy ballast. If this is the case, be sure both tires are filled to the same level. If the load in the rear tires becomes unbalanced while the tractor is traveling at a high rate of speed, the tractor can go out of control. You may have to reduce speed to maintain control of your tractor.

Be careful when going down a hill or incline. Shift to a lower gear before starting down a hill and leave the tractor in gear. CAUTION: Some of the transmissions in modern tractors will not hold a load in certain gears when going down a grade. Check the operator’s manual to determine which gears can be used safely when going down a hill. Rear-view mirrors are especially helpful to persons who operate tractors on highways. The mirrors allow the driver to watch traffic approaching from the rear without having to look back over his or her shoulder. Remember a slight turn of the steering wheel can easily occur if the driver isn’t watching the road carefully.

Rollover protective structures (ROPS) such as roll bars or cabs have saved many lives. The ROPS protects the operator by limiting the upset to 90 degrees and by providing a zone of safety so the operator is not crushed in the overturn. Protective frames are generally two or four-post structures which are attached to the tractor frame.

Tractors with rollover protection are also equipped with seat belts. It is important to wear these belts to insure operator protection in case of a roll over. Many rollovers have occurred where the operator was not injured because the tractor was equipped with rollover protection and he or she was wearing a seat belt.

The rollover protective cabs now give the operator accident protection plus the added advantages of noise reduction to safe levels and the comfort of air conditioning. Reduced noise levels and air conditioning help reduce operator fatigue, another cause of accidents.
Let's discuss some accident situations that have actually happened. Read the story of each accident and then discuss it with your leader and the other members. Use the blanks to tell what you have learned that could help prevent a similar accident from happening.

**Situation 1.** Farmer A was pulling an empty wagon down a single-lane gravel road late at night. He was traveling about 18 miles an hour. When he met an oncoming car he pulled off to the side. The rear wheel dropped into a hole, upsetting the tractor. Farmer A was crushed under the tractor and died instantly.

How could this accident have been prevented?

**Situation 2.** A 16-year-old boy was returning a tractor that had been overhauled in the high school shop. Four other boys went along for the ride. During a little horseplay one of the boys fell from the tractor and caught his pant-leg on the hitch. He was dragged along the ground for about 50 feet before the tractor could be stopped. The boy suffered severe cuts and bruises and spent a week in the hospital.

How could this accident have been prevented?

1. Do you operate a tractor or other equipment on a rural road or highway? ______ How often? ______
   List any dangerous situations you have encountered? ______________________

2. Do you use slow moving vehicle emblems? Describe how SMV are used. ______________________

3. Do you use a special lighting on your tractor or equipment for night travel? ______ Describe how you have lighted your equipment for travel at night. ______________________

4. Make a safety inspection of a tractor. Is it safe for operation on a highway? ______

Don't wait! Correct any unsafe items right away!
HITCHES, PTO AND HYDRAULIC CONTROLS

Have you ever thought about the many different ways in which your tractor can be used? Some tools, such as a disc harrow, are merely hitched to the drawbar. A wheel disk might use a remote-controlled hydraulic cylinder. Still other implements, such as a slasher, may be driven by the PTO (power take-off) shaft from the tractor, with a hydraulic cylinder being used for adjusting the height of the feeding unit. Know how to connect implements correctly, and how to operate the equipment safely.

CHECK THE DRAWBAR HEIGHT

When you hitch your tractor to an implement, it is important always to use the drawbar. Do not pull a load from the axle or seat, or from one of the links of the three-point hitch. When you do, there is danger of upsetting your tractor or damaging it mechanically. On some tractors the drawbar is on the three-point hitch. With this type of drawbar have the hitch at the recommended pulling height. Check the height of the hitch on your tractor. The distance as measured between ground level and the hitch point on the drawbar should be no higher than the maximum height recommended by the operator’s manual. Adjusting your drawbar to this height not only provides safer hitching but will also match the standard height for use of the PTO shaft.

CAUTION - When using a tractor that is equipped with a hydraulically controlled drawbar to pull a load, use the stay braces provided with your tractor to lock the hitch in position. Raising the hitch to increase traction is a dangerous practice that can cause a backward upset.

HITCHES FOR PTO OPERATION

The drawbar on most tractors can be adjusted for either a close hitch or an extended hitch. You will need to use the extended hitch for a machine that is driven by the PTO shaft. There are two standard speeds for the PTO shaft on newer tractors. One is 540 rpm, the other is 1,000. If you use a PTO speed of 540 rpm, the hitch point must be 14 inches from the end of the PTO shaft. Two spline configurations operate at 1000 rpm and the distance from the hitch point to the end of the PTO shaft are different. The 1-3/4 inch diameter stub shaft (20 splines) has a hitch distance of 20 inches while the 2-1/8 inch diameter stub shaft (21 splines) has a hitch distance of 16 inches. Using a drawbar connection that is too short will cause the universal joints on the PTO shaft to bind when you make a short turn. If the tractor hitch can’t be adjusted to the proper distance, check with an equipment dealer. The dealer should have a drawbar extension which will provide the proper length.

When using the PTO shaft, be sure the drawbar is centered directly under the shaft and securely fastened.

HITCHES FOR MOUNTED EQUIPMENT

Most modern tractors are equipped with hydraulic controls for raising, lowering, and adjusting rear-mounted equipment. This is why more rear-mounted equipment is used than in the past. Previously, equipment was raised and lowered with long hand-levers which was quite tiresome.

Rear-mounted equipment is connected to the tractor with integral hitches. Integral hitches may have one-, two-, or three-point connections between the rear-mounted implement and the tractor. Of these three types, the three-point hitch is the most common.

Three-point hitches are standardized so implements and tractors of different makes and models can be used interchangeably. If your tractor does not have a three-point hitch you can probably get an adapter that will let you use three-point mounted equipment. The sizes of three-point hitches are standardized by categories. Hitch dimensions associated with the implement are given in four categories that have been developed to fit tractors of varying size. Notice that the lower hitch studs and upper hitch pins have larger diameters for the higher category hitches. By using special adapters, equipment can be interchanged, for example, Category I equipment can be used on tractors with Category II hitches.

<table>
<thead>
<tr>
<th>Category</th>
<th>Stud diameter</th>
<th>Hole distance</th>
<th>Hole diameter</th>
<th>Hitch spread</th>
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</thead>
<tbody>
<tr>
<td>I</td>
<td>0.36</td>
<td>1.53</td>
<td>0.46</td>
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<td>0.76</td>
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<td>III</td>
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<tr>
<td>IV</td>
<td>1.43</td>
<td>1.91</td>
<td>0.46</td>
<td>45.9</td>
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</table>

Table 1. Dimension for four categories of three-point hitches.

THREE-POINT HITCH ADJUSTMENTS

When a rear-mounted implement is connected to a tractor, the main adjustments are provided by the three-point linkage. On a plow, for example, the length of the top link can be adjusted to provide the proper pitch or depth control. If you wanted the plow to go deeper, you would shorten the...
top link. If you wanted the plow to run shallower, you would lengthen the top link.

Adjustments are also provided for leveling the rear-mounted implements. This is usually done by a hand crank on the linkage that controls the height of the right-hand (as viewed from the rear of the tractor) draft link. On some tractors both of the draft links can be controlled with a leveling crank.

The raising and lowering of the entire three-point hitching system is powered by the hydraulic system. There is a hand lever on the tractor that lets you raise and lower the implements and adjust it to run at a given depth.

**TWO STANDARD PTO SPEEDS**

As mentioned earlier, there are two standard speeds for the PTO shaft. The old standard of 540 rpm was used on all tractors until 1958. At that time a new standard speed of 1,000 rpm was accepted. The new standard speed was needed to increase the amount of power and speed that could be transmitted to a machine. Both standard PTO shafts turn clockwise as viewed from the rear of the tractor.

New tractors usually provide both standard speeds. This is done by making the PTO so it can be operated at either 540 or 1,000 rpm by adjusting a pin or a lever. The stub shaft for 540 rpm has a 6-tooth spline, while the stub shafts for 1,000 rpm have either 20 teeth (1-3/4 inch stub) or 21 teeth (1-3/8 inch stub). Because the stub shafts have different kinds of splines, you can’t accidentally operate a machine at the wrong speed. Some large four-wheel drive (4WD) tractors do not have a PTO drive.

**AUXILIARY POWER SHAFT**

Some mounted equipment must be driven by the PTO but cannot be easily connected to the rear PTO shaft. Therefore, some of the newer tractors have a front or side power shaft that rotates at 540 or 1,000 rpm. This auxiliary power shaft provides a quick and easy means for attaching and lifting various implements and controlling their adjustment. There are many different kinds of auxiliary hydraulic systems. Some have their own oil supply while others may be part of a central system that is also used for power steering or power brakes. In some models, the transmission and hydraulic system use the same oil.

To know how to use the hydraulic system on your tractor study your operator’s manual carefully. It will tell you where all of the adjustments and controls are located and how to use them. Once you become familiar with the hydraulic system on your tractor you will find there is almost no limit to the different ways it can be used.

**REAR-MOUNTED EQUIPMENT**

The hydraulic system controls the raising, lowering, and adjustment of the linkage for rear-mounted equipment. You may find that the tractor has a control for running mounted equipment at a constant depth regardless of the amount of pull required. Or, you can adjust the control so that the load remains the same and the depth will vary slightly. How you adjust this control will depend on the equipment you are using and the conditions under which it operates.

**REMOTE CYLINDERS**

Single-acting cylinders are connected to the hydraulic system by only one hose and can exert force in only one direction. They are usually used on equipment where a simple raising and lowering action is needed. In such cases they are located so the load returns the cylinder to its home position. Double-acting cylinders have two hoses and can exert force on an implement in both directions. Double-acting cylinders are commonly used on equipment where it is necessary to adjust a machine to a given position. These cylinders are standardized so that they can be used on various combinations of tractors and equipment.

When used on an implement such as a plow, double-acting cylinders may contain a device that controls the length of the stroke. With this control you can select the length of stroke needed to operate the equipment at the desired depth.

**SERVICING THE HYDRAULIC SYSTEM**

Dirt is the biggest enemy of the hydraulic system. It can ruin the seals and close-fitting parts that keep the system under high pressure. Always maintain the proper oil level in the reservoir and change the oil at the recommended interval. It is important to use the proper oil for your hydraulic system. Some oils contain additives that are harmful to the seals. Be careful with the hoses and hose connections. Keep them clean and use the dust seals provided when the hoses are disconnected. If a hydraulic system has a filter, be sure to clean or replace it at the interval recommended by the operator’s manual.
WORK UNIT
Third Year Unit 3

HITCHES, PTO, AND HYDRAULIC CONTROLS

1. Check the drawbar on a tractor. What is the height of the hitch point? __________ inches. Can the height be adjusted? __________

2. Does your tractor have a swinging drawbar? __________. Where should it be located when hitched to a machine that is driven by the PTO shaft? __________

3. Which machines on your farm need to be connected to a swinging drawbar when it is allowed to swing freely? __________

4. Does your tractor have a rear-mounted hitch? __________ How many adjustments and controls does it have? __________

What are they? __________

5. Can the PTO shaft be operated at 540 or 1,000 rpm? __________

How is it changed from one speed to another? __________

6. Is the PTO shaft driven from the transmission or does it have a separate clutch? __________ Can the PTO clutch be adjusted? __________ How? __________

7. What kinds of PTO shields are provided for your tractor? __________

8. Does your tractor have a hydraulic system? __________

Is it a separate system or is it combined with some other system on your tractor? __________

Explain __________

9. How many remote cylinders can be used with your tractor? __________

10. Can your tractor use both single and double-acting cylinders? __________ If so, how is this done? __________

11. What precautions are needed to keep dirt out of the hydraulic system? __________

12. Make a list of the safety precautions one should take for each of the following:
   a. Hitching to the drawbar, or attaching rear-mounted equipment __________

   b. Connecting and using the PTO shaft. __________

   c. Connecting and using hydraulic controls. __________

Note: Fill out this work unit, using a tractor at home, work or school. Be ready to discuss your experiences with other 4-H members at the next club meeting.
HITCHES, PTO, AND HYDRAULIC CONTROLS

Place the letter for the correct answer at the right of the page.

1. Raising the drawbar height (A-increases) (B-decreases) the chance of a backward upset.

2. The proper horizontal distance between the end of the PTO shaft and the hitch point on the drawbar for operating the PTO at 1,000 rpm is (A-14 inches) (B-16 inches).

3. The spline for a 540 rpm PTO shaft (A-is) (B-is not) the same as the spline for a 1,000 rpm shaft.

4. Three-point hitches (A-are not) (B-are) standardized.

5. Single-acting hydraulic cylinders (A-exert force in one direction only) (B-exert force in both directions).

6. Auxiliary power shafts all run at (A-540 rpm) (B-1,000 rpm) (C-no certain speed).

7. When an implement is operated with the PTO shaft in use, the drawbar should be in the (A-close) (B-extended) position.

8. Category II mounted equipment (A-can) (B-cannot) be used on a tractor with a Category I rear-mounted hitch.

9. Shortening the top link of a three-point hitch will make a plow run (A-deeper) (B-shallower).

10. It (A-is) (B-is not) always safe to use regular crankcase oil in the hydraulic system.

11. Double-acting hydraulic cylinders are operated by (A-two pressure lines) (B-two lines with one line serving as pressure and one serving as a return line as the cylinder operates) (C-one line which as pressure or return line) (D-one line which serves as pressure and return line at the same time).

12. When attaching a trailed load to a tractor, the operator should remember that (A-excessive drawbar height reduces tractor stability) (B-a load should never be attached to parts other than the 3-point hitch or drawbar) (C-the drawbar should be correctly positioned) (D-all of these are correct).

Note: This Check-Up Sheet is intended to test what you have learned and to stimulate discussion with the other 4-H members. The more you discuss these questions with your leader and the other members the more you learn and understand.