TILLAGE OPTIONS – CONVENTIONAL TILLAGE

Conventional tilled fields are usually moldboard plowed

As mentioned in the introduction, this booklet defines conventional tillage as systems which attempt to cover most of the residue, leaving less than 30% residue cover on the soil. The moldboard plow is commonly used along with other tillage equipment.

The following section gives information on best management practices that maintain soil quality and reduce soil loss.

SOIL MANAGEMENT

A well structured soil is important for all soils in a cropping system.

Some conventional systems provide little residue, or leftover plant matter, to return to the soil. That is why some soils have poor soil structure and do not work up easily. To improve soil structure and fertility in a conventional system, look at practices that return organic matter to the soil. These include crop rotations, using cover crops, adding manure, and reducing tillage to leave residue on the soil surface.

SOIL LOSS WITH CONVENTIONAL TILLAGE

Conventional tillage with the moldboard plow creates the highest risk for soil erosion. Soil loss varies with slope, the amount of run-off, soil organic matter levels and the amount of residue cover. Soil plowed in the fall, left with little or no residue, loses more soil to erosion than soil managed with any other type of tillage system.

To reduce erosion in a conventional system:

- ►Keep the ground covered. Include forages in the rotation or maintain cover crops between regular crops.
- ►Increase residue cover. Modify your plow to leave more residue on the surface.
- ►Plow across the slope. Follow the curvature of the land.
- ►Contour plant row crops so rows follow the contour rather than up and down the slope.
- ►Strip crop. Plant a field with alternating strips of two or more crops such as cereal or hay with row crops. Plant along the contours of the field.
- ►Terrace the field. Terraces are structures that control water run-off in a field.

See the section on Non-tillage Options for more information on contouring, strip cropping and terracing.

TILLAGE OPTIONS – CONVENTIONAL TILLAGE

Tillage Erosion

It is easy to see evidence of severe soil loss on the upper slopes of fields throughout Ontario. Exposed subsoil and undercut fencerows on slopes of ridges and knolls are obvious signs. Severe erosion of upper slopes may be caused by a process called tillage erosion. When soil is worked, the action of the tillage implement lifts soil and moves it forward. Gravity pulls the soil downhill when it is disturbed. The net result is that soil moves down the slope with tillage.

Research done in Ontario estimates that over 100 tonnes per hectare of soil is lost from upper slopes each year. Additional erosion by wind and water can increase the rate to over 150 tonnes per hectare. An acceptable level would be four tonnes per hectare.

To reduce tillage erosion, take the following steps:

- ►Reduce tillage trips. Eliminate all unnecessary trips over a field.
- ►Reduce the intensity of tillage. Soil movement increases with the depth and speed of tillage operations.
- ►Vary tillage patterns. Using the same pattern to work a field each year results in some areas being worked upslope and others being worked downslope. This means increased losses in some areas of the field and will increase variation in the field over time. Vary the pattern used wherever possible so that all areas are tilled upslope as often as downslope.
- ►Reduce the size of implements. The natural action of the equipment is to level the soil. By reducing the width of equipment, the degree to which soil is levelled will change.
- ►Switch to other tillage sytems. If your farm is particularly vulnerable to tillage erosion, you might consider mulch or no-till systems.
- ►Take areas out of production. If it is not possible to reduce tillage erosion or soil is degraded to the point that it is too expensive to reclaim, consider retiring the area.
- ►Contour plow.

Reclaiming Areas that are Severely Eroded

Areas that are severely eroded cannot produce high crop yields because of poor fertility, low water-holding capacity and poor soil structure. The most productive layer of any soil is at the top and that is what is lost to erosion first.

To correct problems on knolls or slopes, make regular applications of manure. When applied regularly at recommended rates, manure will increase organic matter levels and improve conditions on severely-damaged soils. Forage-based rotations and green manure crops such as red clover also help rebuild the soil.

Knolls with light-coloured subsoil at the surface are evidence of past erosion by tillage, wind and water.

TILLAGE OPTIONS – CONVENTIONAL TILLAGE

Best Management Practices for Soil Management:

Include the following in your cropping practices:

- ►Crop rotations that include forages.
- ►Cover crops to protect the soil and add organic matter.
- ►Manure incorporated into the top few inches of the soil surface.
- ►Reduce number of tillage passes to leave residue on the soil surface.
- ►Reduce tillage erosion by decreasing depth and speed of tillage.

RESIDUE MANAGEMENT

Normally, in a conventional tillage system, we do not talk about residue management. Residue is normally plowed into the soil and the ground is left bare. It is possible, however, to reap some of the benefits of surface residue in a conventional system.

Equipment can be modified to leave some residue on the soil surface. See the equipment section for some modification ideas. If you have some lighter-textured soils, try plowing in the spring instead of in the fall. Crops that leave little residue cover after harvest could be left to the spring and the soil worked with a cultivator or disc.

Cover crops can provide some extra residue to protect the soil. If possible, leave the crops on the soil surface as long as possible to reduce spring erosion. Remember cover crops must be controlled by either tillage or herbicides so they will not become weeds in the next crop.

Rotations should include both broadleaf and grass type crops.

CROP ROTATION

Crop rotation is a best management practice. A short rotation that alternates grass type crops with broadleaf crops (i.e. corn-soybeans-wheat-red clover) helps reduce soil erosion, eliminate pest and disease problems and spread the work load out over the growing season. Including a legume crop, such as alfalfa in the rotation will also improve soil structure, build organic matter, and supply nitrogen to the next crop.

NUTRIENT MANAGEMENT

The best management practices for nutrient management in a conventional system are covered in the Understanding the Basics section.

Remember it is key to soil test your fields and find out what fertilizer requirements are needed for your crops. Fertilizer rates should be adjusted for manure applications or legume crops that are grown in the rotation.

TILLAGE OPTIONS – CONVENTIONAL TILLAGE

PEST MANAGEMENT

In a conventional system, it is important to scout your fields and control pests accordingly. Always follow product labels for proper control measures. The Understanding the Basics section covers the best management practices for pest management in a conventional system.

EQUIPMENT

THE PURPOSES OF TILLAGE

Soil aeration - tillage loosens and aerates the soil.

Management of residue - with tillage, residue will be buried, mixed into the soil, left on the surface or chopped. Too little residue will leave the soil open to erosion or crusting, but too much may interfere with some tillage and planting equipment.

Incorporating fertilizer - tillage will work fertilizer and manure into the soil.

Weed control - tillage will bury weed seeds and disturb growing weeds to kill them. Tillage will smother weeds by burying them.

Soil clod breakdown - tillage creates a mix of particle sizes for good seed-to-soil contact and easy operation of planting equipment.

Incorporating herbicides - tillage improves the performance of pre-plant incorporated herbicides by mixing them with the soil.

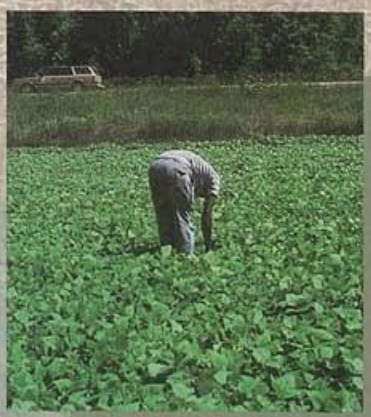
Moisture management - tillage reduces excessive moisture at planting. Bare soil dries and warms up faster then residue covered soils.

Seedbed Structure

One goal of tillage is to allow good seed-to-soil contact for seed germination and crop growth. Fine-textured soils such as clays and clay loams require loosening and a reduction in the size of clumps before crops can be planted.

Fall primary tillage shatters and loosens the soil in order to aid root penetration and growth. Frost action reduces the size of clumps, which increases the area available for root growth.

Secondary tillage produces a layer of soil with particles in the range of 0.5 to 5 mm (.02 - .2 inches) in diameter. This gives the most seed-to-soil contact which allows good germination. It will also limit the moisture lost to evaporation. Do not pulverize the soil, or a heavy rainfall will form a crust that cannot be penetrated by seedlings. A finer seedbed is necessary in dry soil to help draw up soil moisture from deeper soil depths.



In a conventional system it is important to scout your fields.

TILLAGE OPTIONS – CONVENTIONAL TILLAGE

Proper plow adjustment will leave some residue on the soil surface.

PRIMARY TILLAGE EQUIPMENT

The Moldboard Plow

The moldboard plow lifts and fractures the soil. It also incorporates residue, manure and fertilizer. Plowing is a first step in providing a good seedbed. An uneven job of plowing will require extra tillage passes in the spring to level out the ridges left by the plow.

Most moldboard plows work best within a specific speed range. At low speeds, the plow may not fracture the soil and will leave more residue on the surface. By increasing the speed, the soil clumps will be broken down into finer sizes and the plow will bury more residue.

Fall Plowing

In the fall, the soil surface of heavier soils (clay, clay loam) should be left rough and cloddy. Then, frost can act on more of the soil surface. Frost action over the winter is important in improving the structure of heavier soils. When ice forms in the soil, the pressure of the water expanding will break the soil clumps into smaller particles. After repeated cycles of freezing and thawing, the average clump size is reduced. Avoid secondary tillage and working the seedbed very fine in the fall as this will leave the surface susceptible to erosion.

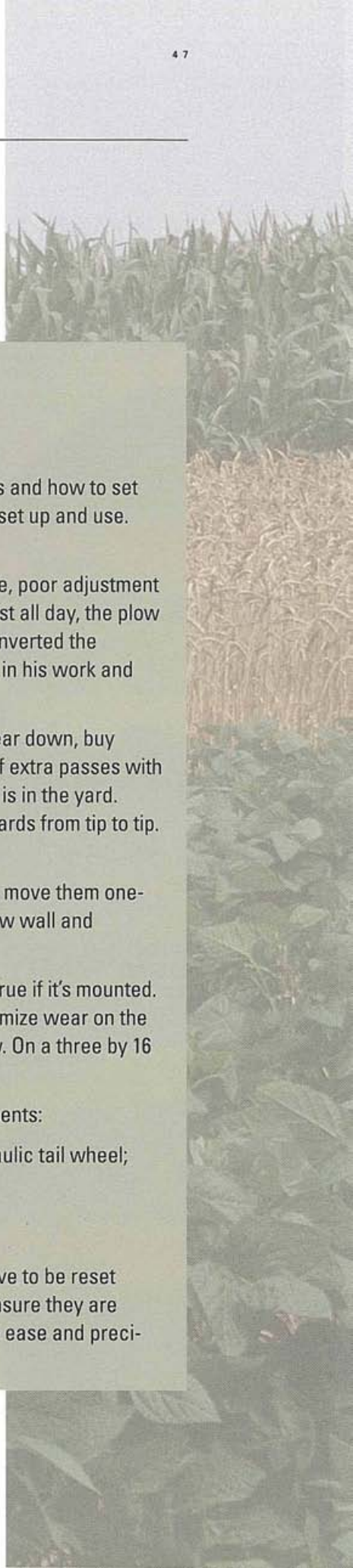
Spring Plowing

Spring plowing is an option for lighter-textured soils such as sands and sandy loams. The guidelines for spring plowing differ from fall plowing. In the spring, the plow should create a smooth, fine-textured seedbed. Harrows or packers may be pulled behind the plow if the soil is dry. This prevents excessive soil drying and will produce an acceptable seedbed. Additional secondary tillage may or may not be required to produce an adequate seedbed. It will depend on the crop to be grown and the type of job the plow did.

Spring plowing is not recommended for heavier soil types. The soil may not dry enough in the spring to allow the plow to properly shatter the soil. Clods will form in wet soils and will be difficult to break down with secondary tillage. This creates a poor seedbed which will tend to dry out during the growing season. In the spring, soils tend to be wet when plowing should be done. If plowing is done on wet soil, compaction will occur which damages the soil and reduces crop yields.

By plowing in the spring rather than in the fall, you reduce soil erosion. For the lighter soil types such as sands, sandy loams with small amounts of residue on the surface (i.e. soybean stubble), you may try not plowing at all and just top working the soil. This will eliminate erosion even further and help preserve soil moisture.

TILLAGE OPTIONS – CONVENTIONAL TILLAGE



Proper Plow Adjustment is not as Easy as it Sounds

By Ron Bailey, New Liskeard College of Agricultural Technology carried in Ontario Farmer, November 13, 1991.

Is your plowing finished? If it is, are you proud of it? If so, don't read this. It is not for you.

So you are still reading, then this article is for you because it is all about moldboard plows and how to set them up. I agree that the moldboard plow is the most difficult piece of farm equipment to set up and use. Yes, that includes the combine.

Have you ever studied the intricacies of, and adjustments on, an old riding plow? On those, poor adjustment couldn't be overcome with more horsepower or more fuel. To get the team of horses to last all day, the plow had to be set and used like the precision instrument it was. It sliced through the soil and inverted the furrow. Winging, nosing and heeling could not be tolerated by a plowman who took pride in his work and cared for his team.

The same applies today, but it is easier to get away from improper adjustment. We just gear down, buy more fuel and pay for costly and unnecessary wear. And a poor job just needs a couple of extra passes with the discs next spring. But it's easier to do the job right in the first place. The place to start is in the yard. Check the plow. Sight along the mouldboards. Are they even? If not, measure the moldboards from tip to tip. Perhaps the braces need adjusting.

Now check the coulters. Set them to cut approximately one-third of the furrow depth and move them one-half inch to three-quarters inch out from the landside. This will give you a nice clear furrow wall and prevent the shin from loosening the wall up.

Did you know your tractor wheel spacing should be set for your plow? This is especially true if it's mounted. Wheel spacing is important to prevent the tractor from being pulled sideways and to minimize wear on the plow. The proper setting is furrow width X number of furrows + one-quarter of one furrow. On a three by 16 for example, spacing from inside to inside is 52 inches.

Now that is done, we are ready to plow. Drop the plow in and make the following adjustments:

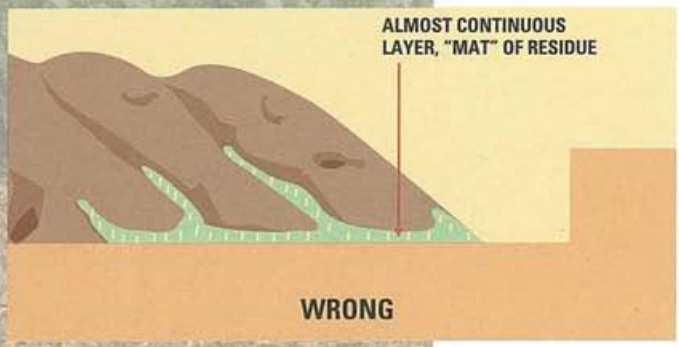
1. Level the plow front to back (use a level and/or tape measure) with the top link or hydraulic tail wheel;

2. Level the plow from side to side by adjusting the lift link on the tractor; and

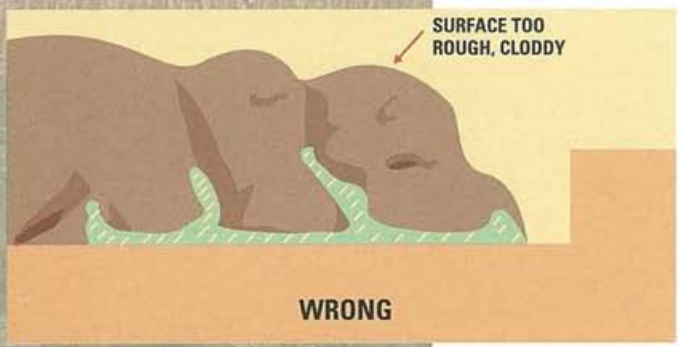
3. Set the front furrow width equal to the others with the cross shaft or landing.

NOTE: That the right side tractor wheels must be in a furrow or these adjustments will have to be reset once the first furrow is made. Now check the coulter adjustments and furrow widths to insure they are correct. If your plow is not badly worn, it should slice and invert the furrow with the same ease and precision of grandfather's old riding plow.

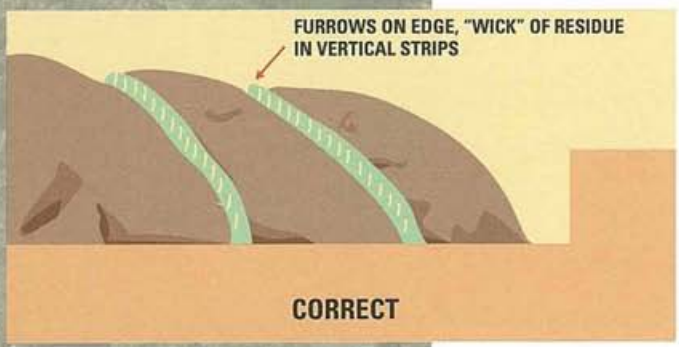
TILLAGE OPTIONS – CONVENTIONAL TILLAGE



Furrow slope too flat, plow set too shallow.



Furrow slope too steep, plow set too deep.



Good furrow shape.

Managing Residue with the Moldboard Plow

In situations with large volumes of residue being plowed, such as with grain corn, plows may plug with residue. Use a plow with high clearance (greater distance between the beam and the plow bottom) because they are designed to handle large volumes of material. They may even handle residue immediately after harvest without discing or chopping stalks first. This reduces labour and energy inputs.

For the best residue management:

- Use the stubble bottom plow or European bottom plow to leave residue on the surface. (The sod bottom or general purpose bottom plow buries more residue).
- On plows with variable furrow width, narrow the furrows to increase residue cover.
- Remove covering blades attached to the top of the moldboard to increase surface residue.

Plows that leave each furrow on its edge, as done by the European models, manage residue better than those which invert the soil. Inverting the soil leaves crop residue in a single, continuous layer beneath the surface. This "mat" of residue traps water above it which reduces water soaking into the subsoil. This in turn, leads to run-off and reduces soil moisture reserves during droughts. By trapping water near the surface, the mat may delay field operations and hurt crop growth during wet weather.

Moldboard plows with bottoms that place the soil on edge leave residue in strips which avoids problems. Residue forms a "wick" which helps water evaporate and traps snow.

TILLAGE OPTIONS – CONVENTIONAL TILLAGE

Modifying the Moldboard to Increase Residue Cover

Modifying the moldboard plow will increase surface residue.

Because the moldboard plow was designed to turn over soil and bury residue, it is not always easy to modify it to leave residue on the surface. There are some things, however, which can be done without sacrificing plow performance.

- ▸Remove the trash covers. This will leave the "wick" of residue open to the soil.
- ▸Adjust the plow. With a wide bottom plow that runs too shallow, the furrow will tend to completely invert and no residue will be left on the surface. The best plowing depth is one-half the width of the bottoms. On a variable width plow, narrow the bottoms and plow shallower to increase the amount of residue left on the surface.
- ▸Cutting back the moldboard will increase the amount of residue but it should be done carefully. A large part of the moldboard would have to be removed to leave significantly more residue. This may affect the draft of the plow. Some people have had success removing the moldboard completely and using the share and shin. At the moment this remains a matter of trial and error.
- ▸Consider a bolt-on kit with a combination sweep and twisted shovel. These, in effect, allow you to use the plow frame to create a low-cost chisel plow. Kits have proven quite effective for this purpose and are available from several companies. Caution must be exercised when making modifications to the moldboard plow, as some attachments change the draft requirements of the plow and it will be harder for the tractor to pull the implement straight.

SECONDARY TILLAGE EQUIPMENT

Secondary tillage equipment is used to level and prepare the seedbed. It is a best management practice to reduce the number of passes to a minimum. Excessive tillage is expensive and unnecessary. It will reduce the organic matter levels in the soil and cause extensive wind and water erosion problems.

Discs are used for secondary tillage to prepare the seedbed and work in fertilizer and herbicides. It tends to chop and bury residue, working in 30 to 70% in a single pass. The disc is a good levelling tool and its sharp edges penetrate hard surface crusts. The surface is left quite smooth, depending on the amount of residue left. The downfall of the disc is that water is likely to run off and wind may erode the soil. Discs can cause compaction if used in wet soil.

TILLAGE OPTIONS – CONVENTIONAL TILLAGE

Field cultivators shatter clumps and sort them by size. Coarser lumps are brought to the surface while finer ones accumulate at lower depths where the seeds are planted. This also brings residue to the soil surface. Cultivators with stiff tines operate better in high-residue conditions than flexible S-tines. However, the field cultivator does not handle residue as well as the disc. Some of the newer models have greater frame clearances to handle residue. They are often followed by a cultipacker or harrow to firm the soil and improve its ability to retain moisture.

Harrows are usually used along with another tillage implement. They smooth the soil and break lumps that are moist enough to shatter. Tines that face backwards are better at crushing clumps than forward-facing tines. Chain-type harrows are better at clump crushing than spike-tooth harrows. Harrows may be used to break up soil crusts and to control germinating weeds after planting.

Cultipackers are used to firm the seedbed and to reduce clump sizes. They may be pulled behind other tillage equipment to save one trip over the field. They also level the soil. Be careful that the packer does not leave soil too fine which can cause crusting.

Combination tillage equipment combines different implements on a single frame. It reduces the number of trips over the field yet still prepares the proper seedbed.

Row cultivators have tines and blades that disturb the soil between crop rows to kill weeds. There are many models to choose from. Modern automatic guidance systems can help the operator avoid cultivating the row itself. Inter-row cultivation breaks up the soil crust, allowing rain water to soak in. It can reduce moisture loss by creating a surface mulch.

The rotary hoe is a series of sharply-spoked steel wheels. The wheels are tightly spaced in a row or two. The hoe, operated at relatively high speed, is used to shatter surface crusts and disturb weed seedlings. It may be used shortly after planting to help crops emerge through a crust or for weed control. It is more effective for weed control after the weed seeds have sprouted, but before they emerge.

Subsoilers are implements that operate at depths over 25 centimetres (10 inches) to loosen compacted layers of soil. If the subsoil is wet, it will be damaged by subsoiling. Unless the practices that caused compaction are changed, compaction will happen again. Unfortunately, the re-compaction of loosened subsoil will be greater than before the operation. In Ontario, subsoiling has not increased crop yields and is not recommended.

TILLAGE OPTIONS – CONVENTIONAL TILLAGE

PLANTING EQUIPMENT

Planters and drills allow precision placement of seeds. The best set-ups for conventional tillage include precise depth control and adequate seed-covering ability. Conventional planters can include optional equipment to apply fertilizer in a band next to the seed row below the seed level. If banding herbicide is part of your system, spraying at the time of planting combines another operation and improves the accuracy of the application to the row.

Planters or drills that are modified with extra coulters or trash whippers may be benefical in a conventional system. Using modified planters eliminates the need for some secondary tillage to prepare the seedbed. This will eliminate some passes over the field and reduce the chance for erosion to occur. The coulters on the planters/drills will do some tillage to prepare the needed seedbed for proper seed-to-soil contact. Modifications on the planter/drill will help handle any crop residue left on the surface. See the Mulch Till or No-till/Ridge till sections for modification ideas.

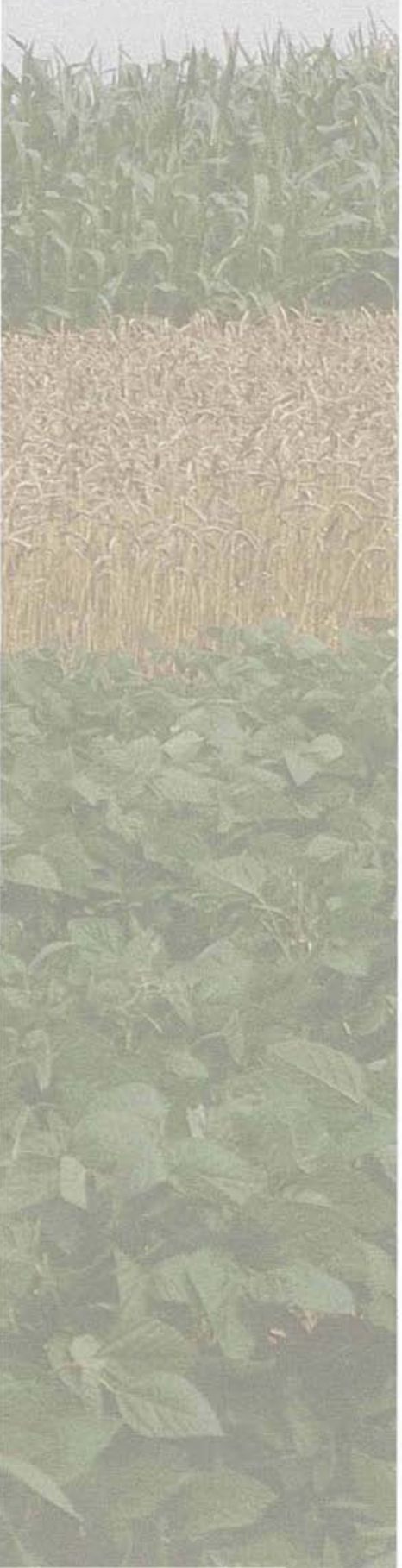
TILLAGE OPERATIONS

Tillage passes should be kept to a minimum to prepare the proper seedbed. Combining operations to get the job done is a best management practice.

Tillage should only be done when the soil is dry enough for proper shattering action. Take a handful of soil and squeeze it. If it stays in a ball when you bounce it in your hand (does not break up) then the soil is too wet and you should wait one or two more days for it to dry properly. Depth of tillage should not exceed 20 centimetres (eight inches) for primary tillage or 5 to 10 centimetres (two to four inches) for secondary tillage. Tilling any deeper will only dry the soil out and cause poor germination and emergence. Deep tillage will bring unproductive subsoil to the surface. On sloping land, tillage should be done on the contour (across the slope) to help eliminate erosion.

Well managed crops insure good yields.

TILLAGE OPTIONS – CONVENTIONAL TILLAGE



Best Management Practices for Equipment and Tillage

- ►Read the instruction manual for your equipment. Learn how to set it and operate it properly.
- ►Properly maintain equipment. Down time during busy seasons is very costly if planting or harvesting is delayed.
- ►Check machinery regularly (daily or even twice a day when in use). Catching a problem in its early stages saves money and time. Early detection may prevent the small problem from developing into a large one.
- ►Operate the machine at the suggested speed and load. This gives peak performance and longer life.
- ►Replace parts when they are worn. Worn parts will not perform properly and will increase the horsepower requirement.
- ►Tillage equipment operates best when it is level in all directions. Level it front to back and side to side. Check that all depth gauge wheels operate at the same depth. These adjustments create even tillage.
- ►Combine operations on each field pass to reduce the number of trips over the field.
- ►Use only the implements necessary to create an ideal seedbed. Soil conditions and results will help you decide which combination of equipment is best. Once you've created a good seedbed, stop tilling
- ►Work the soil across the slope to eliminate water erosion.
- ►Work at the proper depth to prepare an adequate seedbed. Tilling too deep costs money and creates more wear and tear on machinery.

Best management practices for conventional tillage are numerous. If used properly, a conventional system can be environmentally friendly and save you some money. Take a look at the section on Non-tillage Options for more best management ideas that you can try on your farm.

TILLAGE OPTIONS – CONVENTIONAL TILLAGE

TROUBLE SHOOTING

PROBLEM	CAUSES	SOLUTIONS
Plow will not stay in ground	• Plow points are worn • Soil is too dry	• Replace plow points. • Wait until sufficient rainfall raises soil moisture.
Plow is plugging with crop residue	• Plow is not set properly • Residue coulters are not set at proper depth or distance from points • Residue volume is more than plow can handle • Plow doesn't have enough clearance between bottom and beam	• Check adjustments. • Check adjustments of coulters. • Chop residue into small pieces by shredding or discing soil before plowing. • Purchase high-clearance plow.
Plowing is uneven, lumpy, ridging	• Plow is not set properly	• Check set-up of plow.
Plow pan forms	• Performing field operations on wet soil	• Don't go onto wet fields. Vary plowing depth each year. Plant deep-rooted forage crops and increase organic matter in the soil.
Disc ridges soil	• Excessive speed • Disc is not level	• Slow down. • Level implement.
Field cultivator plugs	• Too much residue	• Disc soil before cultivating. Replace with high-residue cultivator.