ALBERTA FARM MACHINERY RESEARCH CENTRE

SOIL AND MOISTURE CONSERVATION EQUIPMENT
HARROWS AND PACKERS

In soil conditions where structure and moisture are not ideal for crop production, farmers have used seedbed preparation and finishing equipment to increase:

- germination
- emergence
- crop uniformity
- soil moisture retention
- overall yields
- management of surface residues.

There are two main devices used for soil finishing, the packer and the harrow. Packing, harrowing and different combinations of packing and harrowing have all been successfully used to create ideal growing conditions for crops. When used properly, packers and harrows serve two major purposes. First, seedbed finishing increases the use of soil moisture reserves by the plant. Secondly, the loss of soil moisture through evaporation is limited by seedbed finishing. These are both important to optimum crop production and the conservation of soil and moisture reserves.

PACKERS

Packers move across the soil, breaking down soil particles and increasing soil density. Most packers are created equal. While numerous weights, sizes and shapes of packers are commercially available, their overall effect on soil moisture is virtually the same. Rather than the physical characteristics of an implement, how an implement is used is more likely to show an effect on crop production.

The forward speed of the packer determines the amount of packing and soil particle breakdown which takes place. The shorter time a packer's weight is on

a specific area of soil, the less that soil will be packed. The speed and amount of packing done should be determined by the available soil moisture. Soils containing high moisture reserves in spring may need little or no packing. Soils containing low moisture reserves may require heavy packing. If little or no moisture is available, no amount of packing will aid in crop production.

Packing the soil makes soil moisture more available to plants in numerous ways. Whether directly over the seed or randomly over the soil surface as with spiral packers, packing can cause an increase in a soil's density. In a typical field, soil moisture increases with depth. Increasing a soil's bulk density can increase available soil moisture to the seed by causing water to be moved out of deeper soil layers towards the soil surface. With an increase in soil density below the seed, a good footing for the roots of emerging seedlings is provided. If packing is done directly over the seed, furrows are created. Furrows concentrate water on the seed and shield emerging seedlings from the wind. Depending on the operations before seeding, packing can also create ridges on the soil surface that can reduce erosion due to wind and water. Packing pressures in the 0.5 to 0.75 psi (3.5 to 5 kPa) range have consistently induced better emergence when adequate water for seed emergence was available.

Packing can also play an important role in preparing a seedbed. Previously tilled soil can be packed to an optimum depth suitable to the crop to be sown. A compacted, moist layer to place the seed on has long been known as the ideal site to enhance seed germination.

While packing the soil has numerous advantages, some disadvantages are evident. Packing can cause large particles to be reduced in size and become more susceptible to wind and water erosion. Soil particle size reduction causes a movement of fine soil particles to the soil surface. If rain follows, the fine soil particles can be compacted through slaking or puddling by rain drops. A crust results after the soil surface drys. Crusting of the soil can result in limiting seedling emergence and future water infiltration. Overpacking can occur with certain soils under high moisture conditions. In this case, the compacted layer impedes root growth/development and reduces the infiltration capacity of

the soil. All of these factors limit crop production. Packing after seeding can also repack weeds into the soil, causing the weeds to reroot.

HARROWING

The harrow penetrates and mixes deep into the soil. The aggressiveness setting of the harrow, i.e., tine angle and shape, determines the amount of soil movement and mixing. The more aggressive the tines are set, the greater the soil movement and mixing. Harrowing of the seedbed serves to reduce soil moisture loss and can improve germination.

The sorting, mixing and levelling effects of harrows can be used to create an evaporation control layer in a seedbed. Evaporation control in a seedbed is usually required above seeding depth. This is accomplished through proper soil distribution and soil particle sizing. An even layer of soil particles in the 0.02 to 0.08 in (0.5 to 2 mm) range provides the most effective evaporation control above a seed. The depth of the evaporation layer increases the control provided. However, the available energy a seed has for emerging must be taken into account when increasing planting depth. Harrowing above seeding depth can also aid in water infiltration, soil porosity, crop uniformity and plant emergence.

The sorting, mixing and levelling action of harrows can also be advantageous in preparing a seedbed.Harrows can sort or string out trash or surface residue so planting equipment can operate without plugging. Harrows are one of the effective ways of incorporating pre-emergence herbicides into the soil surface before the seeding operation. They can level a previously tilled soil into a uniform and smooth seedbed. Lastly, harrows are capable of a limited amount of weed control. Harrows bring the roots to the surface to dry out.

Like packing, harrowing is not without its adverse effects. As harrows move across a soil they break up large soil particles and mix the soil. Excessive mixing of moist subsurface soil with dry surface soil will increase the drying rate of the soil. Like packing, a break-up of large soil particles will increase

the probability of wind and water erosion. Harrows are limited in the amount and type of surface residues they can handle. They can also spread weed seeds and weed infestations throughout a field. Finally, on rocky soil conditions harrowing can bring rocks to the surface, which can cause problems when swathing or combining occurs.

PACKERS AND HARROWS IN COMBINATION

Packers and harrows can be used in combination with each other. Usually packers have followed harrows. While packing after harrowing will retain most of the beneficial and adverse effects of the packing implement, a packing operation will restrict the beneficial effects of harrowing. Packing after a harrowing operation can:

- reduce the evaporation control layer created by the harrows
- decrease the seedling emergence
- decrease water infiltration and soil porosity
- increase the chance of wind erosion and soil crusting.

Harrowing of the soil after packing has its advantages but is not without some drawbacks as well. Packing first causes the soil's density to increase above and below the seed. If harrows are then run just above the seeding depth, only the layer of soil above the seed will be disturbed. Disturbing the soil layer above the seed eliminates the adverse crusting effect caused by packers, while retaining increased soil density below the seed. Harrowing just above seeding level will:

- create an evaporation control layer above the seed
- reduce seed energy requirements for germination
- eliminate repacking of weeds
- sort the particles pulverized by packers.

As with harrow operations alone, harrowing can eliminate furrows, reduces clod size, increase the chance of erosion, bring rocks to the surface and dryout the seedbed.

CONCLUSION

Harrows, packers and combinations of them can be considered an important soil and moisture conservation tillage tool. The problem in using such equipment comes in the operator being able to select the right tool for the right job and at the right time. To take advantage of all the benefits and minimize the adverse effects of packers and harrows the operator must be able to:

1. Identify his soil and moisture conditions.
2. Manage his soil finishing or seedbed preparation equipment accordingly.

Factors such as:

- cropping rotations and practices
- plant available moisture
- soil type
- surface residues
- weed problems
- soil's ability to erode

all have to be taken into consideration.