Soil Tillage in the Tropics and Subtropics

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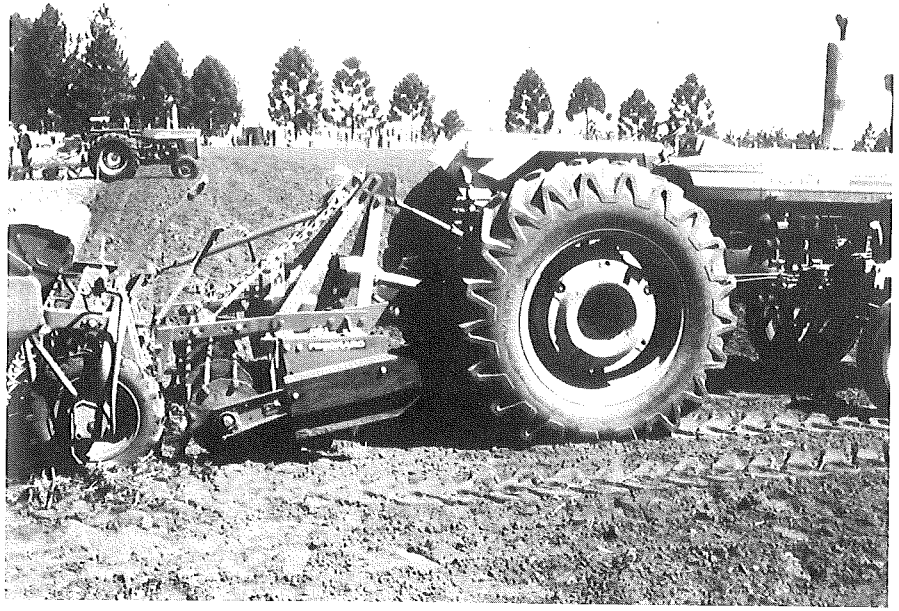
Soil Tillage in the

8.0 IMPLEMENT COMBINATIONS



Generally speaking, individual implements have only a limited range of applications and so attempts are increasingly being made to combine separate implements with different functions for the following reasons:
- to reduce the number of passes over the fields,
- to save time,
- to obtain a specific loosening, crumbling, mixing and (re-)compaction action on the soil,
- to make the equipment more versatile.

Research is being carried out all over the world with the aim of reducing or rationalizing soil tillage under the slogan: "As little as possible, as much as necessary". These matters are usually referred to under the general heading of "Minimum Tillage".

By amalgamating different tillage operations and using combinations of highly efficient implements it becomes possible to use machinery under the optimum conditions for trafficability and workability. This causes the minimum structural damage by wheel-tracks, minimum wear on the implements and minimum energy requirements.

Some serious disadvantages of combinations of equipment should, however, be mentioned:
- The ranges of conditions under which the various elements of a combination work most satisfactorily may differ; for example, the optimum moisture range for the entire unit is narrower than for the individual tools;
- Combination equipment is more expensive, usually requires large tractors and is complicated and thus more difficult to operate and adjust.

These factors are are even more important in less developed countries.

Combinations of implements can be assembled for various purposes but, on a general level, two essentially different groups can be distinguished:
1. Combinations for loosening the deeper layers of the soil while, at the same time, intensively tilling a surface layer.
2. Combinations for seedbed preparation. The best possible seedbed (specific for the crop, soil and climate) can be created with the minimum number of passes by arranging various shallow-working implements or tools one behind the other.

Table 12 summarizes the methods which can be applied in a temperate humid climate.

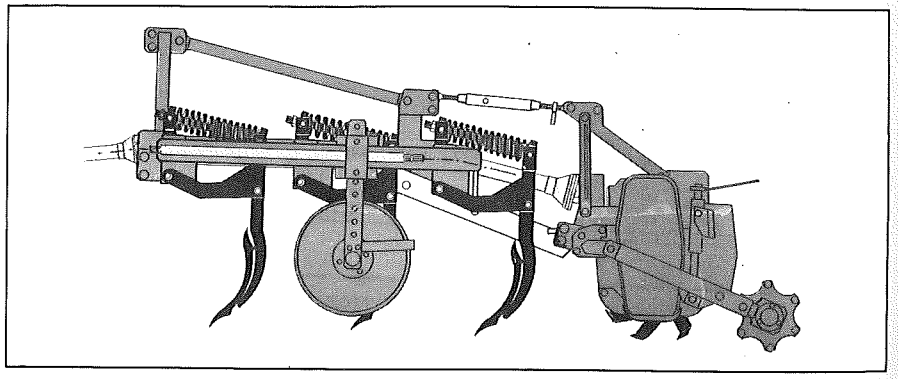
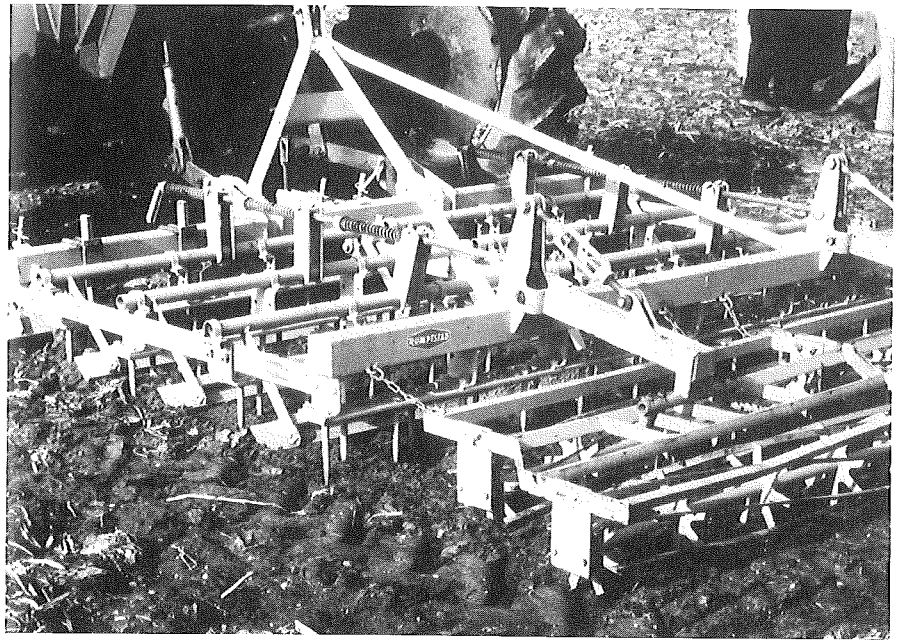


Fig. 126. Combination of chisel plough with rear-mounted rotary tiller.

8.1 Seedbed Preparation in one Operation



Combinations of implements for deep loosening and shallow secondary tillage in one operation are used only in specific situations, e.g. when organic material (plant residue, green manure, etc.) has to be mixed uniformly on the surface and a seedbed is required. When performed at the same time as surface tillage the deep and coarse loosening of the soil (in certain cases, to the full depth of the arable layer) should improve the soil structure for water management by increasing the rooting space and soil pore volume.

A typical combination for this purpose is a chisel plough with rear-mounted tools (Fig. 127). The type of chisel plough should be chosen in keeping with the anticipated field conditions. The follow basic correlations apply:

	tillage	
	medium	deep
Tine clearance	large	large
Furrow distance	20-25 cm	30-35 cm
Frame height	up to 75 cm	over 75 cm
Chisel angle (angle of attack)	approx. 60 deg	approx. 35 deg
Chisel type	wide (e.g. diamond-shaped)	narrow (e.g. pointed)

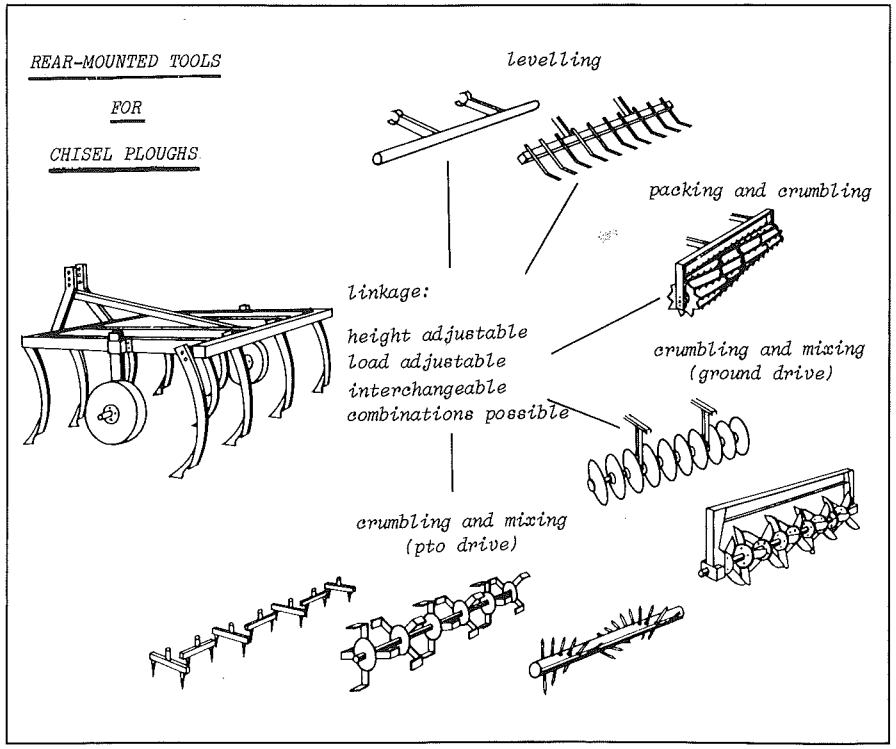


Fig. 127. A chisel plough with various rear-mounted tools. - Source: Estler.

Tillage with the chisel plough produces a slightly corrugated surface owing to the larger furrow and tine distance. The tine and chisel shapes preferred nowadays bury organic material at a depth of only 15 cm even when the soil itself is loosened to greater depths. In addition, too much loosening on the soil often occurs.

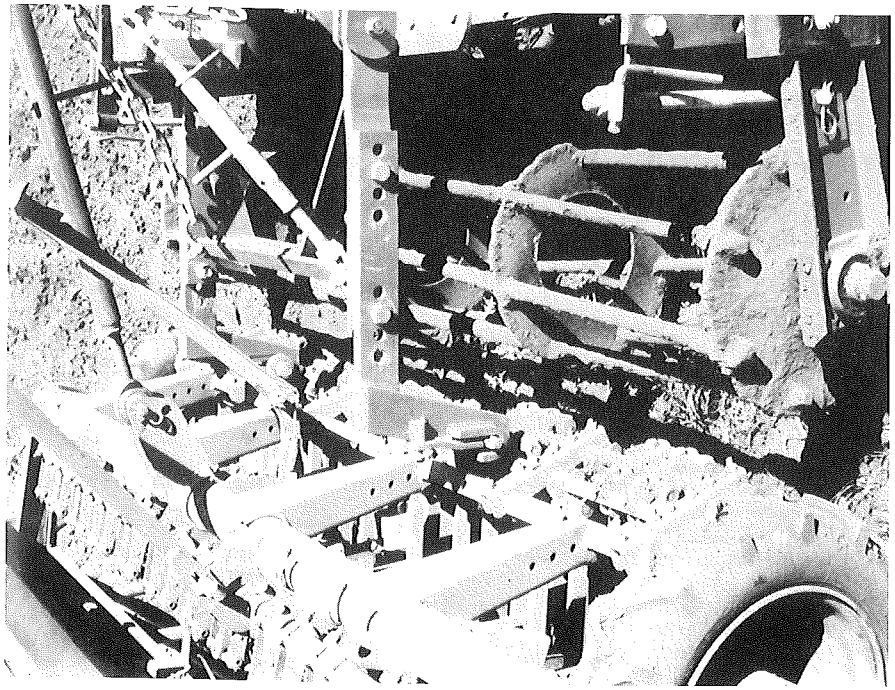
So the chisel plough is frequently equipped with rear-mounted tools which vary in design and are used to level the soil, produce extra crumbling or packing and to mix it well with the organic material. Mention should be made of the beneficial effect of disc gangs on very heavy soils. Pto-driven tools for rear-mounting have recently become available (Fig. 126) in addition to trailing and rolling tools.

Rear-mounted implements have the advantage that their working depth is adjustable and they can carry extra weights and are interchangeable, thus allowing various combinations. With careful selection and arrangement of the tools, these implements can be adapted to a wide range of practical conditions. The rear-mounted tools should not pulverize the soil too intensively in tropical regions with a risk of erosion. If they do, rapid re-establishment of a plant cover should be ensured.

crop	sowing/seedbed preparation		sowing/rotary tillage	direct drilling
	after plough.	comb. with pl.	without plough.	without plough.
cereals	packer light cultivator recipr. hoe, rotating hoe, tine rotor, all combined with fertilizer application	complete system, combining: ploughing fertilization shallow tillage broadcasting rear-mounted drill for plough	full-width rotary tiller with mounted drill. strip tillage by rotary tiller with mounted drill	triple disc equipment killing of sod with herbicides
row crop	strip tillage and combined precision sowing	complete system, (as above) with precision drill	as above	special precision drill
interm. crop	as cereals	skim plough or rear-mounted tools.	as above, or combined with chisel plough or disc harrow.	

Table 12. Sowing after reduced-tillage techniques.

8.2 Combinations for Seedbed Preparation



Combinations of implements for preparing seedbeds can be distinguished according to:
- the arrangement of the individual implements, and
- the number of tools set one behind the other.

With the basic arrangement the front tools loosen the surface of the soil while the rear tool(s) produce adequate pulverization and, when necessary, recompact the soil. The following implements can be combined in keeping with the objectives and prevailing conditions:

seedbed combination						
front-mounted tools			rear-mounted tools			
light cultivator	flex. tine cultivator	rigid tine harrow	rigid tine harrow	rolling harrow	packer	roller

The simplest combination consists of a light cultivator with a rolling harrow mounted directly to the frame (Fig. 128 top). The main support for the cultivator is provided by the roller. An infinitely variable adjustment system allows a precise setting of the working depth and ensures an adequate load on the roller. Support wheels are recommended on very loose soils. In a simpler form the crumbling roller can be mounted to the cultivator by a spring-loaded parallelogram system.

This combination is characterized by a simple, relatively inexpensive and sturdy construction, high reliability and versatility and can be used on almost every soil. A working depth of 10 cm is advisable because of the wide furrow distance (approx. 10 cm). Light cultivators cause problems in the case of crops requiring a very shallow seedbed (e.g. sugar-beet or rye).

Combinations of harrows with various rear-mounted tools require a special type of support frame (Fig. 128 center) to:
- provide proper guidance for front- and rear-mounted tools,
- allow precise depth control even at high speeds,
- permit the load to be adjusted separately on the individual tools.

Supporting frames with toolbars are now preferred. The rear-mounted tool is hitched to the front tools by short chains. With this arrangement the front tools are mounted between the front toolbar and the rear-mounted tools and so have little lateral movement. This permits high travel speeds and precise depth control.

When separate toolbars are used for front- and rear-mounted tools these tools can move independently but precise depth control then becomes difficult because the harrows may start jumping if the speed is too fast. When choosing the implements care must be taken to ensure that the depth of the front tools can be set at the required range of 3-8 cm which is usually done by means of spindles or hydraulic cylinders from the supporting frame.

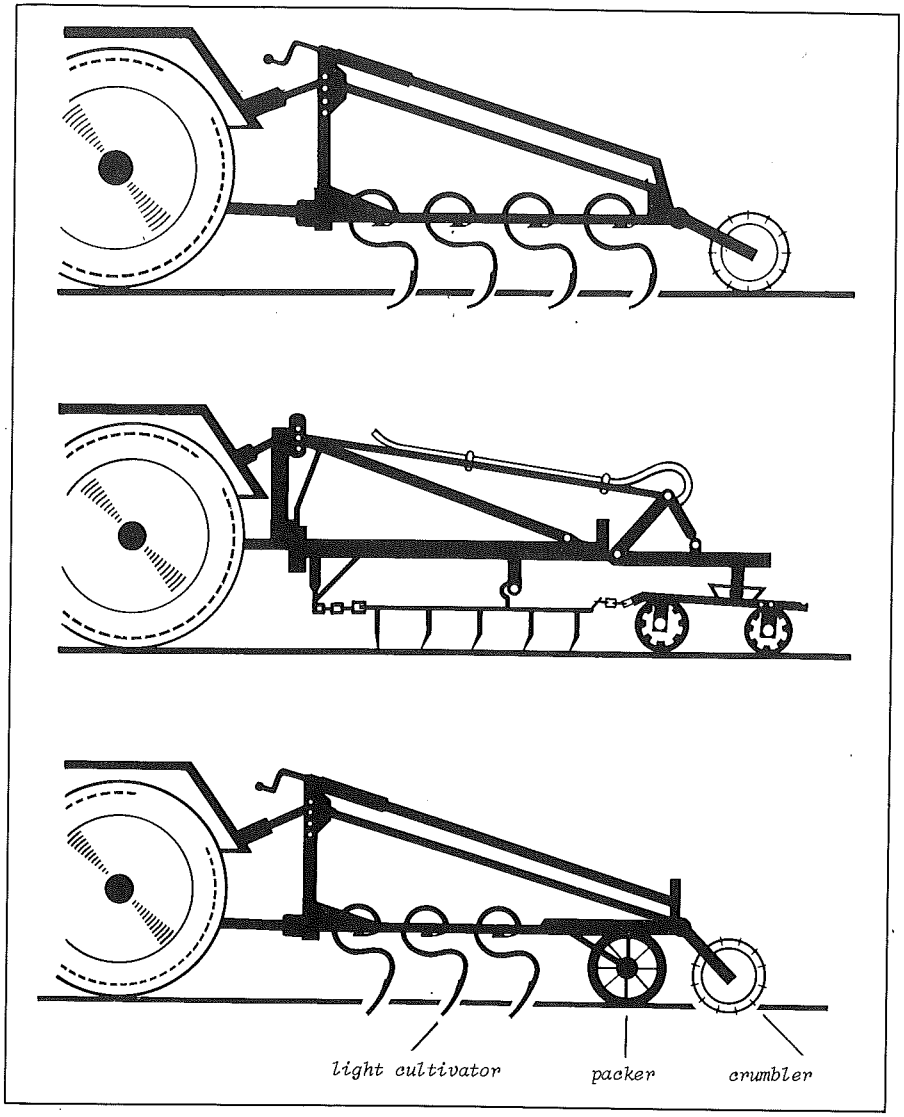


Fig. 128. Seedbed combinations with packer roller (top), suspending frame (center) and front- and rear-mounted tools (bottom).

Multiple combinations

Dual combinations produce a satisfactory effect under normal conditions. The compaction is often inadequate on light and very loose soils but packers can be mounted between front- and rear-mounted tools ("triple combinations", see Fig. 128, bottom, and Fig. 129) for such conditions. This arrangement improves the mechanical consolidation of the soil and provides sufficient contact between the surface and deeper layers. The tools may also be arranged in the following order: tine harrow, rolling harrow and crumbling packing roller.

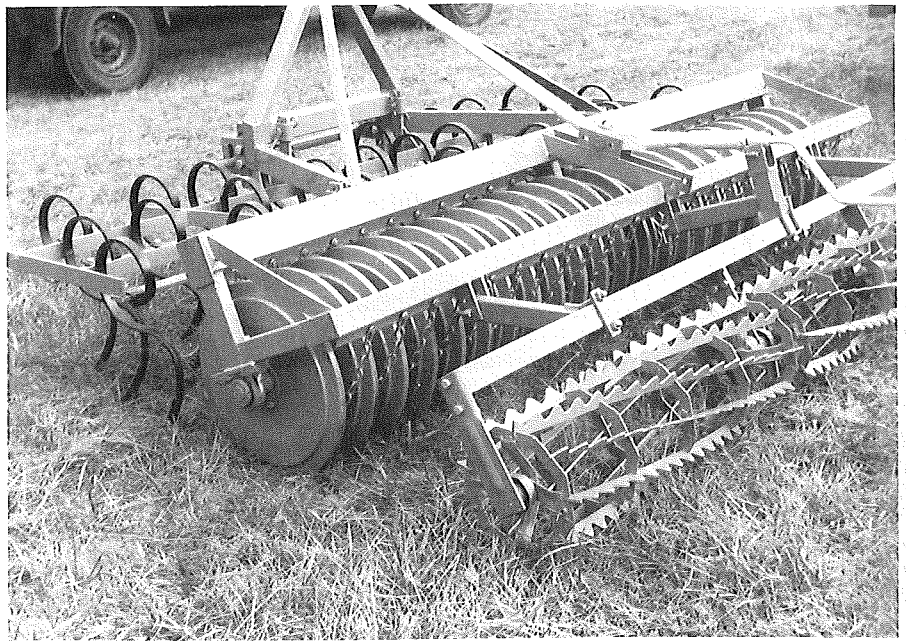


Fig. 129. Triple combination of light cultivator, packer and roller.

Use of the combinations

The implement combinations must be carefully chosen to achieve the required efficiency when the field is being prepared and to adapt to the site and the types of soil and plants. The following aspects should be taken into account:

- A small number of operations: implement combinations are used so that the soil is tilled in as few passes as possible, thus reducing the compaction of the field by traffic to a minimum. The wide range of available combinations offers sufficient potential.

- High travel speed: the implements forming modern combinations are designed to perform well at high speeds. The speed for both groups of tools should be at least 8 km/h and the optimum effect of the tools can be ensured only at such speeds.

- Correct working width: the working width of the combination must match the power available from the tractor. In the event of uncertainty, it is better to work at the optimum speed with a slightly narrower combination rather than working with a combination which is too wide and produces an unsatisfactory effect owing to the low speed.

- Sufficient drawbar performance of the tractor: the various combinations have different power requirements. For chisel plough combinations approx. 5-8 kW per tine is required when working at medium depths while at full depth (to the bottom of the arable layer; 25-35 cm) 10-12 kW/tine should be used. Seedbed combinations require approximately 11-15 kW per metre of working width. It is advisable to use cage wheels or dual-mounted tyres, especially for seedbed preparation. This prevents damage from the load and slippage and improves the efficiency of the drawbar power.

8.2.1 Literature

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