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Soil Tillage in the Tropics and Subtropics

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1.0 THE CHOICE OF IMPLEMENTS

effect / implement	loosen shallow	loosen deep	crumble	mix	incorporate mulch	invert	break crusts	com[illegible]el	ridge	mech. weed control	stubble till	prim. till	second. till	remarks
mouldboard plough	X	X	X		X	X				X	X	X		losses of water and
disc plough	X	X	X	(X)	(X)	(X)				X	X	X		organic matter; erosion danger
chisel plough	X	X	X	X	X					X	X	X		function comparable to wedge plough;
														two operations necessary
rotary tiller	X		X	X	X					(X)	X	(X)	X	erosion danger!
skim plough	X		X		X	(X)				X	X			
disc harrow	X		X	(X)	X		X	X		(X)	X		X	universal and versatile implement
rotary harrow	X		X	(X)	X		X			X	X		X	two operations at high speeds;
														not suitable for dry, hard soils
rotary hoe	X		X				X		X	X				
rigid tine harrow	X		X	(X)						X				
light/flex. tine cultivator	X		X				X			X			X	only on loose soil
roller harrow	X		X					(X					X	(after (chisel) plough)
reciprocating hoe	X		X	(X)			X			X				
rotating hoe	X		X	(X)			X			X	X		X	
leveller/drag			X				X	X					X	
roller							X						X	
subsurface packer		(X)					X						X	
weeder	X		X				X			X				
mouldboard ridger	X		X				X		X	X				
disc ridger	X		X				X		X	X				
leveller														
bed shaper								X	X					
one-way tiller	X		X		X		X			X	X	X	X	
sweep	X	X	X									(X)	X	
rod weeder	X												X	
diamond plough	X	X	X		X	X				X	X	X		
combination *	X	X	X	X	X					X	X	X	X	
clod breaker	(X)		X	(X)				X		X	X	(X)	X	
spade plough	X	X	X	X	X	(X)				X	X	X		

*: sweep with rear mounted tine rotor

X: suited
(X): suited under certain conditions only

Table 1. Possible use of various soil tillage implements.

1.1 Implements For Soil Tillage

The objectives of soil tillage and the basic tillage processes have been discussed in Part I of this book. A large number of implements are available (Table 1) to achieve the various objectives under a wide range of conditions (before, during and after the vegetation period: see Fig. 3).

The following criteria should be considered when choosing the correct implement:
- The implement's trouble-free performance under the given conditions (implement effect) taking the entire sequence of implements into consideration (possible combination of different operations);
- Potential (detrimental or beneficial) side-effects which may be expected, such as weed control, soil compaction, erosion, salinization, mineralization, decomposition of humus, loss or conservation of water;
- Sufficient capacity to cover the entire area in the time available, allowing for the size, shape and accessibility of the fields;
- Compatibility with the available tractor(s), the implement power requirements, available p.t.o. power, lifting and carrying capacities, standards of mounting systems;
- Maintenance requirements, supplies of spare parts, standardization;
- Labour requirements (and for subsequent operations);
- Need to instruct the operators in using and servicing the equipment;
- Available results of internationally recognized testing methods and practical tests.

1.2 Practical Soil Tillage

A soil tillage operation can never be assessed in isolation because all the subsequent operations are influenced. For example, irrigation requires very level fields (one-way instead of two-way ploughs); the accuracy (uniformity) required for a seedbed ranges from low when large amounts of cereal seeds are broadcast, to very high for precision drilling for the final stand of row crops, such as sugarbeet; mechanized harvesting methods may call for very level surfaces so that the crops can be cut close to the ground.

The interactions between soil/climate/plant/machine should always be viewed as a whole. With increasing equipment (and labour) costs and the need for higher productivity per area unit (by operating at the optimum times with a closely integrated crop rotation) high capacity and utilization should be the aims but they must not be achieved at the expense of the quality of the work. This objective must be attained by means of adequate training and attractive working conditions (possibly shift-work) for the personnel, sufficient maintenance, servicing and spare parts for the implements and optimum operating conditions (field shape, trafficability, etc.).
The number of tillage operations, the working depth and the intensity should all be kept to a minimum. Passes with some tillage implements may be combined with others or omitted (savings in energy and time and reduction of the number of wheel-tracks). The following points must be considered when tillage operations are combined:
- The optimum travelling speed of the various implements;
- The lifting capacity and power required from the tractor and the danger of taking the load off the front axle;
- Time required for preparing the implement;

- Control of the various functions (too many demands must not be placed on the operator);
- Manoeuverability of the entire unit, transport.

A number of implement combinations or trains have proved feasible, mainly with well-developed and highly-mechanized farming, and their success depends upon the soil and crops (Chapter 8).

Although self-propelled equipment is now available for nearly every harvesting operation, most tillage implements still have to be drawn or driven by a tractor. Owing to the severe demands on the power transmission, the lifting capacity and the degree of integration with the implement, tractors are still to a large extent constructed and designed to suit tillage implements. So correct matching of the tractor with the implements is essential for effective tillage.
Standardization of the 3-point hitch system and p.t.o. drive system and the development of suitable quick-coupling devices can simplify the mounting of the implements and reduce the risk of accidents.

The number of tractor wheel-tracks and the structural damage to the soil should be reduced to a minimum (avoiding slippage, filling the tyres with water, dual mounting of rear wheels, cage wheels, lower air pressures).

1.3 The Terminology Of Soil Tillage

The wide range of conditions under which tillage equipment is used inevitably means that the terminology for tillage equipment is not standardized.

The most common names and terms for implements, tools and systems are employed in this book. Anyone using or buying equipment will find that in many cases the manufacturer or importer markets equipment under trade-names which are not entirely specific as regards their function or potential field of application (components such as "rota-" or "-tiller" are very popular).
The difference between USA and UK terminology may be confusing; for mouldboard ploughs (moldboard plows, USA) a reversible plough, equipped with opposite sets of plough bodies, is called "one-way" in the UK and "two-way" in the USA, the type with fixed bodies "two-way" in the UK and "one-way" in the USA. In this book, the UK terminology will be used.

A summary of the terminology for dryland tillage equipment is given in FAO (1971) while the American Society of Agricultural Engineers and the Soil Science Society of America issue glossaries of soil tillage terms (ASAE 1979,1982, SSSA, 1978).

1.4 Literature

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