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Tillage: Physical Manipulation of Soil

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Tillage

Tillage is a physical manipulation of soil with tools and implements to bring the soil in good physical condition favorable for the germination of seeds and the growth of crops. It consists of breaking the hard compact surfaces to a certain depth and other operations that are carried out to bring the soil in good tilth for better germination and subsequent growth of crops.

Tilth

Tilth is the physical condition of soil resulting from tillage. A soil is said to be in good tilth when it is soft, friable and properly aerated.

Objectives of tillage:

- To make soil loose and porous.
- To remove weeds.
- To mix manures and fertilizers.
- To destroy insects.
- To aerate the soil.
- To increase soil temperature.
- To remove stubbles.
- To break hard pan.
- To invert soil to improve fertility.
- To have repeated exchange of air.

Modern concept

Tillage systems describe the nature and sequence of tillage operations used in preparing a seedbed for sowing/planting. They differ in the degree of soil manipulation and nature of final tilth required. They may be of two groups according to the degree of tilth.

1. Conventional tillage
2. Conservation tillage

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Conventional Tillage

In conventional tillage, energy is often wasted and sometimes, soil structure is destroyed. Entire field is stirred up to certain depth (plough depth). It incorporates two basic methods: -

1. **Clean cultivation** without any plant debris left on surface.
2. **Mulch tillage** in which some debris left on soil surface.

Advantages of conventional tillage:-

- Minimum soil compaction, which can be easily managed with subsequent operations.
- Easier crop management practices due to clean cultivation.
- Lack of plant debris reduces the opportunity for over wintering/ over summering of pests.

Disadvantages of conventional Tillage: -

- Clean cultivation predisposes the soil for erosion.
- It is an energy consuming costly operation.
- Rapid decomposition of soil organic matter.

Conservation Tillage: -

Conservation tillage systems are methods of soil tillage which leave a minimum of 30% of crop residue on soil of small grain residue on the surface during critical soil erosion period. This slows water movement, which reduces the amount of soil erosion. Conservation tillage systems also benefit farmers by reducing fuel consumption and soil compaction. By reducing the number of times, the farmer travels over the field, farmers realize significant savings in fuel and labour. Conservation tillage was used on about 38% of all US croplands. However, Conservation tillage systems delay warming of the soil due to the reduction of dark earth exposure to the warmth of the spring sun, thus delaying the planting of the next year's spring crop.

The immediate cause for introducing conservation tillage was high cost of tillage due to steep rise in oil prices. In addition, there are problems associated with conventional tillage. Repeated use of heavy machinery, destroys structure, causes soil pans and leads to erosion. The Practice of inverting the top soil in order to bury manures and crop residues becomes less important object of tillage in modem field management as the use of animal and green manure is rather uncommon. Crop residues can and in many cases should be left over the surface as stubble mulch to protect against evaporation and erosion losses. Research has shown that

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frequent tillage is rarely beneficial and often detrimental. All these reasons led to the development and practice of different methods of conservation tillage.

Different methods of conservation tillage practices are summarized below: -

1. **Row zone tillage:** After primary tillage with mould board plough, secondary tillage operations like disking and harrowing are reduced. Secondary tillage is done in the row zone only.
2. **Plough-plant tillage:** After soil is ploughed, a special planter is used and in one run over the field, the row zone is pulverised and seeds are sown.
3. **Wheel track planting:** Ploughing is done as usual. Tractor is used for sowing and wheels of the tractor pulverise the row zone.
4. In Conservation tillage some crop remains on soil surface after field preparation. Chief goals of this system are to reduce soil erosion and moisture conservation. It is often called residue management system, which is not clearly distinct from conservation tillage. These systems are widely practiced in USA. Common types of conservation tillage are no tillage, stubble mulch tillage, strip tillage, minimum tillage and ridge tillage.

1) Minimum tillage:

It involves considerable soil disturbance, though to a much lesser extent than that associated with conventional tillage. Minimum tillage is aimed at reducing tillage to the minimum necessary for ensuring a good seedbed, rapid germination, a satisfactory stand and favourable growing conditions. Tillage can be reduced in two ways:

A. By omitting operation which do not give much benefit when compared to the cost.

B. By combining agricultural operations like seeding and fertilizer application.

Advantages of minimum tillage:

- Improved soil conditions due to decomposition of plant residues *in situ.*
- Higher infiltration caused by the vegetation present on the soil and channels formed by the decomposition of dead roots.
- Less resistance to root growth due to improved structure.
- Less soil compaction by the reduced movement of heavy tillage vehicles and less soil erosion compared to conventional tillage.

Note: These advantages are evident on coarse and medium textured soils and appear after two to three years of practicing minimum tillage.

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Disadvantages of minimum tillage:

- Seed germination is lower with minimum tillage.
- In minimum tillage, more nitrogen has to be added as rate of decomposition of organic matter is slow.
- Nodulation is affected in some leguminous crops like peas and broad beans.
- Sowing operations are difficult with ordinary equipment.
- Continuous use of herbicides causes pollution problems and dominance of perennial problematic weeds.

2) Zero tillage:

Zero tillage is also called as no till. Zero tillage is an extreme form of minimum tillage. Primary tillage is completely avoided and secondary tillage is restricted to seedbed preparation in the row zone only. Till planting is one of the methods of practicing zero tillage. The machinery accomplishes four tasks in one operation: clean a narrow strip over the crop row, open the soil for seed insertion, place the seed and cover the seed properly. A wide sweep and trash bars clear a strip over the previous crop row and planter-shoe opens a narrow strip into which seeds are planted and covered.

In zero tillage, herbicide functions are extended. Before sowing, the vegetation present has to be destroyed for which broad spectrum, nonselective herbicides with relatively short residual effect (Paraquat, Glyphosate etc.,) are used.

3). Stubble mulch tillage:

Conventional method of tillage results in soil erosion. Stubble mulch tillage or stubble mulch farming a new approach was developed for keeping soil protected at all times whether by growing a crop or by crop residues left on the surface during fallow periods. It is a year-round system of managing plant residue with implements that undercut residue, loosen the soil and kill weeds.

Sweeps or blades are generally used to cut the soil up to 12 to 15cm depth in the first operation after harvest and the depth of cut reduced during subsequent operations. When unusually large number of residues are present, a disc type implement is used for the first operation to incorporate some of the residues into the soil. This hastens decomposition, but still keeps enough residues on the soil. Two methods are adopted for sowing crops in stubble mulch farming:

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A. Similar to zero tillage, a wide sweep and trash-bars are used to clear a strip and a narrow planter-shoe opens a narrow furrow into which seeds are placed.

B. A narrow chisel of 5 to 10 cm width is worked through the soil at a depth of 15 to 30 cm leaving all plant residues on the surface.

The chisel shatters tillage pans and surface crusts. Planting is done through residues with special planters.

4) Strip tillage:

It is a system combining the benefits of no-till and full-width tillage. Tillage is confined to narrow strips where seeds will be planted. Loosened soil in the strip creates a ridge 3 to 4 inches high, which improves soil drainage and warming. By the end of season, it usually settles down to 1 to 2 inches high and after planting the field is flat. Row middles are untilled and covered with undisturbed crop residue. Fertilizer can also be applied during strip tillage. Strip tillage is a good alternative to ploughing. Its benefits include:

- **Soil conservation:** undisturbed residue between corn rows (maintains long term no-till benefits).
- **Improved soil condition:** for development of corn plant in row. (warmer, mellow seedbed).
- **Banding of fertilizer:** placing nutrients near crop roots may allow reduced rates.
- **Optimised planting conditions:** earlier planting, less need for starter fertilizer.

Advantages of conservation tillage include:

- Surface crop cover reduces soil erosion.
- Reduced tillage machinery minimizes soil compaction.
- Applicable to steep slopes because of least disturbance to surface soil.
- Soil moisture conservation due to higher infiltration and reduced evaporation with crop residues on soil surface.
- Relatively lower cost of tillage compared to conventional tillage.
- Soil temperature moderation with surface cover of crop residues.
- Improvement in soil organic matter content.

Disadvantages of conservation tillage include:

- Buildup of herbicide residues due to dependence on chemicals for weed control.
- Special equipment is needed for seeding under no tilled or minimum tillage conditions.

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- High risk of pests and diseases due to micro climate favorable to pests and diseases.
- Crop residues on soil surface interfere with cultural operations.
- Herbicide resistance and new weed problems may pose a problem.

It appears that the concept of minimum tillage may not work under Indian conditions except on Vertisols to some extent. Minimum tillage is not suitable for Alfisols to conserve soil moisture as per the results of experiments under different situations. High temperature in tropical environment is not conducive to buildup of soil organic matter content with minimum tillage.