Chapter 8
No-Till Farming

8.1 Seedbed and Soil Tilth

Seedbed refers to “the physical state of the surface soil which affects the germination and emergence of crop seeds,” while tilth is “the physical condition of soil as related to its ease of tillage, fitness as a seedbed, and its impedance to seedling emergence and root penetration.” (SSSA, 2008). The concept of soil tilth is still evolving. Current definitions of soil tilth are somewhat subjective and qualitative because of the highly dynamic nature and complexity of the soil. Soil tilth is the product of complex interactive processes varying over space and time. In this Chapter, soil tilth is defined as the physical condition of a soil described by its complex and dynamic macro- and micro-scale physical, hydrological, thermal, chemical, and biological attributes affecting tillage, seedling emergence, root penetration, and plant growth.

8.2 Factors Affecting Soil Tilth

Soil tilth is influenced by:

- tillage and cropping systems
- soil attributes and landscape characteristics
- soil management (e.g., residue mulch, manuring)
- soil properties (e.g., texture, clay minerals, faunal activity, organic matter content)
- climate
- time

Tillage directly affects tilth because it loosens and mixes the soil, inducing transient improvements in soil tilth. Tilth changes as the loose soil consolidates with time after tillage. Tilth index varies over the cropping season, increasing with tillage and planting operations and then decreasing with time until harvest (Singh et al., 1992). Conservation tillage, crop residue return, and establishment of cover crops improve soil tilth. Identification of an optimum tillage operation for crop establishment and production is critical. Soil tilth is a qualitative parameter and often based on field
experience rather than on a systematic, quantitative, and well-defined approach. It is complex, variable, and site dependent. An accurate assessment of soil tilth is essential to determining an optimum tillage management needed to maximize crop yield.

### 8.3 Tilth Index

Soil tilth is characterized using a tilth index based on easily measurable soil properties (Fig. 8.1). Tilth index is a quantitative value that describes the soil physical condition ranging from 0 to 1, with 0 being for the worst and 1 the best soil physical condition in relation to crop production (Singh et al., 1992). This index is used in various parts of the world to predict changes in soil productivity and identify the type of tillage needed to achieve an optimal crop production for a particular soil. A well-defined index is important to eliminate the unnecessary extra tillage traffic, thereby reducing costs of production and risks of soil degradation. One of the first simple models developed to estimate tilth index is the following (Singh et al., 1992):

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Index = CF_1 \times CF_2 \times CF_3 \ldots \ldots \times CF_n
\]

where \( CF \) is tilth coefficient which varies from 0 to 1, and \( n \) is number of soil properties needed to evaluate the soil tilth. In this model, the values of each \( CF \) are computed for each soil property under consideration. The \( CF \) values are used as multiplicative factors to determine the tilth index. Three defined criteria are used to determine the \( CF \) for each soil property including non-limiting, critical, and limiting levels of crop growth. For example, a \( CF \) value of 0 (most limiting factor) is assigned to soil bulk density values >1.8 Mg m\(^{-3}\) while a value of 1 (least limiting factor) is assigned to densities <1.3 Mg m\(^{-3}\). The tilth index values are regressed against crop yield data to identify the optimum soil tilth. The number of soil parameters for

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**Fig. 8.1** Soil parameters commonly used as input to compute tilth index