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Effects of Tractor Capacity on Soil Physical Properties

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Abstract

Tractors of different capacities and models are imported into Nigeria by the different tiers of government on a regular basis. These tractors impose different loads on the soil which may be deleterious to crop development and growth. There is the need to ascertain the effect of the tractors capacities on soil physical properties in order to recommend appropriate capacities for different soils. Field tests were conducted for 32 different farm tractors varying in capacity in three geopolitical zones of Nigeria. Ploughing which is the primary tillage operation was the only tillage operation considered for this study. The soil physical properties measured include bulk density, moisture content and cone index. Results obtained from measured soil parameters before and after ploughing operations, using paired sample statistics and paired samples test, revealed that cone index generally decreased after tillage operation, while bulk density and moisture content increased. It could be concluded that most of the tractors tested had significant effect on the soil physical properties after tillage.

Keywords: *Tractor capacity, field test, ploughing, soil physical properties.*

1. Introduction

The use of tractors plays a vital role in agriculture, both in developed and developing nations (Mahmood and Gee-Clough, 1989). Ahaneku *et al.* (2011) reported that the primary purpose of agricultural tractors is to provide drawbar work since drawbar is the most commonly used power outlet of a tractor.

The demand for tractor power generally increases with farm size. Excess labour requirements may permit owners of tractors to allow several operators to keep the machine running for extended periods of the day during high-demand times. The extended periods of operation will definitely impact on the soil physical properties. The mass and traffic frequency of farm machinery or trampling by animals determine the pressure accumulation and the rate of change of soil physical properties. These changes are higher in soil with greater soil moisture (Dias Junior and Pierce, 1996). The relation between soil compaction and increased weight of farm machines was emphasized by Bedard *et al.* (1997) and Wood *et al.* (1990). The arrangement of the soil particles resulting in its structure and aggregation is of vital importance to agriculture, since they are related to the availability of water and air to the roots, with the supply of nutrients, with the mechanical resistance to penetration and the root development. Soil tillage is among the important factors affecting soil physical properties and crop yield. Among the crop production factors, tillage contributes up to 20% (Khurshid *et al.*, 2006). The proper use of tillage can improve soil related constraints, while improper tillage may cause a range of undesirable processes, such as destruction of soil structure, accelerated erosion, depletion of organic matter and fertility, and disruption in cycles of water, organic carbon and plant nutrient (Lal, 1993). Use of excessive and unnecessary tillage operations is often harmful to soil. Therefore, currently there is a significance interest and emphasis on the shift to the conservation and no-tillage methods for the purpose of controlling erosion process (Iqbal *et al.*, 2005).
Griffith *et al.* (1986) described the state of aggregation as one of the parameters that can be used to measure soil quality. A high index of aggregation indicates good soil structure and a positive influence on plant growth. There is an evident need to develop and improve agricultural production technology to reduce environmental loading from cultivation areas and to adapt to climate change. The evaluation of soil physical quality requires accurate measurements of soil physical properties.

Knight and Freitag. (1962) reported that cone index could be used to predict whether a given vehicle can cross a given area, whether 50 vehicles can cross that area in the same track, the load that a vehicle can tow through that area and the slope that the vehicle can negotiate in the area. The cone penetrometer has ever since become an extreme important instrument in mobility research. Soil strength is an indicator of how easily roots can penetrate soil. The magnitude of mechanical impedance to root penetration which decreases plant growth is most of the time unknown. Ehlers *et al.* (1983) stated that the penetrometer resistance limiting to oats was 3.6 MPa in tilled Ap horizon, but 4.6 to 5.1 MPa in the untilled Ap horizon and in the subsoil. The limiting penetrometer resistance depends upon the soil conditions and characteristics and the crop of interest. Ayers and Perumpral (1982) pointed out that dry density had a considerable influence on cone index at low moisture contents for soils containing a certain percentage of clay. Cone index became less dependent on dry density at higher moisture