# IMPACT OF SOIL FIRMNESS AND TILLAGE DEPTH ON IRRIGATED MAIZE SILAGE PERFORMANCE

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**ABSTRACT.** *A field experiment was conducted to investigate the response of maize silage (*Zea mays *L.) to tillage depth under different soil firmness levels. The study was carried out on a 16 ha center-pivot irrigated field in a commercial farm located in the eastern region of Saudi Arabia. A soil firmness map was generated and used as a management map. This map was divided into three soil firmness zones based on soil cone index (low: 617 to 1270 kPa for a 0 to 15 cm depth in undisturbed soil, medium: 1271 to 1652 kPa and high: 1653 to 2306 kPa). Three tillage depth treatments (10, 20, and 25 cm) were imposed on each of the three soil firmness zones, using a tandem disc harrow. Maize growth parameters [plant population, plant height, and Normalized Difference Vegetation Index (NDVI)] and maize silage yield were used to evaluate the response of the maize crop to tillage depth. The results revealed that soil firmness and tillage depth at both early (25 days after sowing) and late (60 days after sowing) growth stages did not introduce significant effects on maize plant population. However, the plant height measured at 60 days after sowing showed a significant response to soil firmness. The lowest mean value of plant height (114.4 cm) was recorded at the high soil firmness level, while the greatest mean value (136.3 cm) was recorded under low soil firmness level. Also, significant differences in maize silage yield were recorded under different soil firmness levels and tillage depths. For maize silage production, a tillage depth of 10 cm was observed to be optimum for areas of low and medium soil firmness. For areas of high soil firmness, the optimum tillage depth was 20 cm.*

***Keywords.*** *Disc harrow, Kriging, Maize, Maps, Penetrometer, Tillage depths.*

Soil tillage, the preparation of agricultural soil by mechanical processes, is one of the main and critical operations performed on agricultural fields. Soil tillage significantly affects soil mechanical and hydrological properties (e.g., water accessibility and mechanical impedance), which consequently affect plant growth processes, principally root development and water uptake (Kahlon et al., 2012). Therefore, implementation of soil tillage, which is applied at the right place and at the right depth, for a specific crop and soil condition, is critical for optimum crop production. Conventional uniform tillage (constant tillage depth) is a common practice in many agricultural fields. The conventional tillage system does not consider the different requirements of different locations across agricultural fields. Applying tillage deeper than required can lead to excessive soil disturbance and incorporation of crop residues, which may cause increased soil erosion, greater energy consumption, and decreased crop yield. On the other hand, tillage which is shallower than necessary can result in weak crop stands; hence, reduced crop yields (Lal, 1991; Raper et al., 2001). Both shallow and deep tillage depths are considered as a poor achievement of tillage operations and can have negative impacts on the efficiency of agricultural systems in terms of both the production and economic aspects. Therefore, tailoring tillage depths to fit the requirements of different field locations (precision tillage) can enhance the process of sustainable crop production (Cakir, 2010).

Site-specific tillage or precision tillage is defined as changing soil tillage depth to achieve variable depth tillage (VDT) that matches the requirements of different field locations. In other words, it refers to any tillage system that is used to change soil physical properties for specific selected locations in the field at specific soil depths aiming at improving crop growth, reducing the cost of tillage and enhancing soil conservation (Gilandeh et al., 2006; Khalilian et al., 2002). Performing tillage at a constant depth for the whole field despite the existence of spatial variability in soil firmness would result in a tillage depth either shallower or deeper than the required depth, which could be costly in both cases. Therefore, whenever soil tillage is necessary, it may be beneficial to optimize tillage operations through VDT technology to reduce the negative effects of over- or under-disturbance of the soil in agricultural fields and to minimize energy consumption, and possibly reduce the cost of production through reduced fuel consumption and optimum use of equipment (Gilandeh et al., 2006; El Nahry et al., 2011). Hence, understanding the spatial variations in soil compaction across agricultural fields is important, as the identification of the locations of the compacted soil would greatly assist in adopting the proper tillage depth to improve crop yields (Raper et al., 2005). Specialized soil sensors, such as

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