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Evaluation of tractor specific volumetric fuel consumption during harrowing in loamy-sand and clay-loam soils

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Abstract

Efficient fuel utilisation is very important in mechanised agriculture, particularly during soil tillage operations such as harrowing, where fuel makes up a large part of farm operational cost. This study measured the specific volumetric fuel consumption (SVFC) of a tractor during harrowing in loamy sand and clay loam soils under varying depths (10, 13 and 16 cm) and forward speeds (4, 6 and 8 km/h). Field measurements included soil bulk density, cone index, draught force, power output, and moisture content to observe how they affect the SVFC. Results show that loamy sand soil had lower draught resistance, which resulted to the use of less power and lower fuel consumption (2.92–4.19 L/h (liter/hour) at 10 cm depth). However, SVFC decreased from 0.72 to 0.44 L/kWh with increasing speed, indicating improved fuel efficiency despite fluctuations in fuel usage. In contrast, clay loam soil showed higher draught resistance because it is denser and more cohesive in nature, leading to higher fuel consumption (3.08–4.31 L/h at 10 cm and up to 9.34 L/h at 16 cm depth). Specific volumetric fuel consumption similarly decreased with speed (from 0.59 to 0.35 L/kWh at 10 cm and 0.48 L/kWh at 16 cm), showing the engine performed more efficiently under increased load. Analysis of variance (ANOVA) and paired t-tests, confirmed clear differences in SVFC between the two soil types ($p < 0.05$). These findings tell us that soil type and tractor settings is important when trying to save fuel in mechanised tillage. The study provides empirical data to inform tractor operation strategies, contribute to the optimisation of fuel and support small scale agricultural production. In addition, field conditions are not continuous, and several factors affecting fuel consumption during tillage operations change continuously. Therefore, it is necessary to evaluate tractor performance during ploughing and harrowing operations. Improving the accuracy and efficiency of fuel use in these operations can help reduce costs, save time and enhance overall productivity.

Keywords: Draught, harrowing, soil type, specific volumetric fuel consumption, tractor

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