# The impact of the tillage systems on input-output energy, soil pulverization, and grain yield of barley

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**Abstract** This study aimed to evaluate the effects of tillage systems and tillage speed on, fuel consumption, soil pulverization, and barley grain production, as well as the effects of five tillage systems on energy input-output. The investigation was comprised of three conventional tillage systems involving the use of disk plow + disk harrow + roller (T1), disk plow + two passes of a disk harrow (T2), and moldboard plow + cultivator (T3), and two reduced tillage systems, involving cultivator + roller (T4) and cultivator + disk harrow (T5). Three plowing speeds of 2.70, 5.68, and 6.14 km $h^{-1}$ were used to prepare the soil for barley planting. The results showed that conventional tillage systems T1, T2, and T3 had the highest fuel consumption values, grain yield, and the lowest value of soil pulverization compared to the reduced tillage systems (T4 and T5). Increasing the operating speed from 2.70 to 6.14 km $h^{-1}$ led to a decrease in fuel consumption and soil pulverization index by 21.29% and 19.33% respectively and it had no significant effect on barley grain yield. The interaction between the tillage system and operating speed had a significant effect ($p$<0.05) on fuel consumption and soil pulverization index, while it had no significant effect on barley grain yield. Conventional tillage (T2) led to an increase in the average of the total energy consumed for barley production compared to T1, T3, T4, and T5 by 9.02%, 22.58%, 34.39%, and 41% respectively. While reduced tillage (T5) achieved the lowest total energy-consuming input value of 7586 MJ $ha^{-1}$. Reduced tillage system (T4) achieved the highest energy efficiency, energy productivity, and the lowest specific energy values of 3.53, 0.24 kg $MJ^{-1}$, and 4.16 MJ $kg^{-1}$ respectively. However, the results showed there were no significant effects ($p$<0.05) between T3 and T5 in terms of specific energy and energy productivity.

**Keywords:** tillage systems, fuel consumption, soil pulverization, input-output energy, and grain yield of barley.

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## 1 Introduction

Soil preparation for agriculture requires plowing the soil several times to obtain a suitable seedbed. About 60% of the energy consumed in agriculture is related to plowing practices, therefore essential to take into consideration the passage times of tillage machines and choose appropriate tillage equipment according to the type of soil and the crop to be cultivated to decrease energy consumption (Singh, 2016; Fernandez et al., 2019). The availability of many types of primary and secondary tillage equipment makes the process of selecting the appropriate tillage equipment for optimal agricultural production more difficult. Much research has been done to determine the best tillage equipment to use in

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