On the Correlation between Power Harrow Energy Requirements and Tilled Soil Aggregates Dimension

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**Abstract.** Among all the agricultural operations, tillage is the most energy-intensive operation. In literature, the energy demand of several implements was reported based on different operating conditions (working depth, tractor speed, etc.) and different chemical and physical soil properties. However, tillage operations cannot only be evaluated according to the energy consumption, but the benefit in the soil structure and the consequent agronomic benefits such as crop yield have to be considered. For example, when power harrows are used, soil cloddiness can be adjusted by varying the machinery ground speed and the angular speed of tine rotors as both control the number of tine revolutions per meter (denoted as C). The aim of this paper is to get a deeper insight into controlling the soil structure and finding a correlation with the energy requirement of the power harrow based on different setups. Field tests were conducted at the experimental farm of the University of Bologna on a 3 m working width power harrow coupled with a tractor (107 kW of rated engine power). Two different field tests were performed named Constant C trials (denoted as CC) and Variable C (denoted as VC) trials. Constant C trials were carried out to evaluate the effect of the tractor speed on soil loosening maintaining C fixed at 4 m-1. Variable C trials allowed to evaluate the effect of the number of rotor revolutions per linear meter travelled by the tractor, so tests were performed varying C from 2 m-1 to 13 m-1. Tractor parameters such as speed, engine power, engine speed, fuel rate consumption and Power Take Off (PTO) speed were acquired during the tests through its Controlled Area Network (CAN) SAE J1939 diagnostic port with a datalogger. Moreover, the draught force and PTO torque absorbed by the power harrow were acquired with load pins and a torque meter, respectively. After harrowing, soil samples were sieved, then the granulometric parameters (Mean Weight Diameter -MWD- and Geometric Mean Diameter -GMD-) were calculated and correlated to data acquired from the tractor-power harrow system. The results show that the fuel consumption per hectare is inversely proportional with the increase of the tractor speed in the CC trials and directly proportional with the increase of C in the VC trials, as expected. Regarding the soil structure, MWD and GWD values show that finer aggregates were obtained with the increase of tractor speed in the CC trials and with the increase of C in the VC trials.