Geophysical Research Abstracts
Vol. 14, EGU2012-9128, 2012
EGU General Assembly 2012

An approach for modeling the influence of wheel tractor loads and vibration frequencies on soil compaction

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Both soil compaction and ground vibration are forms of environmental degradation that may be understood in the context of the vehicle-soil interaction process considered (Hildebrand et al., 2008). The transit of tractors on agricultural soil is often the main cause of soil compaction increasing. As known, this can be a serious problems for tillage and sowing and therefore the influence of all the affecting factors have been extensively studied in the last decades in order to understand their impact on the biosystem. There are factors related to the climate, namely to the rainfalls and temperature, and many others. Hence, it is not simple to figure out a complete model for predicting an index of compaction, for a given situation. Soil compaction models are important tools for controlling soil compaction due to agricultural field traffic and they are potentially useful technique to provide information concerning correct soil management. By means of such models, strategies and recommendations for prevention of soil compaction may be developed and specific advice may be given to farmers and advisers. In order to predict field wheeled and tracked vehicle performance, some empirical methods, used for off-road vehicle, were applied by Servadio (2010) on agricultural soil. The empirical indexes included, besides the soil strength, the load carried by the tire or track, some technical characteristics of the tire or track of the vehicle (tire or track width, tire or track wheel diameter, unloaded tire section height, number of wheel station in one track, tire deflection, total length of the belt track, the track pitch) as well as the vehicle passes. They have been validated with the tests results of agricultural vehicles over a range of soil in central Italy. Among the parameters which affect soil compaction, the water content of the soil, the axle load and number of vehicle passes proved to be the most important ones. The present paper concerns mainly vehicle-soil-man interaction. In particular, a model based on elasto-visco-plastic concentrated parameters, with multiple degrees of freedom, will be used in order to build a method for detecting a soil damage index, especially expressed in terms of increasing of soil compaction. Besides the axle load, the model will take into account the frequency of the vibrations that the vehicle is transmitting to the soil. Such model expresses a numerical value for the transmissibility coefficient and also allows evaluating the damage at the surface and on the bulk medium where the agricultural crops initially develop.

Key words: vehicle-soil interaction, vibration, compaction, models.

Acknowledgements
This work was carried out under the auspices of the special project “Sceneries of adaptation of the Italian agriculture to the climatic changes" (AGROSCENARI) of the Agricultural Research Council, and Italian Ministry of the Agricultural and Forestry Politics.