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Risk assessment of soil compaction in Walloon Region (Belgium)

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The proposed Soil Framework Directive COM(2006)232 requires Member States to identify areas at risk of erosion, decline in organic matter, salinisation, compaction, sealing and landslides, as well as to set up an inventory of contaminated sites.

The present project aims to identify the susceptibility to compaction of soils of the Walloon Region (Belgium) and to recommend good farming practices avoiding soil compaction as far as possible.

Within this scope, the concept of precompression stress (Pc) (Horn and Fleige, 2003) was used. Pc is defined as the maximum major principal stress that a soil horizon can withstand against any applied external vertical stress. If applied stress is higher than Pc, the soil enters in a plastic state, not easily reversible. For a given soil, the intensity of soil compaction is mainly due to the applied load which depends on vehicle characteristics (axle load, tyre dimensions, tyre inflation pressure, and vehicle velocity).

To determine soil precompression stress, pedotransfert functions of Lebert and Horn (1991) defined at two water suctions (pF 1.8 and 2.5) were used. Parameters required by these functions were found within several databases (Aardewerk and Digital Map of Walloon Soils) and literature. The validation of Pc was performed by measuring stress-strain relationships using automatic oedometers. Stresses of 15.6, 31, 3, 62.5, 125, 250, 500 and 1000 kPa were applied for 10 min each.

In this study, the compaction due to beet harvesters was considered because the axle load can exceed 10 tons and these machines are often used during wet conditions. The compaction at two depth levels was considered: 30 and 50 cm. Compaction of topsoil was not taken into account because, under conventional tillage, the plough depth is lower than 25 cm. Before and after the passage of the machines, following measurements were performed: granulometry, density, soil moisture, pF curve, Atterberg limits, ... The software Soilflex (Keller et al., 2007) was used to estimate the distribution of the vertical stresses [U+F073]z in the soil. Comparison was performed between [U+F073]z and Pc.

The following data simulated the passage of a beet harvester machine (mass: 23 580 kg; load: 18 000 kg) in a silty soil located in Hesbaye and classified as Aba (Sirjacobs et al., 2000). The passage of the machine would create a Pc of around 100 kPa at 30 cm depth, while the stress induced by the machine would reach 240 kPa. In the field borders, where more vehicle traffic was usually observed and where the soil was over consolidated, Pc would reach 180 kPa, while [U+F073]z would be 220 kPa. In both cases, the risk of compaction created by the passage of the machine would be high.

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