Response of soil physical properties following the application of soil restoration techniques on machine operating trails

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Introduction
Research objectives

• To compare and to quantify the potential of two soil restoration techniques on heavily compacted and damaged machine operating trails.

• To gain a first insight on the influence of technical restoration techniques on soil physical processes.

• To carry out time studies in order to calculate productivity and costs of the two different treatments.
Study Design
Soil restoration techniques

**T1:** Wheel ruts were filled, leveled and then packed with a tracked excavator and mechanically loosened and aerated by a soil tillage machine.

**T2:** Wheel ruts were filled, leveled and packed with a tracked excavator.
Soil aerator

**OWR MM 100 (3-point tractor attachment)**
- Ceased in the early 1990s
- Four spades that are spaced by 60 cm
- Spades: Width of 15 cm and a length up to 100 cm
- Weight: 2,000 kg and a working width of 2.0 m

**Fendt 936 Vario**
- Operating weight of 10,300 kg
- Engine power of 265 kW (355 hp)
- Width of 2.75 m and a length of 5.65 m
- Equipped with a 1,800 kg counter weight
Response of soil physical properties following the application of soil restoration techniques on machine operating trails
Field sampling and instruments

Tested soil properties:

- Standard Proctor
- Grain size distribution
- Plastic and liquid limits
- Resistance to penetration
- Bulk density
- Pore volume
- Air conductivity
- Infiltration rate
- Water conductivity
Soil penetration resistance

**Trail 1**
- **Pre-Impact**
  - Ø MC (pre) = 42.1%
  - Depth [cm]: 0, 10, 20, 30, 40
  - Mean Penetration Resistance [MPa]: 10

**Trail 2**
- **Pre-Impact**
  - Ø MC (pre) = 26.4%
  - Depth [cm]: 0, 10, 20, 30, 40
  - Mean Penetration Resistance [MPa]: 20

**Trail 3**
- **Pre-Impact**
  - Ø MC (pre) = 17.1%
  - Depth [cm]: 0, 10, 20, 30, 40
  - Mean Penetration Resistance [MPa]: 30

**Trail 1: Between Track**
- **Pre-Impact**
  - Ø MC (pre) = 44.6%
  - Depth [cm]: 0, 10, 20, 30, 40
  - Mean Penetration Resistance [MPa]: 40

**Trail 2: Between Track**
- **Pre-Impact**
  - Ø MC (pre) = 25.4%
  - Depth [cm]: 0, 10, 20, 30, 40
  - Mean Penetration Resistance [MPa]: 50

**Trail 3: Between Track**
- **Pre-Impact**
  - Ø MC (pre) = 25.6%
  - Depth [cm]: 0, 10, 20, 30, 40
  - Mean Penetration Resistance [MPa]: 60
Soil bulk density and Pore volume
### Productivity and costs

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<td>Excavator: CAT 314 E</td>
<td>40.00</td>
<td>40.00</td>
<td>80.00</td>
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<td>Aeration: Fendt + OWR MM 100</td>
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<td>245.00</td>
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| Treatment 1 (Tracked excavator + OWR MM100) | 1.46 €/m |
| Treatment 2 (Tracked excavator)            | 0.72 €/m |

- **a)** Backward working excavator.
- **b)** Soil aeration with double processing per trail.

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Conclusion and outlook