J-DISTAS : creation of interoperable tools for the estimation of field readiness

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PO 309

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Carolina Ugarte Nano[1], Isabelle Cousin[2], Mathieu Lamande[3,4], Damian Martin[5], Marine Lacoste[2], Guillaume Giot[2], Pascale Metais[6]*

[1]AGHYLE, UniLaSalle, SFR Condorcet FR CNRS 3417, 19, rue Pierre Waguet, 60000 Beauvais, France. [2]URSOLS, INRAE, Orléans, France, [3]Agroecology, Aarhus University, Tjele, Denmark, [4]Faculty of Environmental Sciences and Natural Resource Managment, Norwegian university of Life Sciences, As, Norway, [5]Agro-Transfert Ressources et Territoires, Estrées Mons, [6]Arvalis Institut du Végétal, Saint Beauzire, France
*corresponding author: p.metais@arvalis.fr

GENEVA Eurosoil 2021

1. Introduction

Sustainable crop production implies high efficiency of field operations and protection of the soil as a natural resource. To fulfill theses two conditions, field operations should be conducted considering **field readiness**, which is the combination of two factors:

- **soil workability** = suitability of soil for field operations involving fragmentation
- **soil trafficability** = soil capacity to support machinery during traffic without soil physical degradation

The concept of field readiness allows strategic decisions such as the evolution of cropping systems or the acquisition of agricultural machinery. The tools currently available in France need to be upgraded. **The J-DISTAS project (2019-2022) aims to create a prototype of interoperable tools which includes all the aspects linked to the concept of field readiness.** It will especially benefit from the Terranimo model, allowing the estimation of the soil compaction risk. This poster presents the **global approach of the project** and then focus on the **assessment of soil workability from field methods.**

2. Global approach

The approach used by J-DISTAS tool for determining the achievement of field readiness conditions for a specific field operation is described in Figure 1.

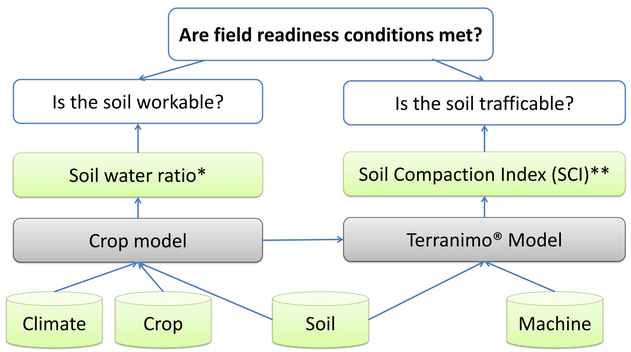

Figure 1 : Functioning of J-DISTAS tool to determine soil readiness.
*Soil water ratio is defined in part 3.2 materials and methods
** SCI = log(Pact/Pc) with Pact = vertical stress, Pc= soil strength (Schjønning and Lamandé, 2020)

2.1 Data collected

Table 1 : Example of data collected to characterize field readiness conditions

Field experiment conditions	Workability	Trafficability
Machine weight and characteristics, wheather, etc.	Soil consistency, soil water content, success of the operation, etc.	Soil matric potential, Bulk Density, air permeability, etc.

2.2 Stages for conceiving J-DISTAS tool

1- Identify the data needed for the conception and evaluation of the prototype *(done)*
2- Build methods and procedures for field and laboratory measurements *(done)*
3- Carry out field experiments to collect data : 75 fields trials in 2019 and 2020 *(done)*
4- Analyze the data to identify which minimum conditions should be fulfilled for both workability and trafficability *(in progress)*
5- Design models to estimate workability, trafficability and field readiness *(in progress)*
6- Evaluate the models *(will start soon)*

3. Soil workability assessment

3.1 Background

Soil workability assessment is mainly based from the comparison between soil water content and workability limits derived from water retention curves, among other methods (Obour et al., 2017). Soil workability may also be assessed from consistency limits (i.e. plastic, semi-plastic, crumbly and hard limits). In this work, we are analyzing the relationship between field consistency limits and soil water ratio. Our hypothesis is that the gravimetric soil water ratio can be used as an indicator of soil workability based on its relationship with soil consistency limits.

3.2 Materials and methods

Among the 75 field trials carried out, 37 from 6 experimental sites were used to analyze the relationship between field consistency and soil water ratio. Soil texture in this experimental site are sandy loam, loam, silt loam and silt clay loam.
Soil water ratio (w/w_{pF2}) is defined as the ratio between soil gravimetric content at field operation time (w) and water content at field capacity :

- Soil gravimetric water content, w (g/g) is measured at the time of field operation from 6 replicates.
- Water content at field capacity, w_{pF2} (g/g) is obtained from lab measurement by HyProp method (3 sites), Wind method (2 sites) or water content characterization at field capacity based on matric potential survey with tensiometers (1 site).

Soil consistency at the time of field operation were assessed following the consistency-workability grid (Figure 2)

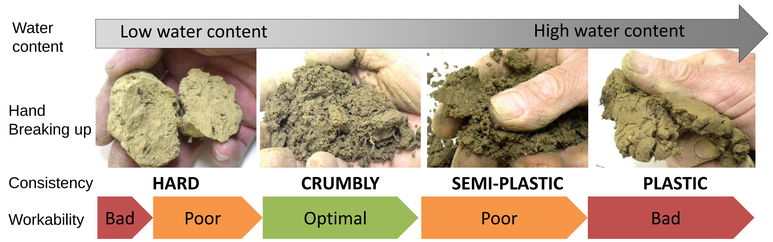

Figure 2 : Consistency-workability grid (adapted from Arvalis-Insitut du Végétal, 2010)

3.3 First results and discussions

Relationship between soil consistency limits and soil water ratio is presented in Figure 3. No plastic consistency was characterized for any of the 37 field workability assessments, according to minimal conditions needed to achieve field operation.

- As expected, the water ratio is lower when field consistency is hard, higher in semi-plastic situations and intermediate if soil is crumbly. The water ratio may be used as an indicator of soil workability
- These data allows to calculate soil water content range for each soil consistency. The next step will be to define relevant thresholds of soil water ratio corresponding to consistency limits

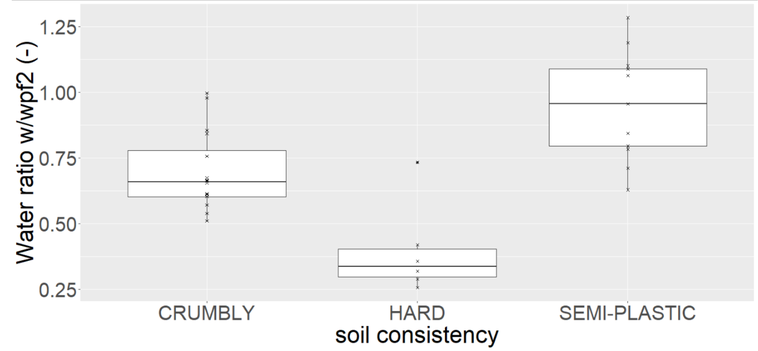

Figure 3 : Relationship between field soil consistency and soil water ratio, w/w_{pF2}

4. Conclusions

We developped a structured approach to evaluate field readiness wich combines severals tools allowing the estimation of th needed indicators (Terranimo model for compaction risk for instance). Work is in progress to define the right calculation methods for each indicator.
With regard to soil workability, a relashionship has been demonstrated between field consistency and soil water content. Further analysis is needed to define water content limits for workability in order to predict soil workability.

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Acknowledgments

The authors thank all the contributors to the project. J-DISTAS (January 2019 - June 2022) receives financial contribution from the Special Allocation Fund for Agricultural and Rural Development (or CASDAR) managed by the French Ministry of Agriculture and Food.