

AGRONOMIC USES OF PENETROMETERS FOR THE STUDY OF STRUCTURE IN TILLED SOILS

J.-F. BILLOT ⁽¹⁾

(Science du Sol n° 1982-3)

ASAE standard S313.1 describes a soil cone penetrometer recommended as a measuring device to characterize the penetration resistance of soils, but many different types of penetrometers were used by searchers. Some ones are very simple others more sophisticated and accurate ones. Commonly penetrometers provide an index of general mechanical conditions for a studied soil. As it is quite impossible to deduce mechanical behaviour of an agricultural soil only from penetrometer's data, agronomists are using penetrometers more to obtain relative data than to have soils strength value. Some types of penetrometer are quickly presented, different by their penetration mode and by the cone point aspect. In agronomy they are used as help for decision and in testing field survey.

As we frequently use the S. Henin's observation method of «profil cultural» to study soil structural variations under tillage implement and wheel impact, we decided to operate with a penetrometer to add numerical non subjective data to qualitative descriptions. New methodological perspectives can thus be derived from that approach.

1. MATERIAL AND METHOD.

We use a special electronic recording penetrometer designed and developed at CEMAGREF (Figure 3).

From a series of penetration curves (Fig. 4) a precise survey of the soil surface level and the penetration resistance of the different soil layers, is then manually or semi-automatically drawn up on the very vertical plane which bears the cone-made holes.

Different graphical representations may be used : we may connect points of equal pressure, form isobar lines and areas so defined are darkened as pressure increases (figures 5 and 7) or have a «scanner» type graphical representation (figures 6, 10 and 11).



Figure 6 : Sugar beet seed bed preparation with tractor large tyres (a) and dual wheel arrangement (b, right), two passes in each case. No pass on b left part.

(1) Centre National du Machinisme Agricole du Génie Rural des Eaux et Forêts, CEMAGREF, 92160 Antony.
Association Française pour l'Étude du Sol - www.afes.fr - 2010

2. USE OF GRAPHICAL REPRESENTATION.

When we want to study the soil macro-structure in a test field, we dig a trench and observe the walls after we have revealed such macro-structure with a knife ; then we can analyse it. Such an analysis which requires highly qualified observers is often to long and sometimes considered as a subjective method, so research workers are now codifying it. Using our penetrometer we work quickly (half an hour for a 1 m wide soil profile), we don't destroy neither soil structure nor crops and experts are required only for result interpretation and for some complementary trench observations of peculiar places considered as typical and interesting taking the penetrometer data into account (to complete numeric penetrometer data by qualitative informations such as root implantation, presence of polished zones and of asphyxiating areas).

We have used that technique for the last years to carry out different soil studies.

ANALYSIS OF SOIL COMPACTION.

When we try to study in the field the action of different types of tyres on soil compaction, we can see that heterogeneity influence on compaction is important (figure 6).

As for as theoretical studies on compaction are concerned we try to work on a homogeneous medium. It should be enticing to read penetration resistance variations directly as soil bulk density changes : more the soil is resistant, bigger is the bulk density and more important is the soil compaction. There is a close connection between penetration resistance and soil compaction but moisture plays an very important part (figure 8). So when we study compaction variations with a penetrometer, homogeneous moisture conditions are required.

ANALYSIS OF TILLAGE IMPLEMENT EFFECT.

We compare penetrometer graphical data before and after one pass of the implement under study (figure 9, a and b), or analyse the revealed soil profile heterogeneity (figure 10 and 11).

CONCLUSIONS

1° An accurate penetrometer may be used in agronomic studies, to objectively show structure heterogeneity of a soil area, using graphical data of numerous regularly spaced penetration resistance versus depth curves.

2° With such a aim, precautions should be taken to carry out measurements in good conditions : homogeneity of soil moisture, neither stony nor adhesive clay soil.

3° The graphical representation obtained may be help full to explain general and particular action of tillage implements upon the soil, and make known the relative intensity and extension of soil compaction.

4° This quick, non destructive method is a valuable one much appreciated by those who carry out comparisons of tillage techniques on plots.

5° On-field automatic analyzing and recording on magnetic tape for further drawing and calculation will increase the interest of the method and related equipment.