Bulletin UASVM, Agriculture 65(2)/2008
pISSN 1843-5246; eISSN 1843-5386

CONSIDERATIONS ABOUT THE GEOMETRY OF THE SLOPE SPOIL PROFILATION WITH THE CPU TILLER WITH OLAC WORKING BODY

Cârdei P., , C. Coța, V. Muraru,
INMA Bucharest, petru_cardei@yahoo.com, INMA Cluj-Napoca, INMA Bucharest

Key words: soil, erosion, profiling

Abstract : The detachment and the transport of the sediments on the slope soil surface are caused by the water in the many cases, rain spray or dispersion or concentrated water rills. The development of these mechanical processes is also influenced by the factors which can be modified by the human intervention.
In aim to disproof the slope soil erosion are necessary a lot of anti-erosion actions, for example the retention or conducted evacuation of the water. There is well known the location of the row crops oriented along of the level curve of the slope, but these actions are not enough for a good reducing of the erosion phenomena. For this reason is proposed another procedure, which made a soil profiling shapes. This procedure is applied using farm machinery which can profile the slope soil in the necessary shapes: billons between the crop rows and billons on the crop rows, simultaneous which other agricultural operations.
In this paper is shown an analysis of the soil crisping (soil transversal shape) influence about the soil erosion. There are used erosion mathematical models based on USLE original model, which is included in the complex software programs.

INTRODUCTION

INMA Cluj has elaborated an antierosional agricultural management based on the using of the CPU tiller with OLAC working body (see fig. 1 and 2).

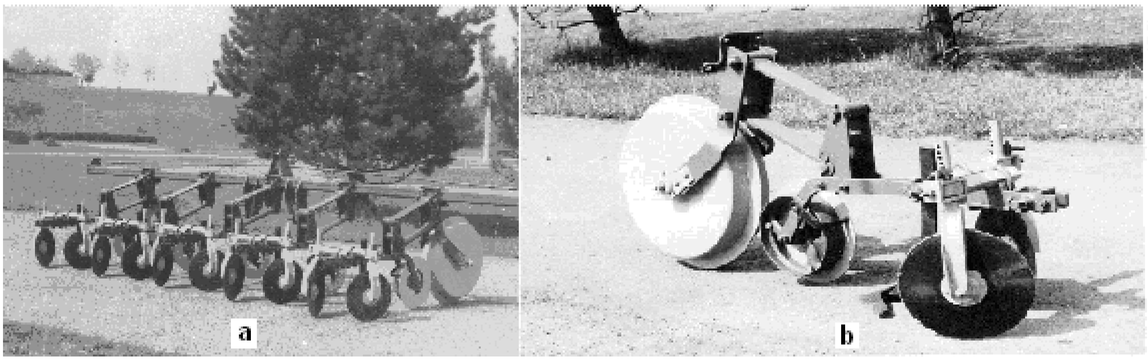

Fig. 1 The universal CPU tiller, a, which using OLAC working body – in detail, mounted by a section, b.

Fig. 2 Slope soil profiling in a corn crop parcel, first tillage, a, and the secondary tillage, b.

The tilling process details were described in [1]. In this paper we try to elaborate a procedure to calculate the capacity to retain and store the detached material which is produced by the own profile.

THE THEORETICALL MECHANISM OF THE RETAIN AND STORE THE DETACHED SOIL ON THE PROFIL

The theoretic mechanism of the retain and store the detached soil inside the profile was described in [1]. This mechanism is based on the stored of the detached soil inside the profile, in this way, the slope do not delivery any sediment material, until the profile retain capacity is available.

The scheme of the soil profile resulted by the CPU tiller (with OLAC working body) is shown in the figure 3.

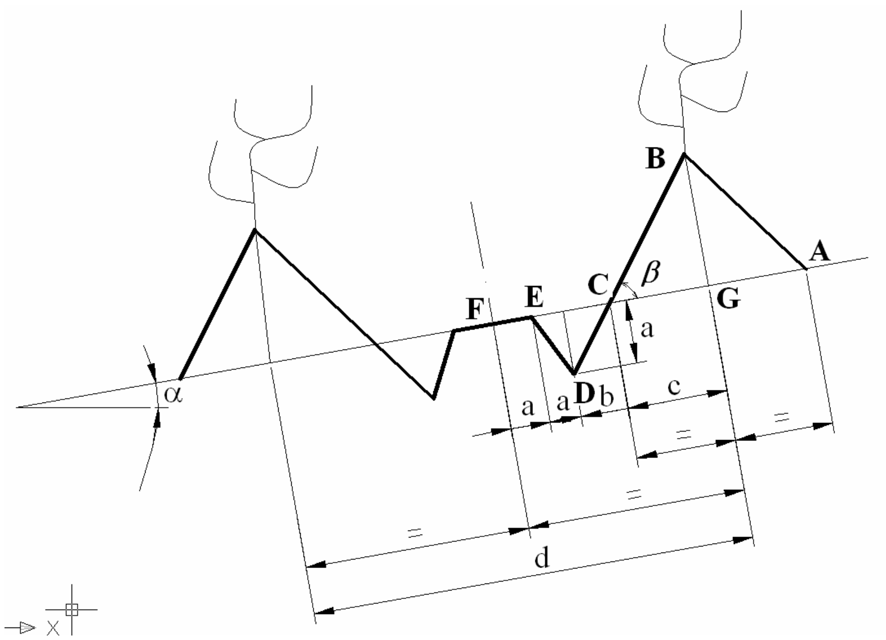

Fig. 3 The soil profile scheme resulted by the CPU tiller.

In the figure 4 is marked the store capacity zone of the profile, on a 10^o slope (17,7 %). The sediment store zone is the interior of the polygon abcdefa, where the edge af is the horizontal free face of the sediment and the other edges on the profile walls. The slope angle is *α*.

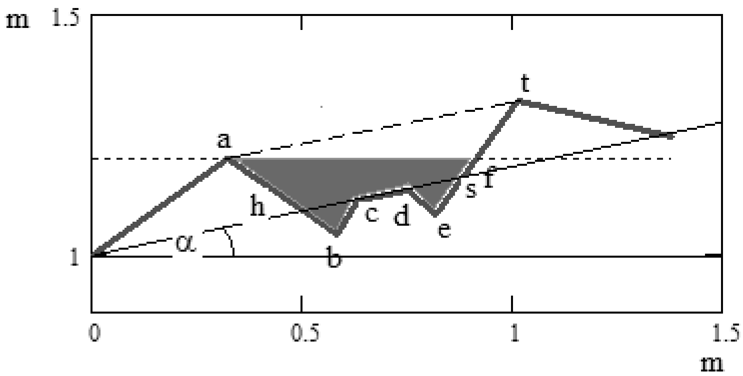

Fig. 4 The store zone of the profile generated by the CPU tiller action on the slope.

The problem of this article is to find an approximation for the soil detachment capacity of the profile, related with the slope angle. In this paper we use the dimensions of the profile which are establish by eng. Cota and the INMA Cluj team, and is varied only the slope angle.

PRELIMINARY CALCULUS

For the calculus of the measure of the soil detached store, we consider only that the store zone is the trapeze **ahft** (fig. 4) if the slope angle is null. If the soil angle is strictly positive, then the store zone of the profile is the polygon **ahsf**. The area of the ahsf polygon is the difference by the area of the trapeze **ahft** and the area of the triangle **aft**.
Using these observations, is obtain the formula of the area of triangle **aft**:

$$A_{aft} = d\frac{\sin\alpha\sin\beta}{2\sin(\alpha+\beta)}, \qquad (1)$$

and the area of the trapeze **ahft**:

$$A_{ahft} = (d-c)\cdot c\cdot tg\beta . \qquad (2)$$

Then, the area of the store zone, is a function of the slope angle, *α*, which is obtained by the difference between the A_{ahft} (formula (2)) and A_{aft} (formula (1)). For the simplicity, the slope width is considered a unit value (1 m).
For the soil detachment delivery by the store zone (the edge **ah**, **hs** and **st**), we use the universal equation of the erosion:

$$A = R\cdot K\cdot LS\cdot C\cdot P, \qquad (3)$$

where: the factors *R* and *K* are constants which show the influence of the soil and clime condition in the zone. The factor *LS* depends by the angle and length of the slope. The factor *C* show the crop management and has two components, and the factor *P* show the influence of the geometrical arrangement of the crop. For the calculus of *LS* is using the formula, after [2]:

$$LS = LS(p, L) = \left(0.065 + 0.0456p + 0.006541p^2\right) \cdot \left(\frac{L}{22.1}\right)^{NN(p)}, \tag{24}$$

where:

$$NN(p) = \begin{cases} 0.2, & daca\ p < 1 \\ 0.3, & daca\ 1 \le p < 3 \\ 0.4, & daca\ 3 \le p < 5 \\ 0.5, & daca\ p \ge 5 \end{cases}, \tag{5}$$

And *p* is the slope percentile angle. *L* is the slope length.

NUMERICAL CALCULUS

Using the formulae described in the paragraph, we made a numerical calculus for the estimation of the parameters which can give an assessment for the quality of the soil profile design. We calculate the sediment delivery by a profile, the store capacity of a profile, and the sediment delivery by the smooth slope which has the same angle with the tilled slope and the length *d*. All the three parameters are calculated related to the slope angle. The results are represented in the figure 5.

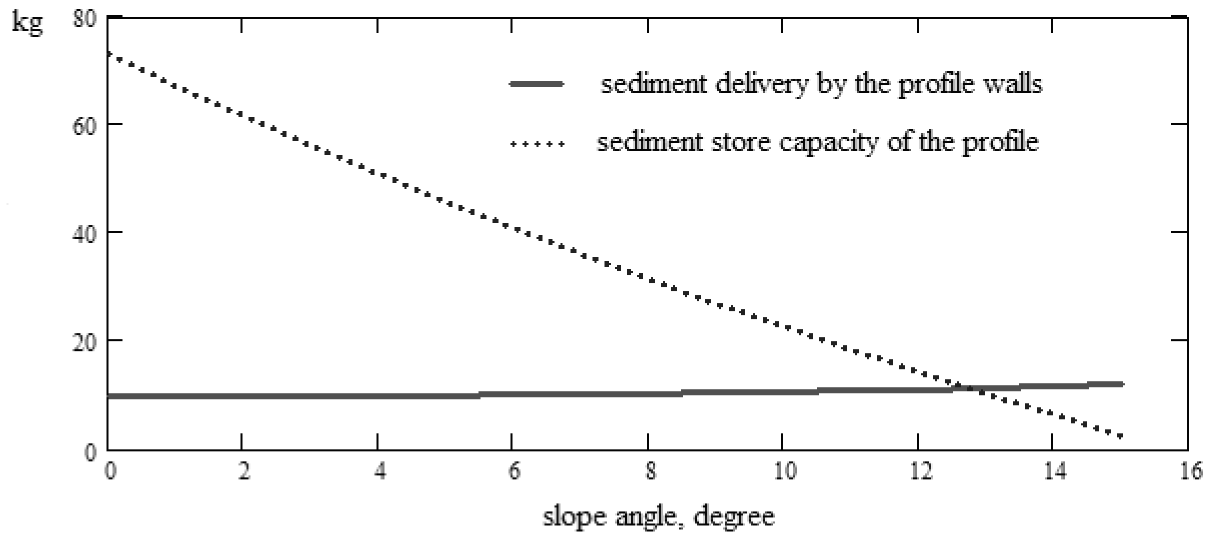

Fig. 5 The variation of the sediment delivery and the sediment store capacity with the slope angle.

It is easy to see, using the figure 5, that the store capacity is enough if the slope is less than 13^o.
If the slope is greater than 13^o then the store capacity is small for the clime conditions which characterize the Cluj zone. These considerations are made in the condition: *R*=105 (this value characterizes the rain annual quantity in Cluj zone, 800 – 900 mm), *K*=0.4, *C*=0.5 and *P*=0.75, which characterizes the corn crops disposed by the slope area in the Gheorghieni (Cluj department) zone, where the experiment has been made. The numerical values of the profile geometry are given by Cota and the team of the INMA Cluj, a=0.06 m, c= 0.07 m, d=0.7 m.

For the soil bulk density we consider the value 990 kg/m^3. These values can be changed in the calculus process and we can obtain improved variants of the soil profile.

CONCLUSIONS

The procedure for the assessment of the sediment store for the soil profile made by the CPU tiller with OLAC working body is a very elementary calculus which contains many hypotheses. The real process of the soil erosion involves a transform of the soil profile walls, but the form of this transform is not easy to describe. For the moment this transform is the subject of our researches. In these conditions the calculus which is exposed in this article, is good enough for the assessment of the soil profile „life”. The soil profile must store the sediment for a year, or the soil profile tilling will be made two or more time, if there is possible, depending of the soil profile „life” time. It is important to not create soil profile too big, because the energy consumption is not justified. The soil profile dimension must be chosen so that its life finished a little time after the beginning of the new agricultural year. For these reason, the procedure which is proposed in this paper, is sufficient.

BIBLIOGRAPHY

[1] Cota C., P. Cardei , The influence of the soil profiling about the erosion of the slope soil row crop cultivated, INMATEH II 2008, International Symposium INMA Bucharest, 18 july,2008;

[2] Revised Universal Soil Loss Equation 2 - RUSLE2 Documentation;