Erosion as Affected by Soil Inherent Properties and Extrinsic Conditions

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Introduction

Soil loss by overland flow in agricultural watersheds is a severe problem worldwide**.**

Agricultural fields usually exhibit a complex spatio-temporal variability related to soil properties and conditions, as well as variable sources of sediments and pollutants, and hydrologically sensitive areas.

Hence, most of the currently used management practices and risk assessment models, can not adequately handle the complexity of the conditions prevailing in the field, probably due to lack of understanding of how soil properties and conditions affect runoff generation and soil erosion.

There is, therefore, an urgent need to assess the combined effects of soil permanent properties and time dependant conditions on runoff generation and erosion, so that suitable management practices can be developed to minimize loss of sediments and/or transport of nutrients having a significant polluting potential.

Objectives

To examine (based mostly on published results), in a systematic manner, the contribution of:

(i) soil inherent properties

(ii) extrinsic conditions prevailing in the field

to soil erosion from numerous top soils collected from cultivated fields.

The variables examined included:

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I. Soil inherent properties

- predominant clay mineralogy (kaolinitic, illitic and smectitic)
- soil texture (4-6 textural classes)
- organic matter content

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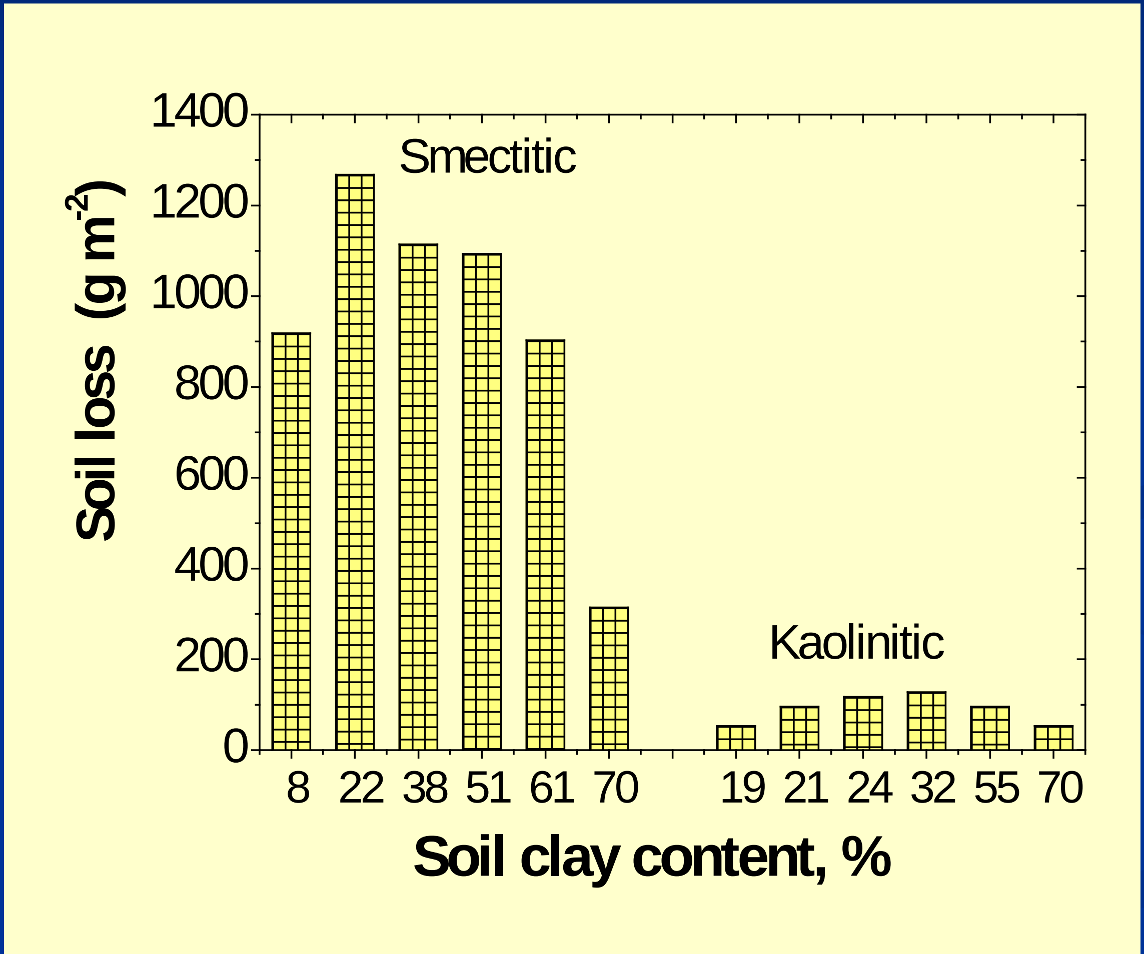
II. Extrinsic conditions

- rain kinetic energy (KE, 0-22 kJ/m3);
- wetting rates (WR) of dry soil
- water quality (rain, fresh, effluent or saline water);
- antecedent moisture contents (from dry to full saturation combined with aging)
- tillage intensity (conventional and minimum tillage);
- use of soil amendments (polymer, gypsum).

Results

Predominant clay mineralogy.

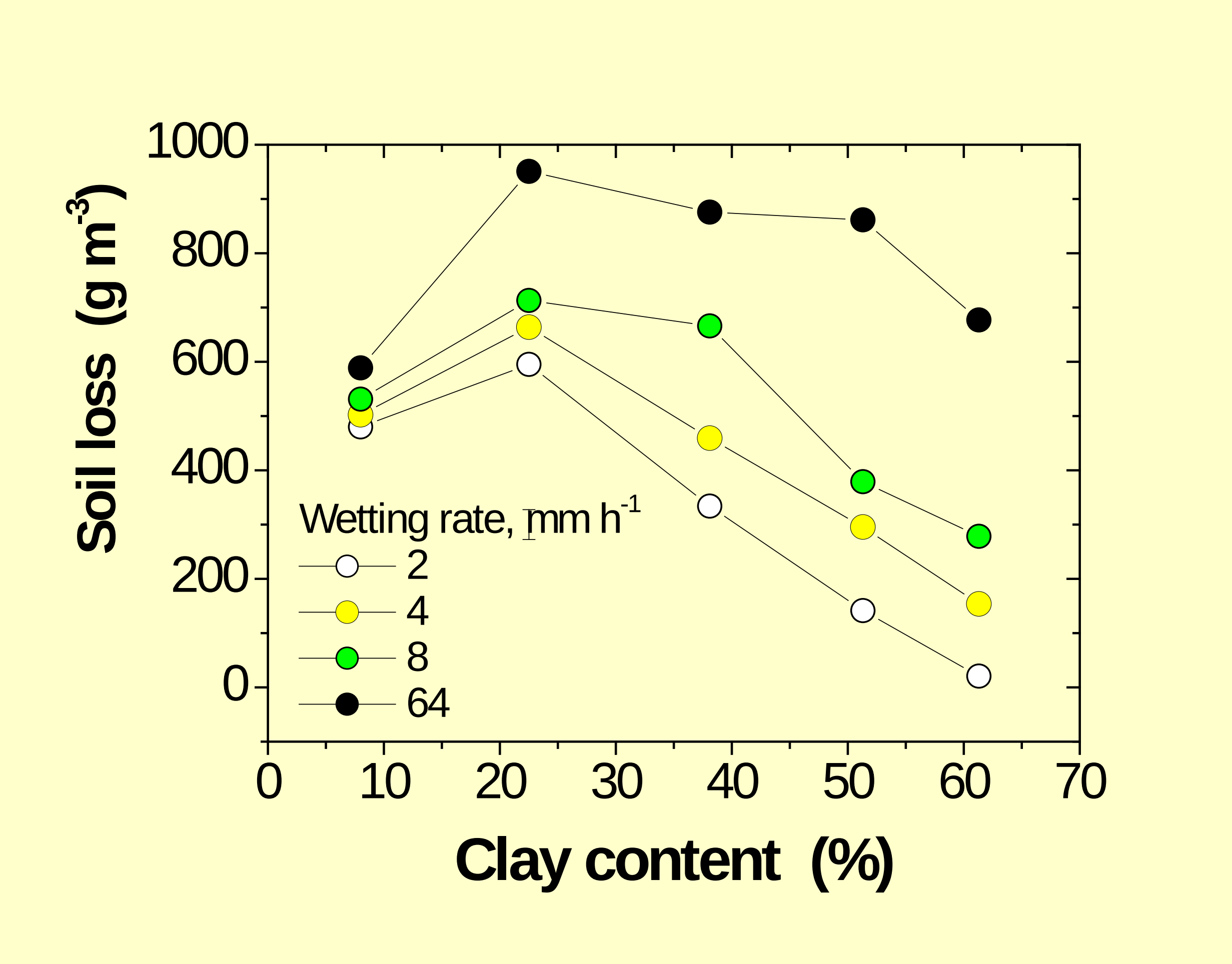


Soil clay mineralogy affects the physicochemical dispersion of the clay and the physical disintegration of soil aggregates and hence affects soil loss.

Soil loss: Smectitic > Illitic > Kaolinitic

(Stern et al, 1991; Mamedov et al., 2002)

Soil texture and wetting rate (WR)

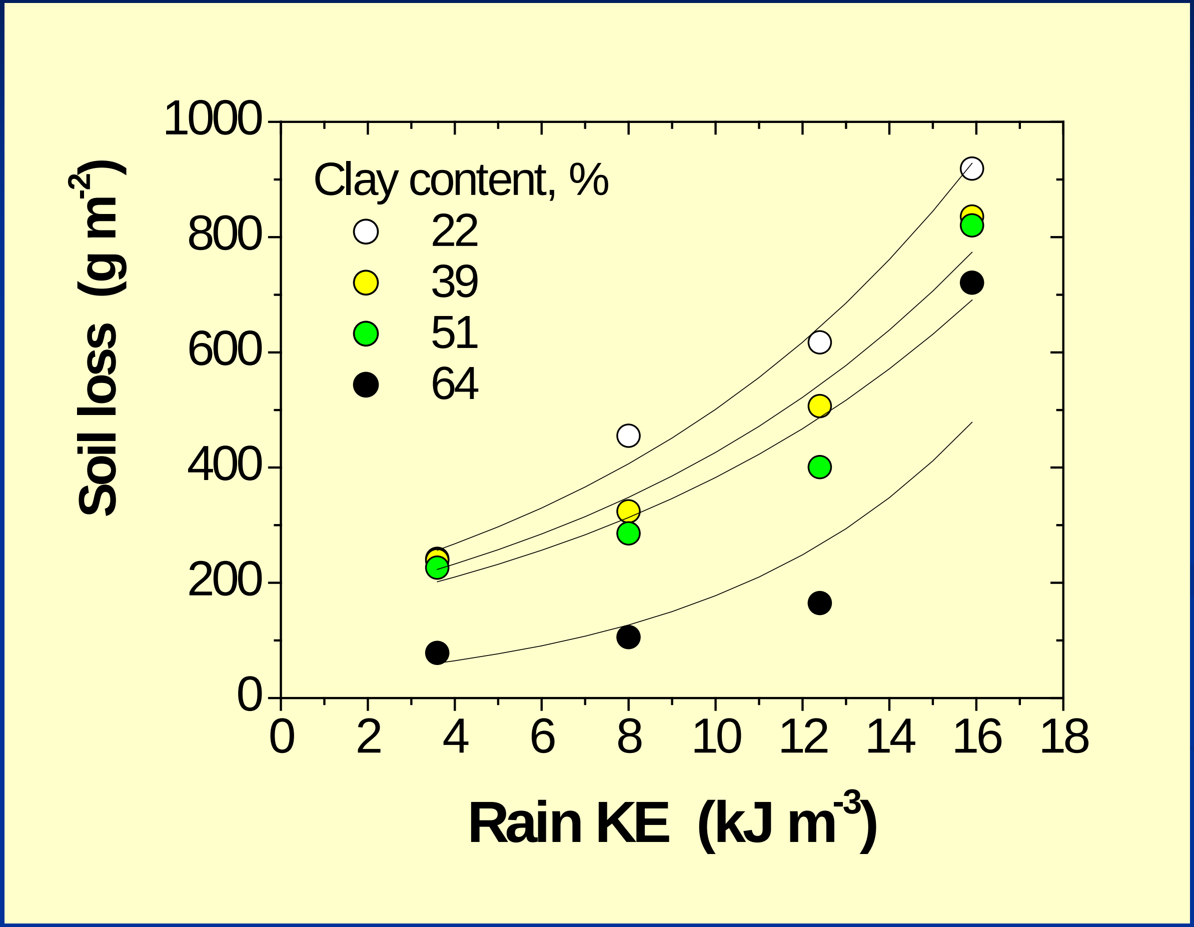


The soils with intermediate clay content (20-40% clay) are the most susceptible to soil erosion.

The effect of WR on soil loss increases with an increase in clay content.

Mamedov et al., 2001

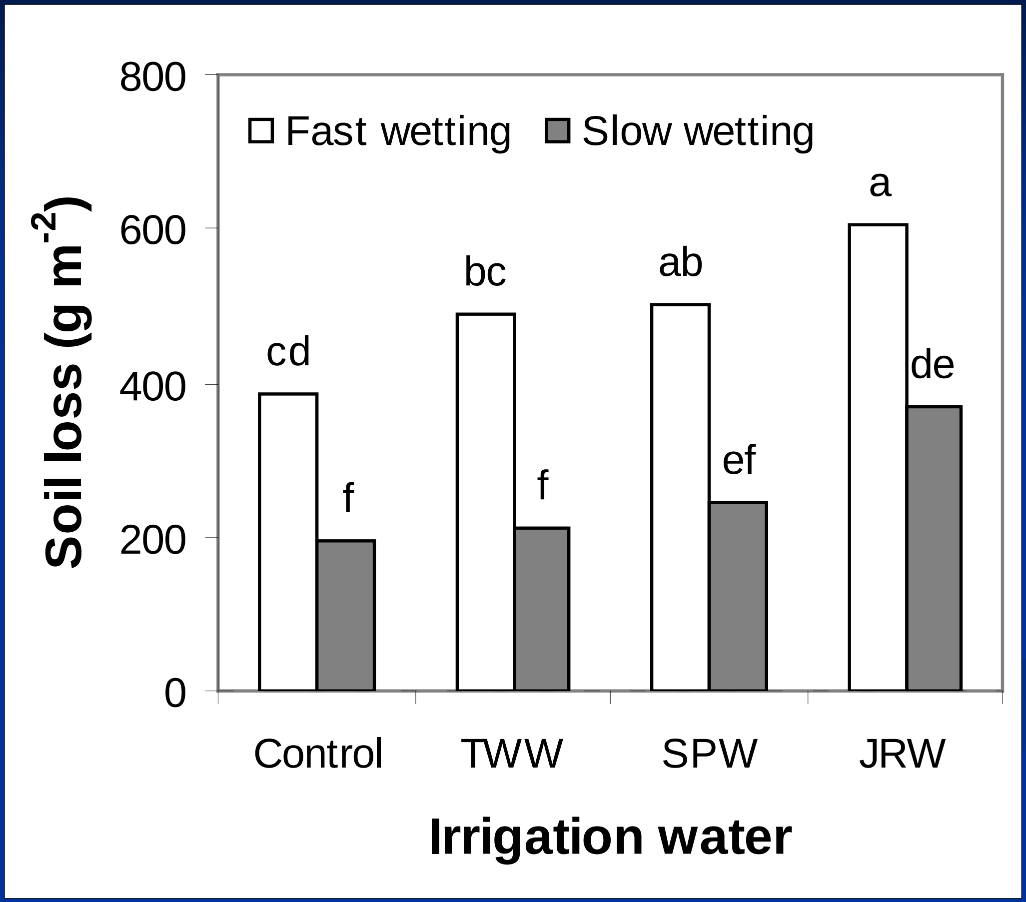
Rain kinetic energy (KE)



Interrill erosion seems to increase exponentially with the increase in rain KE, but for the very clayey soil.

Mamedov et al., 2000

Water quality

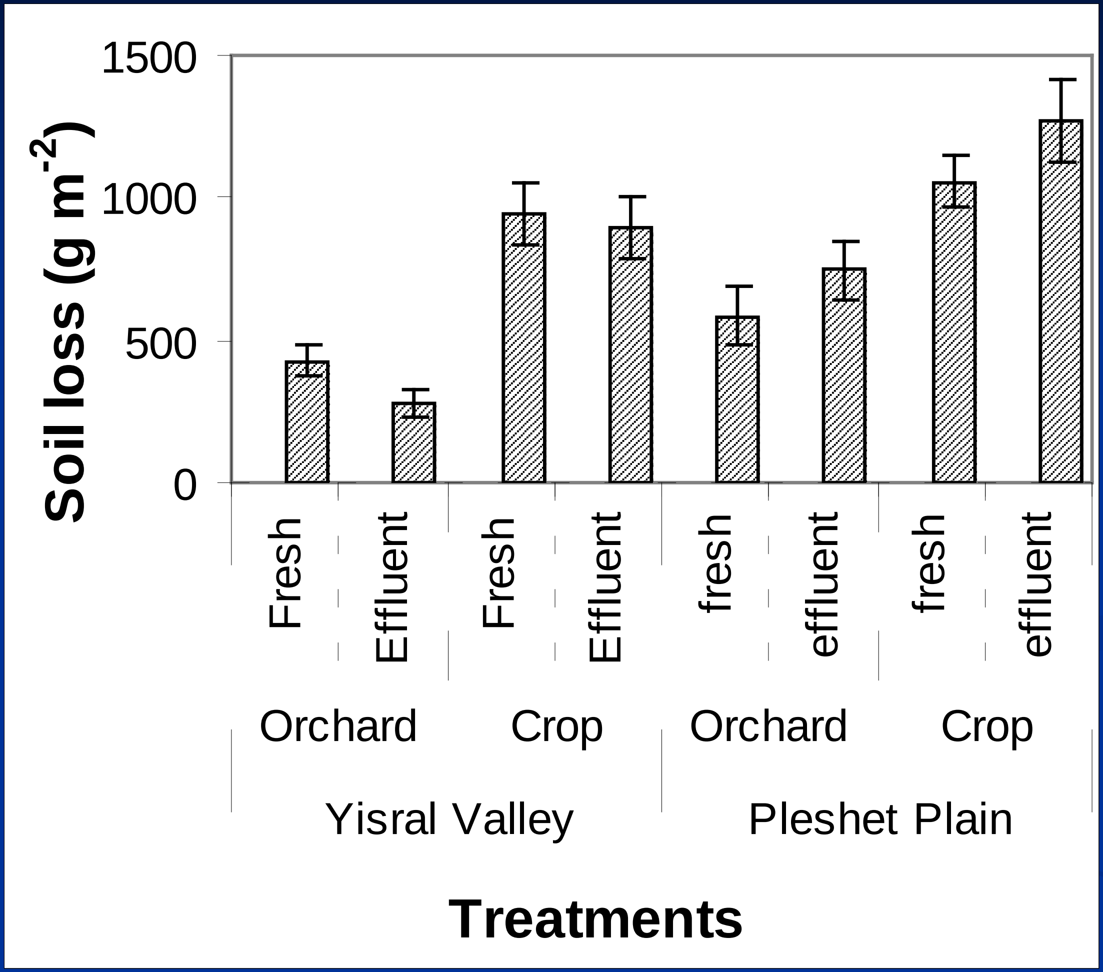


TWW- treated waste water
JRW - saline–sodic water
SPW- moderately saline–sodic water

Replacing saline–sodic irrigation water with TWW, may prove beneficial in improving soil structural stability and mitigate problems associated with high levels of runoff and erosion.

Mandal et al., 2008

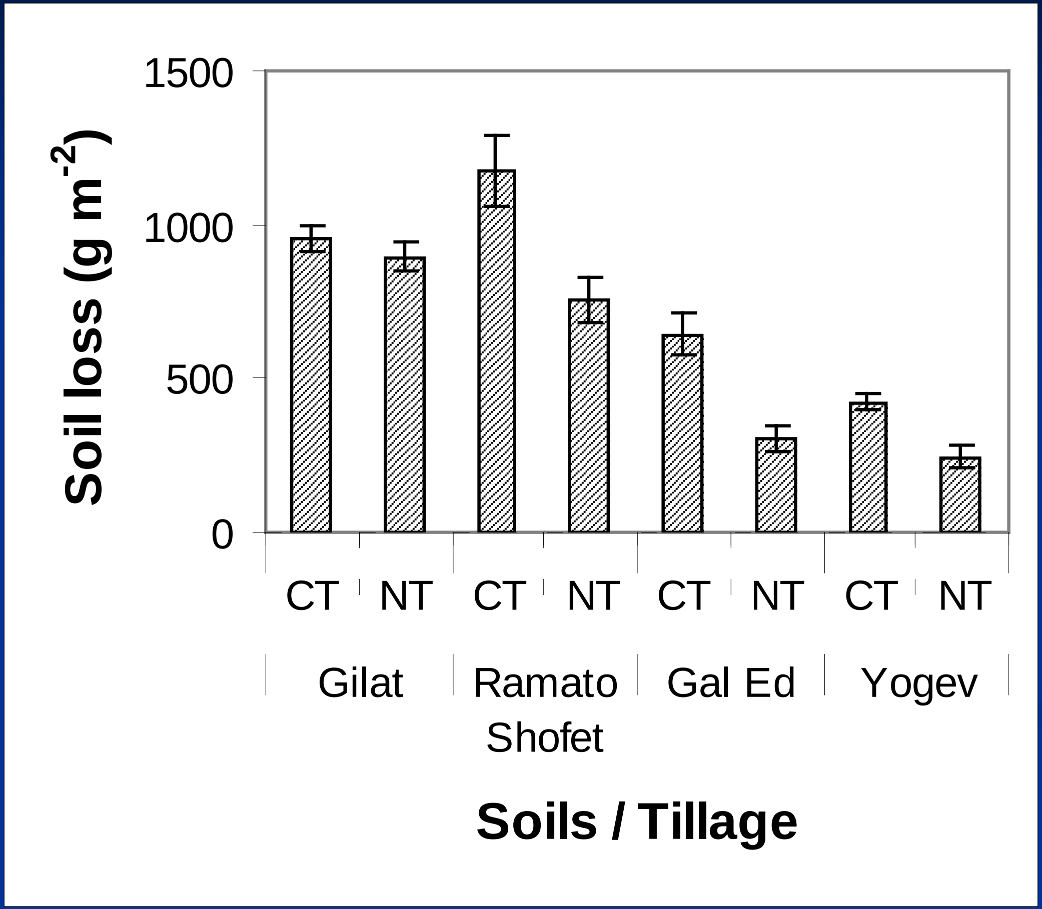
Tillage and water quality



A lower level of soil loss is noted under limited tillage (orchard) than under intensively tilled soil (field crops), irrespective of irrigation water quality.

Shainberg et al., 2003

Tillage (organic matter)



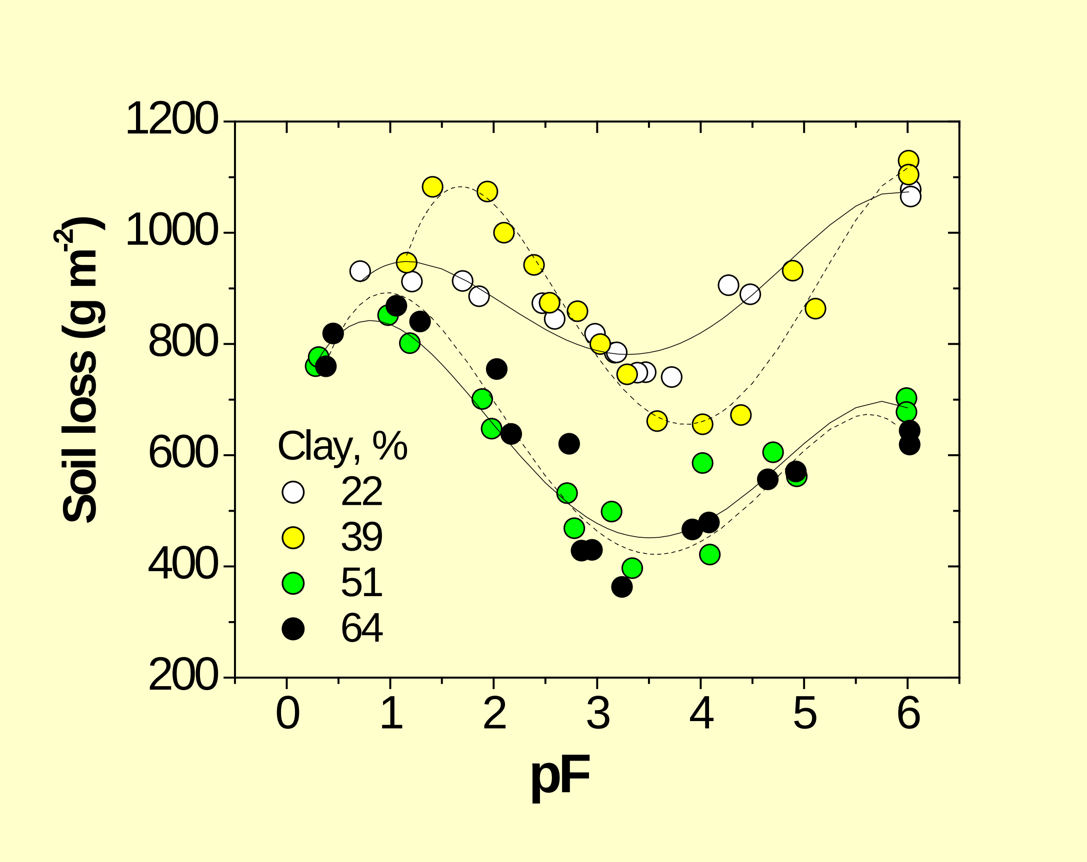
Soil structure stability and erosion do not only depend on organic matter content, but also on the conditions that prevail in the field.

OM (CT) ≤ OM (NT)

Gilat = Loam
Other soils = Clay

Shainberg et al., 2003
Norton et al., 2006

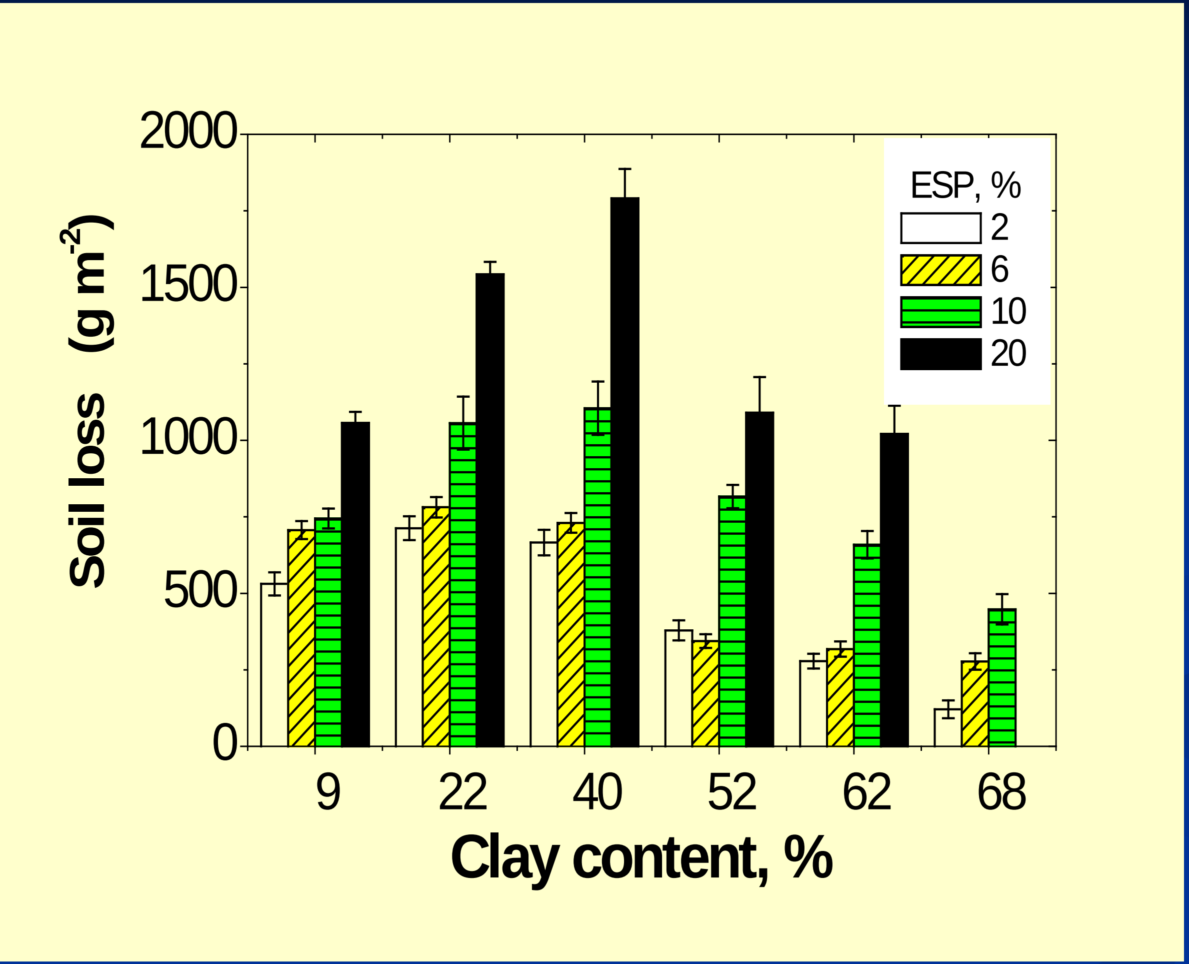
Antecedent moisture content (pF)



Soils from semi-arid regions, particularly clay soils, having moisture content in the range between wilting point and field capacity (pF 2.7-4.2), generate low levels of runoff & sediments.

Mamedov et al., 2006

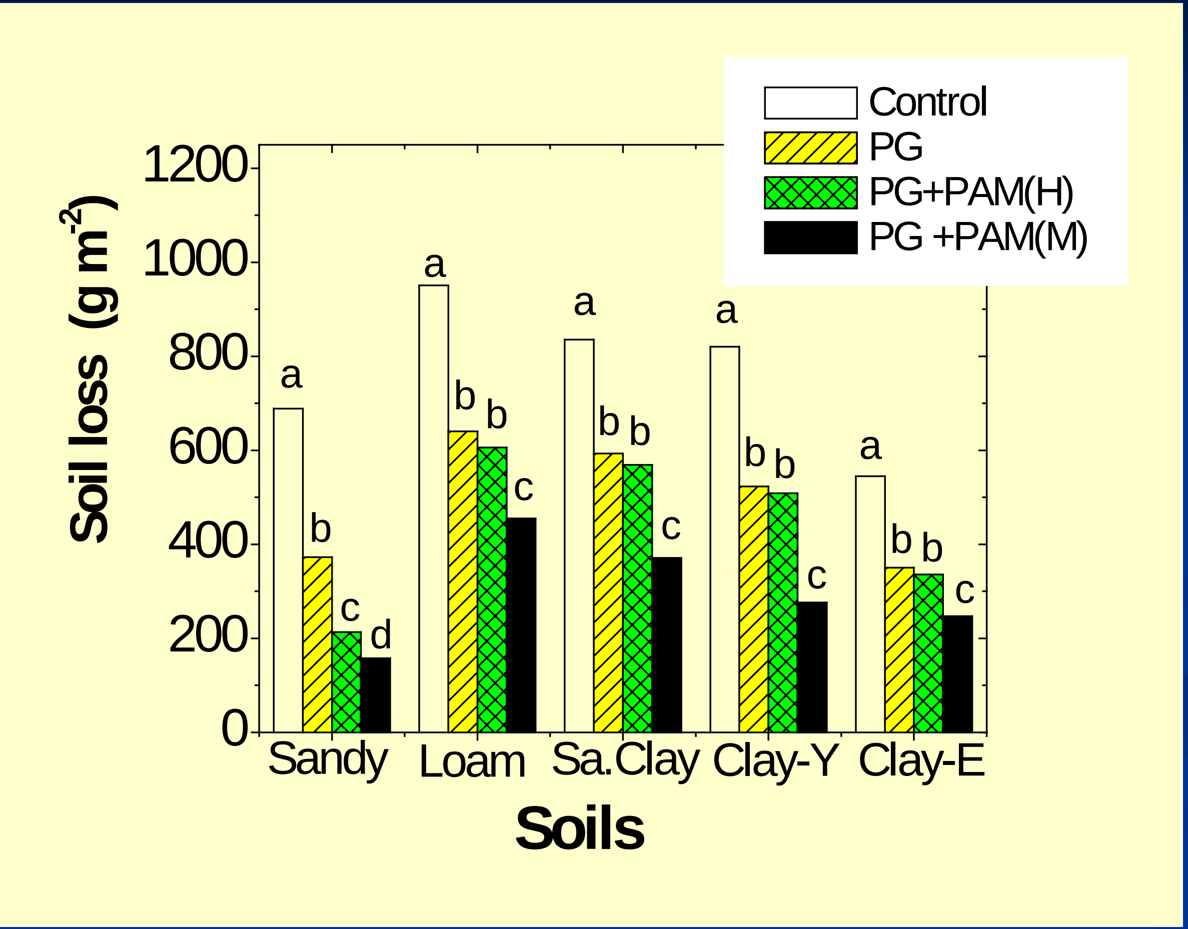
Sodicity



Soil loss increases exponentially with an increase in sodicity (ESP) with the magnitude of this effect depending on clay content.

Mamedov et al., 2002

Amendments



Application of a small amount of polymer (PAM, 20 kg/ha) in combination with gypsum (PG, 4 t/ha) may effectively decrease soil loss by 2-4 times relative to the control.

Mamedov et al., 2009

Conclusions

Our examination of published results suggests that factors and mechanisms controlling soil erosion are complex and depend on both inherent soil properties and extrinsic conditions.

Hence, in order to improve the prediction capabilities of erosion models, not only soil properties but also soil conditions prior to erosive rainstorms should be considered.

Finally, whereas inherent soil properties cannot be changed, conditions prevailing in the soil (e.g., soil WR, moisture content, impact of drop kinetic energy, etc.), can be manipulated by management practices (e.g., tillage intensity, irrigation water quality, use of amendments, etc.,) to arrive at conditions that decrease soil susceptibility to soil erosion.

Thank you for your attention !