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PREVENTIVE MEASURES OF SOIL EROSION

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Abstract: Soil erosion is one of the most important watershed processes in nature, yet quantifying it under field conditions remains a challenge. The lack of soil erosion field data is a major factor hindering our ability to predict soil erosion in a watershed. We present here the development of a simple and sensitive field method that quantifies soil erosion and the resulting particulate nutrient movements in a landscape. The method is based on the principle of the mesh-bag (MB) method that quantifies the redistribution of the eroded soil in a field. The mesh bags allow water and a negligible amount of soil particles to infiltrate the bottom mesh because they are intimately in contact with the bare soil surface. We evaluated the MB method with a runoff plot method and confirmed that soil erosion on a slope assessed by the two methods is significantly and positively correlated. The efficiency of the MB method to assess soil erosion increased with decreased slope or increased plot size. The practical upper limit of the MB method to assess total soil erosion is 15.5 t ha^{-1} (6.3 tn ac^{-1}) in 26 to 47 m^2 (280 to 506 ft^2) plots with 5% to 10% slopes and 6.5 t ha^{-1} (2.6 tn ac^{-1}) in a 35 m^2 (377 ft^2) plot with 25% slope. Mesh-bag sizes, ranging from 10 × 10 to 30 × 30 cm (3.9 × 3.9 to 11.8 × 11.8 in), had no significant effect on the amount of soil erosion assessed. The spatial and temporal patterns of soil erosion and the associated nutrient movement revealed by the MB method may provide valuable insights into the soil erosion processes in agricultural and natural lands\

Key words: Soil Erosion, a simple and sensitive field method

I. DEFINITION

Soil erosion is a naturally occurring process that affects all landforms. In agriculture, soil erosion refers to the wearing away of a field's topsoil by the natural physical forces of water and wind or through forces associated with farming activities such as tillage.

II. TYPES OF WATER EROSION

Water Erosion

The widespread occurrence of water erosion combined with the severity of on-site and off-site impacts have made water erosion the focus of soil conservation efforts in Ontario. The rate and magnitude of soil erosion by water is controlled by the following factors:

Rainfall and Runoff

The greater the intensity and duration of a rainstorm, the higher the erosion potential. The impact of raindrops on the soil surface can break down soil aggregates and disperse the aggregate material. Lighter aggregate materials such as very fine sand, silt, clay and organic matter are easily removed by the raindrop splash and runoff water; greater raindrop energy or runoff amounts are required to move larger sand and gravel particles.

Soil Erodibility

Soil erodibility is an estimate of the ability of soils to resist erosion, based on the physical characteristics of each soil. Texture is the principal characteristic affecting erodibility, but structure, organic matter and permeability also contribute. Generally, soils with faster infiltration rates, higher levels of organic matter and improved soil structure have a greater resistance to erosion. Sand, sandy loam and loam-textured soils tend to be less erodible than silt, very fine sand and certain clay-textured soils.

Tillage and cropping practices that reduce soil organic matter levels, cause poor soil structure, or result in soil compaction, contribute to increases in soil erodibility. As an example, compacted subsurface soil layers can decrease infiltration and increase runoff. The formation of a soil crust, which tends to "seal" the surface, also decreases infiltration. On some sites, a soil crust might decrease the amount of soil loss from raindrop impact and splash; however, a corresponding increase in the amount of runoff water can contribute to more serious erosion problems.

Past erosion also has an effect on a soil's erodibility. Many exposed subsurface soils on eroded sites tend to be more erodible than the original soils were because of their poorer structure and lower organic matter. The lower nutrient levels often associated with subsoils contribute to lower crop yields and generally poorer crop cover, which in turn provides less crop protection for the soil.

Cropping and Vegetation

The potential for soil erosion increases if the soil has no or very little vegetative cover of plants and/or crop residues. Plant and residue cover protects the soil from raindrop impact and splash, tends to slow down the movement of runoff water and allows excess surface water to infiltrate.

The erosion-reducing effectiveness of plant and/or crop residues depends on the type, extent and quantity of cover. Vegetation and residue combinations that completely cover the soil and intercept all falling raindrops at and close to the surface are the most efficient in controlling soil erosion (e.g., forests). Partially incorporated residues and residual roots are also important as these provide channels that allow surface water to move into the soil.

Tillage Practices

The potential for soil erosion by water is affected by tillage operations, depending on the depth, direction and timing of plowing, the type of tillage equipment and the number of passes. Generally, the less the disturbance of vegetation or residue cover at or near the surface, the more effective the tillage practice in reducing water erosion. Minimum till or no-till practices are effective in reducing soil erosion by water.

Tillage and other practices performed up and down field slopes creates pathways for surface water runoff and can accelerate the soil erosion process. Cross-slope cultivation and contour farming techniques discourage the concentration of surface water runoff and limit soil movement.

Bank Erosion

Natural streams and constructed drainage channels act as outlets for surface water runoff and subsurface drainage systems. Bank erosion is the progressive undercutting, scouring and slumping of these drainage ways. Poor construction practices, inadequate maintenance, uncontrolled livestock access and cropping too close can all lead to bank erosion problems.

III. EFFECTS OF WATER EROSION

On-Site

The implications of soil erosion by water extend beyond the removal of valuable topsoil. Crop emergence, growth and yield are directly affected by the loss of natural nutrients and applied fertilizers. Seeds and plants can be disturbed or completely removed by the erosion. Organic matter from the soil, residues and any applied manure is relatively lightweight and can be readily transported off the field, particularly during spring thaw conditions. Pesticides may also be carried off the site with the eroded soil.

Off-Site

The off-site impacts of soil erosion by water are not always as apparent as the on-site effects. Eroded soil, deposited down slope, inhibits or delays the emergence of seeds, buries small seedlings and necessitates replanting in the affected areas. Also, sediment can accumulate on down-slope properties and contribute to road damage. Sediment that reaches streams or watercourses can accelerate bank erosion, obstruct stream and drainage channels, fill in reservoirs, damage fish habitat and degrade downstream water quality

Soil Surface Roughness

Soil surfaces that are not rough offer little resistance to the wind. However, ridges left from tillage can dry out more quickly in a wind event, resulting in more loose, dry soil available to blow. Over time, soil surfaces become filled in, and the roughness is broken down by abrasion. This results in a smoother surface susceptible to the wind. Excess tillage can contribute to soil structure breakdown and increased erosion

Climate:

The speed and duration of the wind have a direct relationship to the extent of soil erosion. Soil moisture levels are very low at the surface of excessively drained soils or during periods of drought, thus releasing the particles for transport by wind. This effect also occurs in freeze-drying of the soil surface during winter months. Accumulation of soil on the leeward side of barriers such as fence rows, trees or buildings, or snow cover that has a brown colour during winter are indicators of wind erosion.Also, soil nutrients and surface-applied chemicals can be carried along with the soil articles, contributing to off-site impacts. In addition, blowing dust can affect human health and create public safety hazards.

IV. CONTROL METHODS

Crop rotation

Crop rotation is the practice of growing a series of dissimilar or different types of crops in the same area in sequenced seasons. It helps in reducing soil erosion and increases soil fertility and crop yield.Crop rotation gives various nutrients to the soil. A traditional element of crop rotation is the replenishment of nitrogen through the use of green manure in sequence with cereals and other crops. Crop rotation also mitigates the build-up of pathogens and pests that often occurs when one species is continuously cropped, and can also improve soil structure and fertility by alternating deep-rooted and shallow-rooted plants. Crop rotation is one component of polyculture.

Erosion Control Methods

Erosion control methods aim to protect the soil surface and prevent soil particles from being dislodged by wind or water. Often featuring biodegradable or natural materials, these methods will help facilitate a natural environment that will allow for plants to take root.

Sediment Control Methods:

These methods help to remove soil particles after they've been dislodged, typically through settling, containment or filtration.

V. CONCLUSION

Soil erosion remains a key challenge for Ontario agriculture. Many farmers have already made significant progress in dealing with soil erosion problems on their farms. However, because of continued advances in soil management and crop production technology that have maintained or increased yields in spite of soil erosion, others are not aware of the increasing problem on farmland. Awareness usually occurs only when property is damaged and productive areas of soil are lost.

The increase in extreme weather events predicted with climate change will magnify the existing water and wind erosion situations and create new areas of concern. Farmland must be protected as much as possible, with special attention to higher risk situations that leave the soil vulnerable to erosion.

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