TURKEY SOIL EROSION ESTIMATION MODEL - TURTEM

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– A PROGRAM TO ASSIST IN THE SELECTION OF MANAGEMENT PRACTICES TO REDUCE EROSION

The computer program TURTEM

(Turkey Soil Erosion Estimation Model)

has been developed to allow the prediction of soil erosion by rainfall

- TURTEM uses the procedures of the Universal Soil Loss Equation (USLE) to predict average annual soil losses due to sheet and rill erosion. TURTEM makes recommendations on ways to reduce soil loss by way of changes to land and cover management practices.

- TURTEM uses methot for calculating the effect of slope stepness and slope lenght from revised USLE (RUSLE) and subfactors for prior land use, crop canopy cover, crop residue cover and surface roughness to estimate the crop management factor for annual crop.

- TURTEM performs all necessary calculations except R factor and only requires information relating to the location, soil type, topography, land use and crop management at a site.

- TURTEM compares the predicted soil loss with target levels and attemts to make recommendations on appropriate changes to land management or crop management.
- The program is run under Windows and was programmed with Visual Basic language.

- The Universal Soil Loss Equation is designed to predict the long term average annual Soil Loss in from specified land units in specified cropping and management systems.

- The origin and aplication of the USLE are described by Wischmeier and Smith (1978) in Agriculture Hand book No: 537, (AH 537).

- Since publication of AH 537, additional research and experience have resulted in improvements including a subfactor approach for evaluating the cover and management factor for cropland, rangeland and disturbed areas: a new equation to reflect slope lenght and steepness and new conservation practice values for both cropland and rangeland. These changes together with a computer program to assist with computation have been released in the United States as the revised Universal Soil loss equation or RUSLE (Renard et al., 1993).

- Development of a new generation of water erosion prediction technology is under way with the USDA water Erosion Prediction Project (WEPP) (Foster and Lane,1987).

USLE EROSION RESARCH IN TURKEY

- Usle studies of various durations have been carried out on 11 General Directorate of Rural Services (GDRS) Resarch stations. Measurements have been : Rainfall (intensity and amount), runoff (total only). Treatments applied in most studies have included studies of slope lenght and steepness, tillage orientation and cropping effects on erosion, giving assessment of not only K but also of L,S,C,P factors.

- The Universal Soil Loss Equation (USLE) is designed to predict the long term average annual soil loss in runoff from specified land units in specified cropping and management systems. It was originally developed in the United States of America (US) for areas east of the Rocky Mountains. It is based on data from more than 10000 years of erosion plot studies in the US. Equation is:
- A = R K L S C P

where;

- A is average annual soil loss,
- R is the rainfall erosivity factor,
- K is the soil erodibility factor,
- L is a slope length factor,
- S is the slope steepness factor,
- C is the crop and cover management factor dependent on the crop and its management, and
- P is the support practice factor describing effects of erosion control practices such as contour tillage and bank systems.

RAINFALL EROSIVITY (R) FACTOR

The R factor is obtained by selecting a location from a choice of 60 meteoroloical stations as published by Dogan (1987). The user has the option of entering a known R factor. The seasonal distribution of erosive rain is selected if and when a C factor is to be calculated using subfactors.

Two options are available for determining the value of R:

a. R value is known

b. Choosing from list

SOIL ERODIBILITY (K) FACTOR

Soil erodobility is a measure of the susceptibility of the soil to erosion. In the USLE it is a quantitative value experimentally determined. For a particular soil, it is the rate of of soil loss per erosion index as measured on a unit plot maintained under continious bare fallow.

Three option are available for determining the value of K:

a. K value is known

b. Choosing from list

c. Laboratory Analysis

TOPOGRAPHIC (LS) FACTOR

Slope length and slope gradient have substantial effects on soil erosion by water. The two effects are represented in the USLE by the slope length factor (L) and slope steepness factor (S).

TURTEM accepts slope steepness as either a gradient (in percent) or as a slope angle (degrees).

TURTEM accepts slope lenghts between 1 to 300 metres depending on slope grade.

COVER AND CROP MANAGEMENT (C) FACTOR

The C factor in the USLE measures the combined effect of all the interrelated cover and crop management variables.

It is defined as the ratio of soil loss from land maintained under specified conditions to the corresponding loss from continious tilled bare fallow.

The value of C is usually expressed as an annual value for a particular cover and crop management system.

Three options are available for determining the value of C:

a. C value is known

b. Choosing from list

c. Calculation

SUPPORT PRACTICE (P) FACTOR

The P factor represents the effect of erosion control practices such as contour cultivation and bank systems. By definition, the value of P will be 1 for soils which are cultivated up and down the slope. Contour cultivation is the most effective in terms of reducing erosion and produces the smallest value of P. Bank systems are very effective at trapping eroded sediment and reducing the off-site effects of soil erosion. Five options are available for determining the value of P:

a. P value is known

b. Cultivation up and down the slope

c. Cultivation around-the-paddock

d. Cultivation on the contour

e. Bank System

Alternative Management Practices

A good soil management program can help control soil and water erosion.

Each soil erosion problem is unique requiring selection of erosion control practices which best suit the situation.

A balance of farming practices, cropping systems, and conservation methods that works best for each problem can be found.

Erosion control practices can be grouped under three categories

- 1. Conservation Tillage
- 2. Conservation Cropping
- 3. Conservation Surface Drainage

1. Conservation Tillage

- conservation tillage leaves as much residue on or close to the soil surface as possible to help reduce erosion and maintain the stability of the soil
- the major functions of the residue are:
- to partially protect soil from impact of rainfall, thereby preventing detachment of soil particles from the surface layer
- to act as a barrier against wind and water erosion
- to increase organic matter content, thereby stabilizing the soil
- to promote infiltration of surface water into the soil

Conservation tillage practices include:

a. optimum timing of tillage

b. optimum direction of tillage

c. reduced depth of tillage

d. minimum number of tillage passes

e. best choice of primary tillage machinery

1.a Optimum Timing of Tillage

The time chosen to till a field can affect the erodibilty of the soil and the condition of the seedbed. Tillage should be done when the soil is relatively dry and primary tillage should be left until the spring.

Advantages: Primary tillage in spring leaves residue on or close to the soil surface for as long as possible, helping to control erosion. Tillage when the soil is relatively dry may reduce compaction and increase water infiltration.

Disadvantages: If tillage is done only in the spring, labour requirements during that period may increase. if tillage is left until spring, planting may be delayed.

Comments

The soil is at the optimum moisture level for tillage if it crumbles easily when rolled between the hands. The optimum timing of primary tillage varies with the type of soil. Sands, gravely loams, and loamy sands should be tilled only in spring. Loams and silt loams should be tilled in the spring taking into consideration that as the clay content increases better yields may occur with fall tillage. Clay loams and clay should be tilled in the fall. Secondary tillage should be left until just before planting.

1.b Optimum Direction of Tillage

Sloping or rolling land is susceptible to erosion. Tillage across the slope or on the contour will help reduce erosion by forming furrows which provide a resistance to soil and water movement.

Advantages: Helps control erosion by: decreasing the speed and volume of surface runoff, aiding the infiltration of water, diverting water laterally into drainage channels.

Disadvantages: May require a change in field layout. Turning and driving time may be increased.

Comments: If field has a number of slopes and contour tillage is impractical, tillage should be done across the longest and steepest slope. If using a moldboard plough, furrows should be turned uphill.

1.c Reduced Depth of Tillage

Reduced tillage depth reduces the erodibility of the soil.

Advantages: Helps control erosion by: Leaving more residues on or close to the soil surface. Reducing the amount of unstable subsoil exposed at the surface. Less implement draught and therefore less energy required.

Disadvantages: Recommended shallow depth may be difficult to acheive with large machinery.

Comments: On erodible knolls and natural draws, depth should be reduced or machinery completely lifted.

1.d Minimum Number of Tillage Passes

The number of tillage passes affects the amount of soil loss due to erosion. Each pass breaks down soil aggregates and buries crop residue, increasing the soils susceptibility to erosion. Tillage should be kept to the minimum required for seedbed preparation.

Advantages: More residue is left on or close to soil surface, thereby reducing erosion. Less chance of compaction.

Disadvantages: No major disadvantage.

Comments: The minimum number of passes required to prepare a seedbed will vary with the soil texture and structure, the previous crop and the present crop.

1.e Best Choice of Primary Tillage Machine

- Tillage machines vary in keeping residue on or close to the soil surface.

Chisel Plough or Mulch Tiller: Excellent erosion control on erodible sloping soils. Leaves 50-70% of the residue on the surface. Yields are comparable to conventional tillage on coarse to medium textured soils. Unsuitable for tillage after sod crop. Additional seedbed preparation may be needed for small seeded crops.

Offset Discs or Heavy Tandem Disks : Excellent erosion control. Leaves 50-60 % of the residue on the surface. Yields are comparable to conventional tillage on coarse to medium textured soils. Unsuitable for tillage after sod crop.

Moldboard Plough : Erosion control is good if plough bottoms are 16 inch or less, often poor if bottoms are 18 inch or more in width. Residue burying action helps control pests. Most economical on some fine textured soils. Leaves dead furrows. Requires skill to operate properly.

No Till Planter: Excellent erosion control. Leaves 100% of residue on the surface. Residue conserves moisture on drought-prone soils. Yields are comparable to conventional tillage on coarse textured soils, but may be reduced on medium to fine textured soils. Pest control is required.

2. Conservation Cropping

The type and management of a crop will influence the productivity and erodibility of the soil. A good vegetative cover protects soil from erosion by dissipating the energy of wind and water and the root system stabilizes the soil. A field placed in the same crop year after year will lose its ability to maintain that crop. Productivity is partially restored by the addition of fertilizer, but proper crop selection and management is the best long-term solution, especially in terms of soil structure. Conservation cropping practices include:

a. Optimum direction of cropping

b. Stripcropping

c. Cover cropping

d. Crop rotation

e. Field border management

2.a Optimum Direction of Cropping

Sloping fields should be worked and planted across slope.

Advantages: Helps control erosion by: Decreasing the speed and volume of surface runoff. Aiding infiltration of water into the soil. Diverting water laterally into drainage channels.

Disadvantages: May require a change in field layout. Turning and driving time may increased.

Comments: If a field has a number of slopes and it is impractical to plant on the contour, planting should be done across the major slope; this direction should be followed on the remainder of the field.

2.b Stripcropping

Stripcropping will help control erosion on slopes prone to water erosion and on fields susceptible to wind erosion. Stripcropping consists of a series of alternate strips of forage or cereal crop and a row crop. The number and width of forage or cereal strips should be equal to or greater than the number and width of row crop strips.

Advantages: The forage or cereal crop helps control erosion by: Decreasing the velocity of water and wind. Trapping sediment from the row crops. Providing organic matter, thereby stabilizing soil particles and increasing the soil's ability to absorb water. Can increase yields by improving soil fertility, moisture, and tilth.

Disadvantages: Inconvenience of laying out strips. Must be a use or market for alternate crop.

Comments: Stripcropping is most effective in controlling erosion on long uniform slopes when the strips are placed along the contour of the field. Stripcropping is most effective on fields exposed to the wind if the strips are arranged at right angles to the prevailing wind. Working widths of farm equipment should be kept in mind, this will assist in choosing a convenient width for the strips. An even number of passes should be made per strip so that farm. Equipment will finish up at the starting end of the strip. Rotating the forage or cereal strips in subsequent years will improve. The condition of the soil. Before planting, it is important to ensure that there is no critical level of residual herbicide in the soil where strips of cereal or forage crops are to be established.

2.c Cover Cropping

Bare soil is susceptible to erosion. A cover crop such as red clover, winter wheat, or winter rye provides vegetative cover for fields that would otherwise be left bare over the winter.

Advantages: Vegetative cover functions similar to residue in controlling erosion. The root system and the organic matter stabilize soil particles. A legume cover crop provides nitrogen for the next crop. Crop residues can conserve moisture on soils prone to drought.

Disadvantages: May delay spring planting if crop residue delays drying of fields. May require a change in herbicide management. May increase insecticide requirements for next crop.

Comments: 1 tonne of red clover, on dry matter basis at plough-down, may contain 25 kg of nitrogen for succeeding crops.

2.d Crop Rotation

Planting the same crop year after year leads to reduced yields, difficulty preparing a good seedbed, slow drainage, crusting problems, and increased spring erosion. Rotating row crops is better than continuous cropping, but cereal or perennial forages should be included in the rotation for increased benefits.

Advantages: Winter cereals and forage crops provide vegetative cover during winter and early spring runoff. Cereal and forage crops included in rotations improves soil structure. Rotations reduce the buildup of insect and disease problems associated with continuous cropping. Legumes provide the soil with nitrogen.

Disadvantages: May require the purchase of additional machinery. Must be a use or market for alternate crops.

2.e Field Border Management

A field border is a cereal or forage crop planted on the perimeter of a row crop. Generally, field borders are the same width as the headlands and are part of the regular crop rotation schedule.

Advantages: Provides excellent vegetative cover and root systems, thereby controlling erosion. Can often filter out soil before it is transported from fields. Can aid in keeping the banks of adjacent drains and streams intact. Provides a protected turning area. Can reduce compaction problems on headlands.

Disadvantages: Care must be taken in herbicide management to prevent crop damage. May not fit in with crop needs and machine availabilty.

3. Conservation Surface Drainage

Conservation tillage and cropping practices help control erosion but their effectiveness may be limited by the presence of surface drainage problems. Some of these problems may be solved by the installation of tile drainage systems. In other cases, conservation surface drainage is needed to safely remove surface water while minimizing the amount of soil lost.

Conservation surface drainage includes:

a. Grassed waterways

b. Drop inlet catchbasins

c. Rock chutes

3.a Grassed Waterways

Grassed waterways are broad, shallow, vegetated channels that are designed to convey runoff from open fields to a drainage outlet. Grassed waterways can be constructed on any field where a concentration of runoff or rill damage is evident.

Advantages: Prevent rill and gully erosion by safely conveying water off fields. Machinery can traverse the waterway. Forage crops can be grown and harvested on the waterway. Easily maintained. Protects subsurface drainage tiles.

Disadvantages: Requires special attention during tillage and planting operations. Should only be crossed under dry conditions. Care is required when spraying herbicides to prevent sod kill in the waterway.

3.b Drop Inlet Catchbasins

Drop inlet catchbasins may be used to divert surface water flow underground through a tile to a satisfactory outlet.

Advantages: Helps prevent rill erosion by reducing the speed and dissipating the energy of the flowing water. Decreases the amount of sediment entering a watercourse.

Disadvantages: May cause slight inconvenience to field operations if located within the field. Regular maintenance inspections for sediment accumulation are required.

3.c Rock Chutes

Rock chutes are structures designed to carry surface water down a short, steep slope with a minimum of erosion. Rock chutes may be constructed as outlets for grassed waterways, along watercourses where concentration of surface runoff entering a watercourse causes gullying of the banks, or at locations along flow paths where there is an abrubt change in grade.

Advantages: Prevents rill and gully erosion by dissipating the energy of the flowing water. Simple design is inexpensive and works effectively. Requires little maintenance. Provides practical use for field stone of sufficient size.

Disadvantages: May cause slight inconvenience to field operations.