ANNALS OF THE FACULTY OF ENGINEERING HUNEDOARA
2006, Tome IV, Fascicole 3, (ISSN 1584 – 2673)
FACULTY OF ENGINEERING HUNEDOARA,
5, REVOLUTIEI, 331128, HUNEDOARA

SOIL CONSERVATION TECHNIQUES FOR DIMINISHING THE WATER EROSION IN THE AGRICULTURAL LAND IN BULGARIA

Peter DIMITROV, Hristo BELOEV

INSTITUTE OF SOIL SCIENCE-SOFIA, BULGARIA
UNIVERSITY OF ROUSSE, BULGARIA

ABSTRACT:
Over 80% of the agricultural land in the Republic of Bulgaria is to some extent subjected to soil water erosion. It causes huge loss and this called for devising and testing several field management erosion control methods and techniques as well as a system of machinery for performing the above activities at Nickola Pushkarov Institute on Soil Science in Sofia and Angel Kanchev University of Ruse.
The present report deals with the characteristic peculiarities and technological requirement for applying them as well as some data obtained from the research work carried out with them which prove their field management, erosion control and technical efficiency.

KEYWORDS:
soil water erosion, erosion control methods, erosion control and technical efficiency

1. INTRODUCTION

Over 80% of the agricultural land in the Republic of Bulgaria is subjected to some extent to soil water erosion.
The loss it causes to the national economy consists in:

- washing out the soil humus horizon;
- decreasing the soil thickness;
- destroying the soil structure;
- deteriorating the water-and-physical qualities of the soil;
- loss in soil fertility;
- rapid decrease in the yields of the grown agricultural crop.

Various field management practices incorporating erosion control methods and techniques are applied for soil and soil fertility conservation. Several erosion control field management methods and techniques as well as a system of machinery for effecting them have been devised, tested and introduced at Nickola Pushkarov Institute on Soil Science in Sofia and Angel Kanchev University of Ruse.

The most efficient ones applied in Bulgaria are:

- soil-breaking with dead-furrowing;
- inter-row erosion control tillage combined with furrowing, soil-breaking and dead-furrowing;
- inter-row erosion control tillage and sowing hoed crops on slopes;

- vertical mulching;
- inter-row erosion control tillage along the slope;
- erosion control technique for growing wheat on slopes;
- erosion control technique for growing corn on slopes.

2. EXPOSITION

When applied the above-mentioned field management methods and techniques for water erosion control in agricultural land as well as the specialized machinery for accomplishing them are characterized by the following features and special requirements.

Soil-breaking with dead-furrowing is an erosion control field management method performed on meadows, pastures, with broadcast crops and at deep plowing on slopes with gradient of 10°. It is carried out through a Russian breaker–dead furrower SHTN-2-140, shown in Fig.1.and is coupled to tractors of towing capacity class 3.0 (DT-75M, T-150K, etc.)

The gist of this method lies in drawing cuts of particular size on the soil surface and into its depth transversely to the gradient of the slope. The cuts have subsoil dead-furrows (canals) at the bottom as the latter are parallel to the soil surface.

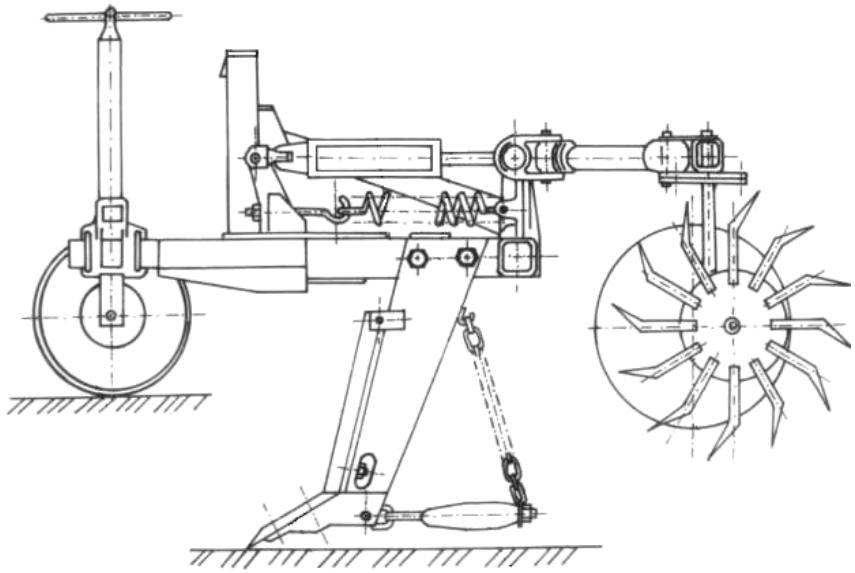

FIGURE 1. A breaker–dead furrower SHTN-2-140

The method is carried out in two versions:

- **First version**

Cutting transversely to the gradient of the slope with dead-furrowing, at deep autumn plowing, in winter or in early spring (Fig.2)

- **Second version**

Cutting with dead-furrowing in fields with broadcast agricultural crops, meadows and pastures, in winter, at shallow frozen soil (0.05-0.08m), transversely to the gradient of the slope (Fig.3).

FIGURE 2. Cuts at deep plowing

FIGURE 3. Cuts in a wheat sown field

The results from the tests carried out for the two versions in accordance with the method of ***soil-breaking with dead-furrowing*** show:

- Soil-breaking at deep plowing, at a depth of 0.4m and at 5 m interspacing decreases the surface water runoff by 1.5 to 2.3 times and the eroded soil by 1.6 to 3.1 times compared to the fields in which soil-breaking was not applied;
- Soil-breaking in wheat sown fields, at a depth of 0.4m and at 10 m interspacing decreases the surface water runoff by 1.3 to 16.3 times and the quantity of the eroded soil by 7.8 to 26.9 times compared to the fields in which soil-breaking was not applied. The yield in the wheat sown fields increases by 14.9% (693kg/ha).

Erosion control inter-row tillage with furrowing, soil-breaking and dead-furrowing is yet another soil conservation method which incorporates soil-breaking with dead-furrowing simultaneously with the standard operations for inter-row tillage of hoed crops in two versions:

- hoeing and soil-breaking with dead-furrowing;
- furrowing (ridging) and soil-breaking with dead-furrowing.

The first version of this method is performed by a special equipment mounted on the working sections of the cultivator for inter-row tillage (KRN and KNP) which is shown in Fig.4. It has been patented by a panel of authors from Nickola Pushkarov Institute on Soil Science in Sofia and Angel Kanchev University of Ruse.

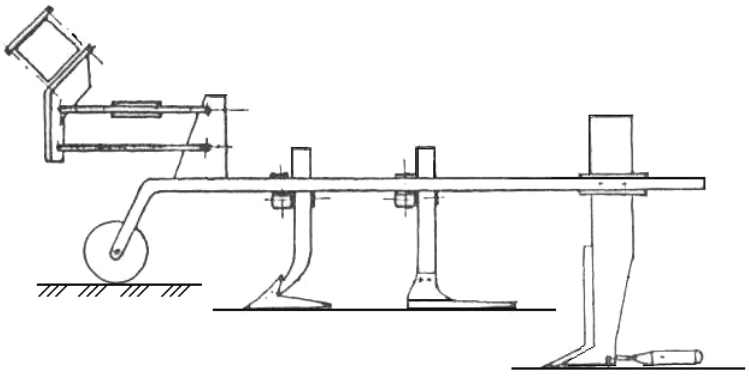

FIGURE 4. An equipment for hoeing, soil-breaking and dead-furrowing

The second version of the method is performed by an equipment which represents a combination of furrowing (ridging), soil-breaking and dead-furrowing tools mounted in explicit succession on the working sections of the cultivator for inter-row tillage which can be seen in Fig.5.

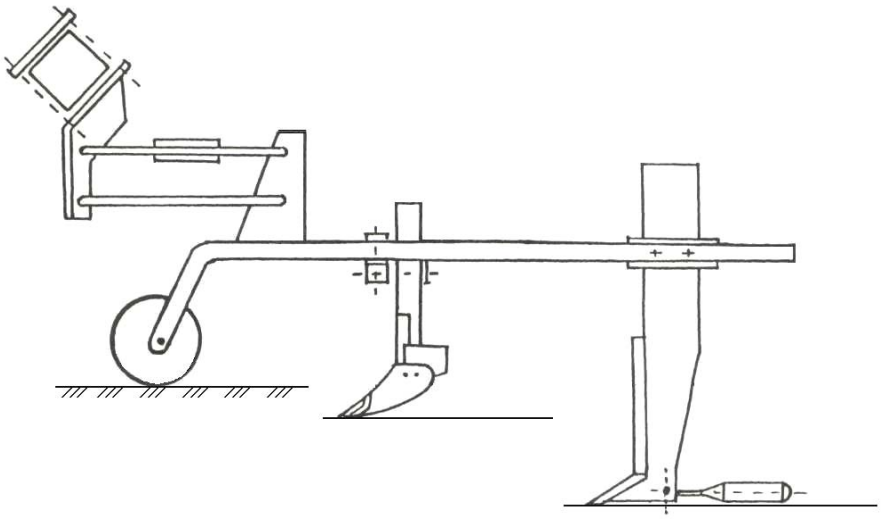

FIGURE 5. An equipment for furrowing, soil-breaking and dead-furrowing

This equipment has been acknowledged by the Bulgarian Agricultural Academy as an established scientific product for introduction on a large scale.

The suggested combination of tools carries out the inter-row tillage transversely to the slope and the soil-breaking with dead-furrowing is performed in the middle of each even or odd interspacing, at a depth 2 to 4 times greater than the depth of the main operation.

This method is presented in Fig.6 and when accomplished it results in:

- Decreasing the surface water runoff by 1.5 to 4.5 times and the quantity of the eroded soil by 2 to 15 times;
- Increases moisture-holding ability and improves water-and-air and thermal conditions of the soil;
- Increases corn yield by 15 to 22% in non-irrigated and by 30% in irrigated conditions;
- Soil fertility conservation.

FIGURE 6. Furrowing, soil-breaking and dead-furrowing in corn sown field

The method of inter-row erosion control tillage and sowing hoed crops on slopes is a soil conservation method and its gist lies in the simultaneous and transverse sowing of hoed crops in rows and soil-breaking with dead-furrowing in the interspacing formed thereof.

This method is carried out by a special equipment (Fig.7), patented by Nickola Pushkarov Institute on Soil Science in Sofia, which represents a row drill for hoed crops on the frame of which, between each two adjacent sections, is mounted a breaking tool with a dead-furrower attached to it.

The equipment operates transversely to the slope coupled to a tractor of towing capacity class 1.4 (UMZ-6L, TK-80), represented in Fig.8 and Fig.9 and its utilization results in:

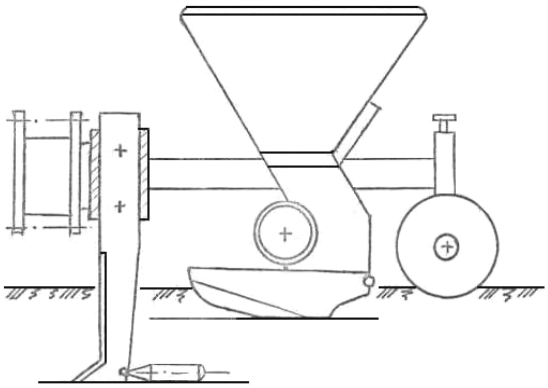

FIGURE 7. An equipment for inter-row erosion control tillage and sowing hoed crops

- Protecting the soil and the sown crop from water erosion within the period after sowing when they are the least protected from the erosion rainfalls;
- Decreasing the surface water runoff by 1.6 to 2.2 times and the quantity of the eroded soil by 3.0 to 4.5 times;
- Increasing the crop yield (corn) by 8.5% (294 kg/ha).

FIGURE 8. Performance of the equipment for inter-row erosion control tillage and sowing hoed crops

Vertical mulching is an efficient water erosion control field management method for soil conservation applied on slopes. Its essence consists in drawing cuts of particular size transversely to the slope and filling them up with crop residue of wheat straw, corn stubble, sunflower stalks and other organic materials

This method is carried out by two different equipments devised at Nickola Pushkarov Institute on Soil Science in Sofia and Angel Kanchev University of Ruse jointly.

FIGURE 9. Corn sown by applying the equipment for inter-row erosion control tillage and sowing hoed crops.

The converted breaker-dead furrower SHTN-2-140 with a mulch hopper, (Fig10) is used mainly in fields with plant residue chopped in advance.

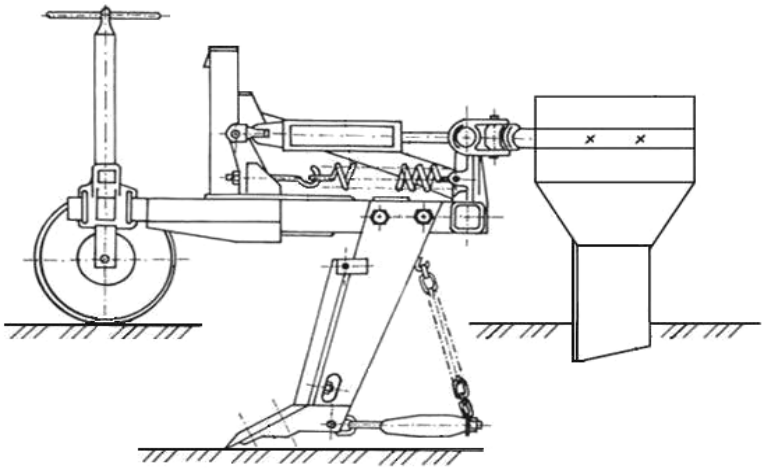

FIGURE 10. A converted breaker-dead furrower shtn-2-140 with a mulch hopper

- A combined machine for chopping plant residue and vertical mulching (Fig.11), applied in fields with plant residue in upright growing position on the roots.

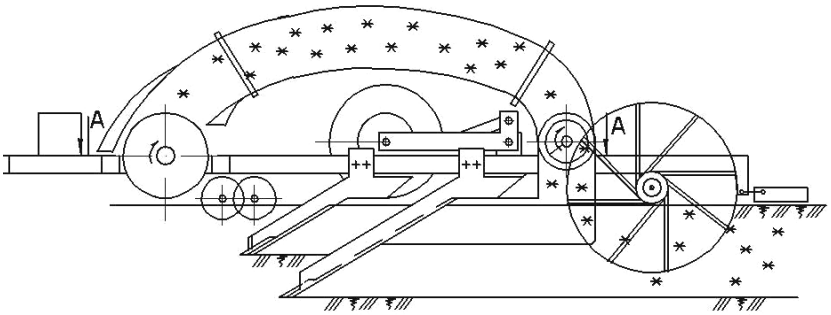

FIGURE 11. A Combined machine for chopping plant residue and vertical mulching

Applying this method on areas sown with wheat results in:

- Increase in the water permeability over 2 times;
- Decrease in the surface water runoff by 2.4 to 4.5 times and in the quantity of the eroded soil by 7.5 times on average;
- Increase in the yield of the mulched crop by 13 to15%.

The method of inter-row erosion control tillage along the slope is utilized for soil conservation at tillage along the slope in two versions:

- At primary tillage of field crops;
- At primary and inter-row tillage of orchards and vineyards

This erosion control field management method is carried out through a special equipment. It has been patented by a panel of authors from Nickola Pushkarov Institute on Soil Science in Sofia and Angel Kanchev University of Ruse. It can operate:

- Independently;
- In combination with other tillage equipment (UNKM-2.0 or UNLM-3,5).

The erosion control equipment shown in Fig.12 comprises of a frame, breaking tools, subsoil dead-furrowers mounted to the lower part of the breakers and a couple of wheels of different diameter bound by a mechanism with transmission ratio of one.

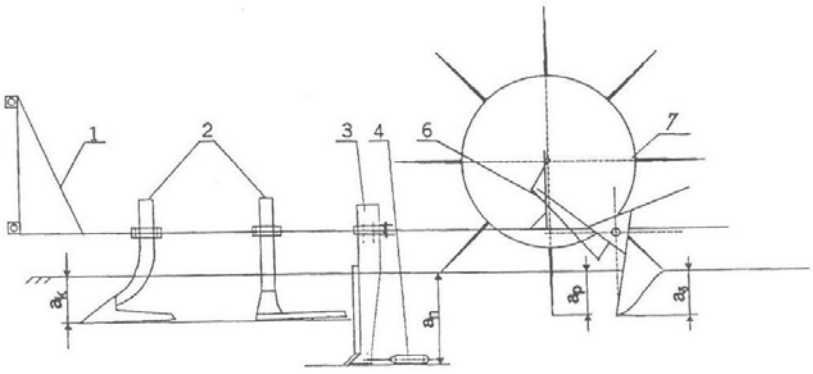

FIGURE 12. An equipment for inter-row erosion control tillage along the slope

When moving along the slope as a part of a complex machinery coupled to tractor TK-80 this equipment (Fig.13) draws interrupted longitudinal cuts with dead-furrows at their bottoms as well as transverse furrows of size 0.50/0.30m, a depth of 0.12 -0.15 m and a spacing of 1 m on the soil surface.

FIGURE 13. A complex machinery coupled to tractor tk-80 and an equipment for inter-row erosion control tillage along the slope.

At applying the method the obstacles formed by this tractor-coupled complex machinery (Fig.14) along the slope create conditions for decreasing the surface water runoff by 1.6 times on average and the quantity of the eroded soil – by 2.1 times.

FIGURE 14. Interrupted longitudinal cuts and transverse furrows formed along the slope.

Erosion control technique for growing wheat on slopes is utilized for soil conservation in non-irrigated conditions and consists of the following erosion control field management methods and tillage:

- Vertical mulching;
- Soil-breaking with dead-furrowing after plant germination in the winter:
- Performs each tillage transversely to the gradient of the slope.

The technological complex of machinery for growing wheat on slopes in non-irrigation conditions comprises of the following machines (Fig.15):

Applying this technological complex of machinery for growing wheat on slopes results in:

- Decreasing the surface water runoff by 5.8 times on average;
- Decreasing the soil erosion by 24 times on average;
- Increasing wheat grain yield by 32,3 % (by 967 kg/ha) on average and straw yield by 30,5 % (690 kg/ha).

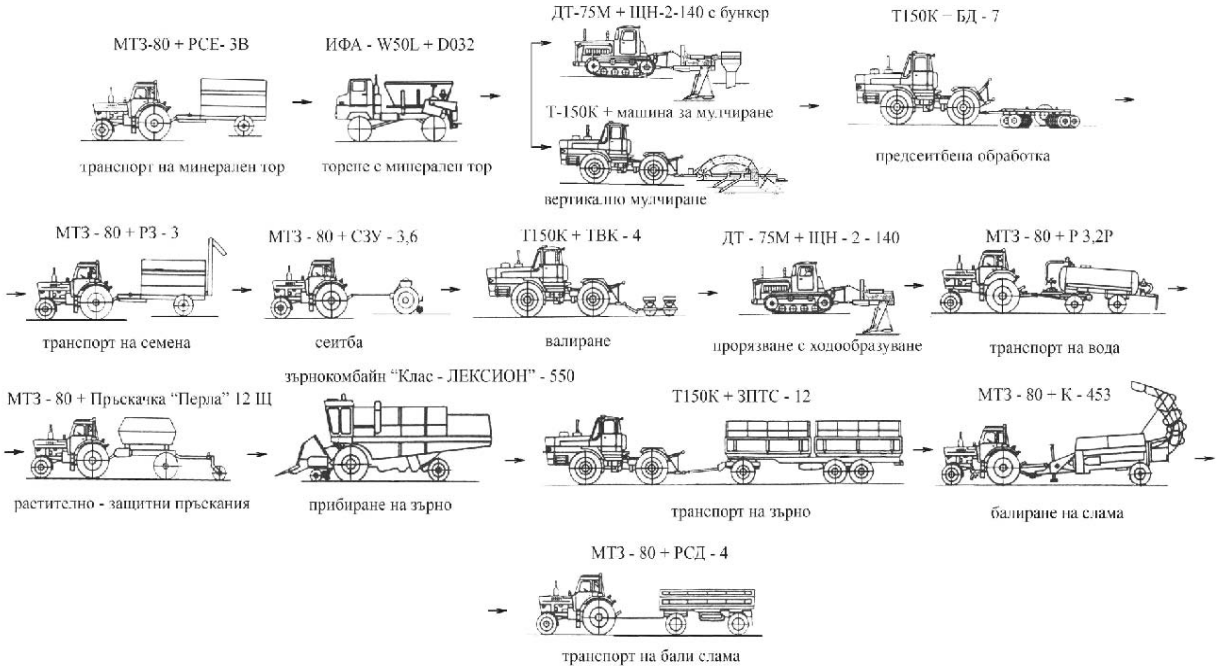

FIGURE 15. The technological complex of machinery for growing wheat on slopes

Erosion control technique for growing corn on slopes is carried out for soil conservation in non-irrigated conditions and consists of the following erosion control field management types of tillage:

- Soil-breaking with dead-furrowing at deep plowing in winter;
- Inter-row erosion control tillage and sowing hoed crops on slopes;
- Inter-row tillage (hoeing) and soil-breaking with dead-furrowing;
- Furrowing (ridging) and soil-breaking with dead-furrowing
- Carrying out each tillage transversely to the gradient of the slope.

The technological complex of machinery for growing corn on slopes in non-irrigation conditions comprises of the following equipment (Fig.16)

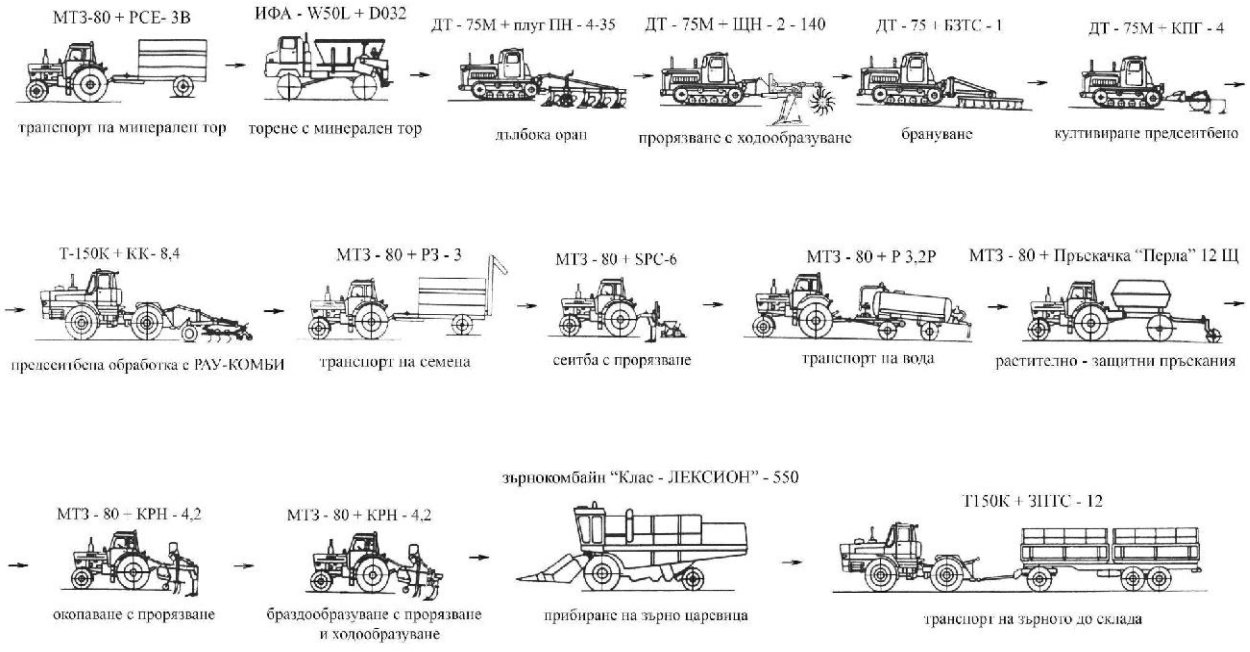

FIGURE16. The technological complex of machinery for growing corn on slopes

Applying this technological complex of machinery for growing corn on slopes results in:

- Decreasing the surface water runoff by 4 times;
- Decreasing the soil erosion by about 14 times;
- Increasing corn yield by 29,9 % (by 1048 kg/ha).

3. CONCLUSION

Introducing these erosion control field management methods and techniques as well as the specialized agricultural machinery equipment on a large scale in the agricultural farming practices in the Republic of Bulgaria would result in diminishing significantly the impact of the water soil erosion and conserving soil fertility in the country.

BIBLIOGRAPHY

[1.] Cherepanov G.G., V.M. Tchudinovskih. Soil Packing and Methods of Eliminating It. (A Review). VNIITEI Agroprom, Moscow 1987.
[2.] Daskalov J.T. Research Work on the Main Factors of Erosion Processes. Dissertation, Sofia, 1972.
[3.] Dimitrov P.D. Research Work on Soil-breaking with Dead-furrowing as an Agricultural Method for Erosion Control of Calcareous Chernozem. Dissertation, Sofia, 1994.
[4.] Zakov D. Erosion. Martilen Lts, Sofia 2001
[5.] Onchev N.G. Prognosticating Soil Water Erosion in the Republic of Bulgaria and Optimizing Erosion Control Activities. SSA, Sofia, 1983.
[6.] Wischmeier W.H. and D.D. Smith. Predicting Rainfall Erosion Losses from Cropland East of Rocky Mountains. Agriculture Handbood, № 282, 1965.