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

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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](image)

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).
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.
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.

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.
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:

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

FIGURE 7. An 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.

The converted breaker-dead furrower SHTN-2-140 with a mulch hopper, (Fig10) is used mainly in fields with plant residue chopped in advance.
• 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](image1)

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 to 15%.

**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](image2)

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.
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.

**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).
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)
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