

Effects of Soil Management for Sustainability Model in Hilly Morphological Units

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Introduction

Morphological unit Zarkovo – Bele Vode and part of Topciderska river watershed in Rakovica community are characteristic for occurrence of all the erosion phenomena in the part of the hilly region of the wider Belgrade area. The existing structure of agricultural production indicates that erosion processes in this region have narrowed and also decelerated the yield increase rate which would be possible on natural and economic conditions. In this paper the establishment is discussed of the production taking into account the conservation of land resources, the needs of the population and profitability in the case of the hilly morphological unit Zarkovo – Bele Vode (occupies 522.53 ha of agricultural land) and part of Topciderska river watershed in Rakovica community (occupies 339.63 ha of agricultural land). In this sense, agricultural, fruit and forest productions are anticipated from the aspect of soil management for sustainability, and the possibilities are given for the improvements of the production model giving better long-term economic effects.

The basic production model (model I) was developed from the aspect of soil management for sustainability, the needs of the population in this area (production lines most frequently applied in practice) and potential economic effects (Zlatic 1994). Production is primarily planned in a quantitative sense, i.e. the relations are designed between the groups within arable farming (erosion-control crop rotations) and orchard production (classical orchards, orchards with self-terracing, and orchards with classical terraces), as well as pasture and forest areas. In the qualitative sense, the lines of production as per crop species are designed. Crop rotation includes cereals like wheat and oats, root crops (corn, soya beans and sunflower) and grasses. Orchard species include apple, pear, peach, apricot, cherry, sour cherry, plum, raspberry, blackberry and walnut.

The improvements of the offered production model have been performed by establishment of the bee hiving production in two variants (I variant – production of honey as the chief product and wax, propolis, flower powder as by products; II variant – production of royal jelly as the chief product without by products).

Material and Methods

On the basis of terrain reconnaissance, at 21 sample plots of the agricultural soil in Zarkovo - Bele Vode morphological unit and 16 sample plots in the part of Topciderska River Watershed, soil losses have been estimated according to USLE erosion equation for present

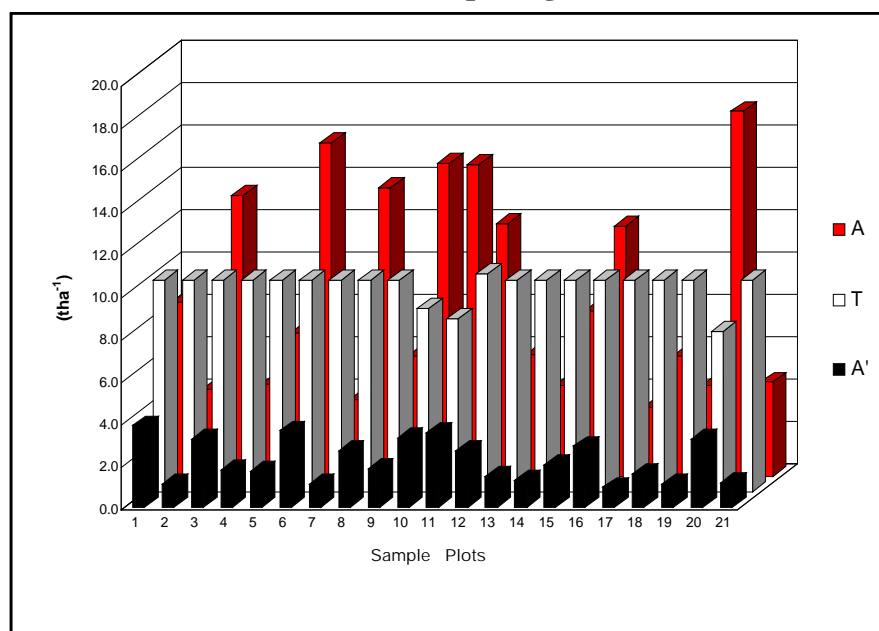
way of soil utilization, as well as for a perspective one - based upon the soil management for sustainability principles.

The assessment of the long term effects of the planned and improved models has been performed in terms of the internal rate of return (IRR), pay back period (PBP), benefit cost ratio (B/C) and net present value (NPV). A period of 15 years has been chosen for the assessment of the economic efficiency according to the average production lifetime of stone-fruit orchard species. The assessment of risk and uncertainty has been performed by sensitivity analysis of IRR and PBP taking into account draught and factors which influences modification in benefit-cost analysis. The prices have been expressed in EUR for the period May-June 2005.

RESULTS

Taking into consideration the evident previous tillage down the slope, which causes soil loss of $8,85 \text{ tka}^{-1}$ in Zarkovo - Bele Vode morphological unit and $32,02 \text{ tka}^{-1}$ in the part of Topciderska river watershed, by the proposed model of production the values of "C" (factor of land use) and "P" (factor of erosion control) in the USLE equation will be reduced several times. Thereby, decreasing the soil losses below the limits of tolerance, it would be on average amount to $2,28$ for the Zarkovo Bele – Vode and $1,74 \text{ tka}^{-1}$ for the investigated part of Topciderska river watershed.

Figure 1. Soil loss on the sample plots of the Žarkovo-Bele Vode morphological unit



Source: original

Legend:

A - Soil Loss According to Present Land Use (t ha^{-1})

T - Tolerant Soil Loss (t ha^{-1})

A' - Soil Loss According to Proposed Model of Production (t ha^{-1})

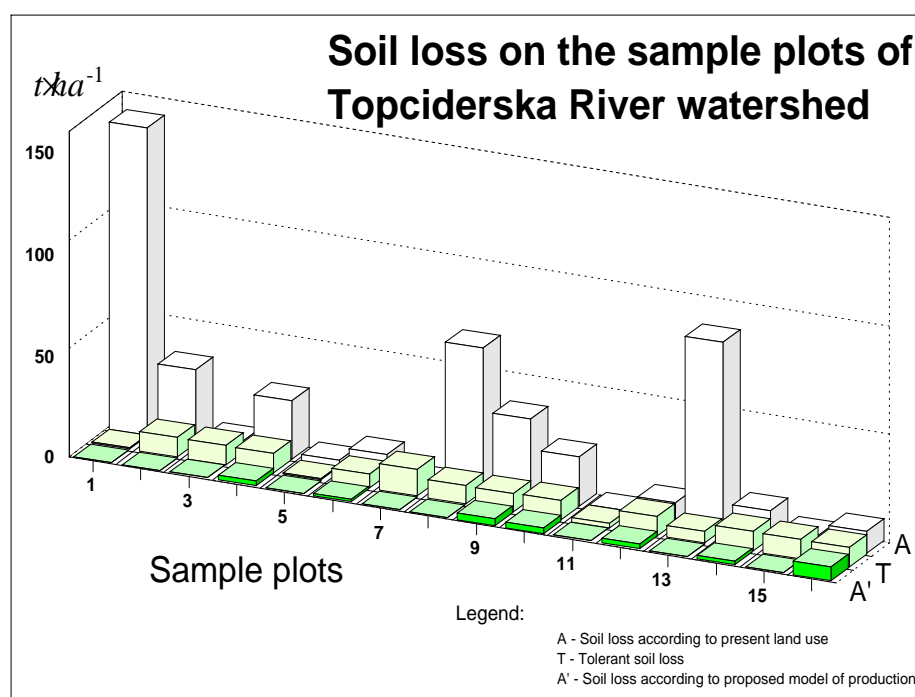


Fig. 2: Soil loss on the sample plots of the part of Topciderska River Watershed in Rakovica Community
 Source: original

The assessment of the investment efficiency, carried out by the discount methods, proves the satisfactory economic efficiency. For the Zarkovo – Bele Vode morphological unit IRR for the offered production model amounts to 18.94%, 22.50% for the improved - variant I and 22.92% for the improved - variant II production models. In all the three cases IRR is higher than the real interest rate of 12%. PBP for the offered production model amounts to 9.50 years, for the improved model - variant I amounts to 8.20 years and for the model - variant II amounts to 8 years which is under the credit return period. Benefit-Cost ratio is above 1 for all the three models, i.e. 1.28 for the planned, 1.39 for the improved - variant I and 1.40 for the improved - variant II production models. NPV for all the three models is considerably above 0, i.e. 476 500 EUR for the offered (planned), 706 500 EUR for the improved - variant I, and 727 000 EUR for the improved - variant II production models.

For the part of Topciderska river watershed IRR for the offered production model amounts to 18.10%, 21.06% for the improved - variant I and 23.63% for the improved - variant II production models. In all the three cases IRR is higher than the real interest rate of 12%. PBP for the offered production model amounts to 10.30 years (about the credit return period), for the improved model - variant I amounts to 8.20 years and for the model - variant II amounts to 8 years which is under the credit return period. Benefit-Cost ratio is above 1 for all the three models, i.e. 1.16 for the planned, 1.22 for the improved - variant I and 1.28 for the improved - variant II production models. NPV for all the three models is considerably above 0, i.e. 367 000 EUR for the offered (planned), 528 000 EUR for the improved - variant I, and 671 000 EUR for the improved - variant II production models.

One can see that the efficiency is enviable of all the three models under consideration for both morphological units. The variant with honey as the chief product also gives somewhat better economic efficiency with IRR and benefit-cost ratio than with the planned production model, and considerably higher with NPV. The improved production model with royal jelly as the chief product has given higher efficiency, significant and noteworthy for these areas.

Table1: Economic Efficiency of SLM in the *Žarkovo-Bele Vode* morphological unit

MODEL	PARAMETERS OF ECONOMIC EFFICIENCY			
	IRR (%)	PBP (years)	<i>B/C</i>	<i>NPV</i> (EUR)
Model I	18.94	9.50	1.28	476 500
Model II	22.58	8.20	1.39	706 500
Model III	22.92	8.00	1.40	727 000

Source: original

Table 2: Economic Efficiency of SLM in the part of Topciderska river watershed

MODEL	PARAMETERS OF ECONOMIC EFFICIENCY			
	IRR (%)	PBP (years)	<i>B/C</i>	<i>NPV</i> (EUR)
Model I	18.10	10.3	1.16	367 000
Model II	21.06	8.5	1.22	528 000
Model III	23.63	7.0	1.28	671 000

Source: original

Sensitivity analysis is performed when the calculated parameters of economic efficiency are tested in order to observe what happens to these parameters if costs or benefits are modified. In this case the sensitivity analysis has been performed for the IRR and PBP parameters, showing satisfied efficiency.

Conclusion

According to the calculated economic efficiency parameters, risk and uncertainty of investments assessments and their unmeasurable effects, it can be concluded that in *Žarkovo-Bele Vode* morphological unit and part of the Topciderska River Watershed in the Rakovica community the investments in soil management for sustainability are cost effective and beneficial for environmental conservation. The offered improvements of the production by introduction of the bee-hiving have considerably increased the economic efficiency, and simultaneously are very acceptable and adaptable for the small farmers, which is the additional reason for people to remain and survive in these areas.

References

Zlati , M. (1994): *“Evaluation of erosion control works from the aspect of technical and economic justification in the endangered region of Belgrade”*, doctoral dissertation, Faculty of Forestry – Belgrade University, Belgrade (in Serbian).