RESEARCHES REGARDING THE SOIL LOSSES PRODUCED BY EROSION IN THE NORTH WESTERN ROMANIA

Radu BREJEA

University of Oradea, Faculty of Environmental Protection
26 Gen. Magheru St., 410048 Oradea, Romania
Corresponding author: rbrejea@yahoo.com

Abstract: *The paper is based on the researches carried out during 2007-2009 in the special plots placed on the hill with 10 % slope in Agricultural Research and Development Station Oradea. The metal panels and soil dams there were between the plots. The variants studied: black fallow, pasture, wheat, maize on the level curves, and maize from hall to valley. The biggest soil losses were determined in the variant with black follow and the variants with maize seeded from hill to valley maize on the level curves, wheat and pasture had the smaller losses in this order. The biggest yield losses were determined in the year with the biggest annual rainfall, 2007. The maize crop from hill to valley determined soil losses bigger than the yield losses from variant with maize cropped on the level cures. The wheat assured a better protection against the erosion in comparison with the maize and the best protection against erosion was assured by the pasture. In the same time the erosion determined the differences between the physical parameters (hydro stability of the macrostructure – aggregates bigger than 0.25 mm, bulk density, g/cm³; total porosity, %; hydraulic conductivity, mm/h; penetration resistance, kg/cm³) of the soil in the top and the base of the hill; in the top of the hill the values of the physical parameters were less favorable for plants in comparison with the hill base. The worst situation was registered in the variant with black fallow fallowing the variants cropped with maize from hill to valley, the variants cropped with maize on the level curves with and pasture. The big soil and the big yield losses determined in the variant with maize on the level curves the big soil losses determined in the variant with black fallow are the arguments to crop the wheat (or other plants with small distance between the rows) or the pasture on the hill with 10% slope in the conditions of the area with 615.2 mm rainfall a multiannual average too. The results were obtained in the project "Study of the risk factors, the quantification of their impact on agricultural systems, the creation of the new genotypes and technologic needed for sustainable development". CEEX 35/2006 project.*

***Key words*:** *hill, erosion, clean fallow, pasture.*

INTRODUCTION

Soil erosion affects and important area in North-Western Romania (ELIADE GH., 1983, BUDOI GH., PENESCU A., 199, GUŞ P. et al., 1998, SAMUEL A.D. et al., 2006). In the Bihor County, an area of 200,000 hectares (38% from the agricultural land) has lands with slopes bigger than 5%, were erosion is possible. The researches regarding the erosion from this area started in 1983 by I. Colibas and I. Mihut, in Hidiselu de Sus, and Pocola and researches regarding the soil management against erosion were made. After 1996, C. Domuta started the researches in Pocola; during 1990-1994 the researches were carried out in Beius and after that in Oradea; the researches regarding the soil erosion determinations using the control plot and regarding the soil management (crop rotation, green manure, chemical fertilization) were made, as well, in Oradea. (DOMUŢA C., 1999, 2005, 2006)

MATERIAL AND METHODS

The researches were carried out during 2007-2009 in Oradea on a hill with 10% slope. The plots for the soil erosion measurement were placed in the 2000 year, in the following variants: clean fallow, maize from top to valley, maize on the level curve direction, wheat, pasture. The plots' dimensions were 45x3.5 m and metal panels were placed at the base of the plots as well as soil dams between the plots on the hill.

The physical and chemical properties of the soil after 9 years of research were determined in a laboratory from the Agricultural Research and Development Station Oradea. The macroaggregates' hydrostability was determined by wet sifting using the Cseratzki method. The bulk density (BD) was determined in 5 repetitions using cylinders with a diameter of 100 cm^3; the same cylinders were used in order to determine the penetration resistance and the hydraulic conductivity of the soil. The total porosity was calculated using the following formula: TP=(1-DA/D)x100, in which D=density=2.65 g/cm^3. The rainfall data was registered in the Meteorological Station Oradea at 45°03' latitude and 21°56' longitude.

RESULTS AND DISCUSSIONS

Erosion during the research period

The annual rainfall during the researched period were of 556.1 mm in 2007, 585.7 mm in 2008 and of 501.4 mm in 2009. The month with maximum rainfall was September (91.2 mm) in 2007, June (92.1 mm) in 2008 and June (97.6 mm), too in 2009.

Table 1

Monthly rainfall during the agricultural year, Oradea 2007-2009

No.	Year	Months												Total
		X	XI	XII	I	II	III	IV	V	VI	VII	VIII	IX	
1.	2007	24,4	27,4	9,7	36,8	69,3	13,0	3,2	80,6	50,5	67,6	82,4	91,2	556,1
2.	2008	75,1	62,6	29,4	21,3	12,5	67,9	43,3	38,9	92,1	69,3	27,3	46,0	585,7
3.	2009	29,9	33,7	62,6	21,2	36,1	60,2	13,3	27,1	97,6	21,9	89,4	8,4	501,4

In the all years, the smallest losses were registered in the variant with pasture: 0.5 t/ha/year in 2007, 0.9 t/ha/year in 2008 and 0.3 t/ha/year in 2009. The variant with wheat is followed. In the variant with maize cropped from top to valley, the soil losses are bigger than the soil losses from the variant with maize sowed on the level curves with 218.5 % in 2007, with 203% in 2008 and with 228.5% in 2009. The biggest soil losses were registered in the variant with clean fallow: 20.3 t/ha/year in 2007, 25.8 t/ha/year in 2008 and 15.7 t/ha/year in 2009 (table 2).

Table 2

The influence of the crop system on the annual losses, Oradea 2007-2009

Crop system	Unit	Year			Average
		2007	2008	2009	
Pasture	t/ha	0.5	0.9	0.3	0.57
	%	100	100	100	100
Wheat	t/ha	1.9	2.1	1.5	1.83
	%	380	233	500	322
Maize on the level curves direction	t/ha	2.7	3.2	2.1	2.67
	%	540	355	700	468
Maize from top to valley	t/ha	8.6	9.7	6.9	8.4
	%	1720	1077	2300	1474
Clean fallow	t/ha	20.3	25.8	15.7	20.6
	%	4060	2866	5000	3614

On the top of the hill, the lowest values of the macro aggregates' hydrostability were registered in the variant with clean fallow. In the other variants studied, the values of the macro aggregates' hydrostability increased; the differences compared with the values in the variant with clean fallow were of 10.0% in the variant with maize cropped from top to valley, 22.2% in the variant with maize cropped on the level curves direction, 31.0% in wheat and 45.1% in pasture. The rows' position from top to valley and the soil erosion between the rows give an explanation for the higher values of the macro aggregates' hydrostability compared to the values registered in the variant with clean fallow from the base of the hill, 56.04% vs. 53.68%; the biggest value of the macro aggregates' hidrostability at the base of the hill was registered 58.82% (table 3).

Table 3

Macroaggregates' hydrostability modifications under the erosion and crop system influence, Oradea 2009

Crop system	Macroaggregates	Difference		
	%	%	%	%
Top of the hill				
1. Clean fallow	38.30	100	-	-
2. Maize, from top to valley	42.13	110.0	3.83	10.0
3. Maize, on the level curves direction	46.78	122.2	8.48	22.2
4. Wheat	50.14	131.0	11.84	31.0
5. Pasture	55.56	145.1	17.26	45.1
Base of the hill				
1. Clean fallow	53.68	100	-	-
2. Maize, from top to valley	56.04	104.4	2.36	4.4
3. Maize, on the level curves direction	52.40	97.7	-1.28	-2.3
4. Wheat	54.25	101.1	0.57	1.1
5. Pasture	58.82	109.6	5.14	9.6

Modifications of the bulk density, total porosity, penetration resistance and hydraulic conductivity under the crop system of the soil located on slopes

On the soil profile located at the top of the hill, the highest value of the bulk density was determined in the variant with clean fallow, 1.54 g/cm^3. In all of the variants, the values of the bulk density show an improvement of the soil settling with 2.6%, in the variant with maize cropped from top to valley, with 7.8%, distinctively significant, in the variant with maize cropped on the level curves direction, with 10.3% and 14.2%, in the variants with wheat and with pasture (table 4).

The values of the bulk density on the soil profile from the base of the hill are lower than the values in all the studied variants. The highest value was registered in the variant with clean fallow, 1.47 g/cm^3, a very high one. In the variants with maize cropped from top to valley and maize cropped on the level curves direction, the values are high and in the variant with wheat and with pasture the values of the bulk density are median ones. (table 4).

As a consequence, the lowest values of the total porosity were registered in the variant with clean fallow both in the top of the hill (41.8%) and in the base of the hill (44.5%). In the top of the plot, in the variant with maize cropped from top to valley, the value of the total porosity (43.4%) is higher than the value registered in the variant with clean fallow (table 5).

The values of the total porosity at the base of the experimental plots are higher than the values determined in the top of the plots in all of the variants. A better value of the total porosity in comparison with the one determined in the top of the plot in the variant with clean fallow (44.5%) was registered in the variant with maize cropped from top to valley (46%); in the variant with maize cropped on the level curves direction a difference of 48.3% was determined. In the variants with wheat and with pasture, the values determined (50.9% and 52.8%) are higher than the values determined in the variant with clean fallow (table 5).

Table 4

Bulk density modifications under the erosion and crop system influence, Oradea 2009

Crop system	Bulk density		Difference	
	g/cm^3	%	g/cm^3	%
Top of the hill				
1. Clean fallow	1.54	100	-	-
2. Maize, from top to valley	1.50	97.4	-0.04	-2.6
3. Maize, on the level curves direction	1.42	92.2	-0.12	-7.8
4. Wheat	1.38	89.7	-0.16	-10.3
5. Pasture	1.32	85.8	-0.22	-14.2
Base of the hill				
1. Clean fallow	1.47	100	-	-
2. Maize, from top to valley	1.43	97.3	-0.04	-2.7
3. Maize, on the level curves direction	1.37	93.2	-0.10	-6.8
4. Wheat	1.30	88.5	-0.17	-11.5
5. Pasture	1.25	85.1	-0.22	-14.9

Table 5

Total porosity modifications under the erosion and crop system influence, Oradea 2009

Crop system	Total porosity		Difference	
	%	%	%	%
Top of the hill				
1. Clean fallow	41.8	100.0	-	-
2. Maize, from top to valley	43.4	103.9	1.6	3.9
3. Maize, on the level curves direction	46.4	106.4	4.6	6.4
4. Wheat	47.9	114.6	6.1	14.6
5. Pasture	50.1	119.9	8.3	19.9
Base of the hill				
1. Clean fallow	44.5	100.0	-	-
2. Maize, from top to valley	46.0	103.4	2.0	3.4
3. Maize, on the level curves direction	48.3	108.6	3.8	8.6
4. Wheat	50.9	114.4	6.4	14.4
5. Pasture	52.8	118.7	8.3	18.7

In the top of the hill, the values of the penetration resistance are high in the variant with clean fallow (55.8 kg/cm^2) and in the variant with maize cropped from top to valley (50.1%). In the other variants, the values of the penetration resistance are median ones, 32.7 kg/cm^2 in the variant with wheat and 25.8 kg/cm^2 in the variant with pasture. A difference of 15.2% was registered when comparing the penetration resistance in the variant with maize cropped on the level curves direction with the penetration resistance in the variant with maize cropped from top to valley (table 6).

Lower values of the penetration resistance were registered at the base of the hill than the ones registered at the top of the hill in all of the studied variants. All of the values registered are median, except for the one registered in the variant with pasture, 20.7 kg/cm^2, situated in the median characterization class. In comparison with clean fallow, the differences are lower negative ones (table 6).

The hydraulic conductivity had the lowest values in the variant with clean fallow both at the top (1.31 mm/h) and base of the hill (2.37 mm/h); the hydraulic conductivity had a low value in the top of the hill and a median one at the base of the hill. In the variant with maize cropped from top to valley, in the top of the hill, the hydraulic conductivity had a low value, as well, but higher (46.6%), than the value determined in the variant with clean fallow. In the

other variants, the differences in comparison with clean fallow are bigger with 155% in the variant with maize cropped on the level curves direction, 206.9% in the variant with wheat and 360.0% in the variant with pasture. There is a difference of 74.0% between the value of the hydraulic conductivity in the variant with maize cropped on the level curves direction and the one in the variant with maize cropped from top to valley (table 7).

Table 6

Penetration resistance modifications under the erosion and crop system influence, Oradea 2009

Crop system	Penetration resistance		Difference	
	kg/cm^2	%	kg/cm^2	%
Top of the hill				
1. Clean fallow	55.8	100.0	-	-
2. Maize, from top to valley	50.1	89.8	-5.7	-10.2
3. Maize, on the level curves direction	38.6	69.2	-17.2	-30.8
4. Wheat	32.7	58.6	-23.1	-41.4
5. Pasture	25.8	46.3	-30.0	-53.7
Base of the hill				
1. Clean fallow	47.0	100.0	-	-
2. Maize, from top to valley	40.1	85.4	6.9	-14.6
3. Maize, on the level curves direction	35.6	75.8	-11.4	-24.2
4. Wheat	25.4	54.1	-21.6	-45.9
5. Pasture	20.7	44.1	-26.3	-55.9

Table 7

Hydraulic conductivity modifications under the erosion and crop system influence, Oradea 2009

Crop system	Hydraulic conductivity		Difference	
Top of the hill				
1. Clean fallow	1.31	100.0	-	-
2. Maize, from top to valley	1.92	146.6	0.61	46.6
3. Maize, on the level curves direction	3.34	255.0	2.03	155.0
4. Wheat	4.02	306.9	2.71	206.9
5. Pasture	6.02	460.0	4.71	360.0
Base of the hill				
1. Clean fallow	2.37	100.0	-	-
2. Maize, from top to valley	3.12	131.7	0.37	31.7
3. Maize, on the level curves direction	4.34	183.2	1.97	83.2
4. Wheat	5.06	214.4	2.69	114.4
5. Pasture	7.32	308.9	4.95	208.9

The values of the hydraulic conductivity at the base of the hill in comparison with the values determined at the top of the hill are situated in the same characterization class, median. In comparison with the hydraulic conductivity from the variant with clean fallow, an increase was registered in the variant with maize cropped from top to valley; the differences registered in all other variants were of: -83.7% in the variant with maize cropped on the level curves direction, 114.4% in the variant with wheat and 208.9% in the variant with pasture. There is a difference of 39.1% between the values of the hydraulic conductivity from the variant with maize cropped on the level curves and the variant with maize cropped from top to valley.

CONCLUSIONS

The researches were carried out in Oradea, in the Northern-Western part of Romania, on a hill with an 10% slope in the plots for soil erosion control. The following variants were studied: clean fallow, maize cropped from top to valley, maize cropped on the level curves direction, wheat and pasture.

The biggest soil losses were registered in the variant with clean fallow and in the variant with maize cropped from top to valley and the smallest soil losses were registered in the variant with pasture.

The lowest values of the aggregates' hydrostability were registered in the variant with clean fallow both at the top and base of the hill (41.8% and 44.5%); the highest values were registered in the variant with pasture, 50.1% and 52.8%. In the variant with maize cropped on the level curves direction, the macrostructure' hydrostability values are higher than the values from the variant with maize cropped from top to valley.

The values of the bulk density, total porosity, penetration resistance and hydraulic conductivity at the top of the hill are worse than the values registered at its base; the biggest difference between the base and top of the hill were registered in the variant with clean fallow and in the variant with maize cropped from top to valley.

The researches results show that the negative effects of the erosion on the land with median slope can be reduced using a good crop structure (pasture, wheat) and working on the level curve.

Acknowledgments

The researches were carried out in the project: PN-II-ID-PCE-2008; 1103/2009 "Study of the relationships in the soil-water-plant-atmosphere system on the land affected succesivelly by excess and deficit of moisture from North Western Romania regarding the improve of the yield quantity and quality".

BIBLIOGRAPHY

1. BUDOI GH., PENESCU A. – Agrotehnica, Editura Ceres, 1996, pag. 427-432.
2. DOMUȚA C. – Ameliorarea fertilității solurilor erodate pe terenurile în pantă din vestul țării. Cereale și plante tehnice nr. 7/1999.
3. DOMUȚA C. – Agrotehnica terenurilor în pantă din nord – vestul României. Editura Universității din Oradea, 2005, pag. 96-117.
4. DOMUȚA C. – Agrotehnica diferențiată. Editura Universității din Oradea, 2006, pag. 377-442.
5. ELIADE GH., GHINEA L., ȘTEFANIC GH., 1983– Bazele biologice ale fertilității solului. Editura Ceres, pag. 127-130.
6. GUȘ P., LĂZUREANU A., SĂNDOIU D., JITĂREANU G., STANCU I. – Agrotehnica. Editura Risoprint, 1998, pag. 496-499.
7. SAMUEL A.D., DRĂGAN – BULARDA M., DOMUȚA C. – The effect of green manure on enzymatic activities in a brown luvic soil. Studia Universitas Babeș – Bolyai, Biologia, L I, 2006, pag. 83-93.