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Research on Soil and Nutrient Losses through Liquid Runoff, in Order to Mitigate the Climate Risks to Which Romania Is Exposed, in the Context of CAP

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Abstract: The current paper presents the monitoring of soil and nutrient losses through runoff as the result of the climate change. The experimental results were recorded on the standard plots for runoff and erosion control. The results of the studies carried out highlight that total nitrogen losses range from 0.05 kg/ha to 12.60 kg/ha, potassium displaced from the plots has values between 0.02 and 1.35 kg/ha, the humus associated with the eroded soil includes values between 0.51 and 176.5 kg/ha, phosphorus is recorded with maximum values of 0.39 kg/ha, the total iron losses have values between 3.14 and 431.16 g/ha, manganese has losses from 1.69 to 290.82 g/ha, copper losses range from 0.15 to 7.62 g/ha, and, regarding zinc, the values are within the limits of 0.25–57.22 g/ha. The maximum values of the displacement of fertilizing elements from the sloping agricultural lands, by means of liquid and solid leaks, are registered at the plots left as permanent black fields, the plots practically unprotected against the rain erosion. The experiments were performed at the Soil Erosion Research and Development Station "Mircea Moţoc", Perieni/Staţiunea de Cercetare Dezvoltare pentru Combaterea Eroziunii Solului "Mircea Moţoc", Perieni (SCDCES—MM, Perieni), Vaslui County, an institution strategically located in an area subject to erosion soil. Additionally, the paper envisages how the National Rural Development Programme (NRDP) and the Common Agricultural Policy (CAP) can be of use in this area by analysing past lessons and providing an overview of what was done.

Keywords: erosion; nutrient; Romania; runoff; soil

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1. Introduction

Soil, considered to be a unique strategic natural resource, can be destroyed quickly, and while its fertility can be restored by appropriate measures, over a period of years or decades, the ecological reconstruction of destroyed soil can take centuries or even millennia.

Climate change and land use change are recognized as the main drivers of future soil erosion dynamics, justifying that this research field needs to be addressed more in forthcoming studies [1].

The application of fertilizers without a scientific system based on the knowledge of plant physiology and biochemistry, pedology, agrochemistry, phytotechnics, and genetics

can lead to a decrease in soil fertility and an increase in the amount of nutrients lost through erosion.

The main macro elements with an important role in plant nutrition are: Nitrogen, phosphorus and potassium, and in terms of microelements, Fe, Mn, Cu, Zn, etc., have an important role.

How are the macro elements and the microelements reduced? This is carried out through:

- losses through the eroded soil, which contribute to the movement of these elements on the slopes and the deposition at the base of the slope, in meadows or in accumulations, depending on the transport power of the erosive agents, together with the transported solid material;
- losses of elements simultaneously with the water that flows on the soil surface, these losses being directly proportional to the solubility and quantity of the elements in the soil;
- the movement of these elements on the soil profile through the water infiltrated into the soil [2,3].

Erosion changes the physico-chemical properties of soils. The changes of the chemical properties of soils as a result of erosion processes are stronger than those produced on the physical properties. The most important changes occur in the content of plant nutrients: nitrogen, phosphorus, and potassium, while humus provides the potential fertility of the soil.

The highest humus losses occur in the upper soil layer (0–30 cm), and this has the effect of damaging the structure, reducing permeability and, finally, the intensification of erosion (feedback process) again. The reduction in humus content is usually associated with losses of organic matter and plant nutrients, especially nitrogen and phosphorus.

As a result of the modification of the physico-chemical properties, due to erosion, there is also a decrease in the activity of soil microorganisms, all of which lead to a decrease in soil fertility and a decrease in agricultural production [4].

Located in Vaslui County, in the southwest (Figure 1), the Perieni locality is surrounded by Tutovei Hills, fragmented in the form of high hills. These hills are crossed by water torrents with increased erosive power [4,5].



Figure 1. The location of Perieni locality. Source: [4,5].

As the Moldavian Plateau in Romania is one of the regions which often has wind erosion incidents, the combination of remote sensing with field observations proved useful in estimating the soil loss and area depositions in arable lands caused by extreme blizzards [6].

The Staţiunea de Cercetare Dezvoltare pentru Combaterea Eroziunii Solului "Mircea Moţoc", Perieni/Soil Erosion Research and Development Station "Mircea Moțoc", Perieni (SCDCES—MM Perieni) was established in 1954, reorganized in 2017, and currently aims to implement a programme called "Measures and Works to prevent and combat soil

erosion." These phenomena have been declared problems of national interest in Romania, because approximately 7,000,000 ha of agricultural land are affected by these destructive processes [7]. The current paper presents the results of the experiments performed at SCDCES—MM Perieni regarding the loss of soil and nutrients through runoff, as a result of the erosion process.

Why does it matter? Besides the obvious technical solutions to the soil problem, this is not just a local problem but a European one, tackled as such by various EU regulations. Under the Common Agricultural Policy (CAP), the compulsory requirement to keep land in a good agricultural and environmental condition plays an important role in soil protection and conservation. Rural development policy, in particular agro-environment measures, offers Member States or regions options for encouraging farmers to achieve environmental quality beyond a predefined reference level [8].

Romania, as a Member State of the European Union, has benefited from non-reimbursable funds under the Common Agricultural Policy (CAP), which has led to a considerable improvement of agriculture with all its branches, rural areas have been supported and measures financed to prevent soil erosion. Thus, the major objectives of the CAP draw attention to water, soil, and air resources, precisely to support their sustainable but also efficient development.

In 2003, the European Union's Common Agricultural Policy (CAP) established the *Good Agricultural Environmental Conditions* (GAEC) requirement to reduce soil erosion rates and to maintain soil organic matter [9].

Under Pillar 1 of the 2014–2020 CAP, the greening practices required the application of crop diversification, the maintenance of permanent grasslands (less susceptible to erosion compared to croplands), and ecological focus areas favouring soil conservation. Under Pillar 2 of the 2014–2020 CAP, the prevention of soil erosion (through the practices of conservation agriculture and green covers) was one of the priorities of rural development [10].

The reduction of soil erosion by water is one of the indicators proposed by the European Commission legislative proposal [11] in order to monitor the environmental and climatic benefits of the future CAP. In the Commission proposal for the post-2020 Common Agricultural Policy (CAP), the main soil conservation policy instruments are GAECs, which focus on tillage management (GAEC 6), no bare soil (GAEC 7), and crop rotation (GAEC 8) [12,13].

2. Materials and Methods

The study on the losses of plant nutrition elements was performed on the standard plots for the control of runoffs located on the left side of the Valea Ţărnii river basin (Figures 2 and 3). The methods of the SCDCES—MM Perieni were used, based on scientific and comprehensive indicators.



Figure 2. Standard plots for drain control overview. Source: [7].



Figure 3. Standard plots for drain control-detail. Source: [7].

The 10 plots had the following dimensions:

- Plots 1–6, 9, 10–100 m^2 (4 m × 25 m);
- Plots 7 and 8–150 m^2 (4 m × 37.5 m).

The plots were cultivated with the following crops:

- Plot 1—wheat,
- Plot 2—corn,
- Plot 3—Bromus sp. in the 2nd year of vegetation,
- Plot 4—beans,
- Plot 5—soybeans,
- Plots 6 and 7—permanent black field (unfertilized),
- Plot 8—wheat,
- Plot 9—corn, cultivated in rotation for 2 years, unfertilized,
- Plot 10—wheat, cultivated in rotation for 2 years, unfertilized,
- Plots 1–5 and 8 were fertilized in autumn with 150 kg/ha NPK 28-28-0 complex fertilizer and in spring with 150 kg/ha amonium nitrate.

Starting with 2009, the rain showers were analysed and for this paper two of the most important ones were taken into consideration, which took place in June and August, one of 20.1 mm on 26/27 June and another of 13.3 mm on 14/15 August. These rain showers are the ones that caused liquid and solid runoffs on the plots for drain control.

In order to establish the level of supply of nutrients, samples were taken from the upstream and downstream parts of the plots of 100 sqm, and at those of 150 sqm, samples were also collected from the middle parts.

Determinations were made regarding the level of the supply of nutrients, the main chemical properties of the profile, the volume of liquid runoff (m^3/ha), the amount of eroded soil (tons/ha), the concentrations and quantities of macroelements (kg/ha), and microelements (Fe, Cu, Mn, Zn (g/ha)) displaced on each culture and on the obverse.

Liquid runoff and erosion measurements were carried out on the standard plots for the control of runoff, the plots that allow the retention of the volume of water and soil in covered basins so as not to induce errors in the assessment of the volume of drained water. Each plot is equipped with 3 basins of 1000, 200, and 50 L, the first basins being equipped with a 1:5 devices to reduce the volume of drained water. Based on the volume of water collected and the turbidity, liquid and solid losses per hectare were estimated. Following the analyses performed on the water and the soil samples taken from the basins, the level of losses of fertilizer elements per hectare was estimated.

3. Results and Discussions

As is well known, agricultural production is dependent on climate change. Romania has one of the highest levels of climate risk among EU countries, leading to production losses of over 30%. Recently, on average, one to three crops have been affected annually, in all regions of the country.

Rainfall erosivity is the soil erosion factor that has gained most attention during the last decade and a lot of research has been carried out to improve the erosivity indexes [14]. Plants diversity has positive effects on soil erosion resistance [15], thus this aspect needs to be very well analysed in regard to Romania.

The risk category includes plant and animal diseases, pest infestations, environmental incidents (toxic waste discharges, etc.), and adverse climatic events (floods, droughts, soil erosion, etc.) [16].

The data provided by SCDCES—MM Perieni show that 43%, i.e., 6.4 million ha of the 14.963 million ha of agricultural land in Romania, is sloping land with erosion potential (Figure 4).

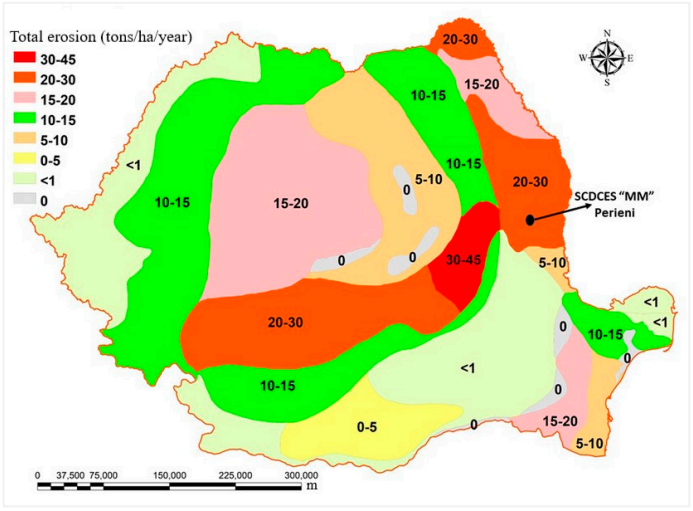


Figure 4. Total erosion on agricultural lands in Romania (tons/-ha/-year). Source: [7].

This is why it is necessary to facilitate farmers' access to insurance, through which they can be compensated for their losses resulting from natural disasters or other unfavourable phenomena. Additionally, NRDP programs help to reduce the damages caused by soil loss problem. Why does it matter? It matters because fighting soil loss problem is as a much a technical problem as financial one and thus the financing measures from NRDP could be a solution as seen below.

Measure 17—Risk Management (Article 36) of the NRDP (National Rural Development Program Romania)/PNDR (Programul Național de Dezvoltare Rurală) 2014–2020 provides risk management tools, through which Romania supports encouraging the involvement of farmers in risk prevention and management schemes through support for premium insurance [16].

The amounts allocated, the financing applications submitted and selected, and the contracts and payments made on 20 May 2021, under sub-measure 17.1, are presented in Table 1.

The aid granted to farmers under sub-measure 17.1 is as follows: the intensity of the non-reimbursable public support represents 70% of the value of the eligible insurance charge that is actually paid by the farmer [16].

Table 1. The stage of the implementation of NRDP 2014–2020 on 20.05.2021.

Measure/ Sub-Measure	Funding Applications Submitted -Number.-	Selected Funding Applications -Number.-	Financing Contracts/Decisions -Number.-			Financing Contracts/DecisionsTransferred Through the Transition Procedure * -Number.-			Payment Conducted- Euro-	Payments Made (Transition) -Euro-	Allocation 2014–2020 -Euro-	% Total Value NRDP 2014–2020
			Ongoing	Completed	Undone Contract	Ongoing	Completed	Undone Contract				
M17 Sub-measure 17.1	7806	6690	6444	5937	9				11,585,209		23,699,076	0.25

* Unfinished contracts from the 2007–2013 programming period that were paid from funds related to the 2014–2020 programming period. Source: [17]

Additionally, the NSP (the National Strategic Plan—version 1 of 28 February 2022)/PNS (Planul Național Strategic), elaborated by Romania in the context of the new CAP, further supports the interventions in order to stop the negative effects on the soil, water, and air.

The support provided will reduce the large agricultural areas affected by soil degradation phenomena (erosion, landslides, desertification, etc.) [18].

There were also a series of analyses performed at the EU level on the impact of CAP on soil, as mentioned earlier. It has had a positive effect yet the progress is limited: "the scarce progress over the 2010–2016 period (−0.4% in all land and −0.8% in arable land) suggests efforts to reduce soil erosion need to be strengthened, in particular in hotspots." [19]

At the Romanian level, a threat, as presented in the NSP, is represented by the low level of access to risk management tools (in the period 2012–2020, the pedological drought affected 1,344,759.18 ha, floods 154,844.93 ha, and the phenomenon of soil erosion over 260,000 ha) [18].

Soil erosion leads to decreased fertility, which results in low crop yields and, over time, contributes to arid areas. Studies conducted at SCDCES—MM Perieni on the erosion process tracked soil productivity and soil and nutrient losses through runoff.

3.1. Soil Productivity

The analytical results regarding the establishment of the level of nutrient supply are presented in Table 2.

The analysis of the data in Table 2 allows the following conclusions:

- pH indicates the presence of a moderate–weak acidic soil with values between 5.17 and 6.33,
- The values of the nitrogen content oscillate between 0.17 and 0.36%, indicating an average supply in this element,
- Phosphorus supply level is very low for non-fertilized crops, 5.89–8.38; low and medium for crops, 12.92–25.15; and good for fertilized crops, 44.89–84.71 ppm,
- A good level of potassium supply exists,
- The humus content places the soil in the plots at a medium supply level, oscillating between 2.58 and 4.15%,
- Hydrolytic acidity, Ah, is an index of soil acidity which comprises a significant fraction of the total acidity of the soil, which, when neutralized by amendments, leads to a neutral pH,
- The degree of saturation at pH = 7, VAh, correlated with the pH, is an index of the appreciation of the need to correct the reaction of acid soils by amendment. VAh values range from 76.5 to 90.6%, considering the existence of a mesobasic soil in the plots.

Additionally, two pedological profiles were made, one downstream and the other upstream of the plots, the analytical results being presented in Tables 3 and 4. From the comparison of the data from Tables 3 and 4, it can be observed that the contents of N, P, and K in the 0–20 cm layer of the soil is higher at the profile in the area upstream of the standards plots.

3.2. Loss of Soil and Nutrients

Table 5 presents the data regarding: the volume of liquid runoff (m^3/ha), the amount of eroded soil (tons/ha), and the concentrations and the quantities of macroelements (kg/ha) displaced on each crop and on the shower. Mineral nitrogen in water is a sum of nitric nitrogen and ammoniacal nitrogen. The lowest losses of macroelements and humus were recorded in the cultivated plots with beans and wheat.

The concentrations and quantities of microelements (Fe, Cu, Mn, Zn) associated with liquid and solid runoffs are shown in Table 6. The highest losses of Fe, Mn, Zn, and Cu are recorded in plots 6 and 7, maintained as a black field, which highlights the fact that the lack of a protective plant can accelerate the erosion phenomena.

Table 2. Analytical results regarding the level of nutrient supply at the standard nutrient leakage control plots, SCDCES—MM Perieni.

Plot	Culture	Place of Harvest	pH	Nt (%)	P-AL ppm	K-AL ppm	Conductivity MicroS/cm	Total Salt Content mg/100 g Sol	Humus (%)	SB me/100 g Sol	Ah me/100 g Sol	T me/100 g Sol	VAh %	Cu, ppm	Zn, ppm	Fe, ppm	Mn, ppm
1	Wheat	upstream	5.71	0.36	54.15	133.33	133.2	45	3.59	22.37	6.22	28.59	78.3	1.66	18.04	76.96	78.36
		downstream	5.25	0.22	55.89	210.00	176.7	60	3.60	20.13	5.72	25.85	77.9	1.30	17.50	67.72	80.06
2	Corn	upstream	5.17	0.22	65.15	138.33	140.5	48	3.63	22.78	6.18	28.96	78.7	1.34	12.78	59.58	73.12
		downstream	5.30	0.27	63.23	135.00	130.5	44	3.47	20.75	5.68	26.42	78.5	1.36	16.32	67.98	66.78
3	Bromus	upstream	5.68	0.27	61.31	125.00	79.2	27	3.34	23.39	5.72	29.11	80.4	1.22	16.18	62.52	67.82
		downstream	5.54	0.24	52.40	133.33	74.8	25	3.36	20.75	5.76	26.50	78.3	1.23	22.26	66.66	67.26
4	Beans	upstream	5.36	0.26	44.89	130.00	137.5	47	3.17	21.76	6.01	27.77	78.4	1.30	11.24	66.90	70.44
		downstream	5.77	0.23	44.89	148.33	118.8	40	4.15	24.21	4.47	28.67	84.4	1.11	14.94	64.66	64.84
5	Soy	upstream	5.21	0.22	84.71	133.33	143.8	49	3.12	22.58	6.47	29.05	77.7	1.11	17.80	64.14	82.56
		downstream	5.28	0.23	48.21	145.00	117.9	40	3.72	20.54	6.30	26.84	76.5	1.17	16.56	68.62	76.56
6	Plot 100	upstream	5.99	0.17	16.59	158.33	77.7	26	2.69	23.39	3.13	26.52	88.2	0.92	8.5	31.40	43.62
		downstream	5.84	0.24	25.15	173.33	83.1	28	2.58	20.54	3.13	23.67	86.8	0.89	11.52	38.9	45.28
7	Plot 150	upstream	6.32	0.29	12.92	161.66	78.2	27	2.69	22.98	2.75	25.74	89.3	0.93	13.34	28.12	40.34
		Middle	6.33	0.19	14.84	165.00	90.8	31	2.64	23.80	2.46	26.26	90.6	0.76	4.22	20.72	38.50
		downstream	6.06	0.18	25.15	170.00	86.2	29	2.94	18.91	3.46	22.38	84.5	0.79	10.92	36.60	46.46
8	Wheat 150	upstream	5.55	0.26	33.88	140.00	110.3	38	3.21	22.58	4.93	27.50	82.1	1.06	18.66	51.26	67.92
		Middle	5.71	0.25	52.40	145.00	99.8	34	3.53	21.97	4.63	26.60	82.6	1.12	7.38	50.02	69.60
		downstream	5.67	0.27	54.14	155.00	173.4	59	3.36	22.17	5.22	27.39	81.0	1.10	18.44	59.90	61.02
9	Corn nf.	upstream	6.07	0.27	5.89	163.33	78.2	27	3.66	22.78	2.75	25.54	89.2	1.05	5.00	30.84	41.28
		downstream	5.93	0.26	6.98	175.00	84.8	29	3.40	23.39	3.71	27.11	86.3	1.22	8.26	46.70	47.10
10	Wheat nf.	upstream	6.22	0.30	7.68	168.33	87.9	30	3.60	22.78	2.96	25.74	88.5	1.18	4.07	37.48	48.72
		downstream	5.97	0.27	8.38	165.00	90.0	32	3.63	21.97	3.55	25.51	86.1	1.28	1.27	45.50	50.94

Nf—nonfertilized. Source: own calculus.

Table 3. Analytical data on the main agrochemical properties of the downstream profile of the standard plots, SCDCES—MM Perieni.

Horizon	pH	N (%)	P ppm	K ppm	Conductivity MicroS/cm	Total Salt Content, mg/100 g sol	Humus %
Ap1 0–10 cm	6.23	0.23	12.92	165.00	134.3	46	4.02
Ap2 10–26 cm	6.45	0.21	7.33	165.00	101.9	35	3.24
Am 26–40 cm	6.69	0.24	3.14	165.00	85.6	29	2.46
AB 40–52 cm	6.57	0.15	3.66	163.33	83.3	28	1.44
Bw1 2 52–73 cm	6.68	0.14	5.59	150.00	111.2	38	1.26
Bw2 73–90 cm	7.11	0.14	11.00	126.66	119.7	41	0.96
Cca 90–103 cm	8.11	0.11	25.15	105.00	189.8	65	0.94

Source: own calculus.

Table 4. Analytical data on the main agrochemical properties of the upstream profile of the standard plots, SCDCES—MM Perieni.

Horizon	pH	N (%)	P ppm	K ppm	Conductivity microS/cm	Total Salt Content, mg/100 g Sol	Humus %
Aţ 0–2 cm	6.42	0.45	42.09	256.66	177.8	60	-
Am 2–35 cm	6.31	0.31	11.00	340.00	124.8	42	4.75
AB 35–44 cm	6.43	0.21	4.19	160.00	176.8	60	2.19
Bw 1 44–62 cm	7.42	0.18	6.46	156.66	174.1	59	2.22
Cca 1(b) 62–72 cm	8.10	0.16	19.56	128.33	167.2	57	1.38

Source: own calculus.

Table 7 shows the total loss of macronutrients, which were as follows:

- total nitrogen losses ranged from 0.05 kg/ha to 12.60 kg/ha,
- potassium displaced from the plots had values between 0.02 and 1.35 kg/ha,
- phosphorus was recorded with maximum values of 0.39 kg/ha,
- the humus associated with the eroded soil included values between 0.51 and 176.5 kg/ha.

Table 8 shows the total losses of microelements, which were as follows:

- iron losses had values between 3.14 and 431.16 g/ha,
- manganese had losses from 1.69 to 290.82 g/ha,
- copper losses ranged from 0.15 to 7.62 g/ha,
- zinc losses, the values of which were within the limits of 0.25–57.22 g/ha.

The maximum values of the displacements of fertilizing elements from the sloping agricultural lands, by means of liquid and solid runoff, are registered at the plots left as permanent black fields, leaving the plots practically unprotected against the rain erosion.

Soil losses due to erosion do not exceed the maximum value of 8 tons/ha, considered as permissible erosion for the experimental area, so soil losses and nutrients associated with soil movements do not seriously affect the fertility of the soil.

Regarding the percentage distribution of the losses of macroelements (Table 9) and microelements (Fe, Cu, Mn, Zn) through water and soil (Table 10), we find that the highest losses are generally associated with eroded soil, so an adequate protection of the soil through cultivation and specific agrotechnics of sloping lands can contribute to maintaining the fertility of the soil.

In the plots left as permanent black fields, not fertilized and not protected by culture, the losses of fertilizing elements through the eroded soil oscillate between 80 and 98% of the total losses. In the case of microelements, the losses with the eroded soil were between 67 and 99 % of the total losses (Table 10).

Table 5. Losses of macroelements on showers and plots, SCDCES—MM Perieni.

Data	Shower	Plot	Crop	Liquid Runoff	Erosion	Water									Soil					
						N-NO		$N-NH_4$		N-min	K_2O		P_2O_5		Humus		N-Total		K_2O		P_2O_5	
	mm			m^3/ha	tons/ha	ppm	kg/ha	ppm	kg/ha	kg/ha	ppm	kg/ha	ppm	kg/ha	%	kg/ha	%	kg/ha	ppm	kg/ha	ppm	kg/ha
26/27.06	20.1	2	corn	17.66	0.33	4.8	0.09	2.5	0.04	0.13	4.6	0.08	1.4	0.03	3.48	11.73	0.23	0.78	168	0.06	144	0.05
		4	beans	4.48	0.04	5.6	0.02	2.8	0.01	0.03	5.2	0.02	1.5	0.007	3.68	1.54	0.24	0.10	166	0.007	103	0.004
		5	soy	46.05	0.79	5.3	0.24	2.7	0.12	0.36	5.1	0.23	1.5	0.06	3.54	28.249	0.22	1.75	173	0.13	119	0.09
		6	plot 100	61.62	4.12	2.2	0.13	1.1	0.06	0.20	2.6	0.16	0.6	0.03	2.62	107.97	0.18	7.41	171	0.70	57.7	0.23
		7	plot 150	64.28	6.38	2.1	0.13	1.1	0.07	0.20	2.6	0.167	0.6	0.03	2.59	165.34	0.18	11.49	170	1.08	51.3	0.32
		9	corn nf.	7.99	0.01	2.2	0.01	0.9	0.007	0.02	2.5	0.02	0.6	0.005	3.40	0.51	0.22	0.03	148	0.002	77.6	0.001
		10	wheat nf.	5.86	0.17	2.2	0.01	0.8	0.005	0.01	2.6	0.01	0.6	0.004	3.39	5.76	0.22	0.37	150	0.02	36.5	0.006
14/15.08	13.3	6	plot 100	9.69	0.36	2.5	0.02	0.6	0.006	0.03	2.4	0.02	0.5	0.005	2.56	9.34	0.19	0.69	168	0.06	55.2	0.02
		7	plot 150	6.96	0.47	2.4	0.02	0.6	0.004	0.02	2.4	0.02	0.5	0.003	2.54	11.86	0.19	0.89	170	0.08	51.4	0.03

Nf—nonfertilized. Source: own calculus.

Table 6. The losses of Fe, Mn, Cu, and Zn on showers and plots, SCDCES—MM Perieni.

Data	Shower	Plot	Crop	Liquid Runoff	Erosion	Water								Soil							
						Fe		Mn		Cu		Zn		Fe		Mn		Cu		Zn	
	mm			m^3/ha	tons/ha	ppm	g/ha	ppm	g/ha	ppm	g/ha	ppm	g/ha	ppm	g/ha	ppm	g/ha	ppm	g/ha	ppm	g/ha
26/27.06	20.1	2	corn	17.66	0.33	0.29	5.26	0.04	0.70	0.02	0.38	0.05	0.90	66.72	22.48	75.16	25.32	1.49	0.50	7.26	2.44
		4	beans	4.48	0.04	0.13	0.61	0.01	0.06	0.02	0.12	0.04	0.21	60.42	2.53	76.52	3.21	1.10	0.04	6.66	0.28
		5	soy	46.05	0.79	0.34	16.02	0.005	0.23	0.01	0.82	0.06	2.94	68.76	54.87	83.00	66.23	1.42	1.13	7.60	6.06
		6	plot 100	61.62	4.12	0.22	13.68	0.008	0.49	0.02	1.29	0.09	5.85	59.66	245.85	38.39	158.20	0.71	2.92	9.220	37.99
		7	plot 150	64.28	6.38	1.12	72.32	0.01	0.90	0.03	2.12	0.04	2.57	55.14	352.01	42.37	270.49	0.77	4.91	7.94	50.68
		9	corn nf.	7.99	0.01	0.41	3.31	0.007	0.05	0.01	0.13	0.02	0.19	102.98	1.54	109.29	1.63	1.17	0.01	4.01	0.06
		10	wheat nf.	5.86	0.17	0.37	2.19	0.00	0.05	0.01	0.08	0.03	0.19	99.78	16.96	106.20	18.05	1.16	0.19	4.12	0.70
14/15.08	13.3	6	plot 100	9.69	0.36	0.23	2.27	0.009	0.08	0.02	0.21	0.09	0.94	58.52	21.36	37.62	13.73	0.69	0.25	9.16	3.34
		7	plot 150	6.95	0.46	0.97	6.80	0.01	0.11	0.03	0.25	0.04	0.29	54.62	0.02	41.37	19.32	0.73	0.34	7.86	3.67

Nf—nonfertilized. Source: own calculus.

Table 7. The total losses of macroelements, SCDCES—MM Perieni.

Plot	Crop	Liquid Runoff	Erosion	Azote			K_2O			P_2O_5			Humus
				Water	Soil	Total	Water	Soil	Total	Water	Soil	Total	Soil
		m^3/ha	tons/ha	kg/ha	kg/ha	kg/ha	kg/ha	kg/ha	kg/ha	kg/ha	kg/ha	kg/ha	kg/ha
2	corn	17.56	0.34	0.13	0.77	0.90	0.08	0.05	0.13	0.02	0.045	0.07	11.72
4	beans	4.48	0.04	0.03	0.10	0.13	0.02	0.01	0.03	0.01	0.004	0.01	1.54
5	soy	46.05	0.79	0.36	1.75	2.12	0.23	0.13	0.37	0.06	0.09	0.16	28.24
6	plot 100	71.32	4.48	0.23	8.11	8.34	0.18	0.76	0.95	0.04	0.25	0.30	117.30
7	plot 150	71.24	6.85	0.22	12.37	12.60	0.18	1.16	1.35	0.04	0.35	0.39	176.50
9	corn nf.	7.99	0.02	0.02	0.03	0.05	0.02	0.002	0.02	0.1	0.001	0.01	0.51
10	wheat nf.	5.86	0.17	0.02	0.37	0.39	0.01	0.02	0.04	0.004	0.1	0.01	5.76

Nf—nonfertilized. Source: own calculus.

Table 8. The total losses of microelements (Fe, Mn, Cu, and Zn), SCDCES—MM Perieni.

Plot.	Crop	Liquid Runoff	Erosion	Fe			Mn			Cu			Zn		
				Water	Soil	Total	Water	Soil	Total	Water	Soil	Total	Water	Soil	Total
		m^3/ha	tons/ha	g/ha	g/ha	g/ha	g/ha	g/ha	g/ha	g/ha	g/ha	g/ha	g/ha	g/ha	g/ha
2	corn	17.56	0.33	5.26	22.48	27.74	0.70	25.32	26.03	0.38	0.50	0.89	0.90	2.44	3.34
4	beans	4.48	0.04	0.61	2.53	3.14	0.06	3.21	3.28	0.12	0.04	0.16	0.21	0.28	0.49
5	soy	46.05	0.79	16.02	54.87	70.89	0.23	66.23	66.46	0.82	1.13	1.96	2.94	6.06	9.01
6	plot 100	71.32	4.48	15.96	267.21	283.17	0.58	171.93	172.51	1.50	3.17	4.68	6.79	41.33	48.13
7	plot 150	71.24	6.85	79.13	352.03	431.16	1.01	289.81	290.82	2.37	5.25	7.62	2.86	54.36	57.22
9	corn nf.	7.99	0.01	3.31	1.54	4.86	0.05	1.63	1.69	0.13	0.01	0.15	0.19	0.06	0.25
10	wheat nf.	5.86	0.17	2.19	16.96	19.15	0.05	18.05	18.10	0.08	0.19	0.27	0.19	0.70	0.89

Nf—nonfertilized. Source: Own calculus.

Table 9. Percentage repartition of the losses of macroelements through water and soil, SCDCES—MM Perieni.

Plot	Crop	Liquid Runoff m^3/ha	Erosion to/ha	Nitrogen		K_2O		P_2O_5		Humus
				Water	Soil	Water	Soil	Water	Soil	Soil
				%	%	%	%	%	%	%
2	corn	17.56	0.33	14.26	85.73	58.87	41.12	33.70	66.29	100.00
4	beans	4.48	0.04	27.20	72.79	76.97	23.02	60.95	39.04	100.00
5	soy	46.05	0.79	17.34	82.65	63.04	36.95	42.03	57.97	100.00
6	plot 100	71.32	4.48	2.79	97.20	19.29	80.70	13.95	86.04	100.00
7	plot 150	71.24	6.85	1.79	98.20	13.62	86.37	10.68	89.31	100.00
9	corn nf.	7.99	0.01	42.89	57.10	89.98	10.01	80.47	19.52	100.00
10	wheat nf.	5.86	0.17	4.49	95.50	37.39	62.60	36.19	63.80	100.00

Nf—nonfertilized. Source: own calculus.

Table 10. Percentage repartition of the losses of Fe, Mn, Cu, and Zn through water and soil, SCDCES—MM Perieni.

Plot	Crop	Runoff	Erosion	Fe		Mn		Cu		Zn	
				Water	Soil	Water	Soil	Water	Soil	Water	Soil
		m^3/ha	to/ha	%	%	%	%	%	%	%	%
2	corn	17.56	0.33	18.96	81.03	2.71	97.28	43.62	56.37	26.90	73.09
4	beans	4.48	0.04	19.37	80.62	2.05	97.95	72.38	27.61	42.97	57.02
5	soy	46.05	0.79	22.60	77.39	0.34	99.65	42.24	57.75	32.70	67.29
6	plot 100	71.32	4.48	5.63	94.36	0.33	99.66	32.17	67.82	14.11	85.88
7	plot 150	71.24	6.85	18.35	81.64	0.34	99.65	31.09	68.90	5.01	94.99
9	corn nf.	7.99	0.01	68.23	31.76	3.30	96.69	88.56	11.43	76.13	23.86
10	wheat nf.	5.86	0.17	11.45	88.54	0.29	99.70	29.40	70.59	21.65	78.34

Nf—nonfertilized. Source: own calculus.

4. Conclusions

The study on nutrient losses through soil and water was carried out at the standard plots for leakage control located on the left side of the Valea Țărnii Experimental Center, SCDCES—MM Perieni.

In order to establish the level of nutrient supply, after two significant rain showers, one of 20.1 mm on June 26/27 and another of 13.3 mm on August 14/15, which caused

liquid and solid leaks on the plots, samples were taken from the upstream and downstream parts of the plots and analysed.

Liquid runoff and erosion measurements were carried out on the standard plots for the control of runoff, the plots that allow the retention of the volume of water and soil in covered basins so as not to induce errors in the assessment of the volume of drained water.

Lower losses of macroelements and humus were recorded in plots cultivated with beans and wheat.

High losses of Fe, Mn, Zn, and Cu were recorded in plots 6 and 7, which were maintained as black fields, which highlights the fact that the lack of a protective plant can accelerate the erosion phenomena.

The highest losses of nutrients and humus are generally associated with eroded soil and therefore adequate soil protection through cultivation and the application of specific agrotechnics for sloping land can help maintain soil fertility.

In order to prevent the risks that may arise in agriculture, the CAP, through the support measures under the two pillars, supports both agricultural activity and the maintenance of soil fertility. The support is allocated through European non-reimbursable funds.

Additionally, from the point of view of CAP, the results are mixed; in the long term it favours a change in the practices of farmers, yet in regard to soil erosion, efforts still need to be made, especially where the erosion level is high. Mapping the at risk and endangered areas, creating a common how-to guide for fighting soil erosion, and bringing together local and state actors across Europe might just be the best thing to be done.

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