Surface Runoff Simulator (SIMU) hastens the research on phosphorus losses from grassland – preliminary results

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In Finland most important grass production areas are located on areas that have severe winter conditions, soil frost and snow cover that affect the runoff patterns. Surface waters of these areas suffer from dissolved phosphorus pollution originated from intensive dairy farming. To study the effects of different treatments and changing winter conditions on surface runoff, we developed a device called Surface runoff Simulator (SIMU). The accuracy of the SIMU device was tested with slurry experiment during spring 2008-2009. The results showed that SIMU was accurate and reliable when measuring the differences between the treatments (see cost abstract for description of the experiment).

Materials and Methods

With the SIMU (Figure 1.) device it is possible to simultaneously test several different methods to reduce phosphorus losses from grassland. The treatments are randomized on grass plots during growing season. At the end of the growing season, the top layer the plots are lifted by a turf grass cutter, covered with plastic sheet and stored in outside temperature until the beginning of the experiment. At the beginning of the melting experiment in January, the frozen grass mats are placed individually on the sloping SIMU devices and covered with chosen amount of snow. Infrared heaters are used to melt the snow and the melt water is collected at the lower edge of the slope. Many factors are completely adjustable: the treatments on the field, the slope of the grass mat, the duration of melting period and the amount of snow that produces the surface runoff.

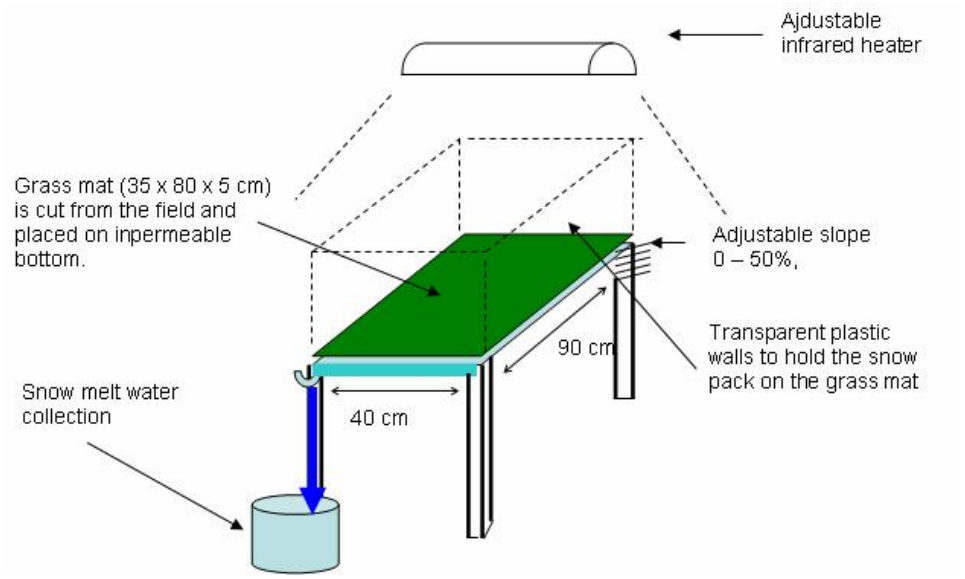

Figure 1. The illustration of the surface runoff simulator (SIMU).

During spring 2009-2010 we studied the effects of different chemical treatments on surface runoff P –concentrations and soil parameters with SIMU. There was four replicates of each treatment. Soil samples were taken before the runoff experiment and analysed for pH, water extractable P (1:150) and P_{aac}. The amount of melted snow equals approximately to 71 mm of water.

Table 1. The soil and the runoff water concentrations in SIMU experiment with different Fe – based flocculation agents

Treatment	**Soil of the grass mats**			**Runoff water from the grass mats**	
	pH	**P_{H2O} mg l^{-1} (1:150)**	**P_{AAC} mg l^{-1}**	**Total P mg l^{-1}**	**Dissolved P mg l^{-1}**
Control	7.06	33.8	40.8	0.81	0.66
100 P kg ha^{-1}	6.67	63.3	105.2	1.79	1.60
100 P + 50g m^2 $Fe_2(SO_4)_3$ granulate	6.71	57.6	83.9	1.03	0.90
100 P + 50g m^2 $Fe_2(SO_4)_3$ solution	6.59	57.7	83.7	0.60	0.49
100 P +50g m^2 $FeSO_4$* $7H_2O$ granulate	6.72	54.0	76.0	0.84	0.71
100 P +50g m^2 $FeSO_4$* $7H_2O$ solution	6.62	59.8	88.1	0.77	0.63
SEM	**-[a]**	**3,68**	**7.93**	**0.113**	**0.107**
tr *P* values	**<0.001**	**<0.001**	**<0.001**	**<0.001**	**<0.001**

a) back transformed from H_3O-concentration

Table 2. The soil and the runoff water concentrations in SIMU experiment with different chemical flocculation agents

Treatment	**Soil of the grass mats**			**Runoff water from the grass mats**	
	pH	**P_{H2O} mg l^{-1} (1:150)**	**P_{AAC} mg l^{-1}**	**Total P mg l^{-1}**	**Dissolved P mg l^{-1}**
Control	7.06	41.9	54.9	0.92	0.83
100 P kg ha^{-1}	6.66	77.0	107.0	1.41	1.28
100P + 50 g m^2 Phoslock®	6.75	68.3	98.6	1.50	1.33
100P + 3000 kg ha^{-1} Biotite	6.76	76.8	112.0	1.70	1.60
100P + 50g m^2 $Al_{2(}SO_4)_3$ granulate	6.74	57.6	84.9	1.16	1.06
100P + 50g m^2 $Al_{2(}SO_4)_3$ solution	6.70	63.1	94.1	0.67	0.53
SEM	**-[a]**	**6.64**	**5.87**	**0.179**	**0.208**
tr *P* values	**0.027**	**0.005**	**<0.001**	**0.007**	**0.02**

a) back transformed from H_3O-concentration

The tested Fe-based chemicals reduced the P-concentration of the runoff water quite effectively. Al-based chemical reduced P-concentration of the runoff water when used as solution. Generally, the solutions seemed to work better that granulates. The effect of Phoslock® and biotite was adverse. The results are preliminary.

Acknowledgements:, $Fe_2(SO_4)_3$ 'Ferix-3', $Fe(SO_4)$*$7H_2O$ 'COP' and $Al_{2(}SO_4)3$ 'ALG' were kindly provided by Kemwater, Phoslock® by Phoslock Water Solutions Ltd. and Biotite by Yara Suomi Oy.