Characteristics of PAM used in the experiment

KANGWON NATIONAL UNIVERSITY

Effect of Surface Cover Materials and Soil Amendments on Sediment Discharge from Upland Fields

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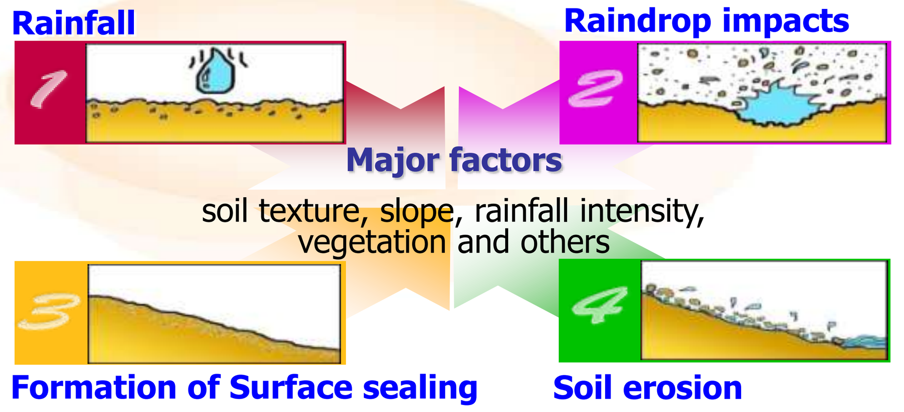
BACKGROUND & OBJECTIVES

- Soil erosion is one of the major reasons for non-point source (NPS) pollution in alpine agricultural fields in Korea. Soil erosion and runoff control are important not only for soil and water conservation but also for the reduction of sediment discharge in runoff.

Key factors of soil erosion



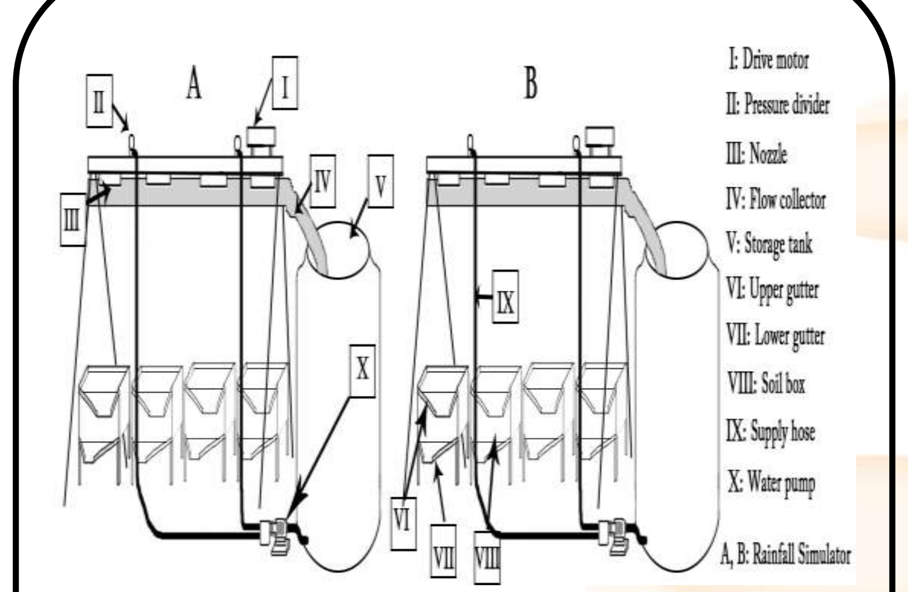
Control methods of soil erosion

Source control methods
- Rice straw mats
- Soil amendments
  ; polyacrylamide (PAM) and gypsum)
- Crop residues

- Best management practices (BMPs) and technologies to control soil erosion and sediment discharges from the alpine regions in Korea using straw mats and soil amendments have not been investigated well both theoretically and experimentally. Especially, the effect of surface cover materials and other residue covers on runoff from the alpine sandy soil fields have not been investigated in Korea.
- The objective of this study was to investigate the effect of surface cover materials and soil amendments on surface runoff and sediment discharge in laboratory scale experiments using an indoor rainfall simulator.

MATERIAL & METHODS

Rainfall simulation



- **Rainfall simulator** ; Norton ladder type rainfall simulators developed by USDA soil laboratory at Purdue University
- **Runoff plots** (Small soil boxes) ; 1.0×1.0×0.65 m
- **Soil texture** ; Loamy sand

Cover Materials

- Rice straw mat (S)

- Rice straw mat+PAM (SP)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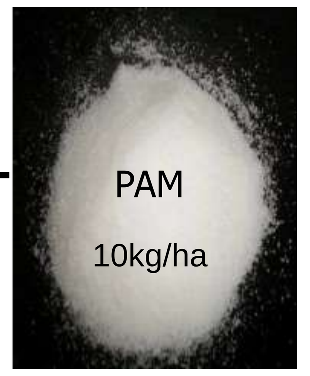


- Rice straw mat+PAM+gypsum (SPG)

+


- Characteristics of PAM used in the experiment

	Form	Color	Odor	Water solubility	Specific gravity	pH (0.5% solution)
PAM	Granular powder	White	Little or no	Soluble	0.75	6~9

Experimental design

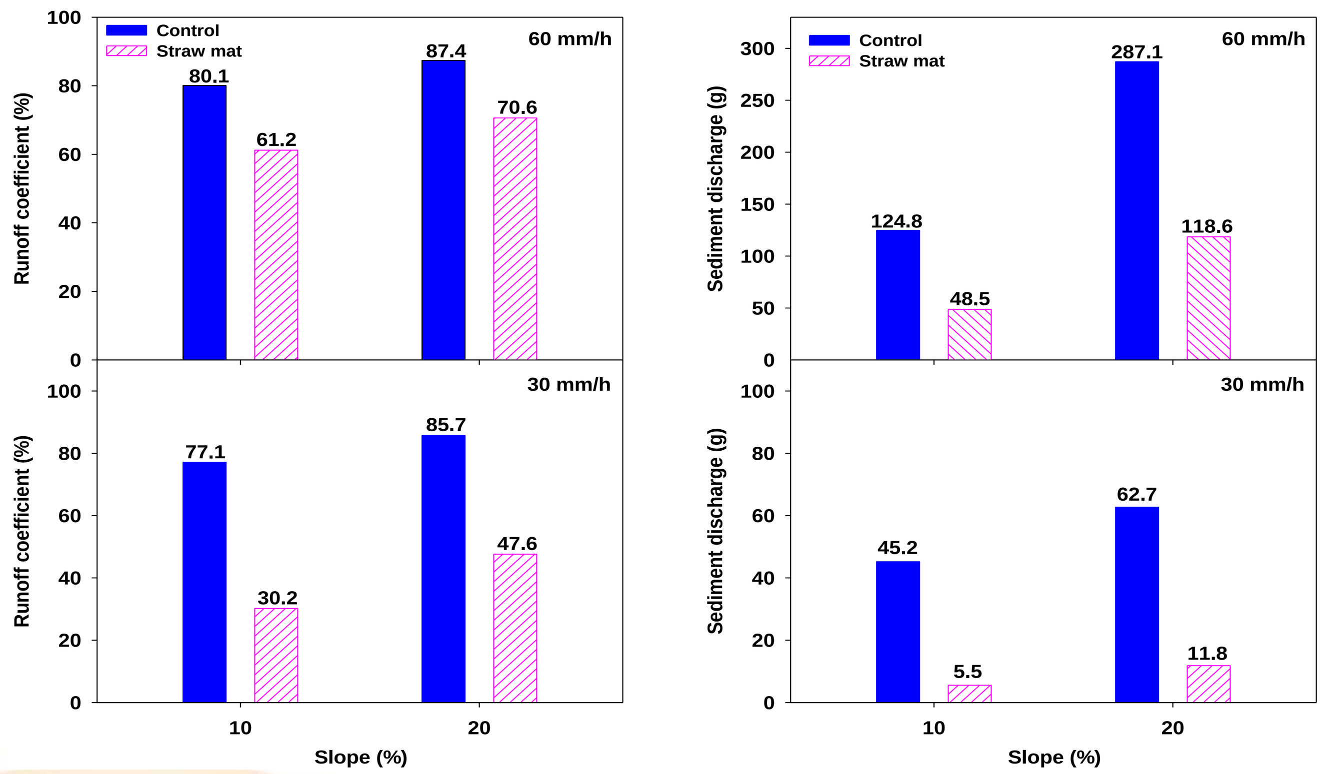
No.	RI* (mm/hr)	Slope (%)	Cover materials
I	30	10	Control
II	30	10	S
III	30	10	SP
IV	30	10	SPG
V	30	20	Control
VI	30	20	S
VII	30	20	SP
VIII	30	20	SPG
IX	60	10	Control
X	60	10	S
XI	60	10	SP
XII	60	10	SPG
XIII	60	20	Control
XIV	60	20	S
XV	60	20	SP
XVI	60	20	SPG

* Rainfall intensity

RESULTS & DISCUSSION

Effect of the Straw Mat

- The runoff coefficient from the mat covered plots decreased significantly compared to the control plots, regardless of rainfall intensity and slope.
- Under 30 mm/h simulation, sediment discharge decreased 87.9% and 81.2% for 10% and 20% plots, respectively, compared to those of control plots. Under 60 mm/h simulation, sediment discharge decreased 61.1% and 58.7% for 10% and 20% plots, respectively.
- Based on the experiment, it was thought that the rice straw mat cover might be an effective best management practice for the control of sediment from sloping highland fields.



Effect of rice straw mats on the runoff coefficient and sediment discharge with respect to slope (10 and 20%) and rainfall intensity (30 and 60 mm/h)

Analysis of water-balance in rainfall simulator

Landcover		Control				Rice straw mat			
Rainfall Intensity		30 mm/hr		60 mm/hr		30 mm/hr		60 mm/hr	
Slope		10%	20%	10%	20%	10%	20%	10%	20%
Analysis of water-balance (%)	Precipitation	100	100	100	100	100	100	100	100
	The rate of surface runoff	77.07	85.65	80.07	87.40	30.21	47.56	61.19	70.61
	The rate of groundwater discharge	13.36	7.09	9.88	5.70	57.88	43.19	28.13	18.13
	The rate of retention in soil	9.57	7.26	10.05	6.90	11.91	9.25	10.68	11.26

Effect of Straw Mat, PAM and Gypsum

- Under 30 mm/h simulation, the runoff coefficient with straw mat covers was 30.2% and 47.6% for 10% and 20% plots, respectively. But when PAM and gypsum were added one by one, the coefficient reduced to 6.2%, 14.3% and then 0.0% and 0.2%, respectively. Under 60 mm/h simulation, the similar reduction pattern of the coefficient was also observed.

- Under 30 mm/h simulation, practically no sediment was occurred if the mats and the soil amendments were applied together. Even under the 60 mm/h simulation, which was a very high rainfall intensity and a steep 20% slope, sediment discharge was very small and reduced 98.8% of sediment compared to that of control plots. The experiment proves that the effect of the combined application of straw mats and the soil amendments can significantly restrain soil erosion by rainfall.

Effect of rice straw mats with PAM/gypsum on the runoff coefficient (Unit: %)

Rainfall intensity	Slope	Straw mat	Straw+P	Straw+P+G
30 mm/h	10%	30.2	6.2	0.0
	20%	47.6	14.3	0.2
60 mm/h	10%	61.2	53.2	24.8
	20%	70.6	52.8	27.9

Effect of rice straw mats with PAM/gypsum on sediment discharge (Unit: g)

Rainfall intensity	Slope	Straw mat	Straw+P	Straw+P+G
30 mm/h	10%	5.5	0.07	0.00
	20%	11.8	1.28	0.00
60 mm/h	10%	48.5	1.90	1.58
	20%	118.6	9.20	1.50

CONCLUSION

- **Runoff coefficient from the mat-covered plots decreased significantly compared to control plots regardless of rainfall intensity and slope.**
- **The effect of the mat cover on the reduction of sediment discharge was greater than runoff. Under 60 mm/h simulation and 20% slope, which was the worst case, the covered plots with the mat and the soil amendments could reduce 98.8% of sediment.**
- **It was concluded that the function of the mats was significantly improved by adding PAM and gypsum.**
- **The combined use of the mats, PAM, and gypsum could be an effective best management practice to reduce runoff and sediment discharge from highland sloping agricultural fields. However, a series of field experiments was recommended to verify the effect of combined use of the mats, PAM and gypsum on runoff and sediment reduction.**

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