Research article

Soil Erosion Control by Coconut Husk Buffer Strip in Bohol Island of Philippines

JULIAN TORILLO JR.
Graduate School of Agriculture, Tokyo University of Agriculture, Japan
Email: juliantorillo@yahoo.com

MACHITO MIHARA
Faculty of Regional Environment Science, Tokyo University of Agriculture, Japan

Received 9 December 2010 Accepted 9 February 2011

Abstract Soil erosion causes serious environmental problems in Bohol Island, Philippines. Considering the agricultural socio-economic situation in the island, utilizing available materials in the region to mitigate soil erosion particularly in the upland fields have been focused. Thus, slope modeling experiments were conducted to evaluate the effects of coconut husk buffer strip on mitigating the losses of soil and nutrients. Based on the experimental results, the coconut husk buffer was effective to trap transported soils, however the nutrient losses from the plots with the coconut husk buffer were slightly higher than that from control plot without any treatments in the initial stage of rainfall events after the installation of coconut husk buffer strip.

Keywords coconut husk, buffer strip, trapping capability, soil and nutrient losses

INTRODUCTION

Parts of the land areas with 8-18% slopes in Bohol Province of the Philippines are covered with upland fields. Even in the mountainous areas with more than 18% in slopes, some portions have been exploited particularly for subsistence agriculture. Along with the higher intensity rainfalls in the interior mountainous areas, upland fields and other less vegetated areas on slopes are susceptible to soil erosion that causes rapid degradation of land (OIDC, 2006).

Upland fields with protruding stones and rocks on ground surfaces as well as abandoned farmlands are now dominant particularly in the southwestern part of the island. Thus, the strategies for rehabilitating and conserving these land resources are necessary where soil erosion is the prime problem to be mitigated. This study dealt with the strategic soil erosion control by utilizing coconut husk which is biodegradable, renewable and locally available material in the region. Considering the agricultural socio-economic situation in the island of Bohol, economical and easy application with high efficiency is also one of important scopes that should be focused. So, the objectives of this study are to observe the capability of coconut husk buffer to trap soil and nutrient losses with measuring the particle sizes that were trapped by buffer medium.

MEHODOLOGY

In order to evaluate the effects of coconut husk buffer on mitigating soil erosion, modeling experiments were carried out in the laboratory with artificial rainfall facilities at Tokyo University of Agriculture, Tokyo, Japan. The soil with clay percentage at 63.8%, silt at 8.1% and sand at 28.1% obtained from abandoned corn field in Tiptip District, Tagbilaran City of Bohol was used in the experiment.

Coconut husk was pounded by hammer to make it into a fibrous material and installed at the lower end of the slope model plots (130 cm long and 11 cm wide) in which around 7.5 kg of the soil was filled. Three plots were prepared as Plot I, Plot II and Plot III as the plot of control, the plot with 2 rows of husk buffer and the plot with 2 rows of husk buffer in addition to 25 cm husk mulch, respectively as shown in Fig. 1. The prepared slope model plots were set up at 8 degrees in slope and simulated by artificial rainfall. Rainfall simulation was carried out for 2 hours at the intensity of 60 mm/h. The experiment was replicated 3 times in separate days. Surface water discharge (Point 1) from each plot was measured and the surface water was collected at every 15 minutes for the first hour and at every 30 minutes for the second hour.

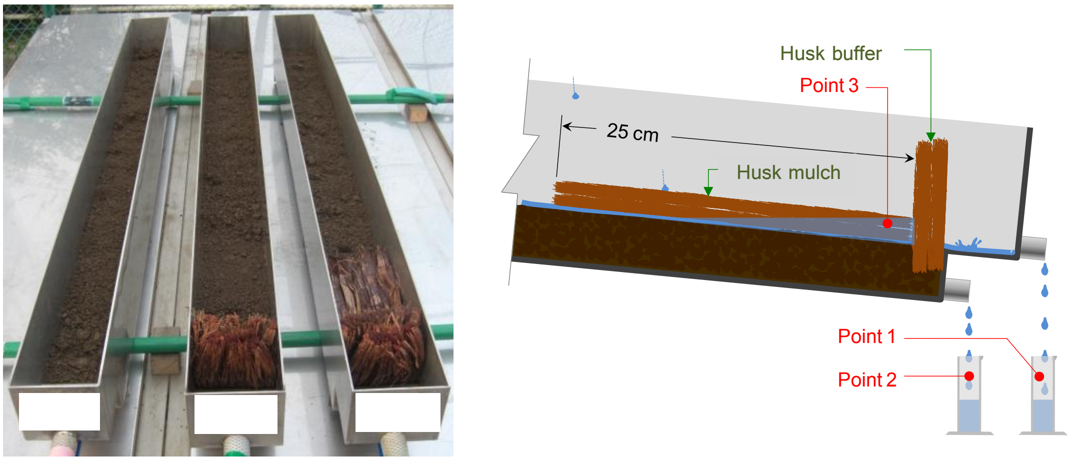

Fig. 1 Stainless slope model plots and installation of coconut husk buffer at slope toe

The amount of percolation water (Point 2) was measured and sampled after 24 hours from the end of each rainfall simulation. Both collected water samples at Point 1 and Point 2 were analyzed for total nitrogen (T-N) and total phosphorous (T-P). Also, the amount of soil losses were measured for collected water samples at Point 1. After the decomposition of water samples with sodium hydroxide (NaOH) and potassium peroxodisulfate ($K_2S_2O_8$), the concentrations of T-N and T-P were measured by spectrometric method (Mihara et al, 2000). Oven drying method was used to measure the soil loss concentration in the suspended water of surface runoff.

For comparing the particle sizes of soils eroded from each plot, the wet sieving method was applied using 106, 250, 500 and 1000 μm sieves (Ghadiri et al., 2001). One liter of suspended water was collected after passing through the sieves to determine the amount of <106 μm in diameters. Then the collected one liter suspended water was sampled by pipette method then filled into the weighing can and dried by oven together with the sieved soils from 106, 250, 500 and 1000 μm sieves.

RESULTS AND DISCUSSION

Soil losses

As shown in Fig. 2, the amounts of soil losses at Plot I as control dramatically increased with the repetition of rainfall simulation compared to that at Plots II and III with husk buffer. Also, there was a significant difference at 99% level between the amounts of soil losses at Plot I as control and that at Plots II and III with husk buffer in the second rainfall simulation test. During the first, second and third rainfall simulation tests, the 2 rows of husk buffer at Plot II could mitigate 36, 45 and 53% of soil losses at Plot I as control while the 2 rows of husk buffer with 25 cm husk mulch at Plot III could mitigate 50, 61 and 54%, respectively.

It was clearly observed that the coconut husk buffer worked to mitigate about 50% of soil losses. Meanwhile, the 2 rows husk buffered with mulch at Plot III had no significant difference in the amounts of soil losses with the 2 rows husk buffered at Plot II.

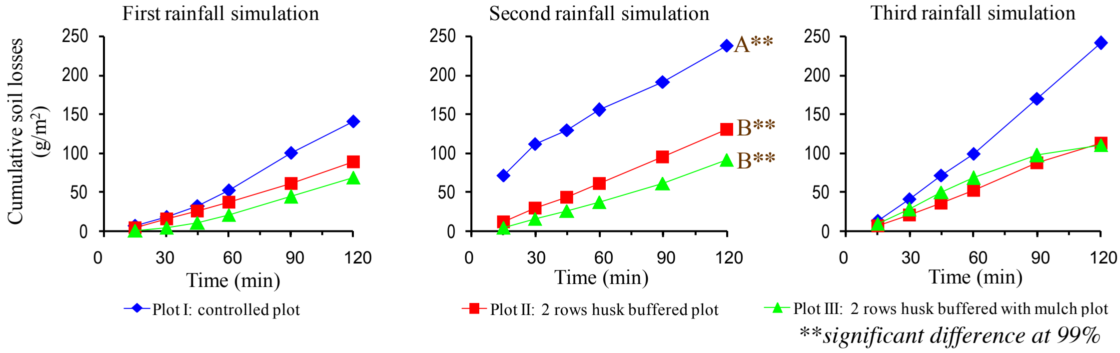

Fig. 2 Cumulative soil losses from Plots I, II and III in each rainfall simulation test

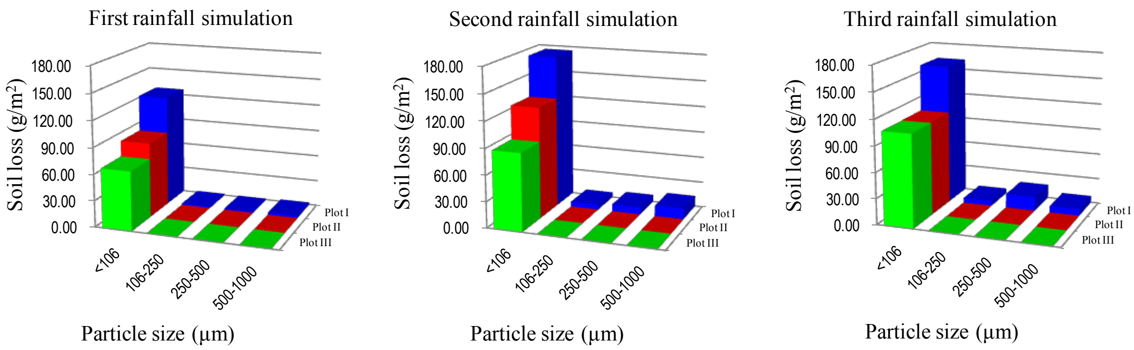

Fig. 3 Particle sizes of eroded soils from Plots I, II and III at first, second and third rainfall simulation tests

Coconut husk buffer strip trapping capability

The amounts of eroded soils from the plots in particle sizes of <106 μm in diameter were dramatically higher compared to the particle sizes of >106 μm (106 to 1000 μm) as shown in Fig. 3. Although coconut husk buffer could mitigate only around 25% to 35% of eroded fine soils in particle sizes of <106 μm, coconut husk buffer trapped 99% of eroded soils in particle sizes of >106 μm (106 to 1000 μm).

The experimental results showed the coconut husk buffer was highly capable to trap eroded soils larger than 106 μm in diameter, however less capable to trap fine soils in particle sizes of <106 μm.

Total nitrogen losses

As shown in Fig.4, the amounts of total nitrogen (T-N) losses through surface discharge from Plots II and III with husk buffer were slightly higher than that from Plot I as control in the first rainfall simulation test. It showed that coconut husk set in the plots released total nitrogen components. However, the amounts of total nitrogen (T-N) losses through surface discharge from Plots II and III became lower than that from Plot I in the second and third rainfall simulation tests.

Higher amounts of total nitrogen losses through percolation were observed at the husk buffered plots, particularly in Plot II (Table 1). The results clearly indicated that coconut husk set in the plots released total nitrogen components not only through surface runoff but also through percolation. In addition, there was a tendency for the amounts of total nitrogen losses through percolation to decrease with the repetition of rainfall simulation.

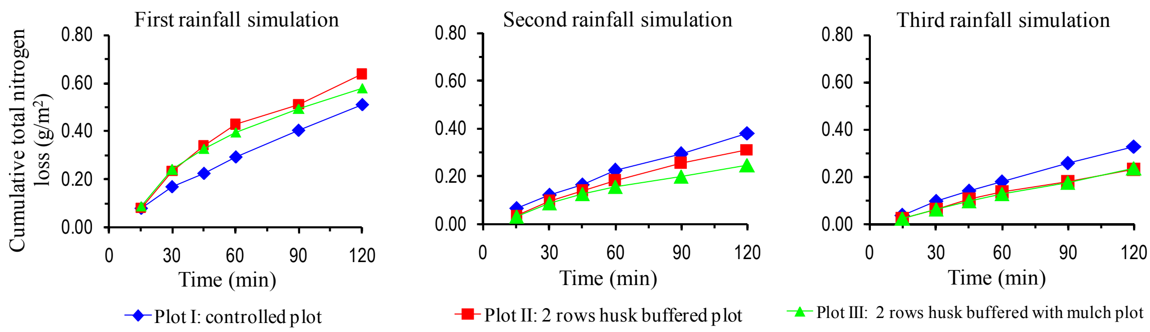

Fig. 4 Cumulative total nitrogen (T-N) losses through surface discharge from Plots I, II and III in each rainfall simulation test

Table 1 Total nitrogen losses through percolation (x10^{-2} g/m^2)

	First rainfall simulation	Second rainfall simulation	Third rainfall simulation
Plot I	2.889	1.561	0.955
Plot II	3.066	1.983	2.500
Plot III	1.615	1.235	1.209

Total phosphorus losses

As shown in Fig. 5, there was a tendency that the amounts of total phosphorus (T-P) losses increased with the repetition of rainfall simulation. Also, the amounts of total phosphorus (T-P) losses from Plots II and III with husk buffer tended to be lower than that from Plot I as control, although a significant difference was not recorded.

As shown in Table 2, the amount of total phosphorus losses through percolation tended to increase with the repetition of rainfall simulation, although some fluctuations in amounts of T-P losses were observed.

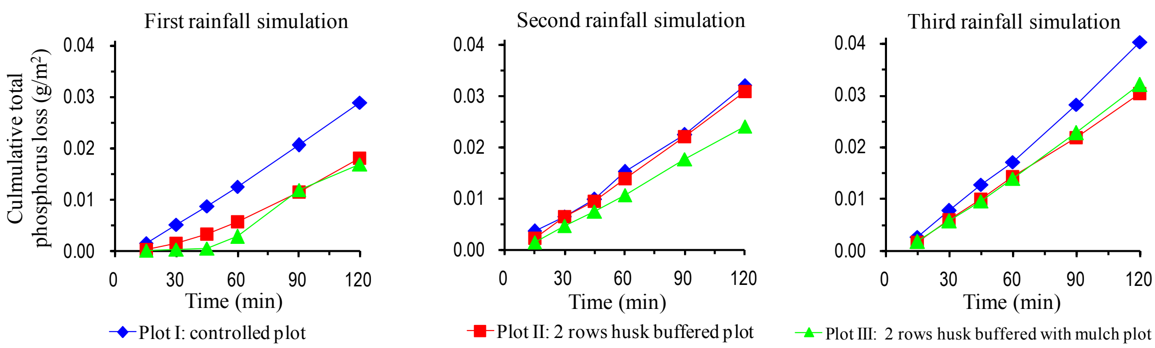

Fig. 5 Total phosphorus (T-P) losses through surface discharge from Plots I, II and III in each rainfall simulation test

Table 2 Total phosphorus losses through percolation (x10^{-2} g/m^2)

	First rainfall simulation	Second rainfall simulation	Third rainfall simulation
Plot I	0.039	0.090	0.120
Plot II	0.052	0.058	0.054
Plot III	0.031	0.161	0.048

Relationship between soil and nutrient component losses

As shown in Fig. 6, the relationship between total nitrogen and soil losses changed remarkably during the first to third rainfall simulation tests. During the first rainfall simulation test, the amounts of total nitrogen losses rapidly increased with the amounts of soil losses. In the second and third rainfall simulation tests, the trend in the first rainfall simulation test became gentler, as the amounts of total nitrogen losses gradually increased with the amounts of soil losses.

The amounts of total phosphorus losses increased with the amounts of soil losses (Fig. 7). The increasing tendencies of total phosphorus losses from each plot changed slightly during the first to third rainfall simulation tests. However, there was a tendency that the amounts of total phosphorus losses from Plots II and III with husk buffer became higher than that from Plot I of control, especially in the first and second rainfall simulation tests. In the third rainfall simulation test, the difference in the amounts of total phosphorus losses among plots became small.

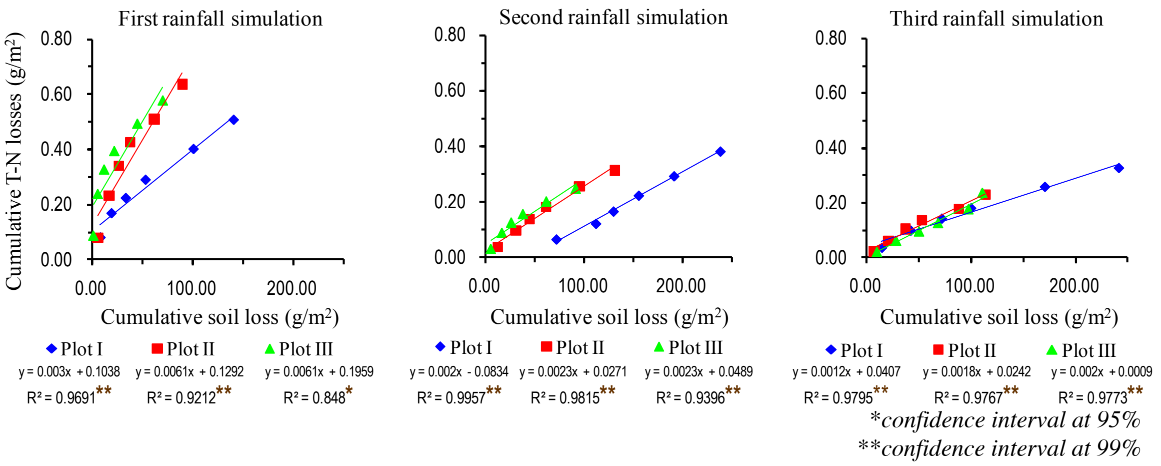

Fig. 6 Relationship between T-N losses and soil losses

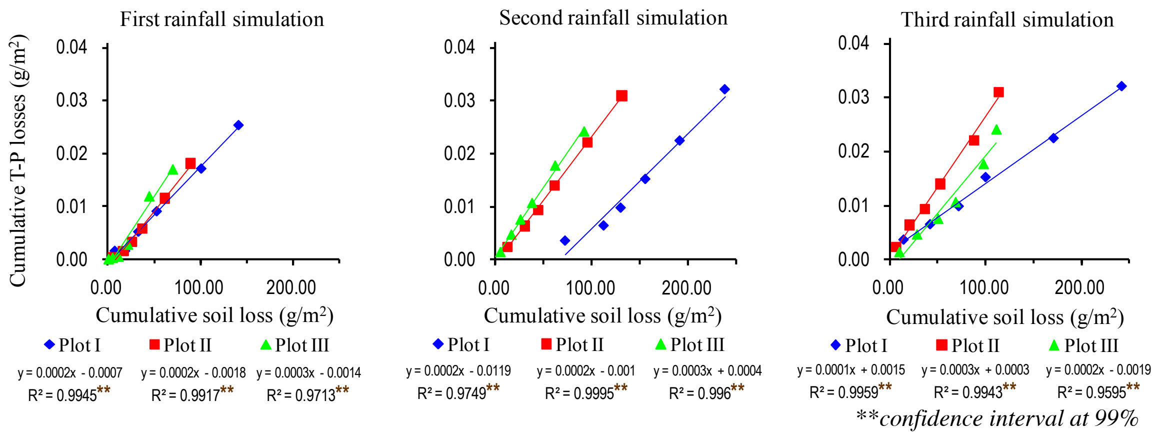

Fig. 7 Relationship between T-P losses and soil losses

CONCLUSION

In Bohol Island of Philippines, soil erosion causes serious environmental problems. Considering the agricultural socio-economic situation in the island, utilizing available materials in the region to mitigate soil erosion particularly in the upland fields have been focused. So, this study dealt with the evaluation of the effects of coconut husk buffer strip on mitigating the losses of soil and nutrients.

The experimental results indicated that coconut husk buffer could trap 99% of eroded soils in particle sizes of >106 μm (106 to 1000μm), however less capable to trap eroded fine soils in particle sizes of <106 μm. In addition, the nutrient losses from the plots with the coconut husk buffer were slightly higher than that from control plot without any treatments in the initial stage of rainfall events after the installation of coconut husk buffer strip. It was considered that coconut husk set in the plots released nutrient components.

ACKNOWLEDGEMENT

I would like to acknowledge the support of President Dr. Elpidio T. Magante of Bohol Island State University for his meaningful guidance and advices.

REFERENCES

Hussein, J., Yu, B., Ghadiri, H. and Rose, C. (2007) Prediction of surface flow hydrology and sediment retention upslope of a vetiver buffer strip, Journal of Hydrology, 338, 261-272.

Mihara, M. and Ueno, T. (2000) Nitrogen and phosphorus transfer in soil erosion processes, IAHS Publication, No. 263.

Orient Integrated Development Consultants Inc. (2006) Bohol Agriculture Master Plan, CY 2006-2026.