

Agricultural Methods of Alleviating Sediment Runoff in the Case of Red-soil Erosion and Runoff Problem in Okinawa

Keigo Noda* Kazutoshi Osawa** Tadatsugu Tanaka* Shunsuke Ikeda**

*:The University of Tokyo **:Tokyo Institute of Technology
Room, 616, Bldg.7A, 1-1-1 Yayoi, Bunkyo-ku, Tokyo, 113-8567 JAPAN
aa077092@mail.ecc.u-tokyo.ac.jp

Abstract

The red-soil erosion and runoff recently observed in Okinawa have led to not only agricultural but also environmental problems. In spite of its seriousness, few effective agricultural methods based on field tests have been proposed so far. The purpose of this study is to examine the difference of the amount of sediment runoff by different conventional cultivating ways of sugarcane and to verify quantitatively erosion reduction effects and crop yields of some methods as grass strips and partial tillage planting and intercropping. Several field tests were set up in the actual sugarcane field. The main findings were followed; 1) ratooning, one of the conventional cultivating ways was much more effective to prevent the sediment runoff than the others 2) the sediment runoff reduction ratio of methods were 17% (grass strips) and 69% (partial tillage planting and intercropping).

Introduction

In Okinawa, the problem of red-soil runoff has been frequently observed since 1970s as farmland improvement and infrastructure construction was in process. Since red-soil is characterized by acidity and being easily eroded, agricultural productivity is damaged by losing fertile soil in the farmland. The runoff soil and nutrient salts flowing into the sea damage water ecosystems as represented by those in coral reef. Several agricultural methods of alleviating erosion are proposed and tested. They were, however, on the laboratory or smaller scale, and only few have been made on the actual farmland scale so far (Osawa et al., 2005, Tamashiro et al., 2006). Here, the purpose of this paper is to examine the difference of the amount of the sediment runoff by different conventional cultivating ways of sugarcane which is a basic crop in Okinawa prefecture and to verify quantitatively erosion reduction effects and crop yields of some methods through field tests.

Outline of Field Tests

Field tests were implemented in Ishigaki city in Okinawa prefecture. Some test plots were set up dividing the sugarcane field actually engaged in agriculture. The test period was from Jun.2004 to Feb.2007. The particle size distribution of the surface soil was clay 5%, silt 19%, sand 32% and gravel 44% by ISSS. **Figure.1** shows the outline of the test plot. The width, the ridge height and the condition of the ground surface were different from the plots. However, on all plots the length was about 85m, and the slope was about 3.5%. The discharge was

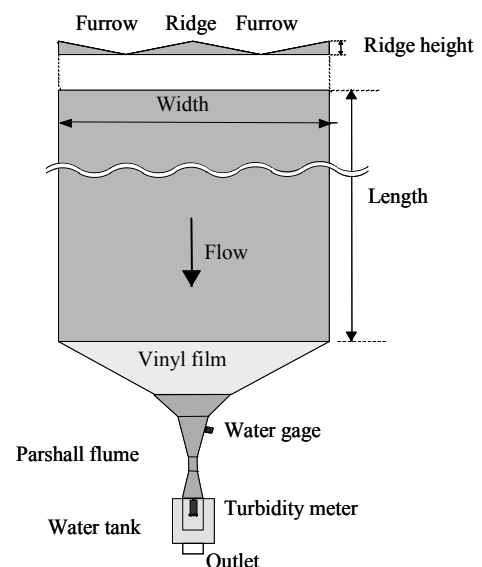


Figure 1. Outline of the test plot

calculated from the water level by the parshall flume flowmeter. The suspended sediment concentration was measured from the surface runoff water by suction filtration. Surface runoff water was sampled by hand. In this paper, the suspended sediment is defined as the soil particles in the surface runoff water. The turbidity interpolated the suspended sediment concentration. The total amount of sediment runoff is calculated from the product of the discharge and the suspended sediment concentration.

Conventional Cultivation Ways of Sugarcane

Table 1 shows the management of the plots. Spring planting and ratooning is annual and summer planting is biennial. On spring planting and summer planting, whole area is tilled before planting, and re-furrow is made after three or four months from planting. Ratooning is a no-tillage way and is made after harvest of spring planting or summer planting. In **Table 1**, it must be noted that spring planting was made twice (2004 and 2005), but summer planting was made once for two years (2005 to 2006).

Table 1. Management of the plots

year	cultivating way		
2004	spring planting	ratooning	
2005	spring planting		summer planting (1st)
2006			summer planting (2nd)

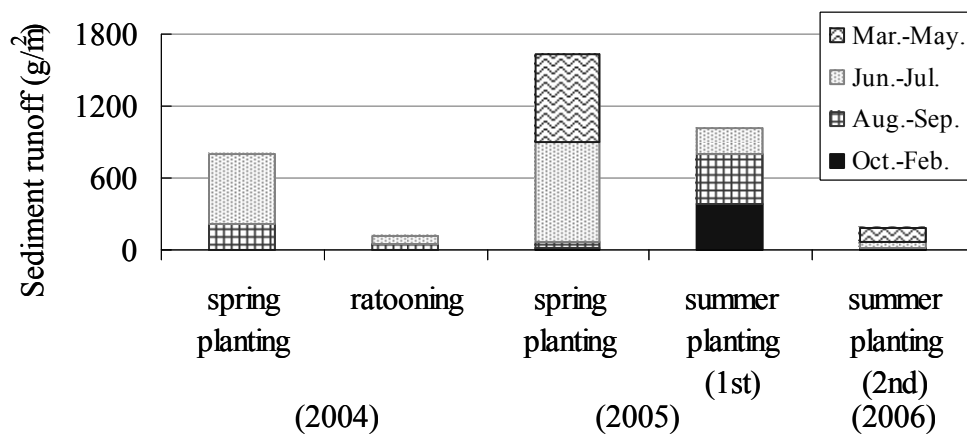


Figure 2. The amount of sediment runoff

The total amounts of sediment runoff for one year on each conventional cultivating way are showed in **Figure 2**, where the data of March to May in 2004 and in 2005 on summer planting were missing. In general, the amount of the sediment runoff is affected by weather condition and it is irrelevant to compare the data of different years. The difference of the spring planting after June between 2004 (790g/m²) and 2005 (910g/m²), however, was under 10% and it seems reasonable to compare the data of different years in **Figure 2**. Ratooning was 120g/m², and much less than the others. The reason for this was that on ratooning the ground coverage ratio being kept higher and the ground surface being kept no-tilled at all time of the year, when the surface water runs off, the suspended sediment concentration did not rise very high. In addition to this, the crop yield of ratooning was as much as that of spring planting which is said to be highly productive. Judging from the above, ratooning should be

recommended. Here it must be noted that for the purpose of ratooning, spring planting or summer planting must be made every two or three years. The total amount of spring planting (2005) was 1630g/m^2 and more than 95% of it was in the period from March to July. One of the reasons for this was that planting on February or March, the surface soil is easily eroded by rainfall splash until August when the sugarcane fully grows up. Another was that much precipitation is concentrated in the period in a year because of Bai-u and typhoon. On summer planting, the periods when sediment runoff was remarkable were before August and August to May. In the former, the farmland is kept bare and tilled before planting, and in the latter, sugarcane is growing up. The amount of sediment runoff in each period made up 17% and 79% to the total (1210g/m^2). It may be worth pointing out that in the bare term relatively smaller rainfall didn't cause surface runoff due to high permeability. It follows from what has been said that on spring planting and summer planting, effective runoff reduction methods are needed from planting to full growth.

Agricultural Methods of Alleviating Sediment Runoff

The agricultural methods of alleviating sediment runoff examined in this test were 1) grass strips and 2) partial tillage planting and intercropping. 1) The grass strips were a kind of turf (*Zoysia matrella*) set in the downstream edge (width 60cm). 2) On partial tillage planting, whole area was not tilled before planting and only dug a ditch for seedling. After making re-furrow, Sunn-hemp (*Crotalaria Juncea L*) was seeded in the rill as intercrop.

1) Grass strips

This test was implemented in 2004. The result is presented in **Figure 3.**, where spring planting was made in both plot. The total amounts of sediment runoff were Plot-1: 630g/m^2 and Plot-2: 690g/m^2 . The reason why Plot-2 was larger than Plot-1 was that in Plot-2 the amount of June was very large, and that the grass strips was set up in 6th June, 2004 and it didn't take root yet and the surface soil was jumbled. For the present, we shall concentrate on August and after September (Plot-1: 200g/m^2 , Plot-2: 170g/m^2). Due to grass strips, the amount of sediment runoff was reduced by 17%. According to Tamashiro et al (2006), the grass strips of 50cm width reduced sediment runoff by 24%. Considering some difference of test condition as slope length, angle, climate and so on, this result seems pretty reasonable. Grass strips, as mentioned above, is not so effective for sediment runoff reduction from the whole farmland but should be useful for slope protection. On the other hand, it must be noted that grass strips affects not on the crop yield very much but on the cultivating management.

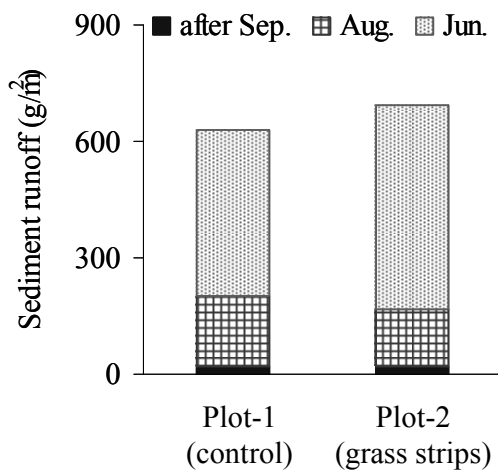


Figure 3. Effect of grass strips

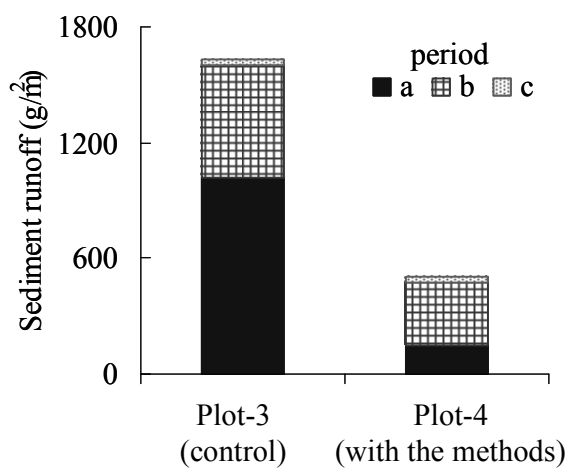


Figure 4. Effect of partial tillage planting and intercropping

2) Partially tillage planting and intercropping

This test was implemented in 2005. The result is shown in **Figure 4.**, where spring planting was made in both plots and in Plot-4 partial tillage planting and intercropping were applied. Here the test period is divided into three; a) Mar. (planting) to Jun. (before re-furrow), b) Jun. (after re-furrow) to Aug. and c) Sep. to Feb (harvest). In period-a, partial tillage planting was effective. In period-b, Sunn-hemp was growing up in the rill but a typhoon killed it in August. In period-c, both plots were in the same condition. The total amounts of sediment runoff were Plot-3: 1630g/m² and Plot-4: 500g/m². Plot-4 was smaller by 69%. The sediment runoff reduction ratio of Plot-4 to Plot-3 in each period were 85% (period-a), 45% (period-b) and -15% (period-c). Since period-a and period-b, as mentioned above, are equivalent to the period when sediment runoff is remarkable, the effect on the total amount of the year was great. The amount of period-c was much less than the others and the reduction ratio makes no sense. Judging from the above, the cultivation with partial tillage planting and intercropping is very effective for reducing sediment runoff. On the other hand, the crop yield of Plot-4 was less than Plot-3 by 36% and it's a serious problem.

Conclusion

In this study, we verified the effective agricultural methods of alleviating the red-soil runoff problem in Okinawa. The findings of several field tests implemented on a farmland scale are followed. First, in the conventional cultivating ways of sugarcane, ratooning is much more desirable than the others in term of soil conservation. Secondly, in respect of alleviating sediment runoff, the grass strips of 50cm are not so effective (only 17% reduction). Thirdly, the cultivating way with partial tillage planting and intercropping on spring planting was very effective (69% reduction) while it remains a problem that the crop yield was cut 36% off.

References

- Osawa K., Yamaguchi S., Ikeda S., Takamuku K. (2005): Field Observation of Sediment Runoff Reduction Methods on Farmland. *Journal of Hydrosience and Hydraulic Engineering*, vol. 49, 1099-1104, 2005.
- Tamashiro K., Nakashima K., Shiono T. (2006): Effect of grass Bands on Erosion Control at Plowed Layer Soil (in Okinawa). *Journal of the Japanese Society of Irrigation, Drainage and Reclamation Engineering* 74(2), 151-152, 2006.