

Selection of soil and water conservation practices for a giant bamboo plantation in Taiwan

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ABSTRACT This paper attempts to find a suitable supplementary conservation measure for a sloping giant bamboo plantation in Taiwan already traversed by ditches. Five treatments are compared: Bahia grass, Geania grass, one-year fallow, natural grass, and natural grass cover without interillage. The experimental plot with a barrier of Bahia grass is found to give the lowest runoff, the lowest soil loss, the highest organic matter content, the best pH value in the upper 5 cm of topsoil, and a reasonable crop yield in both wet and dry years. The one-year fallow plot gave similar results but the yield was lower at harvest. Therefore the Bahia grass barrier was found to be the best supplementary conservation practice.

Choix des moyens de conservation du sol et des eaux pour les plantations de bambous géants à Taiwan

RESUME Un essai est fait pour trouver une technique complémentaire adéquate pour les plantations, sur terrain en pente, de bambous géants de Taiwan qui comportent déjà des rigoles à flanc de coteau à travers de la pente. Une barrière de gazon de Bahia s'est révélée être la meilleure technique parmi les cinq traitements: barrière de gazon de Bahia, barrière de gazon de Geania, une année de jachère, une couverture de gazon spontané, une couverture de gazon spontané sans labour intermédiaire. La parcelle expérimentale avec barrière de gazon de Bahia et rigoles à flanc de coteau assure le minimum de pertes d'eau, le minimum de perte de sol, le contenu de matières organiques le plus élevé et la meilleure valeur du pH dans la couche supérieure de 5 cm, ainsi qu'un rendement de récolte raisonnable d'après les données expérimentales pour une année sèche ou une année humide. Une parcelle laissée en jachère pendant un an a fourni les mêmes avantages que ci-dessus sauf en ce qui concerne le rendement.

INTRODUCTION

According to *The Statute of Slopeland Conservation and Utilization* (1979) (JCRR and MARDB, 1977), slopeland is defined as an area with gradient $\geq 5\%$ or with altitude $\geq 100\text{m}$. According to this classification 73% of Taiwan Island is slopeland. Figure 1 shows the central mountainous regions and the marginal areas which are mainly classified

Liao, 1977). This paper presents the results of an experiment to compare these five treatments on sloping giant bamboo plantations on Taiwan Island.

MATERIALS AND METHOD

Treatments

The five supplementary treatments to be used with hillside ditching are:

- Treatment 1: volunteer grass cover and intertillage (1977-1980);
- Treatment 2: volunteer grass cover but without intertillage (1977-1978);
- Treatment 3: three rows of Geania grass and intertillage (1977-1980);
- Treatment 4: Bahia grass barrier (2.5 m wide) and intertillage (1977-1980);
- Treatment 5: One year fallow (1978-1979).

Intertillage was performed in January.

Plots

The experimental site is located at 23°50'N and 120°43'E. The elevation, the aspect, and the slope are respectively 350 m, north-east and 15°. Moreover, the annual rainfall at the experimental site is the same as the island average annual rainfall of 2500 mm.

The area of each plot is 25 x 36 = 900 m². The number of bamboos per bunch is kept to four or five, and each bunch occupies 5.0 x 6.0 m², therefore, the total number of bamboo bunches is 30. The layout of the plots is shown in Fig.5. The design criteria for hillside ditching is given in the *Handbook of Soil and Water Conservation* (JCRR and MARDB, 1977).

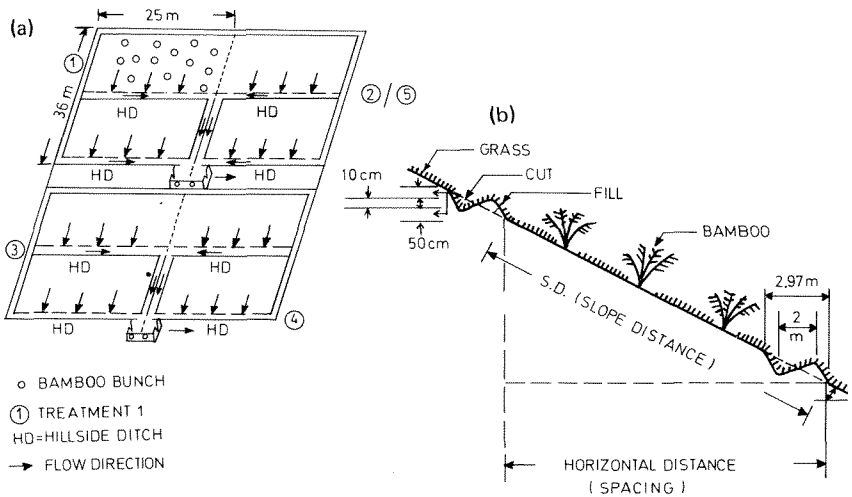


FIG.5 Layout of experimental plots: (a) plan, (b) profile giving dimensions.

Observations and measurements

- (a) Rainfall is measured by a slanting hole gauge (Liang, 1979a).
- (b) Runoff is measured by a triangle weir with a 90° angle.
- (c) Sediment is sampled by an automatic sediment sampler (Liang, 1979b).
- (d) The harvest of young bamboo shoots.
- (e) The cost of labour and management.
- (f) Laboratory analyses of the physical and chemical properties of the upper 5 cm of topsoil on plot and of sediment samples.

RESULTS, DISCUSSIONS AND CONCLUSIONS

Experimental data from 1977 (wet year with 2865 mm rainfall: June-September 1393 mm, and October-November 975 mm) and 1979 (dry year with 1697 mm rainfall: June-September 780 mm, and October-November 635 mm) were examined. Four storms (26.5-148.5 mm, lasting between 4 h and 2 days) in 1977 and three storms (25.0-100.7 mm, lasting between 3 h and 2 days) in 1979 were analysed. Four-hourly data are presented in Fig.6.

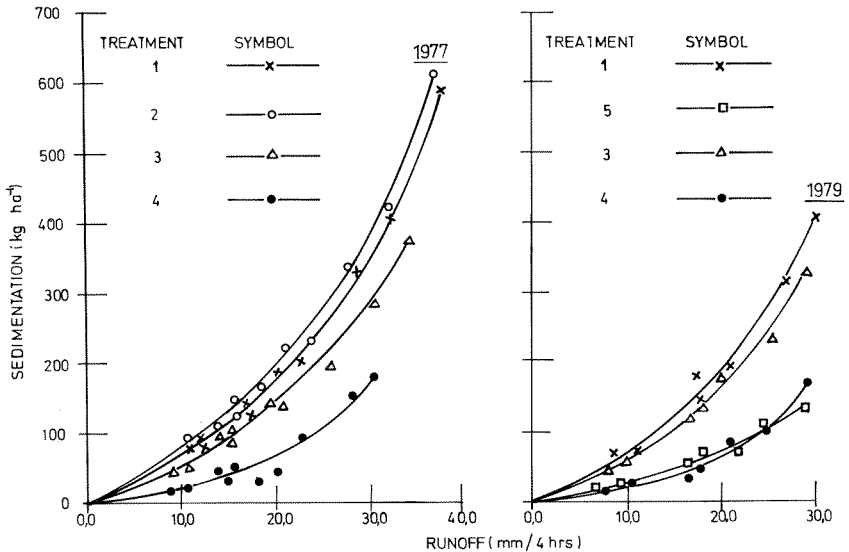


FIG.6 Runoff-soil loss relationship: the reduction of runoff and sediment concentration by treatment 4 are significant for runoffs of less than 32 mm per 4 h.

It is clear that treatments 4 and 5 significantly reduce runoff and sediment concentration. Due to the fact that volunteer grasses and *Geania* grass didn't grow well under the bamboo stands, the poor ground cover of treatments 1, 2 and 3 resulted in higher runoff and correspondingly higher sediment concentrations. The higher the runoff and the sediment concentration the higher the soil loss. For runoff rates above 32 mm per 4 h, even treatment 4 may not provide

any better protection from soil loss than the other treatments.

Treatments 4 and 5 help maintain a higher organic matter and improve the pH value of the upper 5 cm of topsoil (Fig.7(a) and (b)). The pH is higher in sediment samples, and drops to a value of 4.2 in the topsoil. Samples from June to August show a bigger range of drop than those from September to November. The pH values from

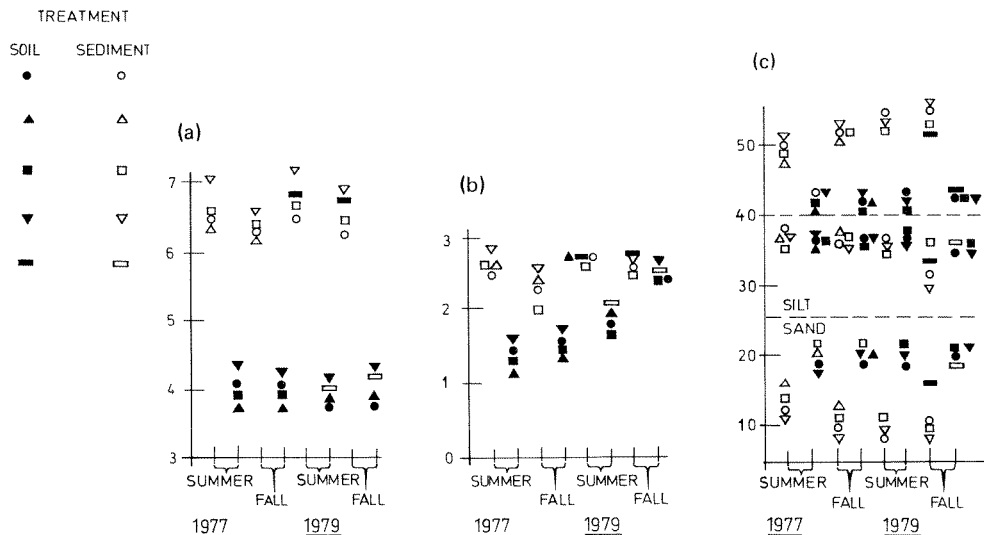


FIG.7 Physical and chemical properties of samples from various treatments: (a) pH value, (b) percentage of organic matter, (c) grain size distribution.

treatments 4 and 5 are higher than those from the other treatments. The organic matter content is as high as 2.5% in sediment samples but decreases to 1.5% in the topsoil, the decrease becoming smaller in drier seasons. Treatments 4 and 5 have a higher organic matter content than the other treatments. Judgements based on the soil properties of the root zone are essentially considered for a long-term experiment rather for this short-term experiment; therefore the soil properties of 5 cm top soil is investigated.

All the samples show homogeneous composition with illite 30%, mica 30%, kaolinite 34% and montmorillonite 6%, due to the fact that both sediment and soil samples originate from the same source. Figure 7 shows (a) a 10% clay increase and a 10% sand decrease in sediment samples, while the silt content remains almost the same in both topsoil and the sediment samples; and (b) the clay increase is inversely proportional to rainfall. The drier the season the bigger the range; however the differences between the treatments are not significant.

Table 1 shows the cost and harvest values of the various treatments. With high runoff rates and soil losses treatment 1 is not a good conservation practice, even though it may result in the highest harvest. The yield of eatable young bamboo shoot varies with the seasonal rainfall: the wetter the season the higher the yield.

TABLE 1 Cost of and harvest from the various treatments on an annual basis (plot size = 36 x 25 = 900 m²; unit = US\$ in 1979)

Treat- ment	Value of young bamboo shoots	Management and harvest cost*	Fertilizers, pesticides, herbicides	Hillside ditch construct- ion cost	Balance
1977					
1	200	55 + 30 + 30	10	10	+65
2	100	48 + 30 + 30	10	10	-28
3	115	44 + 30 + 30	10	10	-9
4	140	30 + 30 + 30	10	10	+30
1979					
1	145	40 + 30 + 30	15	-	+30
5	-	0 + 0 + 30	5	-	-35
3	80	30 + 30 + 30	17	-	-27
4	95	20 + 15 + 30	20	-	+10

*The cost of digging eatable young bamboo shoots under treatment 4 is \$30 (US), the transportation cost is \$30 and management cost is \$30.

Treatment 4 provides a reasonable income. One year fallow, treatment 5, does not produce any harvest.

Above all, hillside ditching with the supplementary practice of a good ground cover gives good protection from soil loss. The Bahia grass barrier of treatment 4 results in not only the lowest soil loss, no deterioration, and lower runoff rate but also a seasonal harvest. Due to the excellent covering of volunteer grasses during the one year fallow treatment, treatment 5 is regarded as a good practice if harvest income can be ignored. Treatment 1 maintains good yield within a short period but suffers from terrible soil loss, soil deterioration, and high runoff hazard. Volunteer grasses cannot grow well under the bamboo stands, treatments 2 and 3 are no good at all and they should be avoided in all cases.

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