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Soil Conservation and Farming Systems on Slope Land in Indonesia and the Philippines

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Abstract

The role of soil conservation in slope land farming systems in Indonesia and the Philippines is very important. In a visit by the authors to some areas in both countries, they observed that many farmers were practicing soil conservation in their agricultural land in response to the land condition and socio-economic environments. The agricultural land was characterized by sloping farmlands and low soil fertility. Soil condition and land topography have great influence in the farmers' adoption of soil conservation practices for sustainable agricultural production.

Key Words : soil conservation, farming system, sloping farmlands, Indonesia, Philippines

Introduction

Racially and culturally, Indonesia and the Philippines are related. Indonesia, particularly Java and Bali islands is quite similar to Philippines. They are characterized by active volcanism and are located in the humid tropic region. Volcanic areas are mainly dominated by sloping lands and volcanic ash soils. High precipitation, sloping topography and volcanic ash soils are factors promoting high erosion rates and land degradation. The problems of land degradation particularly soil erosion beset both countries which is more common in the fragile environment of the uplands and slope lands and cause decreasing land productivity. Moreover, the poverty of farmers and high population in these countries lead to annual crop cultivation moving onto sloping land. Appropriate method of soil erosion control on slope land is needed. Farmers in both countries are already aware of the importance of adopting soil conservation measures in their farming systems, as such appropriate soil conservation strategies and farming system will control soil loss and improve productivity.

This report focuses on the slope land ecosystem in East Java and Bali islands in Indonesia and in the provinces of Davao del Sur and Cebu in the Philippines. The aims of this research are to describe land characteristics and the different soil conservation strategies to achieve sustainable farming system.

Materials and Methods

To ascertain the different soil conservation practices of the farmers at the study areas in Indonesia and Philippines field observation and reconnaissance survey were conducted. In addition, interview with local farmers to assess their perceptions regarding the adoption of soil conservation practices as well as gathering of secondary data from the available literatures were done. In each site, farming system components and land characteristics such as slope, soil texture, soil color, etc. were examined.

Results

Land Characteristics

Land characteristics of the study sites in Indonesia and the Philippines are shown in Table 1. Six villages were studied in Indonesia while there were two in the Philippines. The location of the study sites in Indonesia and the Philippines are shown in Figures 1 and 2, respectively.

East Java, Indonesia

In East Java, particularly in the district of Malang,the villages of Gubuk Klakah, Ngadas, Bendosari and Donomulyo were visited and studied. In general, the soils in the four villages have low soil moisture content due to long dry season. Due to higher elevation, the villages of Ngadas, Gubuk Klakah and Bendosari have relatively cooler temperature than the low-lying village of Donomulyo. Ngadas and Gubuk Klakah soils were developed from volcanic ash material while Donomulyo soil was from limestone.

Bali, Indonesia

The study sites in Bali were the villages of Pancasari and Candikuning, both highland villages with steep topography. Udayana University in Bali, has a research site in Candikuning.

Davao del Sur, Philippines

Pananag, village was the study site in the province of Davao del Sur in the Philippines where the Mindanao Baptist Rural Life Center (MBRLC), a non-government organization (NGO), developed and promoted the adoption of the Sloping Agricultural Land Technology (SALT). The village is located on a ridgeline descending from the peak of Mt. Apo. The topography in the area is characterized by moderately dissected footslopes, sideslopes, crests and ridges (Garcia *et al.*, 1995 b).

Cebu, Philippines

Tabayag village occupies a watershed whose streams are tributaries of the Argao River, The village is part of the study site in the island of Cebu which is an extension site of the Mag-uugmad Foundation, Inc. (MFI). This is an NGO dealing with the promotion of soil and water conservation technologies in upland

Table 1 Land characteristics of study sites in Indonesia and the Philippines

Location	CHARACTERISTICS						
	Elevation (m)	Annual Rainfall (mm/yr)	Ave. T (℃)	Soil Type	Soil Texture	Slope (Degrees)	Soil Color
Gubuk Klakah, East Java, Indonesia	1,200	—	24	Andosol	Sandy clay	—	10 YR 4/3
Ngadas, East Java, Indonesia	2,070	1,900	21	Andosol	Sandy loam	34	—
Bendosari, East Java, Indonesia	930	1,500	25	Regosol, Andosol	Sandy loam	38	10 YR 4/3
Donomulyo, East Java, Indonesia	215	—	28	Mollisol	Clay loam	35	10 YR 2/3
Pancasari, Bali, Indonesia	1,218	1,600	23	Regosol	Sandy loam	—	10 YR 5/4 10 YR 5/3
Candikuning, Bali, Indonesia	1,240	1,000	22	Andosol	Sandy loam	—	10 YR 5/3 10 YR 4/3
Pananag, Davao del Sur, Philippines	300-800	1,750	27	Ultisol	Fine loam to fine clay	5-10	—
Tabayag, Cebu, Philippines	240-700	1,500	28	Entisol	Heavy clay	15-27	10 YR 3/3

— : unknown

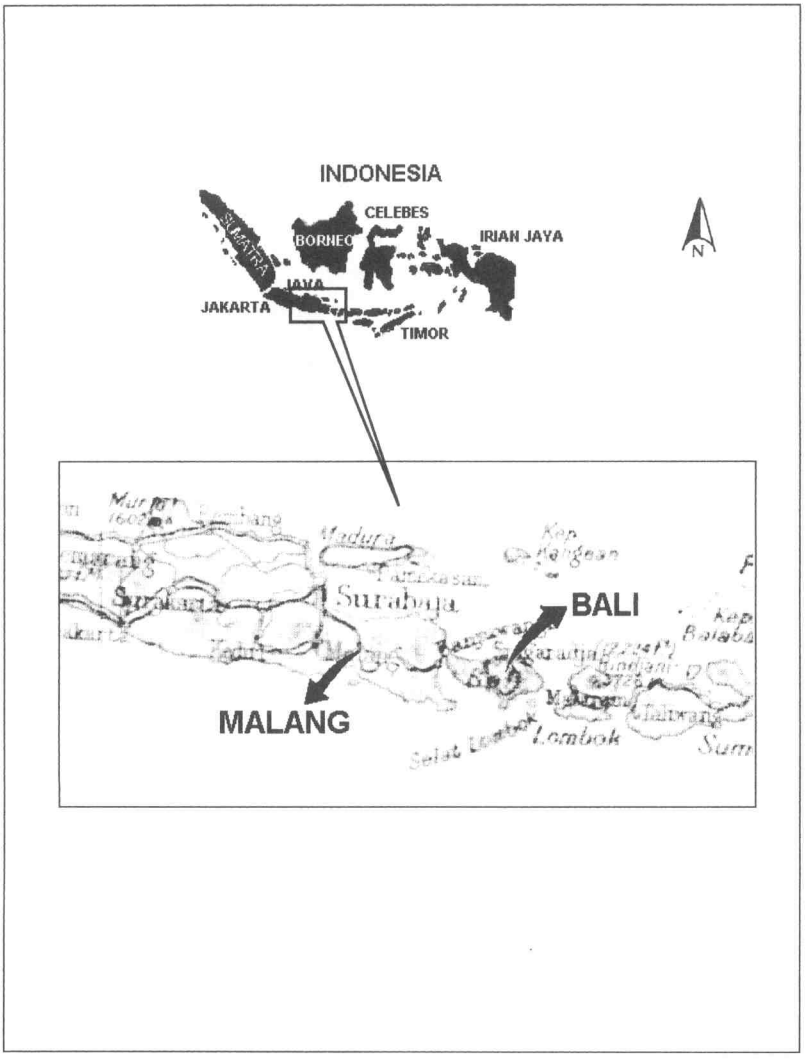

Fig. 1 Location map of study sites in Indonesia

communities.

Farming Systems and Soil Conservation Practices in the Study Areas

East Java, Indonesia

The dominant crop in the village of Gubuk Klakah is apple usually planted on bench terrace to prevent soil erosion. The major outlet for the apple produced in the village is the local market. The important annual crop in the area is corn and planting of grass strips is common.

In Ngadas, a village with relatively higher elevation, vegetables, especially potatoes and onions are the most suitable crops for the local climate. These vegetables are planted up and down the slope on short vertical ridges with contour ditch for each row of plots (Fig. 3). As soil conservation measures, farmers practice grass strips and hedgerow planting with perennial crops planted mainly at the farm boundaries.

In the Bendosari area, the dominant dry season crop is corn planted on terraced mountain slopes and inter-cropped with perennial crops such as avocado, coffee, *Agathis* and *Caliandra*. The terrace riser (Fig. 4) is generally

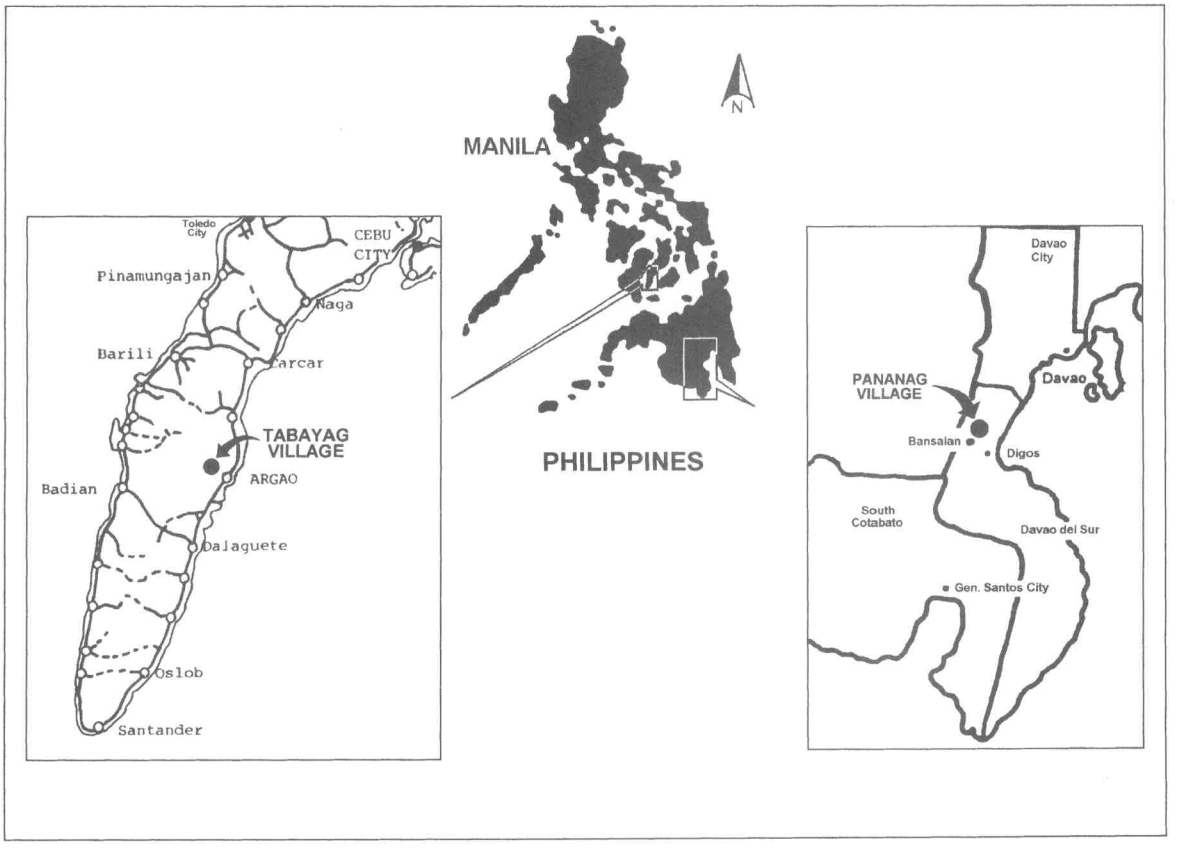

Fig. 2 Location map of study sites in the Philippines

planted with elephant grass. Drainage ditches are constructed in some portions of the farm lots to discharge excess surface runoff. The Local Forestry State Company (PERHUTANI) assists the farmers in implementing the above-mentioned soil conservation measures. Some areas are under the social-forestry program. This land use type is referred to as multistorey agroforestry system.

Soil in Donomulyo is shallow due to steep slopes and past erosion. The soil's parent material is limestone. Soil conservation in this area is practiced by constructing stone walls along the contour. Farmers grow leguminous species such as *Leucaena* and/or *Gliricidia* below the stone wall to strengthen the structure (Fig. 5). Beside the stone walls, stalks of cassava are also piled up which are effective in controlling the velocity of surface runoff. Dry season in

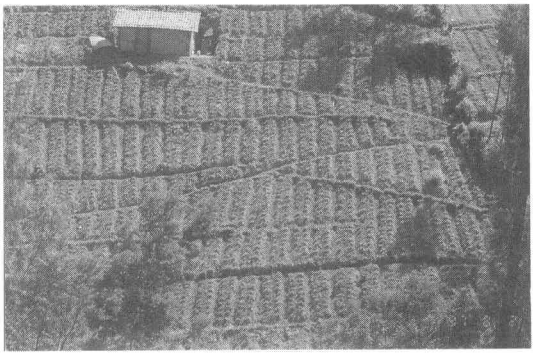

Fig. 3 Potato plots oriented up and down along a vertical ridge in Ngadas village, Malang, Indonesia

Donomulyo is quite long and there is only one cropping season in a year. During the cropping season, farmers also intercrop corn with soybean and cassava. Mahogany trees are pre-

Fig. 4 Terraced mountain slope planted to corn in Bendosari village, Malang, Indonesia

Fig. 6. Terraced slope with legumes as alley crops in Candikuning village, Bali, Indonesia

Fig. 5 Limestone walls together with Leucaena and Gliricida in Donomulyo village, Malang, Indonesia

Fig. 7 Terraced slopes with corn and other vegetables as alley crops in Pancasari village, Bali, Indonesia

dominant in the area and are also planted as a soil conservation measure. Similar to Bendosari area, agroforestry system under the social forestry program is also practiced with teak as the dominant tree species.

Bali, Indonesia

The villages of Pancasari and Candikuning have similar farming systems and soil conservation practices. Farming system in both areas is generally mixed cropping where the main crops are tomato, potato, legumes, cabbage, chili, onion and corn. The slopes in both areas are terraced with napier grass planted along the terrace embankment (Figs. 6 & 7). In the Pancasari area, it was noted that the steep slopes had trees and generally not cultivated. This practice could be a soil conservation strategy by the farmers.

Davao del Sur, Philippines

In the village of Pananag corn is the most widely grown annual crop although some areas are planted with tuber crops. The most common perennial cash crops are coconut and coffee. In the past, farmers did not have traditional soil conservation practices. The introduction of the Sloping Agricultural Land Technology (SALT) led the majority of the farmers to establish hedgerows in their farms devoted to maize production (Fig. 8). Leguminous hedgerow species being grown are *Flemingia, Desmodium, Leucaena, Gliricidia* and *Acacia.*

Similar to the village in Davao del Sur, the

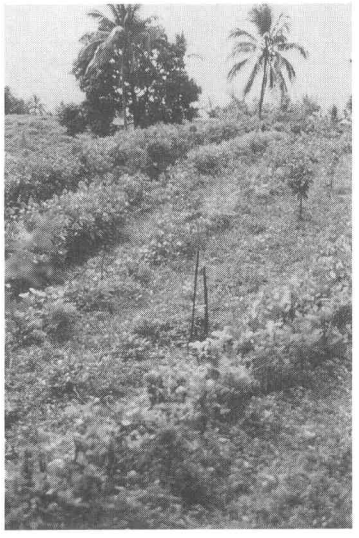

Fig. 8 Sloping agricultural land technology (hedgerow intercropping) in a farmer's field in Pananag village, Davao del Sur, Philippines

farming system in Tabayag village, Cebu is subsistence farming with corn as the dominant crop. Coconut and vegetables are also grown in the area. Soil conservation was introduced by the Mag-uugmad Foundation Inc. (MFI) by planting contour hedgerows and constructing contour bench terraces, check dams, drainage canals and stone walls (Fig. 9).

Discussion

This section focuses on the effect and importance of the soil conservation practices on the farming systems and crop production in the study villages. The bench terraces in Gubuk Klakah which is one of the major apple producing areas in Malang, East Java can support sustainable farming by controlling soil erosion. It means that land productivity will be maintained and the economic situation in the village can be improved. Without soil conservation practices, apple production as the main source of income by the local farmers may be threatened due to increased soil erosion. Steep slopes, high precipitation and highly erodible soils cause accelerated erosion problems in this

Fig. 9 Contour stone walls with corn and legumes intercrop in Tabayag village, Cebu, Philippines

area.

Compared with the soil in Gubuk Klakah, which contains higher clay, soil texture in Ngadas is coarser. Volcanic ash from Mt. Semeru still fall continually in the area. This combined with the parent material (volcanic ash) causing high sand content of the soil in Ngadas. High content of sand makes the soil to have high erodibility and low stability. Previous studies support this finding. Shibuya *et al.* (1981), in comparing soil erosion on sandy and loamy soils, observed that loam had a greater resistance than sand to the erosive power of rainfall and surface runoff. Also, Bruce-okine and Lal (1975) observed that erodibility varies directly with sand and inversely with clay content. Bench terrace is not suitable in Ngadas due to instability of the soil. As such, short vertical ridges combined with contour and drainage canals are the typical conservation measures. While there is no impermeable layer in the soil, the combination of the vertical ridges and drainage canals can convey excess water during high rainfall events outside of the planted area and is more effective in controlling soil erosion.

Potatoes and onions require intensive soil cultivation in addition to the fact that soil in Ngadas is very loose which may accelerate the rate of soil erosion although soil aeration is enhanced (Mastur *et al.*, 1996). Fertilizer effi-

ciency is better when placed in ridges than when there are no ridges (Mastur *et al.*, 1996). The combined conservation practice may assure the farmers of long term productivity.

Similarly in Bendosari, terracing allows the farmers to pursue a sustainable farming system. In this area, intensive farming is established by combining both annual and perennial crops. Bendosari and Donomulyo are both under the Social Forestry Program and farmers can produce food crops during the early stages of establishing forestry trees. Since the main forestry trees take a long time to establish before the canopy becomes dense and thick, the land can still be planted with other perennial crops such as coffee, avocado, durian and *Agathis*. In Donomulyo, which has different soil type, the construction of stone walls promote two benefits. The farmers get their farms cleared for planting and soil erosion is controlled as well. In addition, the piling of cassava stalks along the stone walls will also improve the soil organic matter content through decomposition. Moreover planting of *Leucaena* or *Gliricidia* not only strengthen the stone walls but also supply nitrogen through green manure.

Terraces in combination with grass strips is a common conservation strategy practiced in both Pancasari and Candikuning. In these areas, the main farming system is multiple vegetable cropping system. The soil in the study village is also loose and sandy, but it is more stable than the soil in Ngadas. Soil in these areas is deep and the slope more gentle than in Ngadas. Basically, bench terrace is suitable on deep soil and gentle to moderate slope. Terracing has been found to be very effective in controlling soil erosion.

In the province of Davao del Sur in Philippines, the effect of hedgerows is very evident as perceived by the farmers. Increase in the yield of maize was realized by majority of farmers. Moreover, the benefits of soil conservation practices to the farmers was increase in soil fertility and soil moisture holding capacity due to mulching with hedgerow trimmings (Garcia *et al.*, 1995 b).

Even in qualitative terms, farmers in the study area in Cebu, the Philippines recognize the effect and importance of the various soil conservation strategies in their farm land by improving soil fertility. Furthermore, contour hedgerows planted at the base of stone walls reinforce the walls as well as supplying green manure and fodder for livestock (Garcia *et al.*, 1995 a). Because of the benefits realized from the conservation practices, majority of the farmers in the community continue to adopt the soil conservation measures.

Looking at the various soil conservation strategies being practiced in the study sites, some differences can be noted. While all the areas have a generally sloping topography, the practices differ.

One factor that could have influenced the difference is the soil. In the village of Gubuk Klakah, Indonesia for example, bench terrace was adopted and found suitable because the soil was deep and has high clay content. Terracing is not possible in Ngadas village because the soil is extremely coarse with high sand content. Hence, the soil conservation practice being adopted is the construction of short vertical ridges and contour canals to control soil erosion.

Another factor is the availability of local materials useful in establishing a soil conservation measure. The example here is the village of Donomulyo where limestone is abundant and cassava is a major crop. Using these materials, the farmers in the area had limestone walls with cassava stalks piled along the walls. In the villages where these materials are not available, such soil conservation strategy will not most likely be established.

The two study sites in the Philippines have also differences in soil conservation strategies. In Pananag village, majority of the farmers adopt the Sloping Agricultural Land technology (SALT), an alley cropping system while Tabayag village has bench terraces, check

dams and rockwalls. The identifiable reason for this difference is that different groups promoted the soil conservation strategies. In Pananag village, it was the Mindanao Baptist Rural Life Center while in Tabayag village, it was the Mag-uugmad Foundation, Inc. It cannot be discounted however, that the difference could also be due to soil, topography, available resource and farmer's preferences.

Conclusion

Food production is a natural and inherent activity of farmers. However, whether this is on a large scale or at subsistence level the adoption of soil conservation practices is vital for sustainable farming system through erosion control and improvement of soil fertility. The combination of agronomic and mechanical methods is effective to control soil erosion and improve land productivity.

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インドネシアおよびフィリピン両国の傾斜畑における土壌保全と農法との関係

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要　旨

インドネシアとフィリピン両国では，傾斜地の土壌保全に対して各々適切な農法を行うことが極めて重要とされている。著者らは両国のいくつかの地域を調査し，土壌条件および社会経済条件等の環境に対応して，多くの農家が農地の土壌保全を実践していることに気づいた。農地は，傾斜畑の性質や肥沃度などによって特徴づけられていた。土壌条件と地形は，持続的農業生産にとって最も必要な土壌保全方策に強い影響を与え，農家の伝統的農法の実践によってその制御が行われている。

本論は，両国の傾斜畑現場の実践的実例を観察し，傾斜地農業の在り方について考察したものである。

キーワード：土壌保全，ファーミング・システム，傾斜畑，インドネシア，フィリピン

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