American-Eurasian Journal of Sustainable Agriculture, 5(3): 378-383, 2011
ISSN 1995-0748

ORIGINAL ARTICLES

A Comparative Assessment of Rain Erosion Hazard of Five Land Use Types And Management Practices In Mhong Chun Yen Village, Northern Thailand Using Soil Surface Micro-Topographic Features of Erosion.

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M.A. Nwachokor and E. Bergsma: A Comparative Assessment of Rain Erosion Hazard of Five Land Use Types And Management Practices In Mhong Chun Yen Village, Northern Thailand Using Soil Surface Micro-Topographic Features of Erosion. By

ABSTRACT

A study was carried out to compare rain erosion hazard on five sites representing different land use systems and management practices on the hill farms of Mhong Chun Yen Village in Northern Thailand, by a rapid, cheap, effective but unconventional method. This method employs seven soil surface micro-topographic features of erosion by rain. The aim was to identify which of these land use types and management practices present the most resistance to land degradation in the highly erosion-prone hill farms region. The results obtained showed that the differences observed in erosion-resistance on the five sites were traceable to variability in the type and density of surface cover, surface roughness, management practices, timing of agricultural activities and slope steepness. In a decreasing order of resistance to erosion, the five different land use types/management practice combinations ranked as follows: Orchard of 5 years old longan, litchi and mango/grass cover (70% of total surface area) and surface graved (5%)/ herbicide and pesticide use > agro-forestry (of teak, banana and lemon grass)/ grass cover (65%)/grazing/old terrace > arable (maize and melon)/slash and burn/tillage with hand hoe/weeding with hand hoe and later with herbicide/fertilizers use/ stubble mulching/land cultivated for the 20th year continually/contour ploughing > arable (maize and melon)/slash and burn/land cultivated for the 20th year continually/contour ploughing with a 4-wheal tractor > young orchard (1 year old longan) interplanted with ginger/mulching/fertilizer use/land cultivated to cotton for 14 years continually/ploughing with a 4-wheal tractor up-and-down slope. Invariably, the land use types and management practices that provided more cover and surface roughness exhibited greater resistance to erosion. Moreover, surface cover, wherever dense and perpetual appeared to have the potential to mask the expected hazardous effect of slope steepness on erosion hazard on the hill farms. With this information, the right extension advice could then be preferred, which if adopted by the farmers could do much to preserve the region's soil resources and improve their own livelihoods.

Key words: Comparative, assessment, erosion hazard, land use, management practices, Mhong Chun Yen Village, Northern Thailand.

Introduction

With increasing human population and a decreasing agricultural land mass per capita, the need to increase productivity per unit land area has become more urgent than ever before. In Mhong Chun Yen Village, Northern Thailand, this need has reached a most challenging stage due to its hilly topography, heavy tropical precipitations and, often, coupled with wrong farm management practices, a combination which has rendered the hill farms very vulnerable to erosion by rain. At farm level, soil erosion causes crop yields to drop (Thao, 2001), and only soil conservation can improve productivity on such hill farms (Ahmad, 1991).

In order to provide adequate information for rural extension about soil conservation, the erosion hazard itself has to be fully appreciated through appropriate assessment methods. Moody and Cong (2008) have stated that erosion hazard should be based on a consideration of slope and observed erosion. Evaluating erosion hazard through the conventional method of measuring soil loss (Wischmeier, 1975) is not only time consuming and expensive, often data are rare. Also, prediction models are insufficiently calibrated in most areas (Kunwar *et al.*,

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2002). Hence, there is a need for a more rapid, cheap and efficient alternative procedure for determining erosion hazard.

Without the need to determine soil loss in it $(ha.yr)^{-1}$, a method that satisfies these conditions has been developed that can be used to measure rain erosion intensity and to compare cropping systems, land use practices and conservation systems for their resistance to erosion (Bergsma, 1992, 1997; Bergsma and Kwaad, 1992). Essentially, this method recognizes and uses seven features of soil surface micro-topography for erosion hazard evaluation; namely, Resistant or recently made clods, Eroding clods, Flow surfaces, Prerills, Rills, Depressions and Vegetal matter. Compared to conventional methods of measuring soil loss in erosion studies, this procedure can conveniently be applied on whatever important types of land use, such as annual and perennial crops, grassland, forest, orchard or plantation (de Bie, 2000).

In the present research, this method will be employed to assess and compare rain erosion hazard on five sites representing five different land use types (cropping systems) and management practices. The results would provide information for conservation advice aimed at sustainable agricultural production on the hill farms.

In order to know the soil types covering the study area, modal profile pits would be located, dug and described in accordance with standard procedure (FAO, 1997). Subsequently, the soils will be classified accordingly (Soil Survey Staff, 1998).

Materials and Methods

The erosion hazard assessment was carried out during the rainy season, on five sites that represented five different land use types and management practices in the farming communities of Mhong Chun Yen Village, about 7km from Ban Mae Malai, West of Mae Ping River, in the central part of Chiang Mai Province, Northern Thailand. It is situated within latitudes $19^{o}05^{1}$ to $19^{o}10^{1}$ N and longitudes $98^{o}51^{1}$ to $98^{o}53^{1}$ E.

The climate of Northern Thailand is monsoonal, and it is characterized by three distinct seasons, namely; the rainy season, the cool dry season and the hot dry season. The climatic data from Chiang Mai Meteorological Station show that the mean annual average rainfall in the area is about 1,200 mm yr^{-1}. The soil moisture regime is ustic, although at higher elevations it can be udic (as per Soil Survey Staff, 1998). The soil temperature regime is iso- hyperthemic, with the mean monthly temperature ranging from $27^{0}C$ in the wet season to $37^{0}C$ in the dry season. Geologically, the area is underlain by marble derived from the Ordovician era. They are metamorphic rocks with white sugary texture (an equivalent of limestone), outcropping in many places. Sometimes bedding planes with streaks and bands of other mineral impurities such as Mica schists and quartzites are observed.

The land scope of the study area is hillland, with a mean ultitude of over 500m above sea level. The relief form is convexly dissected mesa.

Table 1 shows the site specific information. Standard soil survey procedure was carried out (FAO, 1977) and consequently three soil types were identified for the whole study area (Soil Survey Staff, 1998).

Characterization of The Erosion Hazard:

To characterize the erosion hazard, the accumulated effect of erosion was observed as expressed by microtopographic erosion features formed over a previous rainy period. These specific features were used instead of the 'random roughness' of the eroded soil surface (Kunwar *et al*., 2002). The microtopographic features used for evaluating the rain erosion hazard were seven types as described by Bergsma (2002).

At each site a measuring tape of 2.5m long was stretched along the contour, so that surface flow features were met across the tape. The tape had alternately coloured intervals of 25cm. For each interval the dominant of the seven microtopographic features along the tape was determined. The record covered 50 intervals, following the same contour line. Thus each tape interval represented 2% of the area. Two repetitions of the feature record were made, in the contour direction, at one or two meters above or below the first observation line. The recording of the microtopographic erosion features has an accuracy of 4% in a feature percentage that is obtained from observation of 50 tape intervals (Bergsma, 1992).

Next, the percentage distribution of the seven features was determined. An indicator of erosion intensity was calculated as the '*percentage flow + two times the percentage prerill areas'* (Bergsma, 1997, 1999).

Erosion Hazard Ranking of The Sites:

The indicator of erosion intensity was determined for each site on the last day of the observation period. With this information a relative ranking of the erosion hazard of the sites was then carried out.

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Table 1: Site Specific Information

Site No.	Slope (%)	Land use and management practice	Soil Name (Soil Taxonomy)	Remark
(1)	55	Arable: Maize, melon; slash and burn, tillage with hand hoes, weeding first with hand hoes and later with herbicide; stubble mulching.	Petrocalcic Calciustoll, fine loamy, carbonatic.	Land has been cultivated for twenty Years now.
(2)	19	Like site 1, but Ploughing is by 4-wheel tractor up and down slope; Plus fertilizer use.	----do-----	----do----- Surface sealing.
(2)	21	Agroforestry: teak, banana, lemon grass; Grazing	Pachic Argustoll fine loamy, mixed, nonacid.	Old terrace, Grass cover (65%), earthworm caste.
(4)	20	Orchad: longan (1 yr old), inter-planted with ginger; mulching, fertilizer use, ploughing with 4-wheel tractor up and down slope.	Typic Kandiustalf, clayey, mixed, nonacid	Land cultivated to cotton for 13 yr. until 2007. & Surface sealing.
(5)	20	Orchard: longan (5yr old), litchi, mango; herbicide use, pesticide use.	----do------	Grass cover (70%), Earthworm caste, Surface gravel (5%), Green algae

Erosion Pins Recordings:

Also, the erosion processes were observed using erosion pins. After each erosive shower, the level of change of the microtopographic features was recorded using a mm rule. An erosion pin was carefully installed on each erosion feature before the first erosive shower and left on the feature throughout the observation period. The objective was to observe the surface level changes, that is, loss (erosion) or gain (deposition) of soil on each erosion feature as a measure of erosion hazard.

Results and Discussion

The percentage coverage and change in level of the features as observed through erosion pin readings on the last day of observation is shown in Table 2.

Table 2: Summary of pin reading showing change in level and percent coverage of features on the last observation day.

Site	Res	Ero	Flo	Pre	Ril	Features Dep	Veg		Net change in level of all the feature types (mm)
	(a)	2	36	34	8	20	/	/	-332
1.	(b)	-5	-170	+6	-32	-131	/	/	
	(c)	-2.5	-4.7	+0.8	-4.9	-6.6	/	/	
	(a)	6	52	26	6	10	/	/	
2.	(b)	-32	-83	+52	-16	-53	/	/	-132
	(c)	-5.3	-1.6	+2.0	-2.7	-5.3	/	/	
	(a)	/	58	22	2	6	/	12	
3.	(b)	/	-25	+23	0	+25	/	0	+23
	(c)	/	-0.4	+1.1	0	+4.2	/	0	
	(a)	/	36	26	12	26	/	/	
4.	(b)	/	-40	-30	-22	-88	/	/	-180
	(c)	/	-1.1	-1.2	-1.8	-3.4	/	/	
	(a)	/	64	28	4	/	/	4	
5.	(b)	/	+8	-20	-8	/	/	0	-20
	(c)	/	+0.1	-0.7	-2.0	/	/	0	

Legend:

(a) = precent coverage of a feature (%)
(b) = total change in level of a feature (mm)
(c) = average change in level of a feature (mm)
\+ = deposition (soil gain)
\- = erosion (soil loss)
/ = feature not present.

Identification of The Erosion Problems:

From Table 2 the erosion problems on each site can be identified, and this is a necessary step to take whenever effective control measures are needed to be put in place (Meyer *et al*.,1991). This step is facilitated by the fact that the erosion features have been found to correlate with the dominant processes of erosion. Eroding features are dominantly formed by splash, flow areas are formed by interrill erosion, while pre-rills and rills indicate the degree of rill erosion (Bergsma, 2008).

Hence on site 1 the erosion problems were identified as rill, interill and splash erosion. Another problem of this site is the steep slope (55%) (See Table 1). The erosion problems on site 2 were rill, interrill and splash erosion. Judging from the percent coverage of features splash erosion was the dominant problem, followed by interrill erosion. The problems on site 3 were rill, interrill and splash erosion. Although splash was the dominant problem here, the observed soil detachment by splash process was almost negligible (Table 2). This was probably because the energy of impact of the raindrops had been modified by the canopy of the trees, and the basal vegetal cover also intercepted the splash impact.

On site 4, the erosion problems were rill, interrill and splash. The splash and rill erosion were very comparable in areal coverage. Splash, interrill and rill erosion were the problems in site 5.

Ranking the erosion hazard of the sites:

Erosion hazard is based on a consideration of slope and observed erosion (Moody and long, 2008). The observed erosion has been summarized in Table2, while the slope details are shown in Table 1. Based on these, the erosion hazard has been ranked in categories ranging from 1 (lowest) to 5 (highest) (Table 2).

Comparing The Erosion Hazard of The Sites:

From Table 2, the erosion hazard of the sites can be compared. In a decreasing order of erosion hazard, the sites compared as follows: Site 4 > site 1 > site 2 > site 3 > site 5. In other words, the land use and management practices on site 5 showed the highest resistance to erosion, while the land use on site 4 was most vulnerable to erosion.

The reasons for these differences in erosion resistance of the sites may be briefly discussed below so as to proffer solutions and preventive measures, based on the work of Meyer *et al*., (1991).

The land use on site 4 had exposed most of the soil surface to the erosive forces of the rainstorms. Moreover, the wrong tillage practice of ploughing up and down, instead of across the slope, with heavy equipment had worsened the erosion hazard. Also, the continuous cultivation of cotton on the same land for that long period (20 years) had destroyed the soil structure leading to reduced infiltration and the sealing problem which together aggravated the erosion. The erosion problems in site 1 could be attributed to the fact that the land use and management practice had exposed most of the soil surface to erosive rainstorms. The slash and burn and the continuous cultivation for so long a period (20 years) had adversely affected the organic matter content and the structure of the soil, hence reducing the soil resistance to erosion.

The causes of the erosion problems in site 2 are similar to those of site 1, but resistance to erosion is higher in site 2 than that of site 1 probably because of the contour tillage across slope and the fertilizer application which encouraged growth of the crops to provide better surface cover. However, it was observed that if the fertilizer was applied earlier than the time it was done, it would have supported earlier growth of the crops to provide more cover. Land use on site 3 presented greater resistance to erosion than sites 4, 1, and 2, probably due to better surface cover provided by the basal grass and the fact that the canopy of the trees intercepted and reduced the soil detachment energy of the raindrops to a negligible level. The land use of site 5 showed the highest resistance to erosion probably because of the dense basal grass cover and the surface roughness provided by the surface gravels. Also the canopies of the trees of the orchard had provided additional protective cover against the raindrop impact.

Summary, Conclusion And Recommendations:

Resistance to erosion varied among the different land use types and management practices. The land use types and management practices that exposed the soil more to the erosive forces of rainstorms exhibited greater erosion hazard. Also wrong tillage practices such as ploughing up and down, instead of across slope encouraged greater erodibility.

Therefore it is recommended that ground cover be improved. To achieve this purpose the recommended control practices must include adequate presence or establishment of vegetation and/or mulches to protect soil surface during seasons of major rainstorms. Where necessary, fertilizers should be applied early enough to encourage early growth of crops to provide the much needed timely cover. An additional control measure is to make the surface rough enough to encourage ponding. Also, there should be runoff routing structures to reduce overland flow velocities. Only contour cultivation should be practised on sloping lands. The effective approaches to the erosion hazard that is due to steep slopes are first, preventing soil detachment and secondly, controlling runoff, by ensuring adequate presence of vegetation or mulches to protect the soil surface.

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