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Mora grass in contour hedgerow: A technology for a sustainable upland farming system

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ABSTRACT

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The study was conducted on six adjacent upland farms usually planted to native corn under a few old coconut trees. The site had a slope ranging from 9 - 17% and had a clayey soil. The following were the objectives of the study: a) to determine the feasibility of using "mora" or vetiver grass (*Vetiveria zizanoides*) as foundation for establishing contour hedgerows, b) to determine the physical and chemical changes of the soil in the farm site in terms of color, slope, crop yield over time and the kind of vegetation and crops planted in between the contour strips, and c) to document farmer-cooperators' responses and feedback on the effectiveness of "mora" used as contour hedgerow.

Farmer-users of "mora" grass as contour hedgerow claimed that the grass adapted well in the upland, checked soil erosion, stabilized the farm, and improved soil fertility. The consistent increase in the values of extractable phosphorus, potassium, calcium, and organic matter of the soil was believed to have caused the ramarkable increase in the yield of corn during the last two cropping seasons. Apparently, lesser soil erosion, improved soil fertility, and availability of moisture in the soil have contributed to the increase in productivity and profitability of the contour farms. The technology on the use of "mora" as foundation for contour hedgerows in upland corn fields has helped sustain crop productivity and supports current thrust on sustainable agriculture.

Keywords: "mora" grass, contour hedgerow, soil erosion, fallow-rotation farming

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INTRODUCTION

Today upland farms are considered a major source of human food and livestock feeds, like rice, corn, rootcrops and food crops. Hundreds and thousands of upland farmers, regardless of tenurial status, largely depend on upland agro-ecosystem for their livelihood. However, decades of "slash-and-burn" and shifting cultivation as methods of farming have rendered many upland farms unproductive. This situation has been aggravated by population pressure and poor farming practices resulting in an irreversible soil nutrient depletion due to soil erosion. As a consequence, poor soil fertility, declining yield of almost all crops, insufficient livestock feed, and low farm income have demoralized upland farmers. Moreover, food security for an ever growing population is threatened by the unstoppable conversion of prime crop lands into subdivisions and industrial establishments. This has resulted in a serious imbalance between population growth and food supply inasmuch as the tillable land area of the Philippines has been greatly reduced and many upland farms have been rendered unproductive. The low crop productivity of most upland farms has triggered farmers to shift to other available farm parcels just to produce food. When yields become unbearably low, these farmers would later on abandon their farms.

Aware of these problems, policymakers and researchers have realized the limitation and disadvantages of "slash-and-burn" and shifting cultivation. Thus, they have designed technologies for upland farming systems aimed at increasing soil fertility, crop productivity, and sustainability of upland farms. The use of "mora" grass (vetiver) as contour hedgerow is expected to help minimize soil loss due to erosion and in restoring soil fertility. Greenfield (1988) had reported that vetiver grass (*Vetiveria zizanoides*) used as hedgerows is the right and the only plant for long term control of soil erosion and to promote *in situ* moisture conservation. It grows well in a wide range of soils and climate. In fact, Grimshaw (1990) reported that "mora" grass grows in all types of soil, regardless of fertility and pH or salinity.

In a study on soil loss, Grimshaw (1994) reported that vetiver hedgerow proved significantly better than other technologies for reduction of soil losses. Soil losses were reduced by a mean 70% over 6 years compared to 45% for

Leucaena and 24% for earth bunds. After sometime and the continuous addition of organic matter, soil fertility was restored and consequently, crop yield will increase.

Specifically the objectives of the study were to: determine the feasibility of using "mora" grass as foundation for establishing contour hedregrows; determine the physical and chemical changes of soil in terms of color, scope, crop yield over time, kinds of vegetation, crops planted in between for the contour strips; and document farmer cooperators' responses and feedback on the effectiveness of "mora" grass used as contour hedgerows.

MATERIALS AND METHODS

The study was conducted on six upland farms in Barangay Punta, Baybay, Leyte. It followed a participatory technology development approach (PTD) where barangay officials, landowners or their representatives, and farmers were interviewed on the farming situation in the area before a multidisciplinary team conducted a participatory rural appraisal to identify the priority problems. Two farmer-leaders joined the field trip to Cebu to observe on-going projects on soil and water conservation in the uplands. After the trip, the two farmer-leaders shared their experiences with other farmers. As a result, two farmers (one farmer-leader who joined the trip and his eldest son) planted few strips of "mora" grass in contour in one of their corn farms.

While the project was in-progress, the FARMI technical staff conducted an informal interaction with a group of farmers which was locally known as "alayon". This was done during the establishment of the contours. They also conducted regular farm visits. The farmer-cooperators were likewise invited to join in cross-site visits to farms with existing contour hegdegrows of "mora" and to the FARMI Demonstration Farm during the LSU Farmers' Field Day.

Soil samples were collected by strips from each experimental farm and from the control farms for analyses of major soil nutrients and other trace elements.

Erosion gadgets were installed in every strip in all five contour farms to record soil build-up and soil eroded.

Grain yield of corn was collected on 3 x 4 sq.m., air dried and adjusted to 14% moisture content to get the computed yield in t/ha. Other agronomic characteristics of corn were collected by strips throughout the 5 plots.

Farmer-cooperators' cultivation practices and their feedback on the established "mora" contour strips were recorded.

RESULTS AND DISCUSSION

The Experimental Farms

The study was conducted in five contour farms established by a group of farmers locally known as "alayon". It sought to test the adaptability of "mora" grass as foundation hedgerow, its effect on the fertility of the soil, and on the grain yield of corn. Two non-contour farm parcels adjacent to the contour farms were also identified as control plots. Three contour strips along the slope were used in each of the farm. Yield samples and plant data were collected from the three contour strips of the five contour farms and the two control plots.

Rainfall Distribution

Rainfall data were taken from the LSU Agrometeorological Station. The station was about 15 km away from the experimental farms. Table 1 shows the average monthly rainfall (mm) during the conduct of the experiment. It can be noted that the average monthly rainfall appears high but does not give a true picture of the rainfall pattern per day. For instance, the average rainfall for the month of January 1994 was 427.4 mm which appears that there was sufficient rain, however, the values were mostly taken from the rain that occurred on January 5, 19, 20, 21, 24 and 30. The remaining 25 days had less than 4 mm rainfall per day.

The average montly rainfall data show that the lowest recorded average rainfall consistently falls in the months of March, April and May from year 1995 up to 1998 for the last three consecutive cropping seasons. In this part of the region,the ideal growing period of corn starts from the months of March to May because rainfall is evenly distributed.

Table 1. Average monthly rainfall (mm) from 1994 to 1998 recorded at the Agrometeorological Station, LSU, Visca, Baybay, Leyte.

Month	1994	1995	1996	1997	1998
January	427.40	171.30	508.20	117.30	107.40
February	109.20	37.20	499.80	278.50	41.50
March	338.40	102.0	189.70	117.40	74.60
April	307.60	78.50	270.10	19.90	44.10
May	139.50	99.70	97.20	83.70	73.50
June	303.20	230.60	226.40	167.60	56.10
July	147.90	131.00	298.70	235.20	92.40
August	348.50	220.80	151.40	211.30	96.40
September	465.30	361.30	171.60	236.00	329.00
October	209.35	310.10	228.40	132.60	302.60
November	213.30	238.80	345.80	217.40	347.60
December	588.10	236.30	376.30	135.30	362.20

Physical and Chemical Changes of the Soil

Over the years, the farmer cooperators observed that the color of their farm soil was more or less whitish. There was also the proliferation of *Imperata* (or "cogon" in the Cebuano dialect) which farmers generally claim as an indicator of soil nutrient depletion (Figure 1). With the introduction of "mora" grass as contour hedgerow, leguminous weed species started to appear and increase in all test farm parcels after a year from its establishment. The farmer-cooperators also observed that soil color has turned brownish (figure 2) which implies that soil fertility has improved. This observation is supported by the results of soil analysis of major and trace elements (Table 2).

Soil Analyses

Results of the soil analysis prove that chemical changes occurred as a result of using "mora" as contour hedgerow (Table 2). Data reveal that contour farms had higher average pH values of 7.81 across farms in year 4 (1996) compared with the initial values of 7.05, 7.03 and 6.56 in the previous years, i.e. year 1 to 3, respectively. The average soil pH values ranged from 6.37 (Farm 2) to 7.92 (Farm 1) which was slightly acidic to mildly alkaline. The

Figure 1. Non-contoured sloping farm showing whitish soil due to continues cropping and severe soil erosion.

Figure 2. Test farm with "mora" contour hedgerows showing improved soil fertility.

Table 2. Results of soil analysis for pH, % OM, trace elements and average percent (%) slope of the farms with "mora" contour hedgerows and non-contour farms, years 1 to 5.

Farms	Soil pH	% OM	Exchangeable Al (me/100g)	% Slope
		Year 1 (1993)		
1	7.40	3.88	0.14	18
2	6.45	3.37	0.14	18
3	6.75	3.41	0.87	12
4	6.90	3.17	0.14	14
5	7.75	4.55	0.55	13
Average	7.05	3.68	0.37	15
Non-Contour	6.50	1.89	-	9
		Year 2 (1994)		
1	7.80	4.22	0.03	18
2	5.55	3.46	0.11	18
3	6.60	3.44	0.14	12
4	6.95	3.36	0.06	14
5	7.95	4.67	0.03	13
Average	7.03	3.83	0.08	15
Non-contour	6.70	2.69	-	9
		Year 3 (1995)		
1	7.50	3.92	-	18
2	5.60	3.92	0.52	18
3	6.10	3.81	0.06	12
4	6.00	4.10	0.17	14
5	7.60	4.64	-	13
Average	6.56	4.05		15
Non-contour	7.70	2.91		9
		Year 4 (1996)		
1 Strip 1	7.90	3.43	0.16	
2	7.75	5.15	0.41	
3	8.10	3.98	-	
Average	7.92	4.19	0.28	
2 strip 1	5.95	3.37	0.06	
2	5.50	2.57	1.09	
3	7.65	3.79	-	
Average	6.37	3.41	0.57	

Table 2. Continuation...

Farms		Soil pH	% OM	Exchangeable Al (me/100g)	% Slope
			Year 4 (1996)		
3 Strip	1	7.90	2.69	0.09	
	2	7.30	4.24	-	
	3	5.95	3.51	0.15	
Average		7.05	3.84	0.12	
4 strip	1	7.15	4.24	-	
	2	7.65	1.80	-	
	3	7.20	3.87	-	
Average		7.33	3.30	-	
5 Strip	1	7.90	6.05	0.19	
	2	7.80	6.05	-	
	3	7.90	4.43	0.51	
Average		7.81	5.51	0.35	
Non-contour		7.75	2.61		
			Year 5 (1997)		
1Strip	1	7.75	2.66		
	2	7.65	3.50		
	3	7.70	4.22		
Average		7.70	3.46		
2 Strip	1	5.40	3.20		
	2	6.25	2.51		
	3	7.45	3.32		
Average		6.37	2.68		
3 Strip	1	7.75	2.46		
	2	6.45	2.91		
	2	5.45	3.55		
Average		6.55	2.97		
4Strip	1	5.50	2.30		
	2	5.95	2.83		
	3	7.35	2.39		
Average		6.27	2.51		
5 Strip	1	7.90	3.94		
	2	7.85	2.79		
	3	7.80	3.01		
Average		7.85	3.25		
Non-contour		7.90	1.90		

increase in soil pH could be attributed to the continuous addition of organic matter from the stalks of previous crops and weed residues in the contour farm which apparently checked soil acidity. Continuous increase of % OM in year 4 was also noted in Farms 1 and 5 with values of 4.19 and 5.51% OM, respectively. These values are considered adequate for growing upland crops. Other contour farms also experienced a relative increase in OM values, as shown in Table 2. The increase in percent organic matter could be due to the proliferation and the decomposition of native leguminous weeds as well as organic matter from the previous crop residues (Figure 3). It can be inferred that in due time, and with the continuous adoption of this technology, soil fertility of the farms would become sufficient for a more productive farming venture.

Aluminum (Al) content of the soil across contour farms in year 4 (1996) ranged from 0.12 to 0.57 me/100g (Table 2). These values are considered not toxic to plants since the level of Al toxicity for upland crops, especially corn, is more than 1 me/100g of soil.

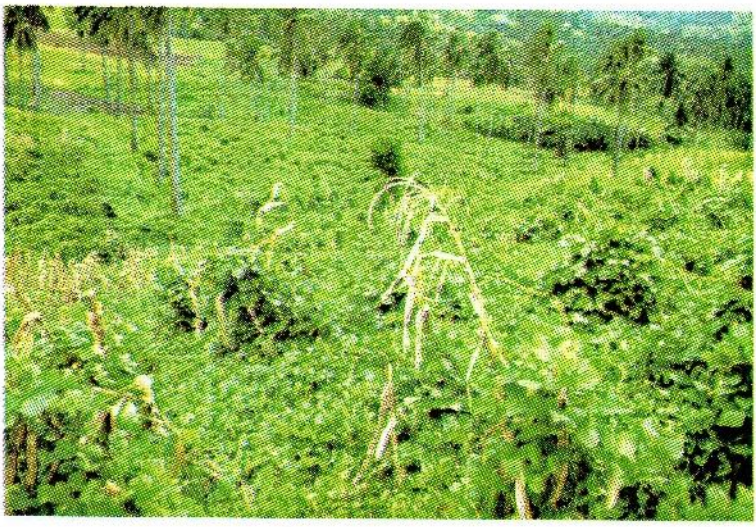

Figure 3. Test farm with abundant native leguminous weed species (*Calopogonium mucunoides*).

Figure 4. Test farm showing *Calopogonium mucunoides* and *Mimosa invisa* growing luxuriantly before land preparation.

It is noteworthy that percent organic matter (%OM) contents revealed an increasing trend but values differed between strips and across contour farms. This is expected due to differences in slope, kinds of vegetation, and farmers' cultivation practices.It was further observed that in farm 1, *Calopogonium* and *Mimosa invisa* were the dominant weed species found prior to land preparation for three consecutive cropping seasons of corn (Figure 4). Moreover, results of soil analysis of the test plots showed a general reduction in percent nitrogen (N) (Tables 3 and 4). The average %N decreased from 0.17 in year 3 (1995) to 0.14, 0.15, 0.14 and 0.15 (Farms 1, 2, 3, and 4, respectively) in year 4, except in Farm 5 with an average value of 0.22%. The reduction in %N in most farms may be due to the use of nitrogen by the microorganism in the decomposition of carbonaceous residues (Tisdale, 1975).

Table 3. Results of soil analysis for %N, P, K, Ca, Mg and Na of the farms with "mora" grass planted in contour, Year 1, 2, and 3.

Farm	%N	P	K	Ca	Mg	Na
			mg/kg			
			Year 1 (1993)			
1	0.26	4.25	183	15,125	1300	104
2	0.16	4.96	233	12,617	850	104
3	0.16	3.41	180	13,250	783	123
4	0.18	3.22	247	13,300	750	120
5	0.23	2.12	163	15,500	208	147
Average	0.20	3.59	201.20	13,958.40	578.20	119.60
Non-contour	0.18	1.44	193	5,677	800	93
			Year 2 (1994)			
1	0.27	3.08	173	12,987	244	30
2	0.57	0.68	197	9,674	921	70
3	0.67	1.35	165	9,912	606	65
4	0.64	2.07	232	9,217	810	46
5	0.76	1.84	132	12,884	192	50
Average	0.58	1.80	179.80	10,934.80	554.60	52.20
Non-contour	0.20	1.25	165	9,813	704	56
			Year 3 (1995)			
1	0.20	4.08	170	17961	116	36
2	0.14	1.04	286	10044	589	58
3	0.14	1.51	171	10486	391	63
4	0.16	4.51	302	11187	201	60
5	0.20	1.89	159	16301	121	65
Average	0.17	2.61	217.60	13195.80	283.60	56.4
Non-contour	0.14	1.87	174	104361	365	64

The data in Table 3 show a consistent increase in the observed values of extractable phosphorus, exchangeable potassium, and calcium contents (year 3).

Contour farms showed higher soil analysis results for extractable phosphorus in year 4 (Table 4) compared to the previous years of cropping. The average P values increased from 1.80 and 2.61 in year 2 to 3 to 3.56, 2.09, 9.30 and 2.72 mg/kg soil in farms 1, 2, 3, 4, and 5. The increase in P

Table 4. Results of soil analysis for %N and extractable phosphorus in contour strips, year 4-5.

Farms		%N	P	%N	P
		Year 4 (1996)		Year 5 (1997)	
1 Strip	1	0.11	2.35	0.13	2.33
	2	0.18	4.42	0.17	3.58
	3	0.14	3.92	0.21	7.66
Average		0.14	3.56	0.17	4.52
2 Strip	1	0.18	1.38	0.16	1.86
	2	0.12	0.92	0.13	1.00
	3	0.16	3.97	0.13	1.46
Average		0.15	2.09	0.14	1.44
3 Strip	1	0.12	2.53	0.13	1.59
	2	0.15	2.00	0.14	1.63
	3	0.16	0.92	0.19	2.52
Average		0.14	1.82	0.15	1.91
4 Strip	1	0.18	3.92	0.13	3.46
	2	0.10	17.19	0.15	6.36
	3	0.16	6.80	0.13	5.88
Average		0.15	9.30	0.14	5.23
5 Strip	1	0.24	2.19	0.18	5.18
	2	0.23	2.41	0.15	6.36
	3	0.18	3.57	0.15	6.84
Average		0.22	2.72	0.16	6.13
Non-Contour		0.07	5.95	0.12	3.32

across contour farms in year 4 could be due to the increase in mineralization with plowing and continuous decomposition of crop and weed residues. It is then reasonable to conclude that using "mora" as hedgerow in contour farming is advantageous for its positive effects on the soil pH and chemical composition.

Erosion gadgets were installed in every strip of all contour farms under study to record soil build-up and soil eroded. As shown in Table 5, the depth of soil build-up ranged from 3 to 7 cm. These values were taken before the contoured area was partitioned into strips.

Table 6 shows that strips 1 and 2 in farm 2 had the highest and lowest values of soil build-up. It is only in Farm 1 where 3 mm of soil was eroded. Soil build-up at the upper strips of the contour ranged from 16.67 to 38 cm

Table 5. Average percent slope, depth of soil eroded (mm) after cropping season of corn, 1994 (three months after installation of erosion gadget) and average soil build-up (cm) of the contour farms after three years establishment of contour hedgerows using mora as foundation.

Farms	Ave. % slope	Ave. soil build-up (cm)	Depth (mm) of soil build-up (+)
1	18	31.50	+7
2	18	28.00	+5
3	12	23.50	+3
4	14	22.50	+4
5	13	24.50	+3

while at the lower strips, it ranged from 11 to 28 cm. This observation proves that more soil got trapped and remained in place at the upper strips, indicating that "mora" hedgerows effectively shields, minimized soil erosion, stabilized the farm and improved soil fertility.

No data collecttion was done in the succeeding years due to the disappearance of the soil erosion gadgets. However, previous data demonstrate the effectiveness of mora grass in holding the soil, thus minimizing soil erosion within the contour farms.

Farmer-Users' Feedback on the Use of "Mora" Grass

It is noteworthy that no one among the farmer-cooperators had abandoned his farm with "mora" hedgerows in contour during the course of the study. As reflected in Table 7, majority of the farmer-cooperators provided very encouraging feedback on the effectiveness of "mora". Among others, they claimed that "mora" has stabilized the farm, improved soil fertility, and reduced the needed frequency of plowing (6 plowings per cropping) by 50%. It can be inferred that mora grass is well-adapted and accepted by this group of upland farmers.

Table 6. Average percent (%) slope, soil build-up (1991-1995), and depth of soil build-up (+) & eroded (-) after the cropping season of corn, 1995 and 1996 in each strips.

Farms		Ave. % slope	Ave. soil build-up (cm)	Depth (mm) of soil build-up (+) and eroded (-)	
				1995	1996
1 Strip	1	25.79	38.00	+3	+4
	2	23.69	30.00	+4	-
	3	22.93	22.00	0	-
2 Strip	1	15.78	34.00	+20	+10
	2	14.71	32.00	+2	+2
	3	13.33	26.00	+2	-
3 Strip	1	9.72	16.67	0	+2
	2	8.72	12.00	-	-
	3	7.00	11.00	-	-
4 Strip	1	18.48	34.33	-3	+5
	2	18.03	30.33	+4	-
	3	17.00	28.00	0	-
5 Strip	1	16.10	32.33	+3	-
	2	16.04	27.33	0	+4
	3	14.57	27.00	-	-

- No data

Grain Yield and Yield Components of Corn

Data on the yield components of corn for the 1996 and 1998 cropping seasons (Table 8) reveal that corn plants in the contour farms were generally taller and had longer and heavier ears which obviously contributed to higher grain yield as shown in Table 9. Figure 6 further reflects a remarkable increase in grain yield during the last cropping season in 1998. This finding manifests sustained crop productivity and profitability. It can be noted that all grain yield components in contour farm 1 differed significantly from those found in the

Table 7. Farmer-users' positive and negative feedback of contour hedgerows using "mora" grass as foundation

Feedback	N=16	%
A. Positve		
1. Its capacity for soil erosion		
- Mora holds and raises up the soil	16	100
- Strong root system	16	100
-Decrease soil slope "patag-patag" or "kahon-kahon"	13	81
2. Effect on soil color		
- Whitish, brownish to blackish soil color	6	37
3. Effect on farm vegetation		
- Cogon weeds to "nipay-nipay" and "benet"	5	31
- Others were still dominated with "nipay-nipay", benet and other weeds	9	56
4. Effect on plowing		
- Established permanent direction in plowing	16	100
5. As feed for animals		
- When young, mora is a palatable feed for goats and carabaos	16	100
6. Economic benefit		
- Reduced frequency of plowing and harrowing per cropping to at least 50%	10	62
B. Negative		
1. Maintenance and shading effect		
- Needs regular clipping	16	100
-When tall, mora shades corn seedlings near the strips	13	81
2. Some contour hedgerows collapsed due to grazing of carabaos	5	31

Figure 5. Farm with mora hedgerows showing improved soil fertility and healthy corn plants.

Figure 6. Shelled corn showing a marked difference in grain yield (t/ha) in farms with "mora" hedgerows than in control plots.

Table 8. Mean average of plant height (cm), ear length (cm), ear weight (gm) of corn by strips on contour farms and the control farms for two cropping seasons (1996 and 1998).

Contour Farms/Strips		Crop Year (1996)			Crop Year (1998)		
		Plt. ht (cm)	Ear lgt. (gm)	Ear wt. (cm)	Plt. ht (cm)	Ear lgt. (gm)	Ear wt. (cm)
1 Strip	1	191.20	10.65	92.12	185.53	11.91	96.06
	2	277.40	15.25	169.31	275.40	15.62	172.00
Average		234.30a	12.95ab	130.71a	230.46ab	13.76a	134.03a
2 Strip	1	161.90	8.35	61.60	171.80	8.65	62.70
	2	219.30	10.80	81.18	216.30	11.42	78.10
Average		190.60abcd	9.57c	71.39cd	194.05abc	10.03bc	70.40cd
3 Strip	1	162.40	8.60	78.49	164.50	9.12	80.30
	2	194.00	9.65	69.92	201.30	10.00	75.40
Average		178.20bcd	9.12c	74.20cd	182.90abcd	9.56c	77.85c
4 Strip	1	183.40	12.00	115.14	181.06	10.40	114.40
	2	218.50	12.10	123.56	182.60	13.10	127.10
Average		200.95abc	12.05abc	119.35ab	181.83abcd	11.75abc	120.75ab
5 Strip	1	135.07	11.00	108.10	154.93	10.38	59.60
	2	140.00	9.00	119.40	171.26	11.60	84.40
Average		137.53d	10.00bc	113.75ab	163.09	10.99abc	72.00c
Control farms							
	1	149.40	8.95	78.60	-		
	2	172.90	10.05	86.03	-		
Average		161.15cd	9.50c	82.32cd			

- fallowed , no harvest

Means followed by the same letters are not significantly different at 0.05 DMRT

non-contour farms for the last two cropping year of 1996 and 1998.Other contour farms/strips recorded the same trend. It can be inferred then that farms with "mora" hedgerows are stable, profitable, and sustainable. The higher yield of corn from the experimental farms was apparently due to minimal soil erosion and improved soil fertility as a beneficial effect of using "mora" grass as contour hedgerow. This observation concurs with the findings of Grimshaw (1994) that vetiver hedgerow proved significantly better than other technologies for the reduction of soil losses. Grimshaw believes that the accumulation of more soil along the hedgerows and the continuous addition of organic matter

Table 9. Mean average yield of corn (t/ha) for two cropping seasons, year 4 (1996) and year 5 (1998)

Contour Farms/Strips		Yield (t/ha)	
		1996	1998
1 (April 23-July 24)	Strip 1	1.36	3.26
	2	2.02	4.10
	Mean Average	1.69a	3.63a
2 (July 5-Oct. 9)	Strip 1	0.46	1.54
	2	0.99	2.05
	Mean Average	0.73bc	1.80bc
3 (May 3- Aug. 9)	Strip 1	0.70	1.32
	2	1.26	2.15
	Mean Average	0.98ab	1.73bc
4 (June 2- Sept. 6)	Strip 1	1.20	1.78
	2	1.22	2.65
	Mean Average	1.21ab	2.21ab
5 (June 2- Sept. 6)	Strip 1	1.05	2.02
	2	1.22	1.61
	Mean Average	1.13ab	1.81bc
Non-contour farms (Control)			
1 (May 14- Aug. 25)		0.60	0 (fallowed)
2 (May 14- Aug 20)		0.60	0 (fallowed)
	Mean Avearge	0.60c	

Means folowed by the same letters are not significantly different at 0.05 DMRT

will make the soil along the hedgerows and the continuous addition of organic matter will make the soil more fertile and consequently increase crop yield. Good farming management such as thorough land preparation, non-burning of previous crop residues, and the proper timing in planting should have also contributed in getting higher crop yield and thus, better economic return, as shown in the cost-benefit analysis (Table 10).

The data in Table 9 show a remarkable increase in grain yield for the last cropping year (1998). Evidently, grain yield values obtained by strips differed from each contour farm, with practically all the downslope strips having higher yield values. In descending order, contour farms 1, 4, 5, 2, and 3 had an

Table 10. Cost-benefit analysis of the contour farms for 1996 cropping season

Activities	No. of days per ha/farmer	Rate per man-day	Expenses*
I. Estmated gross expenses of the contour farm			
A. Land preparation			
1. 1st plowing	7	P100.00	P1050.00
2. 2nd plowing	5	P100.00	P750.00
3. 3rd plowing	4	P100.00	P600.00
4. Harrowing	2	P100.00	P300.00
B. Pruning of mora	2.5	P60.00	P150.00
C. Hillinh-up	3	P100.00P	P450.00
D. Weeding	4	P60.00	P240.00
E. Harvesting and post-harvest activities	6	P60.00	P360.00
F. Transportation	26.2 cavans	P5.0/cav	P131.00
			P4,031.00

II. Gross farm benefits and income for 1996 cropping season

Farm	Ave. farm Yield (t/ha)	Gross Income	Gross Expenses	Net Income
1	1.69	P10140.00	P4031.00	P6109.00
2	0.73	P4380.00	P3342.00	P1046.00
3	0.98	P5880.00	P3925.00	P1955.00
4	1.21	P7260.00	P4009.00	P2531.00
5	1.13	P6780.00	P3506.00	P3274.00
Control	0.60	P3600.00	P3690.00	P-90.00

*Additional of P50.00 expenses for food for every contour Farm in plowing and harrowing. Prevailing price of corn at the market was P6.00/kilo.

average grain yield of 3.63, 2.21, 1.81, 1.80 and 1.73, t/ha, respectively (Figure 6). It implies that more nutrients were available for crop growth at the downslope strips than at the upper strips. These findings corroborate with the results of the soil analyses (Table 3) during the three sampling years where farm 1 obtained a consistent higher % OM and extractable phosphorus which are considered important elements for crop growth.

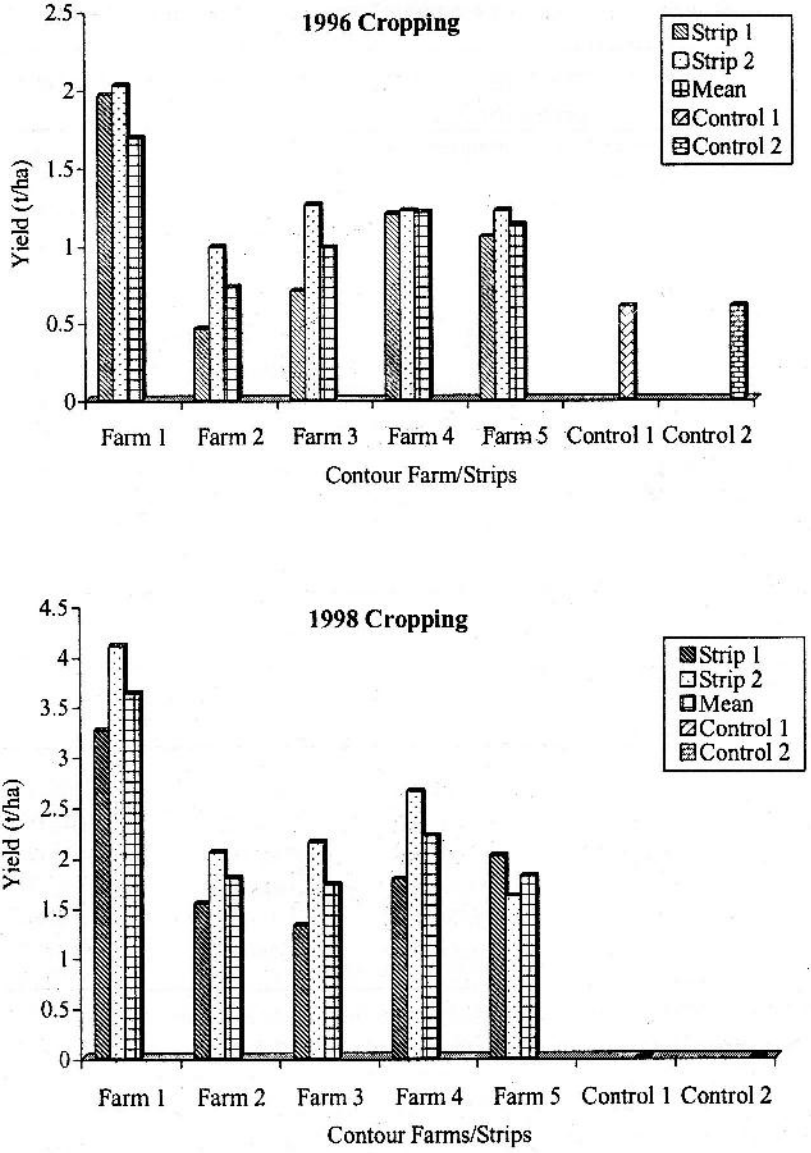

Figure 7. Showing a remarkable increase in grain yield in farms with "mora" contour hedgerow than in control plots.

Table 11. Cost-benefit analysis of the contour farms and non-contour farms for 1998 cropping season.

I. Gross expenses of the contour farm

Activities	No. of days per ha/farmer	Rate per man-day	Expenses*
A. Land preparation			
1. 1st plowing	7	P130.00	P1260.00
2. 2nd plowing	5	P130.00	P900.00
3. 3rd plowing	4	P130.00	P130.00
4. Harrowing	2	P130.00	P130.00
B. Pruning of mora	2.5	P60.00	P150.00
C. Hilling-up	3	P100.00	P450.00
D. Weeding	4	P65.00	P260.00
E. Harvesting and postharvest activities	6	P60.00	P360.00
F. Transporation	58.6 cavans	P5.00/cav	P293.00
			P4,753.00

II. Gross farm benefits and income for 1998 cropping

Farm	Ave. farm yield	Gross Income	Gross Expenses	Net Income
1	3.63	P22,687.75	P4,753.00	P17,934.75
2	1.80	P11,250.00	P4,753.00	P6,497.00
3	1.73	P10,812.50	P4,753.00	P6,059.50
4	2.21	P13,812.50	P4,753.00	P9,059.50
5	1.81	P11,312.50	P4,753.00	P6,559.50

Non-contour farms - all fallowed (field used as communal pasture)
* Additional of P50.00/day expenses for food for every contour farm in plowing and harrowing

On the other hand, non-contour farms had only 0.60 t/ha grain yield for the 1996 cropping season and had been totally fallowed thereafter due to poor soil fertility. Average grain yield from all contour farms are significantly higher than from the average yield of non-contour farms. These findings indicate

that farms with vetiver hedgerows are more fertile, productive, and sustainable.

Cost-Benefit Analysis

The data in Table 10 reveal that for the 1996 cropping season, contour farm 1 had the highest computed net income of P6,109.00/ha. Contour farm 2 had the lowest income of P1,046.00. The non-contour farm suffered a loss of P90.00/ha considering that the average yield was only 0.60 t/ha. In the 1998 cropping season (Table 11) contour farm 1 obtained the highest net income of P17,934.75/ha, followed by farms 4, 5, 2 and 3 in descending order.

All contour farms had higher income than the non-contour farms. Apparently, lesser soil erosion, improved soil fertility, and available moisture in the soil have contributed to the increase in productivity and profitability of the contour farms. It was further noted that during the 1998 cropping season, farmers of non-contour farms fallowed their fields due to poor soil fertility and unbearably low yield (0.60 t/ha) in the previous cropping season.

CONCLUSION

The technology on the use of "mora" as contour hedgerow for soil and water conservation (SWC) in upland farms proved to be adaptable and acceptable to a group of upland farmers in Barangay Punta, Baybay, Leyte, Philippines. Furthermore, the technology has minimized soil erosion, stabilized the farm, and improved soil fertility, thereby transforming the traditional fallow-rotation farming scheme to a more permanent and sustainable upland farming system.

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