The Role of Terraces on Land and Water Conservation in Yemen

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Abstract

Yemen is characterized by terrace cultivation, which is considered as an important national heritage. **From a technical point of view terrace cultivation is an advanced farming system for soil and water harvesting and utilization of mountainous lands.**

The arable land under cultivation is estimated to be 1.1 million hectares , representing less than 2% of the total red of the country in 2001 . The mountain terraces land is estimated to be 20% - 25% of the arable land**.** It is noticed that during the last sixty years the Yemen society has faced many social and economic changes and evolution, which negatively affected terrace cultivation. It is worth to note that absence of regular maintenance is one of the most important factors of terraces abandonment. Negligence of land for several seasons or years made farmlands, forests and rangelands prone to excessive felling, overcuting, overgrazing and consequently loses their fertility and become prone to erosion. Also the rate or desertification is about 3-4% and the population growth rate is 3.7% this will increase the costs and complex the satiation of food poverty in Yemen.

According to the results of the National Poverty Survey of 1999, almost 50% of the households are poor, 80% of which are reside in the rural areas. A growing number of Yemenis lacks accesses to adequate housing, safe drinking water, health care services, education, income, or sufficient nutrition. Problems of poverty have become more widespread since the beginning of this decade as a consequence of a series of economic and political crises that have shaken the fragile infrastructure of the country. Hence, those that were already poor have become poorer and many who were not have since joined the ranks of the poor.

Agriculture is considered the back bone of the Yemen national economy. It employs roughly about half of the resident labor force and accounts for allot 18% of gross domestic product. Yemen is classified as a low-income and Food Deficit country (LIFDC).

At the present time most of the Kuhlan - Affer terraces are facing reduction in their areas due to the degradation. This due to attribute to the negligence of regular terrace conservation, cutting and eradication of trees and shrubs in order to meet demand for firewood and grazing. It is observed that the out- migration from the area, as young people to seek employment in the cities, is one of the most important, causes of the degradation of the resource management systems in the area. **Aloes the terrace system is threatened in a lot of places.** That reflects the importance of household labor in maintaining terraces [1].

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THE STUDY PROBLEM: -

Migration, lack of labor and Poverty in the last decades has resulted in considerable changes in the pattern of resource management. As a consequence of those changes, terraces have been abandoned. So, the statistical hypothesis can be stated as follows:

Labor in rural Yemen is differentiated by gender. Adult men and women are generally responsible for different, if complementary, tasks. Implicit assumption that women are spent a great deal of time fetching water and firewood for the household. These activities take priority over other possible allocation of labor, including attention to terrace maintenance and crop and livestock production.

RESEARCH OBJECTIVES: -

Based on the stated hypothesis, the main objectives of this research can be summarized as follows:

1. Identification of the underlying causes of the degradation of the Terraces systems and the Role of Terraces on Land and Water Conservation in Yemen
2. To determine if there is indeed a change in labor allocation once alternative fuel and water sources are acquired.
3. To analysis the relationships between labor and other factors.
4. Recommending practical and feasible methods to re-allocation the labor time for maintaining and repairing terraces.

DATA AND METHODS: -

The participatory observation method that included informal interview on schedule and allocation of family labor has been applied to select the study sample.

A sample of 233 farm-households has been selected on the basis of the type of land and water and their uses. So, questionnaire, including ninety variables, has been implemented and administered utilizing Sana'a University, AREA, ICARDA staff, teachers and students at Kuhlan Secondary School and other School in three zones of the area to collect the data. This study is sponsoring by IDRC Cairo office.

This case study was conducted in Kuhlan - Affar / Wadi Sharis area- this area was selected as representative of traditional highland farming system.

It is divided into three zones based on the topographic variations zone I represents lower Mountain / Wadi which extends up from 500- 1200 Mater (m), above the sea level, Zone II represents Middle Mountain, which extends up from 1200-1800 m.; Zone III represents Upper Mountain, which extends up from 1800-2400 m above the sea level.

Table (1) shows that the study sample of household (233) was drawn from the three Zones in a percentage of about 21%, 33% and 46% respectively. These households include 518 men in a percentage of about 17%, 35% and 48% in the three Zones respectively. Number of women in sample was 457 in a percentage of about 25%, 24% and 51% in the three Zones respectively. Total number of boys was 457 in percentage of about 21%, 26% and 53% respectively. Total number of girls was 403 in a percentage of about 21%, 33% and 46% respectively.

Table (1) sample Distribution, December 1997

SAMPLE CHARACTERISTIC LABOR ALLOCATION SURVEY					
	Households	Men	Women	Boys	Girls
Zone 1	49	89	117	95	85
Zone 2	76	181	112	120	132
Zone 3	108	248	233	242	186
Totaux	233	518	462	457	403

Source: Compiled and computed from the study survey Dec.1997

RESULTS AND DISCUSSION:

The main findings of this study can be summarized as follows:

1- LABOR RESOURCES:

Data presented in table (2) reveal that there is 230 households (98.7 of sample) have god. Men is working on-farm and off -farm in a percentage of about 53%, 47% respectively of these households. The data also indicate that 228 households (97.9 of sample) have got women working on - farm and off-farm in a percentage of about 84%, 16% respectively of these households. In relation to boy's labor there are 172 households (73.8 of sample) about 16% and 84% of them have got boys working on and off - farm respectively. Concerning girls labor there are 171 households (74.3% of sample) has got girls working on and off-farm in percentage of 36%, 64% respectively of these households.

From this table it can be concluded that in spite of the highest proportion of households depending on women as one of the farm labor resources, their actual contribution to farm labor hours was relatively low, that can be attributed to the excess time devoted for off - farm labor

2-FAMILY SIZE: -

Data presented in table (3) show that the average number of male was 4.90 individual in household and the average number of female was 4.69 individual in family. The total average number was 9.59 individual per family, about 51% of them were male and 49% of them were female. In general, the large family size pattern was common and dominant phenomenon. Traditionally, the large family size system was connected with traditional farming, which usually provides the households with the needed labor resources for performing the farm activities.

Table 2. Number of families that have members working in and out the field
At Kuhlan-Affar area, Yemen

Gender	Male				Female			
Variable ê	Boys		Adults		Girls		Adults	
Status ê	No	%	No	%	No	%	No	%
Member of family Working in the field	28	16.3	122	53.1	61	35.7	191	83.8
Member of family Working out field	144	83.7	108	46.9	110	64.3	37	16.2
TOTAL	172	100	230	100	171	100	228	100

- Source compiled and computed from the study surveys Dec.1997
- Note Total numbers of family are 233; three of them indicated that they do not have men god the family.

Table 3. Means and percent (%) of family structure by gender
At Kuhlan-Affar area, Yemen

Gender	Male				Female			
	Boys		Adults		Girls		Adults	
Variable ê		%		%		%		
Household	2.65	27.6	2.25	23.5	2.36	24.6	2.33	24.3
TOTAL	457		518		404		531	
Gender	975	935						
	51%				49%			

Source compiled and computed from the study surveys Dec.1997

3- LABOR ALLOCATION BY GENDER:

Data presented in table (4) indicate that in spite of the importance of household labor, only 51 %, 41%, 49% and 51 % of the per-capita daily labor hours is devoted to one-farm labor for men, women, boys and girls respectively. Moreover, an additional three hours a day per man were spent in chewing Qat. It can be concluded that household labor contribution to form activities is relatively limited in general for women` labor in particular. Also, the table indicates that women to collect water and fuel devote about 3.88 hours a day. If that time could be reduced it would become available for more productive activities.

4- *EDUCATIONAL STATUS FOR CHILDREN: -*

Data presented in table (5) indicate that about of 96% of boys and 36% of girls in study sample attended the formal education. Based on these findings, it is very important to implement training programs for all the students (boys and girls) in productive farm activities especially in maintaining terraces during the summer holiday. Also these who didn't attend the formal education, either those who were not at the schooling age or those who didn't assign any farming works should be trained to participate in farm activities in this area. Moreover, maintaining terraces is relatively a simple practice and doesn't require skilled labor, which is deferent from repairing and building terraces.

Table 4. Means and percent (%) for general time allocation by gender
AT KUHLAN-AFFAR AREA, YEMEN

GENDER	MEN				WOMEN			
	Boys		Adults		Girls		Adults	
Status ê		%		%		%		%
Hours spent in the field	4.78	48.5	7.03	50.5	7.45	50.6	5.66	40.9
Hours spent not in the field	5.08	51.5	6.89	49.5	7.26	49.4	8.21	59.2
Hours spent chewing Qat	-	-	3.26	-	-		-	
Hours spent collecting wood			1.3				3.5	
Hours spent fetching water			.72				3.3	
TOTAL			*9.05*				*12.4*	

Source Compiled and computed from the study SURVEY DEC.1997

Table 5. Number of families that children attending school or not
At Kuhlan Affar Yemen

Gender	BOYS		GIRLS	
	NO	%	NO	%
Family's Children attend school	134	95.7	56	35.8
Family's Children not attend school	6	4.3	100	61.2
TOTAL	140	100	156	100

SOURCE COMPILED AND COMPUTED FROM THE STUDY SURVEY DEC.1997

Table 6. Source of fuel in at Kuhlan-Affar area

Source	Price Of unit	Weight of Unit	Daily Consume.	Per-Capita expenditure, YR/Day		Collected By Women %	Hours Spent	Daily Consume.	Source
			Keg	**YR/da**	**%**				
from owned trees	261	10.20 (Bundle)	1.25	12.75	19.5	83.2	16.8	1.25	1.24
from owned range.	-	10.20 (Bundle)	0.98	10.00	14.95	97.8	2.2	.98	2.00
from the market	3629	4.75 (Load)	1.62	7.70	11.50	37.1	62.9	1.62	1.68
SUB TO.			***3.83***	30.45	45.51	***72.7***	***27.3***	***3.85***	***4.92****
Crop residue	-	23.5 (Bundle)	0.75	-	-	86.1	13.9	.75	2.48
Dried cow dung	-	2.32 (Keba)	3.66	-	-	100	0	3.66	1.48
Charcoal from the market	809	22.1 (Sack)	1.62	35.80	53.50	53.6	46.4	1.62	2.57
Gas from	145.8	2.89 (bottle)	.11	0.32	0.48	50	50	.11	1.39
Kerosene	131.4	6.40 (container)	0.05	0.34	0.51			.05	2.05
TOTAL				66.91	100				***14.89***

* Number of Hours spent collecting fuel-wood.

* SOURCE COMPILED AND COMPUTED FROM THE STUDY SURVEY DEC.1997

5-FUEL SOURCES:

Table (6) shows that the firewood is the main fuel source, followed by charcoal, gas and kerosene. Inspire of the different fuel sources available to the farm households; per-capita daily consumption of firewood fuel was relatively high. As regard to per - capita daily expenditure on fuel, firewood represented about 45.5% of the total expenditure on the fuel sources. Thus, firewood was considered as important source of fuel to many households in the area, while other sources were considered as secondary and less important. Excluding charcoal from the market, which mainly used in only by about 20% of household's sample for chewing Qat and heating in the cool area. Over-cutting for trade due to low individual income, this problem is finding in many cases. It is important to point out that low income and high rate of Population growth which is about 3.7% lead to over - cutting to meet the numerous and increasing needs, which to cusses the terrace degradation.

6- WATER SOURCES

Table (7) indicates that the estimated daily water consumption was about 803.3 liters per households. On the average, the time spent in bringing the water into the house was about 4.35 hours; women, girls collected about 83% of water consumption and the rest by men. With respect to time spent in brining water from the different sources, it should be mentioned that the quantity of water and the time spent in bringing it depend on location and rainfall season.

Table 7. Source of water, price in yr, daily consumption by liter times and used at Kuhlan-Affar area, Yemen

Source Water	Unit	Price Of Unit	Daily Consume.	Collected by Wom. %	Men %	Hour.	Used for (%)* 1	2	3	4
From spring.1	-	-	53.3	80	20	5.1	60	0	40	0
spring2	20	-	123	100	0	1.18	9.6	45.2	41.1	4.1
cist ran	20	-	146.7	100	0	.30	0	0	0	100
Majel	30.6	875	157.5	93.75	6.25	1.0	0	0	4.2	95.8
Wadi	20	-	131.7	100	0	1.12	3.5	20.7	6.90	68.9
Siqayah	-	-	74.4	100	0	.75	0	20	0	80
By Wayet	6.3	1069	116.7	6.4	83.6	6.4	10.7	21.4	75.2	10.7
TOTAL	-	*1944*	*803.3*	*82.9*	*17.1*	*4.35**				

•1 Number of Hours spent fetching water.

•2 1) Drinking, 2) Cocking, 3) 1 and 2, 4) others.

Source Compiled and computed from the study survey Dec.1997

7- Regression Model 1

This study regression model was used to relate the percent of degraded Terries to family daily working hours in the field. The results of regression analysis (see the tables) indicated a negative relationship between percent of degraded area (Y) and the family working hours in the field (X). That mean if the family daily working hours in the field decreased by one hour the degraded terraces will increase by 1.33%

Y = 47.629 -1.33 X

Regression Statistics

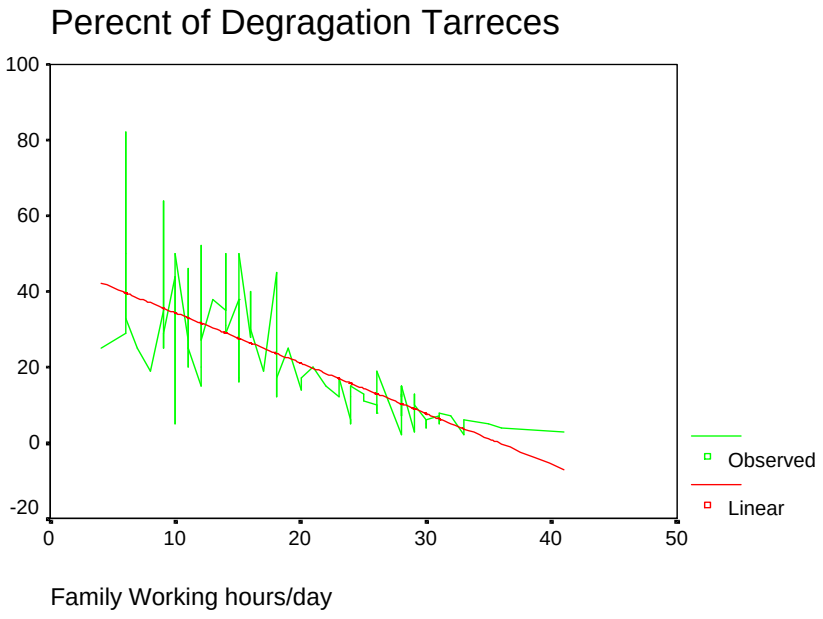
Multiple R	0.74128165
Multiple R	0.54949848
Adjusted R Square	0.54400456
Standard Error	10.8349163
Observations	84

ANOVA

	Df.	S.S	M.S	F	Significant F.
Regression	1	11741.81443	11741.81	100.0194	7.43241E-16
Residual	82	9626.423662	117.3954		
Total	83	21368.2381			

	Coefficients	Standard Error	T.	P-value	Lower.95%
Intercept	47.6286083	2.876305643	16.558	7.01E-28	41.906
X	-1.3318036	0.133167463	-10.001	7.43E-16	-1.59671620

Curve Fit
Independent: X



8 - Benefit - Cost Ratio Of Main Crops at Kuhlan-Affar area, Yemen

The estimated benefit - cost ratios presented in table (8) for the major crops indicate that all these crops are profitable where their benefit - cost ratios eschewed unit . Nevertheless, these ratios ranged from 1.10 for millet 1.71 for Qat . "**Qat Consumption** is one of the principle causes of poverty in Yemen, considerable size of many household budgets goes to buy qat which meet none of the human basic or secondary needs."

The harmonic mean of the estimated ratios amounted to about 1.30 which means that the net return per Rail of cost is about 30 Fails . Based on this criterion , net return for mast of major craps appears to be relatively low to net return in other sectors.

Table (8) Benefit Cost Analysis of the main crops in Kuhlan & Affer Mountain Terraces by YR/ Ha., in 1997.

Crops	Total Revenue	Total Cost	B/C
Qat	1055556	616731	1.71
Maize & Sorghum	81581	54805	1.49
Wheat	120686	88137	1.37
Lentils	164282	122952	1.34
Beans	155701	117851	1.32
Fenugreek	869059	680985	1.28
Barley	80391	65989	1.22
Coffee	178554	150360	1.19
Banana	416667	353230	1.18
Millet	193044	175344	1.10
Harmonic Mean			1.3

9- SHARES AND KUHLAN MARKETING MARGIN:

In Shares and Kuhlan, the marketing margins have been calculated for the studied crops as presented in table (9).

It has been revealed that marketing margin between farm gate price and Shares market ranged from about 11% for lentils to about 60% for Banana and wheat. Through this marketing channel, the farmers, shares ranged from 40% for Banana to about 89% for lentils.

Through the Kuhlan marketing margins ranged from about 17%for coffee to about 64% for wheat. Concerning farmers, shares, they ranged from 36% for wheat to about 83% for coffee.

To compare between the stated two marketing channels, the geometric mean has been estimated for the studied crops.

It amounted to about 62.4% and 58.3% for the first and the second marketing channel respectively. This conclusion indicates that farmers, shares under Sharis marketing farm products are low market and it is relatively higher than that under Kuhlan market. In general, it can be said that farmers share of marketing price for the studied crops, exception, lentils, Qat and coffee, appears to be relatively low that can be attributed to the relatively high marketing margin which in clouds the marketing costs and profit margins of middlemen through the various marketing stages.

Table (9) Farmers` shares and Marketing Margins for
The major crops in Study Sample, Yemen 1997

	Farm Gate	Shares Market	Kuhlan Market	Marketing Marring		Marketing Marring		Farmers ` Sharis	
				Shares M.		Kuhlan M		Shares	Kuhlan
Crop	Price							Market	Market
	YR/Keg	YR / K .g	YR / k .g	YR / K .g	%	YR K .g	%	%	%
Coffee	448	560	538	112	20	90	17	80	83
Maize& Sorghum	26	42	36	16	38	10	28	62	72
Qat	279	343	350	64	19	71	20	81	80
Barley	35	56	66	21	38	31	47	62	53
Wheat	27	68	74	41	60	47	64	40	36
Millet	20	47	50	17	36	20	40	64	60
Fenugreek	132	224	336	92	41	204	61	59	39
Beans	47	70	74	23	33	27	36	67	64
Lentils	80	90	100	10	11	20	25	89	75
Banana	20	50	45	30	60	25	56	40	44
Geometric Mean								62.40%	58.30%

Source: Compiled and Computed from Study Sample in 1997

10- The degradation of Terraces Land.[♠]

The majority of the farmers 164 (86%) reported losing land due to erosion As regards to the change in farm area by zone, it seems that the farmers of the lower slopes /wadi represented the majority of farmers who had lost land by erosion (95%), then the farmers in the middle slopes (86%), and the farmers in the upper mountain (67%). Numbers of farmers reporting losing their land to flooding (water erosion) from zone I were 46 (78%), from zone II, 61 farmers (51%) and from zone III, 11 farmers (26%).

The problems related to the losses of farm land mentioned above, although (number wise) mentioned by small number of farmers 11 (26%) in the upper mountain (zone III) compared with the number of farmers reported a losses in farm lands, proportional imply 3:2:1 in zones 1, II and III, really posed a remarkable consideration in any maintenance investments of terraces in zone III and the results on the terraces deterioration /maintains process in zones 1 and 2 (the lower /wadi and middle slopes).

However, because of data limitations, the findings presented in this study should be considered preliminary and they remain subject to further refinement as more data become available.

11- Surface & groundwater discharge

Evidently, terracing is the most efficient technique, the maintenance and rehabilitation of which requires special consideration. Also, management decisions should emphasize protecting catchments for rainwater harvesting, controlling wadi flood, minimizing water losses in delivery systems and improving groundwater abstraction techniques.

[♠] Based in the work of Dr. A. M. Bamatraf

1. Components of Surface Discharge: surface discharge, which is also frequently called total flow or total runoff, is the water flow which is observed in a stream or wadi channel. It is commonly differentiated into three components.

(i) Storm or Direct Runoff: this is the surface discharge which originates as hill slope runoff and reaches a stream channel shortly after the rainstorm. It is considered *direct* runoff since it reaches the stream channel directly by an overland or surface path. As such, direct runoff which is observed in a stream channel is essentially the same as floodwater flow,

(ii) Base flow: this surface discharge originates when rainwater percolates down to the water table - i.e., recharges the groundwater aquifer(s) - and then moves, at much lower velocities and by longer subsurface paths, to the stream channel reaching it over long periods of time. Therefore, base flow is an *indirect* type of runoff, since the water enters the ground and becomes part of the groundwater storage prior to emerging (later on) as natural groundwater discharge. Base flow is also often called delayed flow to distinguish it from the "quick" direct runoff and

(iii) Interflow: this surface discharge originates by a process similar to that of base flow, except that the percolating water is discharged into the stream channel before reaching the water table. Thus, interflow re-emerges (or is discharged) to the surface quicker than base flow but slower than direct runoff. Commonly, interflow accompanies major floods in which the floodwater overflows the stream channel and percolates into the stream banks to form what is called bank-storage.

Subsequently, when the flood recedes, the bank-storage is gradually discharged into the channel along with the baseflow.

Although spring discharge is commonly dealt with as part of groundwater discharge (rather than as surface discharge) estimates of this flow shall be handled jointly with baseflow. One reason for this unusual approach is the similarity of the two types of flow (i.e., spring and baseflow discharges) in that they both originate from groundwater aquifers. The other reason is the lack of any spring discharge data for W. Sharis, hence, it was safer to estimate it in combination with baseflow.

(iii) the annual volume of rainfall received by the study area (52 km^2) is estimated at about (28.7×10^6 m^3).

Bearing in mind the above characteristics of runoff processes in Yemen's catchments, assessment of the total runoff in W. Sharis revealed the following:

(i) total runoff generated by the whole catchment of W. Sharis (340 km^2) is estimated at about (12 MCM/yr). This is the runoff volume which is expected at the outlet of W. Sharis where it joins W. Mawr's channel. It represents a runoff coefficient (R) of about 6.4% which is in good agreement with the (R) value obtained by Gun's equation (6.6%) as well as with W. Mawr's general value of 6% matching results indicate that the estimated total runoff of (12 MCM/yr) is most likely within a (±) 10% range from the correct value.

(ii) total runoff from the upper catchment area of W. Sharis down to the channel segment adjacent to Jabal Kuhlan foothills (184 km^2), was estimated at (6.49 MCM/yr). However, we should point out that the actual volume which flows in W. Sharis main channel past J. Kuhlan foothills may be less, because of upstream diversions of various components of surface discharge (mainly as floodflow and baseflow).

(iii) total runoff which is generated on the mountain slopes of the study area is estimated at about (0.68 MCM/yr). This volume represents about 2.7% of the average annual rainfall (i.e.; R = 2.7%).

12- Summary & Recommendations:

Terraces in the highlands of Yemen were built by the family, community assistance and participation.
This study indicated the following: -
1. Terraces in the highlands of Yemen were built by the family labor with the community cooperation. However this study indicated that, about 47% form Family labor men in the area are working out the agricultural sector. Also the 53% are working less than 8 hours per day if we consider the time of chewing Qat, we can concluded that their actual time is very low to meet maintain the terraces.
2. Women is the main labor resources in the area about 84% of the sample are working in the field, but their actual time is less than 6 hours, because she devoted three hours for collecting fuel-wood and the another three for fetching water.
3. Girls and Boys in the area are devoted only 36% and 16% of their time to the fieldwork. Also, 36% and 96% of the girls and boys are attending the formal education. So the reallocation time can be done only in the girls and boys time in the summer holidays. Since, Population less than 16 years old in the area is about 47%. Implementing training programs for students in summer holiday for the terraces maintenance practices, will be suitable cheap and quicker solution in the short run.
4. Lack of a national understanding of the Role of Terraces on Land and Water Conservation in Yemen.
To reduce the time of collecting water for household consumption, some new technique in water harvesting methods must be introduced and implemented in the different zones.
5. As the terraces on the slopes fall into disrepair, or are abandoned, runoff is increased, which not only erodes the slopes but leads to destructive floods to the wadi bed. For a better use of time and resources allocation and it's affected in terraces Maintenance some kind of relationship and coordination between zones, NGO's, Local community Internationals Organizations should be developed to improve terraces maintenance and conditions.
6. Poverty and the environment are closely linked. A key issue challenging Yemen is poverty, and the linkage with environmental degradation, and resource depletion - occurring in both rural and urban areas. In rural areas, high levels of poverty often have led to environmental degradation. Households are living at levels below Poverty line and use soils, forest, and other resources at rates that exceed sustainable limits for recovery or renewal. The poor have no other option than to adopt short-term survival strategies which do not incorporate longer term resource management considerations. If the poor have no alternatives, they will continue to use land and water resources in ways that will threaten their future productivity. The conditions that

exacerbate these trends include: corruption, unclear land and water rights, the use of modem technology without adequate knowledge of its impact on natural resources, and population pressure. Those who plan for the poverty redaction should not be far away from poor people realities and the relationship between environment degradation and Poverty. The participatory process: Poverty focused on natural resources investments based on participatory planning processes can impact upon both poverty and the environment. In the participatory planning approaches (e.g. Gender equity in rural area , strengthening local governance and community participation, supporting data management for developing planning, monitoring and evaluation) will produced measurably better designed and implemented technical interventions. The income will increased for all groups within what are overall poor, tribal communities. Understanding poverty: environment links: the probability of achieving poverty-environment win-win outcomes is enhanced if policy starts from an understanding of peoples' livelihood strategies and the constraints they face.

7- Encouraging farm households to use alternative fuel sources such as gas, which has economical and environmental advantages over the use of fuel-wood, and to free time from women work to productive on farm activities.

8- poor water-related educational programs and lack of capability to determine or monitor proper water-use norms due to lack of technically capable institutions. Enhancing the decentralization and community participations

9-Addressing the terraces, water and natural recourses issues

10-Enhancing nation capacity for economics & policy analysis of terraces degradation and it is effect to water and agricultural land.

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