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Radical Terraces in Rwanda

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Abstract: This study was undertaken in Rwanda to assess the system of radical terraces. The erosion was the main cause for soil degradation. The results showed that several strategies and techniques were taken in order to protect the environment against effects of different natural disasters. Among them for example are the digs and hedge anti-erosion and radical terraces. It was revealed that the Radical terraces have a positive impact to increase farm productivity. The lack of materials, lack of financial supports, hard soil and straight slope were among main problems identified in region that were barriers for significant positive achievements. It was used method of whole for measuring of erosion though water flow from mountainsides. The results indicated that its speed was reduced from 1 hour in April 2007 to 7 hours 12 minutes in April 2008. The radical terrace technique is a good solution for environment protection.

Keywords: Environment, Erosion, Radical Terraces

1 Introduction

Soil erosion is a complex phenomenon involving the detachment and transport of soil particles, storage and runoff of rainwater, and infiltration (Lindstrom, 1986). It has been shown that the surface effect is considered from the viewpoint of local topographic gradient on soil loss (Wischmeier and Smith, 1978). The study in Ontario indicated that there are several forms of erosion that cause the loss of large quantities of top soil and subsoil each year (Omafra and Wall, 1987). In Rwanda, rivers became brown-red during the rain seasons because of eroded soils by rainfall from mountainsides; and many nutrients are also washed away implying the decrease of soil fertility. Since most of Rwandese population

lives in the rural area and 83.4% depends on agricultural production (Kaberuka, 2002), agriculture is still done artificially where the farmers use rudimentary instruments. The topography of country dominated by high mountains (Joe and Mary, 2003) is a big problem for environmental protection. The relief of Rwanda is one of the causes of soil erosion, which is a big barrier to the improvement of farm produce.

The study in 2008 showed that over 1 tone of soil per hectare was swept away by erosion of rivers and lakes every month. Erosion has been responsible of soil degradation with the soil nutrients losses estimated at 945200 T of organic materials, 41210 T of nitrogen, 200T of phosphorus and 3055 T of potash annually. An estimation of 39.1% of land in the country

has been affected by erosion (PMI Country Profile, 2009). It was indicated that between 1930 and 1950, the land of Rwanda was sufficient for cultivation because the population was estimated to about 1 million, and the soil erosion was not a serious problem due to the vegetation cover. The population grew to 10.5 million (PMI Country Profile, 2009) and the needs of soil cultivation increased hence led to complete destruction of vegetation cover. From 1980, erosion has been affecting agricultural activities (MINIPLAN, 1991; Encyclopedia of the Nations, 2008; MINITERE, 2003). In order to mediate these problems, different strategies have been taken with the aim of increasing farm productivity. For instance, the population has been mobilized and enlightened about the system of radical terraces in the whole country especially for those who live on highlands. The radical terraces were introduced in Rwanda in 1972 at Kizaro on ex Buyoga District in ex Byumba Province by a religious person named Syrille Wieme in 1979. This method was recognized by the Government of Rwanda and was officially encouraged; it was counted around 900ha of radical terraces in 1990 and was noted that the achievement of radical terraces required many processes. Since Rwanda is a hilly and rainy country, measures have been taken to control erosion with estimation of 23% of land having no risk of erosion, but 39% are highly risky of erosion. It was showed that the erosion is the cause of the loss of 1.4 millions tones of fertile soils through water flow along the rivers. The study in CAMERO JIEJO (North western Iberian system, Spain) showed that, since 1950s, the Spanish Mediterranean Mountains have become a marginal territory and erosions were a big problem, the farmers constructed the terraces consisting of the small plot with stone walls and used them for intensive cultivation. The walls retained the soil and

the damage caused by collapsing walls due to heavy rainfalls was quickly repaired by farmers in order to prevent further intense erosion (FAO, 1984; Theodore-Lasanta et al., 2001). Radical Terraces was among the strategies taken to protect land in order to increase farm productivity through mobilization of the population living in highlands.

2 Materials and Methodology

During this study taken at Kaniga Sector in Gicumbi district, a survey method was applied on five units called cells. 9 farmers per unit with a total of 45 people were interviewed. A questionnaire was used to get information about different activities regarding the system of radical terraces. This questionnaire was sent to different farmers sampled during 30 day period from 1st to 30th June 2008. After getting information from farmers, we interviewed some local governors for confirmation and finally we proceeded by searching different documents concerning this case. The method used for erosion measurement was preceded with water flow measurement when it was raining. Water was captured through digging of 1 m³ on three different locations for determinate the speed of water flow from the mountain. The three 1m³ holes were located in three different zones, two holes were located at the foot of the mountain where the activities of terracing of radical terraces had a high intensity and another was placed where the evolution of Radical terraces was limited

Study area:

Relief: Its relief is characterized by a high altitude of 2500m. The region experiences heavy rainfall with an annual average between 1400-1500mm; the annual average temperature varies between 15-20°C with four seasons: rainy season from mid-September to December and March to May,

a dry season from January to February and June to September.

Soil and Vegetation: Most of its soil is acidic with pH varying between 4 and 5.5 and characterized by much organic matter, potted on mountainsides. In Mulindi valley, which had been covered by Papyrus in the past, bracken and others weed; the surface is filled up because of the growing rate of population. Previously, it has been shown that between 1983 and 1993, Rwanda lost 4.8% of its forest and woodland areas (Mupenzi, 2010; Mupenzi et al., 2009).

Hydrology: A big part of Kaniga sector is supplied by ground water from Mulindi valley, which crosses Mulindi River; with many small stream rivers identified in this region.

Agriculture and Livestock farming: 90% of the population practice a subsistence agriculture dominated by living cultivation land (beans, maize sorghum potatoes, wheat, cassava, banana and soya bean), it has also an agricultural industrial area dominated by tea and coffee. The livestock farming does not have a good infrastructure, but some farmers possessed domestic animals like cows, goat, pigs, chicken and rabbit.

Environment and forest: This involves the action to protect, preserve and improve the quality of environment. The Government's major responsibility is to mobilize and teach the population on the effects of land degradation on the country's economy. The biggest problems are deforestation and soil erosion, which have a negative impact on human health. The presence of Mulindi tea factory in Kaniga sector appears to be the main cause of environmental degradation because of the use of different pesticides on tea plantation, and then the factory uses a high quantity of

wood fuel; around 100 ha of forest were cut in 2008. It is noted that pollution is also caused by domestic and industrial wastes, agro-pastoral activities and lack of modern sanitation facilities.

Erosion: The rainfall and topography are the major causal factors of soil erosion. Among others causal factors are; human activities such as deforestation, fire bush, pasture, extensive agriculture, and high demography. All those factors contributed to soil and environment degradation by loss of a large amount of nutrients element, water pollution and augmentation of flood on lowlands (SESA, 1986). It is indicated that between 1987-1990, the loss of soil fertility was a big problem that caused the decrease in farm productivity of maize and sorghum. Table 1 shows that a total of 516T/ha were lost through soil erosion; the production of maize was decrease from 1.2T/ha in 1987 to 0.09T/ha in 1990 and the production of sorghum reduced from 1.3T/ha in 1987 to 0.06 T/ha in 1990 (ISAR 1991). This situation is not only the specialty of Rwanda, the study held in India showed that 6 million tones of fertilizers were lost every year because of soil erosion (FAO, 1984)

Table 1 Soil Lost and Reduction of Production of Maize and Sorghum

year	soil lost (t/ha)	production of maize	production of sorghum
1987	10	1.2	1.3
1988	100	0.4	0.4
1989	124	0.3	0.5
1990	282	0.09	0.06
Total	516		

3 Results and Discussion

Table 2 Importance of Radical Terraces

importance	Frequency	%
Fight against erosion	20	44.4
retained water	1	22
getting forage	4	8.8
increase of farm productivity	10	22
reduction of poverty	7	15.6
increase of cultivation soil	3	6.6
total	45	100

The study showed that the biggest importance of radical terraces is to fight against erosion as it was an opinion of 44.4% of farmers. This hypothesis was confirmed by the decrease of floods in Mulindi valley; it was indicated that the soil is no longer washed away by rainfall after installation of radical terraces. It was also revealed through Table 2 that the importance of radical terraces is to increase the farm productivity as it was an opinion of 22% of farmers, and 15.6% of farmers esteemed that the importance of radical terraces is to reduce the poverty. Other importance of radical terraces are to get a forage by conifer which is planted between two radical terraces for retain of soil, increase of cultivation soil that represent an opinion of 8.8% and 6.6% of farmers respectively. However, the other importance of radical terraces is to retain water, which was an opinion from few members of farmers.

Radical Terraces in increasing the farm productivity

Table3 Production of potatoes gotten before and after terracing radical terraces

Before terracing of radical terraces

production (t/ha)	frequency	%
>25	0	0
25-20	3	6.6
20-15	5	11
15-10	8	16
<10	29	64.4
total	45	100

After terracing of Radical terraces

production (t/ha)	frequency	%
>25	2	4.4
25-20	8	18
20-15	20	44.4
15-10	12	27
<10	3	6.6
total	45	100

The potatoes were tested in order to compare the importance of radical terraces on farm productivity before and after terracing of radical terraces. It was showed through Table 3 that before the terracing of radical terraces any farmer was able to get the production > 25tones per hectare; 6.6% were the farmers who got between 25-20tones of potatoes per hectare and a big part of farmers produced less that 10tones of potatoes per hectare. However, it was showed that around 4.4% of farmers produced plus 25tones per hectare after terracing the radical terraces in their plots; 18% of farmers produced between 25-20tones per hectare and 44.4 of farmers were able to produce between 20-15tones per hectare; 27% of farmers got 15-10tones by hectare, but only 6.6% of farmers harvested less than 10tones of potatoes per hectare.

In general, it was revealed that 66.8% of farmers produced more than

15tones of potatoes per hectare after the terracing of radical terraces.

Difficulties in terracing of radical terraces

Even if the radical terraces contributed positively on environment protection, but many problems were big barriers for their achievement as indicated on Table 4 below:

Table 4 Difficulties which blocked the progress of terracing of the radical terraces

difficulties	frequency	%
heavy soil	15	33
raid slope	6	13.2
lack of means	15	33
negligence	2	4.4
lack of methods	3	6.6
lack of supervisor	2	4.4
lack of ownership	2	4.4
total	45	100

It showed that 66% of farmers were facing the problem of heavy soil and lack of means in their activities, 13.2% of farmers were confronted by the problem of raid slope; 6.6% of farmers faced the problem of lack of methods. Other problems which blocked the farmers in their activities to terrace the radical terraces were negligence and lack of supervision. It was revealed through Table 4 that many farmers failed to achieve the terracing of radical terraces because of they worked separately, yet this activity needs to put the force together; it was better if the farmers have been putting their forces together and worked in groups or associations for good achievement

Radical Terraces in Poverty Reduction

Table 5 Contribution of radical terraces on reduction of poverty

ways	frequency	%
giving job	4	9
augmentation of production	38	84
Program "Girinka" cow	3	7
Total	45	100

The reduction of poverty was one of the main objectives fixed by the Government of Rwanda in 2020 vision program. Many ways were tried and it was showed that the use of radical terraces had a positive impact on poverty reduction. The results in Table 5 showed that 84% of farmers confirmed this hypothesis where the radical terraces contributed to increase the farm productivity; the radical terraces help the population to get jobs or occupation as an opinion of 9% of farmers; the persons who achieved their radical terraces completely benefited by receiving a cow from National program called "Girinka" or a cow per family, this was the opinion of 7% of farmers.

4 Conclusions

The radical terraces have a positive impact on environment where it contributed to limiting water flow, which was the main cause of soil degradation. The results of the study showed that the radical terraces contributed to increase in the farm productivity, fight against erosion and also contributed to poverty reduction. Many difficulties such as heavy soil, raid slope, lack of means and lack of qualified supervisors were a big barrier to achieving aims of radical terraces. In order to protect the environment and to increase the farm productivity, it was recommended:

- An appropriate mobilization of population about the importance of radical terraces must be a good method for convincing the farmers
- Soil study and analysis are necessary to determine the type of soil before taking a decision on terraces in order to help the farmers in their activities
- The creation of associations or cooperatives must be good solution to achieve the radical terraces, and intensify the training of engineers and other technicians about radical terraces for capacity building.

Acknowledgments

This work was supported by finance from the Knowledge Innovation project of Chinese Academy of science (XJYS0907-2011-03). The Research and Consultancy office of INILAK

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