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Effect of Terracing on Soil Erosion in High Altitude Cold Arid Region-(Leh Ladakh) of J&K

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Abstract: Leh district is situated between 31-36° N latitude and 76-80° E longitude with an altitude ranging from 2500 to 6000 m above mean sea level. Leh is the largest district in the country with an area of 45,100 Km^2. Soil erosion is the main problem of the cold desert region. Terracing is one of the oldest means of saving soil and water. The objective of this paper is to provide information on the different types of terraces and to describe advantages and disadvantages of terraces regarding their efficacy to stop or reduce soil erosion. It is observed that terraces can considerably reduce soil loss due to water erosion if they are well planned, correctly constructed and properly maintained. If not maintained, they can provoke land degradation. Terracing has to be combined with additional soil conservation practices, of which the most important one is the maintenance of a permanent soil cover. There are several disadvantages to terracing. A future challenge is to develop conservation practices that are also productive.
Keywords: Leh, Terracing, Erosion, degradation, Productive.

I. INTRODUCTION

The cold arid region of Ladakh covers about 24,205 ha of cultivated area. The soils of the region are coarse textured, shallow, sandy, derived from weathered debris of rocks, subjected to severe wind erosion, have high permeability, low water holding capacity and low organic carbon (Sharma 2000). Leh is situated in the trans-Himalayan cold arid region and lies between 32°-36° N latitude and 76°-79°E longitude at an altitude of 11,300 to 18,000 ft. above MSL (Sharma 2000). Cultivated area under Leh district is 12,058 ha , where barley *(Hordeum vulgare)*, wheat *(Triticum aestivum)* and alfalfa *(Medicago sativa)* are major crops (Chaurasia and Singh, 1996), which cover 83% of the total cultivated area and are situated near the *Indus* river or at the entrance of small microwatersheds.

It is more and more agreed that soil degradation is a major threat to the Earth's ability to feed itself as nearly 40% of the world's agricultural land is seriously degraded (Kirby, 2000). Water erosion is one of the major causes of soil loss and soil degradation. Terracing could be one way to stop or reduce the degrading effect of soil erosion. It is one of the oldest means of saving soil and water. Moreover, it is the most widely used soil conservation practice throughout the world. Nowadays terracing is still in many cases promoted as being a best management practice for effective soil and water conservation.

Terracing refers to building a mechanical structure of a channel and a bank or a single terrace wall, such as an earthen ridge or a stone wall. Terracing reduces slope steepness and divides the slope into short gently sloping sections (Morgan, 1986). Terraces are created to intercept surface runoff, encourage it to infiltrate, evaporate or be diverted towards a predetermined and protected safe outlet at a controlled velocity to avoid soil erosion (FAO, 2000).

II. MATERIAL AND METHODS

Leh has an extremely harsh environment and one of the highest and driest inhabited places on earth (Fig. 1). Leh’s climate is referred to as a “cold desert” climate due to its combined features of arctic and desert climates. These include wide diurnal and seasonal fluctuations in temperature, from -40°C in winter to +35°C in summer, and extremely low precipitation, with an annual 10cm to 30cm primarily from snow (Demenge, 2006). Due to high altitude and low humidity, the radiation level is amongst the highest in the world (up to 6-7 Kwh/mm). The soil is thin, sandy and porous. These combined factors explain why the entire area is nearly devoid of vegetation, with the exception of valley floors and irrigated areas (Demenge, 2006).

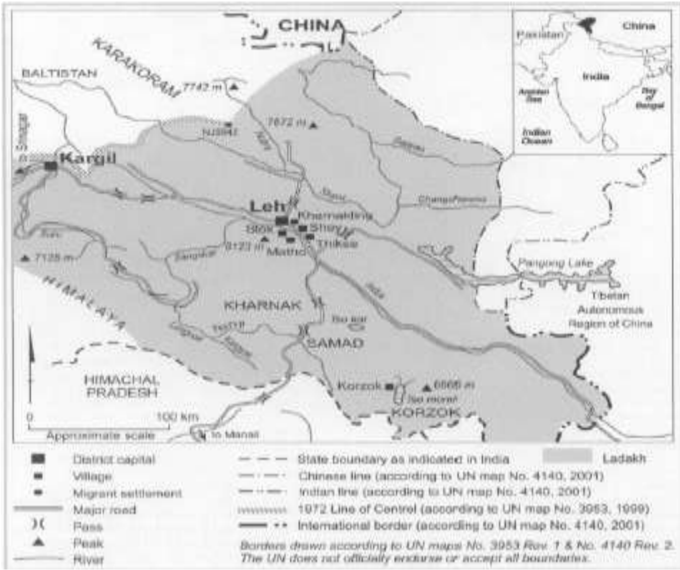

Fig. 1: Map of Ladakh region (J&K)

The survey on the type of terraces and their effect on soil erosion was conducted in cold desert zone of India. Five microwatershed villages from Leh district (Hemis, Skurbuchan, Phyang, Stok and Saboo) which receives glacial water for irrigition, were purposively selected and the investigations were made through multiple field visits, questionnaires and interviews with elderly people and expert.

III. RESULT AND DISCUSSION

Different Types Of Terraces

Terraces that protect against soil erosion can be naturally formed upslope contour hedgerows, vegetative filter strips and grass barriers. Many terraces however are directly man-made, i.e. the explicit terrace form has been constructed by humans. To classify the various types of terraces, different criteria have to be used. They could be classified according to 1) their main function, 2) the size of the terrace base, and 3) Terrace shape. A description of the different types according to these criteria will be given below.

1) Main function of the terrace

• **Retention terraces:** Also called absorption or level terraces. These are designed to accumulate and retain runoff in the terrace channel so that it will eventually infiltrate and the sediment accumulates. These terraces are recommended for low rainfall areas, permeable soils, and for land of less than 8 percent slope. They are normally broad-based terraces.

• **Graded or diversion terraces:** These are sloping terraces, designed to intercept or divert runoff into protected waterways. These terraces are recommended for high rainfall regions, for slightly or moderately permeable soils, and for slopes of between 8 and 20 percent.

2) Size Of The Terrace Base

• Narrow-base terraces; where soil movement is limited to about three metres.
• Medium-base terraces; where soil movement is three to six metres.
• Wide-base or broad-based terraces; where soil is moved more than six metres, but normally less than 12 metres.

3) Terrace Shape

Bertolini *et al.* (1989) classify terraces according to their shapes, which are mainly determined by the slope angle:

• **Normal Terrace:** A common or a normal terrace consists of a ridge or bank and a channel, which may be constructed on a gradient or level. This type of terrace is normally used in areas where the slope is less than 20 percent. These terraces mostly include broad-based terraces.

• **Bench Terraces (Fig. 2):** These terraces form a series of level or nearly level strips of earth and a steep or vertical downhill face, constructed on or nearly on the contour. The terrace could be supported by a barrier of rocks or similar material. Bench terraces are constructed by cutting and filling, and are used in land with slopes in excess of 20 percent. The bench terrace is perhaps one of the oldest forms of terraces. All other types of terraces have been derived from this terrace type.

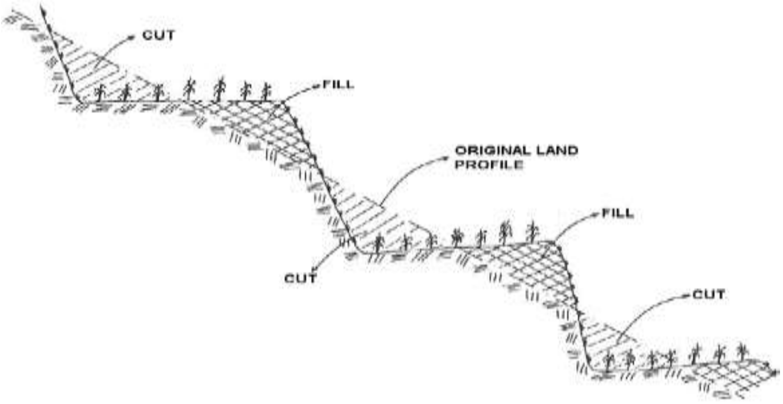

Fig. 2. A sketch of a typical bench terrace (FAO, 2000)

Effect Of Terracing On Erosion

Terracing changes the landscape. Therefore, they directly affect local hydrology and consequently runoff characteristics. In addition, terraces indirectly affect soil moisture and soil characteristics (Chow *et al.,* 1999). Terracing has only an effect on water erosion, it does not stop or reduce the impacts of wind erosion. Here we describes the advantages and disadvantages of terracing.

Many scientists, soil conservation services agree that terracing reduces runoff and soil loss due to water erosion. Runoff was reduced by as much as 25% of the total growing season rainfall, making it more available to the crop (Hatch, 1981). Terracing is much more effective in reducing sediment yield than planting trees only. The combination of the two resulted in continuous decrease of sediment yield (Mizuyama *et al.,* 1999). Traditional terrace farming reduces erosion in comparison with non-terraced fields, if terracing is combined with contour cropping (Inbar and Llerena, 2000). One of the most important erosion reducing activities is the maintenance of the terrace walls. Abandonment of terraces could create a major risk of massive soil loss (Harden, 1996). Soil fertility increases from the upper to the lower part of terraces, especially concerning organic matter and nutrients. Small contour ridges, made by vegetation and stones, were much more efficient than diversion terraces, because the latter concentrated storm water in single channels, leading to erosion down slope. By using the small ridges, the soil strata would be left untouched, which has a more positive effect on infiltration than creating diversion terraces. These small contour ridges would also entrap sediment and slowly let the slope evolve to a terraced slope after 4 to 10 years (Dercon *et al.,* 2003).

Disadvantages Of Terracing

The foot of a terrace wall is often affected by erosion, because of the steepness and the sparse vegetation cover. Poor management of the terrace toe drain in combination with the steep slope gradient of terraced slopes and the high amount of generated runoff are important causes for the lack of efficacy of terracing in combating erosion. Erosion on the foot of the terrace slope could lead to deterioration of the terrace as a whole as well as gully formation, which eventually leads to increased erosion (Lasanta *et al.*, 2001). Construction of bench terraces was inappropriate because the topsoil was too thin so that the construction exposed the infertile subsoil.

IV. CONCLUSION

It may be concluded that terraces could considerably reduce soil loss due to water erosion if they are well planned, correctly constructed and properly maintained. There is a large variety of terrace types, each adapted to certain landscapes with various slopes gradients. The most important aspect of terracing is that it has to be combined with additional soil conservation practices, of which the most important one is the maintenance of a permanent soil cover. This latter is especially needed on the foot slope of the terrace, because terraces themselves could be easily eroded and they generally require a lot of maintenance and repair.

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