

PLANTATION OF CITRUS ORCHARDS IN ERODED SOILS TO PROTECT FURTHER EROSION IN THE SUB-MOUNTAINOUS TRACT

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INTRODUCTION

The agriculture in irrigated tract is dependent on canal water, whereas in barani tract the rainwater is the only source. The water losses and its inefficient use exist in both the tracts. In irrigated areas, there are huge conveyance and application losses with the existing irrigation system and the efficiency is far below the satisfactory level. In barani tract, stored rainwater in the form of small dams, mini dams, and ponds is highly expensive input but it is not being utilized properly to produce valuable outputs. It should be used for growing high value crops i.e. fruit and vegetables instead of traditional arable cropping. Many streams are flowing, water of which can be used by pumping. Moreover, there is an ample scope for rain water harvesting and lot of improvement is needed in moisture conservation techniques.

In rainfed tract of Pothowar region, 31 small dams and 519 mini dams have been constructed with the capacity of 85351 acre feet quantity of water (Table-1). Most of the mini dams are located in gullied areas. Gully erosion threaten vast tract of agriculture land (Bhushan and Yadav, 1990). The farmers generally develop land by leveling the gullied area with bulldozers. In this tract, lot of financial resources has been invested on leveling but unfortunately benefit doesn't correspond with the investment. Yadav, *et al* (1994) also reported severe criticism on the construction cost of drop spillway to control the

gullies. By leveling gullied area with bulldozers, the top fertile soil is burried and underlying unfertile part of the soil comes on the surface (Table-2). In majority of such areas farmers could not see a single blade of grass for many years. With the passage of time, these soils become more prone to soil erosion. The cost effective use of water is only possible by raising valuable crops on gullied land with out intervention of bulldozer.

A long term experiment was conducted to study the possibility of raising orchard in a gullied area by using the irrigation water of mini dam at Dhaku village near Chakwal. The efficiency of various erosion control measures such as stop wash barriers and half moon terraces in staggered arrangement was also studied. The monitoring of soil and water losses with each storm was done through the study period.

Rainfall Pattern in Chakwal

In Pothowar region, generally 70% rainfall is received in summer in monsoon and 30% in winter. It is highly variable during different years. The data for the last 26 years at Chakwal are presented in Figures-I. This figure clearly shows the diversity of rainfall. During 1979, there was no rainfall in the month of August but during 1997 Chakwal received 443 mm rainfall during this month. Similarly, in July 1988, the rainfall received in the same tract was 19 mm but during July 1978, the rainfall was 322 mm. Similar, behavior was observed during the month of

September. During the year 1992, the rainfall was 291 mm during this month but in 1993 there was no rainfall.

was divided into four naturally existing mini catchments.

Table 1: Detail of small and mini dams in Pothowar tract

District	Dams	Live storage (acre feet)
Islamabad	1	43000
Rawalpindi	6	1534
Chakwal	11	13476
Attock	10	17620
Jhelum	3	6721
S. Total	31	85351
Mini dams	519	-
Total	550	85351

Source: Directorate of Water Management, Pb. Lahore, June, 2001

Table 2: Analysis of leveled gullied area with Bulldozer at Fateh Jang

#	pH	P (mg/kg)	K (mg/kg)	Zn (mg/kg)	Cu (mg/kg)	Fe (mg/kg)	Mn (mg/kg)
1	7.28	0.67	60.00	0.14	-	4.00	3.80
2	7.56	0.93	110.00	Traces	-	5.00	3.00
3	7.32	1.20	76.00	0.13	-	2.60	2.60
4	7.40	1.06	120.00	0.18	-	5.40	4.40
5	7.15	1.00	50.00	Traces	-	5.20	4.00
6	7.47	0.40	90.00	Do	-	5.00	3.00
7	7.62	0.47	80.00	Do	-	6.40	4.20
8	7.64	0.67	164.00	0.24	-	5.40	3.00
9	7.30	1.20	74.00	Traces	-	3.20	-
10	7.67	0.60	96.00	do	-	4.40	1.20

Source: Rashid, M. *et al* (1998)

In such situation, it becomes difficult to plan agricultural activities in this region and the task of using water efficiently becomes more difficult.

METHODOLOGY

A severely eroded piece of land was selected in Dhaku village about 18 km from Soil & Water Conservation Research Institute, Chakwal in 1996. The area was selected because it had a series of mini dams in the vicinity and the precious water was being used to grow ordinary field crops. The area

1. Citrus Catchment

This catchment covers an area of 1.56 ha with a maximum elevation of 10.91 m. In this catchment, five hundred citrus plants were planted in March 1996 and 1997.

2. Peach Catchment

The area of this catchment was 1.25 ha with an elevation of 9.81 m. In this catchment, about two hundred peach plants were planted during 1997/98. Some plants of almond and apple were also planted.

3. Control Catchment

This catchment comprised of an area of 0.4 ha. No plantation was done in this catchment. All plantation comprised of existing forest trees mainly *Acacia modesta*.

4. Eucalyptus Catchment

This catchment covered an area of 0.586 ha. Mainly Eucalyptus was planted in this catchment along with

Figure1: Rainfall Pattern in Chakwal

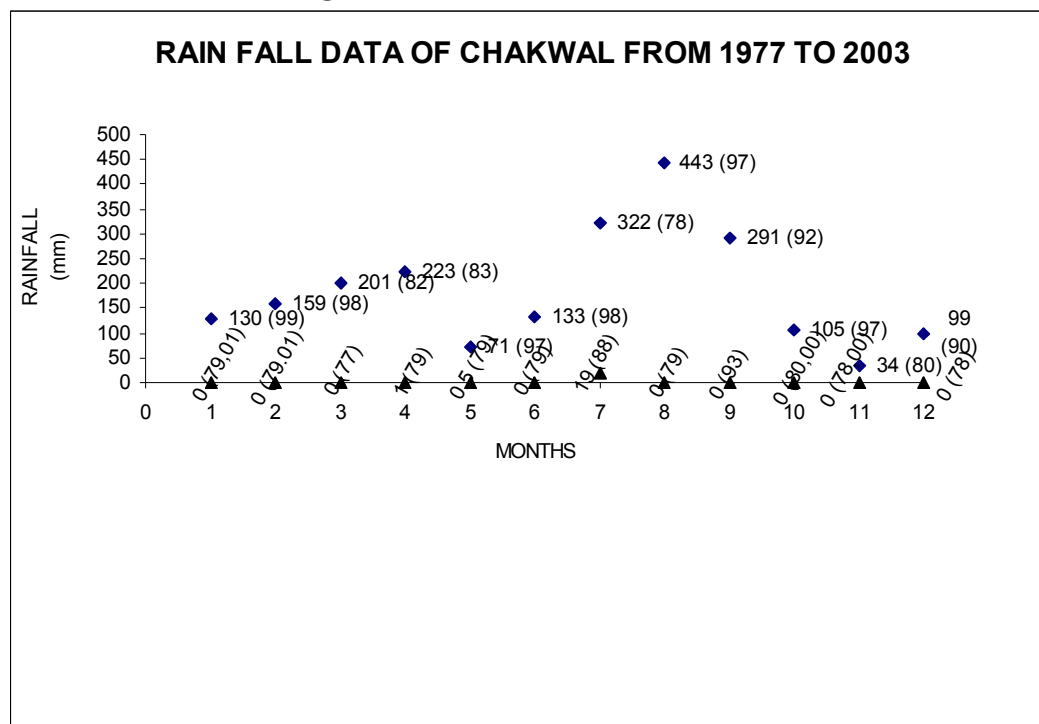


Table 3: Salient feature of the experimental site near Dhaku village

Typical features	Catchment # 1 (citrus)	Catchment # 2 (peach)	Catchment # 3 (control)	Catchment # 4 (eucalyptus)
Perimeter (m)	548.69	483.39	274.5	209.25
Area (ha)	1.56	1.25	0.40	0.59
Elevation of the highest point (m)	10.91	9.81	9.85	9.79
Elevation of the lowest point (m)	0.00	0.00	0.00	0.00
Distance between highest point and lowest point (m)	184	164.5	81.25	77.25
Slope (%)	5.93	5.96	12.12	12.67
Average slope of catchment (%)	6.97	7.18	17.15	17.12

the already existing forest trees.

All the catchments were surveyed and the topography & salient features are given in the Table 3.

The nutritional survey of the area was also done. The soil samples were collected and analyzed for pH, E_c , organic matter, available phosphorus and potassium. The pH and E_c were in normal range. The organic matter ranged from 0.4 to 0.6 percent. The status of available phosphorus was poor and all the samples had this nutrient less than 6 mg/Kg. The Available potassium was in the range of 100 to 160 mg/kg.

IRRIGATION SYSTEM

Water source was available in the form of mini dam in the area. It is evident from the various features of the catchments that the terrain of the area was highly undulating. It was difficult to use the water of the dam for irrigating the fruit plants. The engineers of the institute designed an irrigation system comprising of diesel engine and pump, suction pipe, PVC pipe and conveyance pipe. A sketch of

outlet is fixed for one hundred plants in each citrus and peach catchment.

The irrigation water was being applied to the basin of each plant and mulch was also applied to minimize evaporation. The system proved very effective and efficient. In this system, no loss occurred to the pipe by rats/porcupine. There were no conveyance losses. All the pumped water was used directly by the plant. The initial cost was Rs 36,600/- (Table 4) for installation of the system for two catchments over an area of 2.81 ha. The system worked very efficiently during the entire study period and plants grew very well.

Erosion Control Practices

In all the catchments various cost effective erosion control measures were adopted which are briefly narrated below:

1. Eye Brow Terraces in Staggered arrangement

Semi-circular bunds are prepared against the slope for each tree to collect the rain water from the catchment area of the tree. These are also called half moon terraces. These

Table: 4 Expenditure involved in developing irrigation systems

Name of the items	Price (Rs)
Diesel Engine (16hp) and pump (meco 2"x2")	18000
Suction pipe	1000
Joints, clips, valves, nozzle, sockets etc	6000
Delivery pipe (PVC) (1000ft)	10000
Conveyance pipe (100 ft)	1600
Total	36600

the system is given in the figure-2. The detail of expenditure involved in this irrigation system is given in the Table-4. The water was being pumped from the dam. The conveyance pipe was attached to the water out let fixed on PVC line. One person was irrigating hundred plants in two hours. One

bunds were prepared for all the fruit trees in staggered arrangement to collect all the rainfall water. In this system no runoff water was flowing down and all the water was being used for plant.

Stop Wash Barriers

Runoff water moves very fast in gullies. To dissipate the energy of

water, the barriers are constructed. The vegetative barriers were developed in all the catchments. To develop these barriers the branches of the native trees were used, which were followed by live material i-e Mott grass. It worked well and in addition to reducing the speed of water, the eroded soil material started settling and gullies started reclaiming.

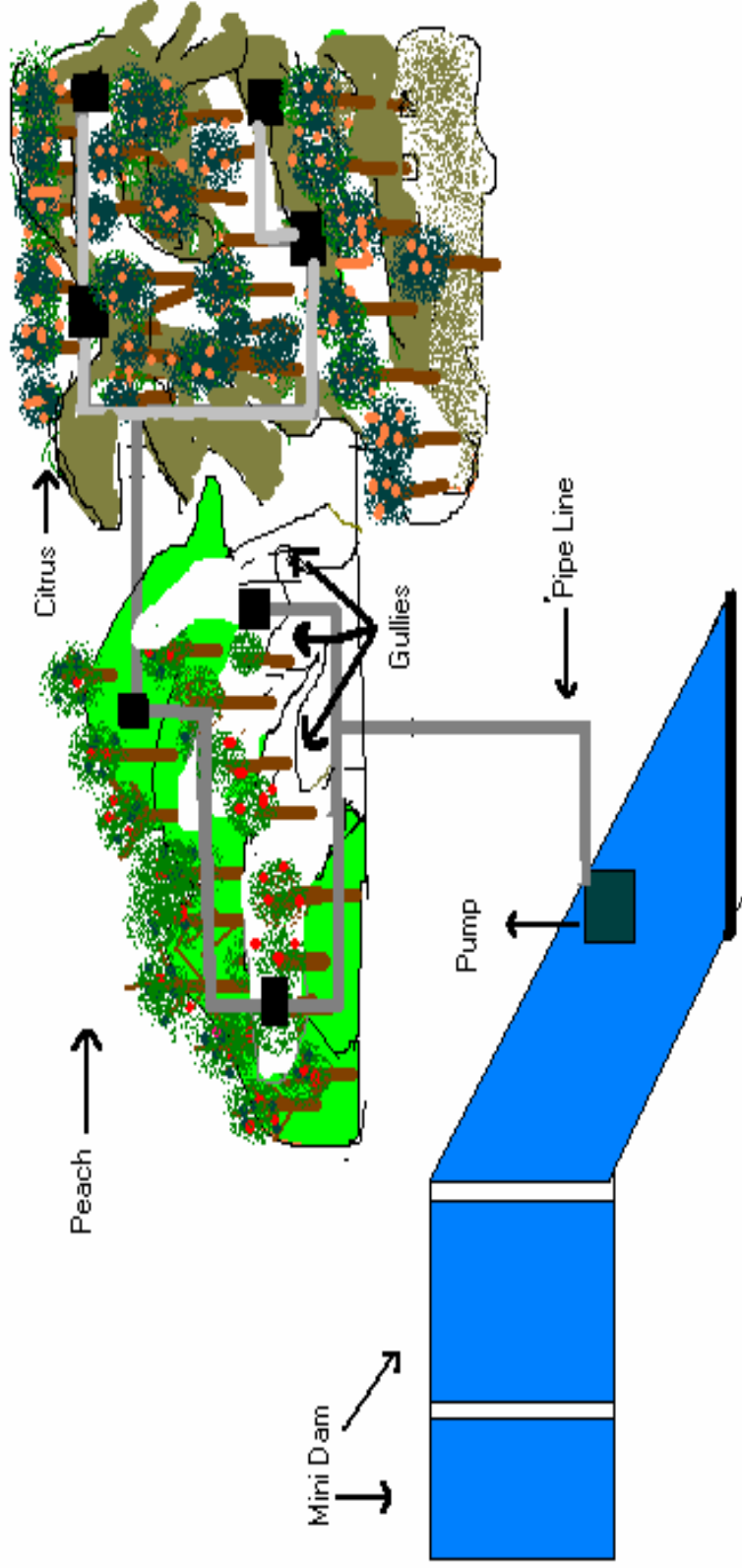
Mulch

By adopting above measures, the infiltration of runoff water increased resulting into more grass in between plants. This grass was used as mulch in the basins of fruit trees to minimize evaporation of moisture.

Soil and Water Losses Monitoring

To monitor the soil and water losses, automatic water level recorders were installed at the drainage points of all the four catchments. Sediment traps were installed to collect the samples. The samples were brought to laboratories for determining the quantity of soil in the samples. The rainfall recorders were also installed at the site.

Figure: 2 Schematic sketch of the system, where citrus and peach plants are growing successfully in eroded/degraded gullied area with new designed irrigation water technique.

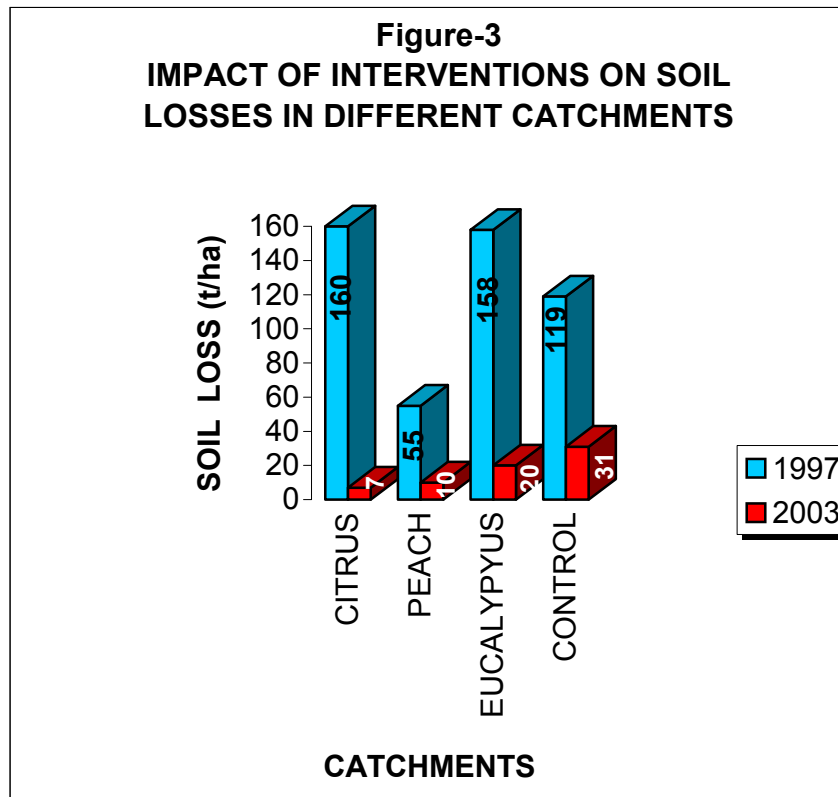


Present status and findings

The piece of land under this study was highly gullied and it was not under any use except few forest trees for the last fifty years. In this study, the prevalent practice of land leveling with bulldozer was avoided leading to substantial financial saving. Moreover, this study had clearly demonstrated in the field that water stored in the dam can be very efficiently used for raising fruit plants. The citrus, peach and apple are growing well and all the fruit trees are bearings fruit.

The erosion control measures such as eyebrow terraces in staggered

The farmers of the Pothowar area do not give priority to the agriculture as a profession, therefore, majority of them is not willing to use high-pressure irrigation techniques because of high initial investment. Although Shoji (1977) stated that the efficiency of sprinkler irrigation system could be raised up to 70-80 percent while with drip irrigation efficiency can be raised up to 80-90 percent but farmers interest have to be kept in view during standardizing of technology. Moreover, in a highly gullied area, these systems could not prove their worth because of rodents. The irrigation technique used in

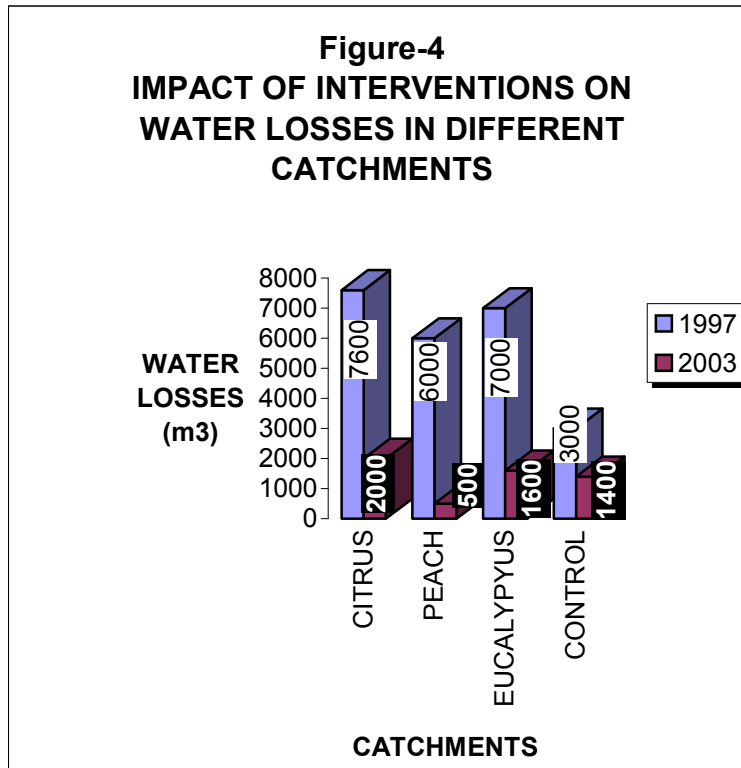


arrangement, stop wash barriers and mulching proved very successful in controlling erosion and efficient use of rain water. The soil and water losses were decreased to minimum by adopting these measures (figs 3 & 4).

this system is a very simple and economical on one hand and on the other hand, plants were fully saturated by applying the water with conveyance pipe. It may be interesting to explore the possibilities of further improving the system that may facilitate the use of this

technology and to achieve the dual goal of horizontal and vertical expansion of the area under high value crops in Pothowar.

crops can be raised in such areas by utilizing the stored rainwater in the form of mini dams, ponds, small dams etc.



CONCLUSIONS

The experiment was completed in October 2003 and the conclusions were:-

- Citrus, apple and peach plants attained the age of full fruit bearing.
- Stop wash barriers proved their efficacy.
- Eyebrow terraces with plantation in staggered arrangements completely stopped the soil erosion.
- Soil losses of all the catchments decreased by 90%.
- It is inferred from this study that gullied area can be used without involvement of bulldozer leveling. Depending on the management, the high value

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