*__Original Research Article__*

# Impact Assessment of Soil and Water Conservation Measures at Gharat Watershed in Pindwara, Sirohi


## ABSTRACT

The study was carried out 2020-2021 at the Gharat watershed is located in Pindwaradistrict. To evaluate the impact of various biological and physical soil and water conservation (SWC) measures, implemented in the Gharat watershed during 2011-12 in combating minimal land resource use, land degradation caused by soil erosion, and lack of implementation of agriculture technology. Therefore, evaluation is required to determine the success or failure of conservation measures and to alter future planning appropriately. Due to the implementation of the watershed program, arable area increased by 16.56 percent, irrigated area by 53 percent, and additional farm income increased by approximately 17 lakhs, according to data collected through field observation, survey, semi-structured interviews, and field measurements. SWC measures applied in this watershed, cropping intensity and irrigated area increased from 122.12 percent to 137.08 percent, 51ha to 78ha respectively. The understanding and adaption of soil and water conservation strategies has a favorable influence on the overall development of the watershed. Existing SWC measures should be improved for continuing monitoring and extended as part of an integrated strategy to restore damaged regions to their full potential. It provides project planners and managers, programme leaders, and policymakers with details about actual project accomplishments in the format they need.



*Keywords:*Impact assessment, soil and water conservation, Gharat watershed and soil fertility.


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## 1. INTRODUCTION

Land degradation is one of the most pressing global environmental issues, threatening global food security and reducing agricultural output. "Land degradation" has a wide range of implications, but it essentially refers to conditions in which the biological productivity of the land is reduced (Sharma *et al.*, 2015).

Rajasthan is the country's largest state by area, and it is located in the country's northwestern corner. It has a geographical size of 34.22 million hectares, accounting for 10.41% of the country's total area. The state's population is 68.62 million people, or 5.67 percent of India's total population. Rajasthan is second in the country in terms of livestock population, with 56.66 million animals. The most important land use is net sown area, which accounts for almost half of the state's entire geographical area (170.38 million hectare). It is critical in deciding agricultural prosperity in a long-term manner.

Wind erosion (44.2 percent) is the most significant cause to desertification or land degradation in Rajasthan, followed by water (112 percent), vegetal degradation (6.25 percent), and salinization (1.07 percent). As a result, the problem of soil degradation poses a major danger to long-term agricultural productivity. Massive unemployment, labour migration, regional and intergenerational inequality, loss of natural resource base, and ecological imbalance are all consequences of the deterioration (Salvati*et al*., 2021).

Land degradation results in lower agricultural output indicated,economic loss and increasing societal stress (Gautam*et al*., 2020). Low soil moisture due to unpredictably and irregularly distributed rainfall, significant soil loss due to run-off and the associated low soil fertility are the main drivers of land degradation and low agricultural output. Furthermore, as the world's population rises, subsistence agriculture has spread to remote areas, producing land degradation and jeopardizing the environment's and agricultural production's long-term viability. The value of grain lost due to soil erosion was estimated to be over 10 million Ethiopian Birr (1 USD 2 ETB at the time). Land degradation, in the form of soil erosion and poor soil quality, represents a serious danger to agricultural productivity and overall economic growth in the country. Soil and water conservation (SWC) strategies have been introduced to address these issues, reducing both the concerns of increased erosion and poor production. Physical SWC measures have short- and long-term effects, depending on how long it takes for them to become effective against soil erosion. The reduction in slope length and the construction of retention basins for run-off and sediment are the short-term benefits of stone bunds. Overland flow quantity and erodibility are reduced as a result. Such impacts arise very quickly once the stone bunds are built. The formation of bench terraces, the growth of plant cover on the bunds and gullies, and changes in land management are all medium and long-term consequences.

## 2. MATERIALS AND METHODS

### 2.1 Study area:

The study was carried out 2020-2021 at the Gharat watershed is located in Pindwara district. The project area is situated at latitudes of 24°43' 34 N" to 24° 47' 45N" and 73° 01' 57E" to 73° 08' 30E" longitudes. It is 15 kilometers from its block headquarters and 50 kilometers from its district headquarters. Gharat village is a micro watershed of these 11 villages with a total area of 962 ha that has been completely managed with soil and water conservation methods such as check dams, contour vegetative hedges, V-ditches, percolation tanks. The research area's climate is characterized as subtropical humid. The yearly rainfall averages 861.3mm. Rainfall is inconsistent, irregular, and fluctuates year to year. The months of June to October receive around 94 percent of total rainfall, whereas the remaining months of the year receive just 6% of total rainfall.

Maximum temperatures of 48°C to 31°C are usually observed in May and June, while low temperatures of 23°C to 5°C are usually recorded in December and January. Temperatures range from 30°C to 35°C during the rainy season, with high relative humidity of 75–90%. In the research region, Kharif is the most significant growing season. During Kharif, the main crops include local grains and pulses, as well as oilseeds. Bajara, maize, and a variety of coarse grains are among the major cereals cultivated during the Kharif season. Crop production during Rabi is primarily restricted to areas with well-developed irrigation systems. The most significant Rabi cereal crop is wheat. The other produce in the Rabi season features Wheat, Gram, Mustard rapeseed and cotton.

### 2.2 Data acquisition

The collection of primary and secondary data was required for the integrated effect evaluation of SWC measures in the watershed. Farmers' primary data, as well as field measurements and observations, were collected (transect walks, semi-structured questionnaire interviews, group discussions). During data collection, the methodologies mentioned in Table 1, such as before and after soil and water conservation measures, and comparisons of environmental effect indicators, were employed. Secondary data, such as climate, demographics, and other related information, was provided by the Department of Agriculture for this study.

**Table 1: Ideal and operational performance indicators for implementation of SWC measure at the Gharat watershed**

| Performance Criterion | Ideal indicator | Operational indicator used in the study |
|---|---|---|
| **Status of soil erosion** | Measurement of erosion and associated yield loss<br>Presence, expansion and development of new active erosion features by slope, soil and land use types | Impact on soil fertility and soil moisture through vegetative cover and yield indicators.<br>Qualitative comparison of treated and untreated watershed with respect to soil fertility. |
| **Water recharge** | Surface water storage amount<br>Ground water levels before and after SWC measures | Approximate change in the number of wells<br>Change in irrigated area<br>Change in village water supply |
| **Soilmoisture retention** | Time series, intra and inter year<br>Variations in soil moisture using measuring instruments | Change in cropping pattern<br>Change in cropping intensity<br>Relative change in yield and productivity |
| **Productivity of non-arable lands** | Change in production of plantation lands | Relative change in the farm land area<br>Change in arable lands |



The transect walk method was used to assess natural resources and present SWC measures in the watershed. Throughout the transect walk, observations and evaluations of vegetation and density, the impact of current SWC measures, and levels of SWC measures at various points in the landscape were all recorded. Farmers were questioned informally utilizing semi-structured interviews, group discussions, and a variety of participatory rural appraisal (PRA) methods. Secondary data collected from Department of Agriculture supplement the focus group discussions.

A total of 25 household heads were interviewed in semi-structured interviews. Observations and informal participative talks with persons and groups representing men and women from varied socioeconomic backgrounds resulted in the formation of focus groups. During the holidays, these groups came together as a team for three days of discussions. The winners of each wealth category were picked at random. There was no significant difference in economic status or gender in this research.

### 2.3 Assessment of Soil Fertility

The present study deals with the analysis of soil samples which were collected in a period 2019-2021 from Gharat watershed. The soil samples were collected by standard procedure in polythene bags. The soil samples were collected at surface level (0-10cm in depth) from the field. Air-dried soil samples were ground and sieved. Each sample was separated into two portions before sifting; one was sieved through a 2mm sieve, while the other was sieved through muslin fabric.Soil samples were suspended in distilled water (1:4 w/v) and allowed to settle down before being analyzed for physicochemical characteristics. A glass electrode pH meter (Equiptronics, India) was used to determine the pH of the suspension (Lark *et al*., 2002). The electrical conductivity of the soil was evaluated using a conductivity meter and a saturation extract. The percentage of organic carbon (OC) in the sample was evaluated using the Walkley and Black technique and a diphenylamine indicator. Subbaiah and Asija described an alkaline permanganate technique for estimating available nitrogen (1956). The volumetric approach was used to determine the available phosphorus and potassium in the soil (Ifenna and Osuji, 2013). Titration with a standard $KMnO_4$ solution can be used to evaluate available calcium. The amounts of heavy metals (Cu, Fe, and Zn) were measured using an Atomic Absorption GBC Avanta version 1.31 Spectrophotometer and flame atomization (Lark et al., 2002).

## 3. RESULT AND DISCUSSIONS

The results have been presented and discussed in the ensuing sections.

### 3.1 Status of farm families

The total number of farm families is 490 and average size of family was (5-6) members. The literacy rate in the study area was 36.18%. The distribution of land holdings is shown in Table 2.

**Table2: Status of farm families in study area**

| Size Group | No. of Farmers | Percentage |
|---|---|---|
| Landless | 26 | 5.30% |
| Marginal Holding (0-1)ha | 387 | 78.97% |
| Small Holding (1-2)ha | 42 | 8.57% |
| Medium Holding (2-3)ha | 31 | 6.32% |
| Large Holding (>4)ha | 4 | 0.84% |

### 3.2 Status of land use pattern

Following the project's assessment,the watershed's arable and silvi-pasture land had changed radically. The watershed's arable land, which was 372 ha in the base year out of 962 ha total land, has been increased to 433.66 ha. The Silvi-Pasture land, which was 175.47 hectares in the base year, has been increased to 288.65 hectares, with an additional 27 hectares irrigated. Table 3depicts the changes in land use trends in detail.

**Table 3: Change in land use pattern before and after the project implementation**

| S.No. | Particulars | Before the Project (ha) | After the project (ha) | % change in Area |
|---|---|---|---|---|
| 1. | Arable land | 372 | 433.6 | +16.56% |
| 2. | Irrigated area | 51 | 78 | +53% |
| 3. | Non arable land | 496 | 407.34 | -17.87% |
| | Private waste land | 55.53 | 23.69 | -57.34% |

| | | | | |
|---|---|---|---|---|
| | Govt. waste land | 265 | 135 | -49.05% |
| | Silvi-pasture | 175.47 | 258.65 | +47.40% |
| 4. | Others | 43 | 43 | - |
| **Total** | | **962** | **962** | **-** |

**Fig 1: Small-scale irrigation facilities in the watershed**

### 3.3 Cropped area and cropping intensity

In both the Kharif and Rabi crop seasons, a large area has been brought under cultivation due to the implementation of soil and water conservation initiatives, improved irrigation facilities, and the use of improved methods. Cropping intensity rose from 122.12 % in the base year to 137.08 % in the research year. The area planted in maize, wheat, jowar, gram, and mustard has increased. There has been a major improvement in wheat cropped area in Rabi season and maize cropped area in Kharif season due to increased irrigation facilities. Some crops were also introduced in the summer due to the availability of irrigation water in open wells and soil moisture(Table 4).

**Table 4: Area under different crop and cropping intensity before and after the project implementation**

| S.No. | Crops | Before the project (ha) | After the project (ha) | % change in Area |
|---|---|---|---|---|
| **1.** | **Kharif crop** | | | |
| | Maize | 213 | 262 | +23% |
| | Jowar | 142 | 168 | +18.31% |
| | Paddy | 5 | 5.5 | +10% |
| | Black gram | 9 | 16 | +77.77% |
| **2.** | **Rabi crop** | | | |
| | Wheat | 55.8 | 75 | +34.41% |
| | Gram | 20.5 | 42.5 | +107.32% |
| | Mustard | 4.5 | 15 | +233.33% |
| | Jow | 1.5 | 6.5 | +330% |

| 3. | Summer crop | | | |
|---|---|---|---|---|
| | Vegetables | 1.5 | 4 | +166.66% |
| | Green gram | 3 | 9 | +200% |
| **Total** | | **454.3** | **594.5** | **-** |
| **Cropping Intensity** | | **122.12%** | **137.08%** | **-** |

## 3.4 Productivity status

Crop yields have increased as a result of soil and water conservation measures, the use of improved seeds, and fertilizers. In the maize crop, productivity increased by a maximum of 55.40 percent and a minimum of 12.96 percent. Wheat, mustard, and gram productivity all increased by 21.62, 31.33, and 19.07 percent (Table 5).

**Table 5: Productivity status of different crops**

| S.No. | Crops | Yield before the project (ha) | Yield after the project (ha) | % change in Yield |
|---|---|---|---|---|
| **1.** | **Kharif crop** | | | |
| | Maize | 7.40 | 11.5 | +55.40% |
| | Jowar | 3.50 | 4.32 | +23.42% |
| | Paddy | 8.25 | 9.32 | +12.96% |
| | Black gram | 3.30 | 4.82 | +46.60% |
| **2.** | **Rabi crop** | | | |
| | Wheat | 18.50 | 22.50 | +21.62% |
| | Gram | 8.23 | 9.80 | +19.07% |
| | Mustard | 4.82 | 6.33 | +31.33% |
| | Jow | 14.50 | 20.20 | +39.31% |
| **3.** | **Summer crop** | | | |
| | Vegetables | 13 | 17.5 | +34.61% |
| | Green gram | 6.5 | 7.8 | +20% |

## 3.5 Maximization of farm income

The total additional income was as Rs. 1704250 which is the average additional income in the watershed area. Average additional income per hectare in the area was Rs. 4581 which highlights the direct benefits of soil and water conservation works. The maximum return was reported from maize followed by mustard and gram (Table 6).

**Table 6: Increase in the agriculture income after implementation of project in Gharat watershed**

| S.No. | Crop | Yield increased (q/ha) | Maximized farm total land income |
|---|---|---|---|
| **1.** | **Kharif crop** | | |
| | Maize | 4.1 | 371665 |
| | Jowar | 0.82 | 56285 |
| | Paddy | 1.07 | 6000 |
| | Black gram | 1.52 | 163840 |
| **2.** | **Rabi crop** | | |
| | Wheat | 4 | 151680 |
| | Gram | 1.57 | 276154 |
| | Mustard | 1.51 | 273725 |
| | Jow | 5.7 | 45600 |
| **3.** | **Summer crop** | | |
| | Vegetables | 4.5 | 112500 |
| | Green gram | 1.3 | 246800 |
| **Total** | | | **1704250** |

### 3.6 Irrigation potentiality

During the study period, the number of open wells in the watershed raised from 47 to 58. Furthermore, these wells, which had a low volume of water prior to the project, now have a sufficient volume of water due to recharging and deepening, and are now used for irrigation. The supply of water in the wells was about 6-7 months at the start of the project, but after it was implemented, water was available for the whole year. After the project, the irrigated area, which was previously 51 ha, has increased to 78 ha. As a result, the improvement in groundwater recharge has brought farmers prosperity.

### 3.7 Status of soil fertility

The organic carbon content was a measure of available nitrogen in the soil. The organic carbon in treated area (7.45) was high as compared to untreated area(5.99)indicating accumulation of high organic matter clearly indicating impact of soil and water conservation measures.The electrical conductivity which indicates measures of soluble salts was high in treated area (0.52) as compared to untreated area (0.11). The average pH value of both treated (7.38) and untreated area (7.80) were in neutral conditions. Others parameters such as organic carbon, available Nitrogen, Phosphorus, Potassium, Zinc, Manganese, Copper and Ironare shown in (Table 7) .

**Table 7: Soil fertility in treated and untreated area**

| S.No. | Parameters | Treated watershed | Untreated watershed |
|---|---|---|---|
| **1.** | pH | 7.38 | 7.80 |
| **2.** | EC (dS/m) | 0.52 | 0.11 |
| **3.** | Organic Carbon (g/kg) | 7.45 | 5.99 |
| **4.** | $CaCo_3$ (g/kg) | 67.33 | 58.66 |
| **5.** | Available N (kg/ha) | 224.88 | 188.57 |
| **6.** | Available P (kg/ha) | 24.6 | 18.8 |
| **7.** | Available K (kg/ha) | 247 | 233 |
| **8.** | Available Fe (ppm) | 4.794 | 3.227 |
| **9.** | Available Cu (ppm) | 1.620 | 0.787 |
| **10.** | Available Zn (ppm) | 0.952 | 0.611 |

## 4. CONCLUSION

The watershed management practices benefited nearly all farmers in terms of water management and increased crop yield, but it was reported that, medium farmers benefited more than the small farmers. Cropping intensity has increased from 122.12% to 137.08% in the maximized farm income also increased to 17 lakhs in the study period due to implementation of soil and water conservation measures. Moisture conservation practices i.e., contour trenches, staggered trenches etc. were found to establish good grass cover on non-arable area.The soil fertility of treated area increased as compared to untreated area. The organic carbon percentage was higher in the treated area than that of untreated area of the watershed.The irrigated area which was 51ha before the project implementation has been increased up to 78ha which shows that due to project interventions, the irrigation potential of the area, livelihood status of local people increased considerably. The migration of locals towards urban city reduced effectively. So, implementation of project has improved the overall conditions of watershed as well as locals. This study will also provide information about the local environment and assist the policy makers to plan a suitable scheme for sustainable development of study area.

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