

**RESPONSE OF SOIL AND WATER CONSERVATION
TECHNOLOGIES ON SOIL MOISTURE DYNAMICS IN RAINFED
AREA OF JAMMU DISTRICT**

by

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(J-19-M-701)

**A Thesis submitted to
Faculty of Agriculture
in partial fulfillment of the requirements
for the degree of**

**MASTER OF TECHNOLOGY
(AGRICULTURAL ENGINEERING)
IN
SOIL AND WATER ENGINEERING**



Division of Agricultural Engineering

Sher-e-Kashmir University of Agricultural Sciences & Technology of Jammu,
Main Campus, Chatha, Jammu-180009

2021

CERTIFICATE - I

This is to certify that the thesis entitled, “**Response of Soil and Water Conservation Technologies on Soil Moisture Dynamics in Rainfed Area of Jammu District**” submitted in partial fulfilment of the requirements for the degree of **Master of Technology (Agricultural Engineering) in Soil and Water Engineering** to the Faculty of Agriculture, Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu, is original work and has similarities with published work not more than minor similarities as per UGC norms of 2018 adopted by the University. Further, the level of minor similarities has been declared after checking the manuscript with **Urkund** software provided by the University.

The work has been carried out by **Er. Zubair Ahmad Khan**, Registration No. **J-19-M-701** under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma. It is further certified that help and assistance received during the course of thesis investigation have been duly acknowledged.



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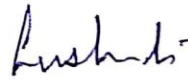
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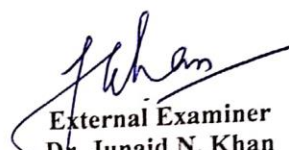
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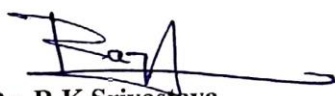
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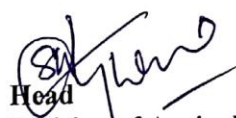


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ABSTRACT

Title of Thesis : Response of Soil and Water Conservation Technologies on Soil Moisture Dynamics in Rainfed Area of Jammu District
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ABSTRACT

The study was undertaken to evaluate the impact of various conservation technologies for conservation of soil moisture at different depths and distances from soil and water conservation measures in the village Kandi. Village under study is located in dry land area of mountainous eco-system in Akhnoor tehsil of Jammu district. The conservation technologies adopted during the study were; Contour bund cum trench (T₁), Contour bund (T₂), Contour trench (T₃) and Control plot (T₄).

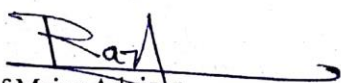
Soil sample were taken for moisture estimation from the all conservation measures at three depths D₁ (0-15 cm), D₂ (15 -30 cm) and D₃ (30 – 45 cm) each at three distances from the conservation measures L₁ (1 m), L₂ (2 m) and L₃ (3 m) on fortnightly basis during the growth period of wheat crop from October 2020- April 2021. In addition, bulk density analysis and infiltration rate was also recorded at three instants i.e. before rainfall, after rainfall and at the time of harvest of crop. Moisture distribution pattern w.r.t. depth and distance from each conservation measures was evaluated. Impact of enhanced moisture regime within the soil mass was recorded on crop productivity of wheat.

The moisture content was found maximum in T₁ in all months of crop growth period with the maximum value i.e. 11.52 % in the month of December. T₄ showed lowest moisture content in all months and least with the value of 3.37% during the 3rd week of November. The moisture content showed increasing trend before the rainfall and decreasing trend after the rainfall with respect to lower depths for all treatments. Increasing trend of moisture content was found w.r.t. distance from the conservation measures in T₁, T₃, T₂ w.r.t. T₄. The infiltration rate and bulk density was higher before the rainfall and lower after the rainfall.

The crop productivity was found with a value of 20.5, 18.7, 16.5 and 14.3 q/ha in T₁, T₂, T₃ and T₄ respectively. The crop productivity was found higher in the T₁ by 43.35%, 30.76% for the treatment T₃, 15.38% for the treatment T₂ in comparison to T₄.

Key words: Rainfed area, Contour bund cum trench, Contour bund, Contour trench, Moisture dynamics

Signature of Major Advisor



Signature of Student



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CHAPTER-1

INTRODUCTION

Agriculture is an important aspect and backbone of the Indian economy, and the rainfed agro-ecosystem plays an important role in India's food security by covering 67 percent of the cultivated area, supporting 40 percent of the human population, 60 percent of the livestock population, and producing 44 percent of the food requirement (Ramachandrappa *et al.* 2014). With intermittent dry spells, around 67 percent of the entire farmed land receives less than 750 mm of rainfall on average. As a result, rainfed areas have challenges with soil and crop management, as well as socioeconomic issues. To address the issues and satisfy the growing population's food needs, production and productivity must be boosted from 1 t/ha to 2.5 t/ha. Inadequate soil water conservation practises are also causing soil health to deteriorate.

Soil and water are two crucial and critical natural resources bestowed by God for the existence of life on Earth, yet rising population and rising standards of living have put great strain on these finite resources. The loss of soil due to wind and water erosion has put the soil resource base in danger. According to one recent estimate, around 16.35 MT/ha of soil is detached annually, with 29 percent being taken away by rivers to the ocean and 10 percent being deposited in reservoirs, resulting in a 1-2 percent loss in storage capacity, therefore soil health is another issue to consider. Low productivity, damaged natural resources, and widespread poverty characterise rainfed agriculture in India. Agriculture is the primary source of income for the majority of people in rural regions. Many people rely on natural resources and rainfed agriculture, both of which are dependent on soil health. Soil health is a phrase used in sustainable agriculture to describe the quality or condition of a soil. Rainfed farming relies heavily on the conservation and wise use of natural resources such as soil and water to ensure long-term crop production. In India, there is only a small window of opportunity to expand cropland to satisfy the growing food and fodder demands of the people. The only way to solve this problem is to boost agricultural productivity per unit area per unit time. This may be accomplished through scientific soil and water resource management. Contour bunding, contour terracing, and contour trenching are soil and water conservation techniques that attempt to provide a consistent distribution of moisture in the inter terraced area while also preventing sheet or rill erosion. The primary guideline of soil and water conservation is to extend the infiltration opportunity time for enhanced rainfall efficiency and safe drainage of surplus rainfall from crop areas. To minimise soil loss and

degradation, soil management measures should be used. Erosion, loss of nutrients, organic matter, pollution, compaction, and increased salinity all contribute to agricultural deterioration. This decomposition occurs quickly and has a significant influence on agricultural productivity.

The erstwhile state of Jammu and Kashmir lies within the latitudes 32°17' to 36°58' North and longitudes 73°26' and 80°30' East. It has total geographical area of 22.22 Mha with three regions Jammu, Kashmir valley and Ladakh. The dry semi hilly belt covers around 12% of the entire area of the Jammu region. The Jammu region of Jammu and Kashmir State is a typical example of rainfed farming since cultivable land is primarily monocropped and rainfed, accounting for 75.26 percent of the area in Jammu division and 40.80 percent in Kashmir division (DES, 2015-2016). Jammu district receives around 1275.3 mm of precipitation each year, with 28.8 mm falling during the winter, 134 mm during the pre-monsoon, 1110 mm during the monsoon, and 2.5 mm during the post-monsoon (IMD Pune, Rainfall statistics of India, 2016). It is evident from the Jammu district's rainfall study that there is extra water available during the rainy season, which may be stored by building a water harvesting structure. Jammu district is made up of 38% rainfed land with scant vegetation, degraded soil, and a lack of variety in productivity and production, all of which may be addressed by providing lifesaving irrigation through a water harvesting structure. The lower Shivalik rainfed portion of Jammu has distinct terrain, soil, and climatic features that indicate a semi-arid or sub-humid climate, while the overall climate of the area is sub-tropical. Deep water table, undulating topography, frequent droughts, poor soil organic matter, and coarse textured soils define the rainfed foothill region of Jammu, locally known as Kandi (Arora *et al.* 2007). Approximately 80 percent of the rain falls during the first two and a half months of the monsoon season, with high-intensity rainstorms. Soil erosion is particularly bad during the rainy season, resulting in nutrient loss and the loss of the top fertile soil layer. Soil erosion has damaged most of Jammu and Kashmir's rich soils, with 0.56 million hectares under water erosion, 1.36 million hectares under wind erosion, and 0.2 million hectares under physical degradation (Sharma, 2004). The Kandi belt in the Jammu area is severely eroded by sheet and rill erosion. Poor management of natural resources has resulted in widespread environmental deterioration. During the rainy season, farmers are less concerned about land, soil, and conservation measures, resulting in massive soil erosion and low crop yield.

Rainfall is a geographic and temporal variable since it fluctuates with time and place. Annual rainfall fluctuates significantly from year to year, with a larger coefficient of variation

for more rainfall and a lower coefficient of variation for lower rainfall. In other words, crop failures are more common in areas with less rainfall. More than a third of India's entire land area receives rainfall of less than 750 mm. Only one crop is cultivated in dryland agriculture, but the droughts that occur practically every other year are causing famine conditions. The two primary issues in such locations are rainfall uncertainty and a lack of understanding about moisture conservation methods. Increased runoff, reduced ground water recharge, severe erosion, shifting cultivation, overgrazing, bunding without vegetative cover, plugging of natural drains, failure to provide drainage while preparing programmes with natural drainage, and poor soil and water movement practises. The water resource base is being disrupted by frequent variations in rainfall in the problematic regions of the rainfed zone. Extreme rainfall occurrences, such as extremely high and deficient rainfall, increasing intensity, and a reduction in the number of rainy days as a result of climate change, necessitate even more rigorous soil and water conservation measures. There is rising concern throughout the world that we cannot afford to waste these resources much longer. Furthermore, these resources must be handled in a coordinated manner.

The present study entitled “**Response of Soil and Water Conservation Technologies on Soil Moisture Dynamics in Rainfed Area of Jammu District**” has been undertaken with the following objectives:

1. To study the impact of soil and water conservation measures on moisture dynamics within the soil.
2. To study the response of moisture conservation in crop productivity.

CHAPTER-2

REVIEW OF LITERATURE

The literature on previous and current techniques for responding to soil and water conservation technology was evaluated in light of the study's goals. The following categories are used to organise a quick survey of literature related to the current study.

2.1 Soil and water conservation structures in rainfed areas

2.2 Impact of soil and water conservation structures on erosion

2.3 Impact of soil and water conservation measures on soil moisture

2.4 Impact of soil and water conservation measures on crop productivity

2.5 Salient finding from the review of literature

2.1 Soil and water conservation structures in rainfed areas

Amsalua and Graaff (2007) studied land degradation resulting from soil erosion and nutrient depletion is a serious environmental and socio-economic problem in the Ethiopian highland watershed. Over the last few decades, soil and water conservation techniques such as stone terraces (ST) have been widely used to evaluate data. The findings reveal that several factors influence the adoption and sustained usage of stone terraces.. Farmers' age, farm size, perceptions of technology profitability, slope, livestock size, and soil fertility influence adoption, whereas actual technology profitability, slope, soil fertility, family size, farm size, and engagement in off-farm jobs influence continuation. Perceptions of the erosion problem, security of land ownership, and extension contacts had little bearing. They came to the conclusion that conservation interventions should focus not only on the biophysical performance of the measures, but also on the economic advantages that farmers may get at appropriate discount rates in order to increase long-term usage of the measures..

Zhou *et al.* (2009) investigated the efficacy and economic advantages of various conservation strategies in reducing sediment erosion in nine key soil regions in Iowa. The Water Erosion Prediction Project (WEPP) model was used to investigate three tillage systems [no-tillage (NT), strip-tillage (ST), and chisel plough tillage (CP)] and three conservation structures [grassed waterways (GS), grass filter strips (FS), and terrace systems (TS)] under a corn–soybean rotation. Corn yields were statistically lower under NT than under CP in some regions, but soybean yields were unaffected by tillage. Annual sediment yields from the

chisel plough method were estimated to be between 0.7 and 56.9 T/ha. In comparison to the CP system, the WEPP simulations indicated that the NT and ST systems were very efficient in lowering soil erosion and sediment output by nearly 90% in highly erodible areas. Conservation tillage in conjunction with soil erosion control structures reduced soil loss even more and was more successful in regions with significant water erosion potential than in flat areas. After accounting for the cost of eroded soil, the costs and benefits analysis revealed that the simulated conservation measures may improve the net benefit by up to \$300/ha when compared to the CP system. They discovered that in locations with a high risk of water erosion, NT and conservation buildings provide larger environmental and economic advantages. They proposed that the efficiency of structural conservation techniques combined with tillage systems was location-specific, depending on the soil and landscape in each area.

Panwar *et al.* (2012) investigated the influence of conservation measures on the hydrological behaviour and community structure of micro watersheds In the Shivaliks,. In 1959, two watersheds (WM1 and WM2) with identical features were recognized and calibrated over a period of ten years. In 1968, soil and water conservation methods, as well as sowing and planting plants, were implemented in WM2, with WM1 serving as a control. With an increase in rainfall, the amount of runoff created increased dramatically in WM1. When compared to the control watershed, the treated watershed (WM2) maintained runoff at a lower level across the spectrum of rainfall due to the implementation of conservation measures (WM1). In both treated and control watersheds, an exponential connection between soil loss and rainfall was observed. The quantity of soil loss (t/ha) rose as the amount of rainfall increased. Due to the adoption of conservation measures, soil loss in the treated watershed was consistently lower throughout the range of rainfall than in the control watershed..

Alemu *et al.* (2013) looked at the effects of soil and water conservation measures in Ethiopia, which was suffering from soil erosion and land degradation. They created Land Suitability Classes by combining Land Suitability Classes (LSC) with Multiple Criteria Analysis (MCA) on biophysical factors in the environment (LSC). They used a combination of FAO land evaluation techniques and GIS technology to sort LSC. They found LSC for teff (*Eragrostis teff*), maize (*zea mays* L), barley (*Hordeum Vulgaris* L), and wheat (*Hordeum Vulgaris* L) between 1984 and 1997. (*Triticum aestivum* L). Certain portions were changed to S1 classes for wheat in 2010, while around 40% of the land was categorised as S2 for all crops. In 1997, barley and teff accounted for 29.2% and 28.9% of the market, respectively.

Teff covered 19 percent of the land in 2010, followed by maize (18.9%), barley (16.9%), and wheat (15.6%).

Birhanu *et al.* (2014) tested contour bunding technique in three Mali areas (Mopti, Koulikoro, and Sikasso) in order to enhance land and water management. They introduced and adopted CBT in farmers' fields to improve land and water resource management, and they received a positive response from the farmers, as CBT has conserved 81 percent soil and water resources and reduced 73 percent gully formation. They also discovered that soil fertility has increased by 84 percent since CBT was introduced.

Wickama *et al.* (2015) used pixel (Maximum Likelihood Classification) and object-based image analysis (OBIA) remote sensing techniques to detect land use patterns and adoption of soil conservation technologies in the west Usambara highlands of north-eastern Tanzania as a paired plot design in which two blocks of 100 km² each were studied using pixel (Maximum Likelihood Classification) and object-based image analysis (OBIA) remote sensing techniques to. They discovered that the two blocks have vastly different rates of adoption of soil conservation methods. The Maximum Likelihood Classifier is also shown to be reliable in creating land use theme layer maps from which soil conservation strategies in hilly locations may be investigated with ease. The OBIA-method was shown to be effective in detecting, categorising, and mapping the SWC technologies that had been deployed. The effectiveness of the implemented technologies was similar throughout the blocks, with Sunga having higher indices. The study indicates that SWC technology adoption in the two blocks is primarily driven by biophysical circumstances inside and between the two blocks, and is unrelated to the quality of the technologies deployed in either block.

Bagdi *et al.* (2015) study was conducted in Indian Institute of Soil and Water Conservation (IISWC) and its Research Centres have developed and implemented many successful model watershed projects in India in the past, as well as many Soil and Water Conservation (SWC) technologies for sustainable watershed management. Farmers abandoned more than one-fourth (27%) of SWC technology, according to the findings. A little less than one-fifth (19%) of the total continuing to be used SWC technologies by farmers are still being accepted with a technology gap. More than a quarter (28%) of SWC technologies were also disseminated to other farmers' fields in adjacent villages, and on average, 1.2 technologies were infused into the farmers' fields from beyond the watersheds established by the IISWC and its Centres by their own efforts.

Sahoo *et al.* (2016) investigated the influence of farming practises on soil and water conservation efficiency in a new tea plantation in the Nilgiris of South India. One-year-old B-6 tea clones were planted at double hedges pacing (135 cm 75 cm 75 cm) in two slopes (8–12 percent and 30–35 percent) with treatments such as contour staggered trenches (CST), vegetative barrier (VB), CST alternate with VB, CST with cover crop of beans, and farmers' practise of plantation. CST with cover crop of beans had the lowest run off (14.6 percent) followed by VB. Contrary to runoff, CST (4.9 and $6.9 \text{ t ha}^{-1} \text{ yr}^{-1}$) had the lowest soil loss, followed by CST with a cover crop of beans (5.3 and $7.3 \text{ t ha}^{-1} \text{ yr}^{-1}$) with 8–12 percent and 30–35 percent soil loss, respectively. Under new tea plantations on the steep slopes, CST alone or in conjunction with a bean cover crop is advised for soil and water conservation.

Hishe *et al.* (2017) examined the impact of community-based soil and water conservation (SWC) practises on selected soil characteristics in the middle Silluh valley, Tigray area, Northern Ethiopia, since 1991 for restoration of the degraded landscape. They contrasted preserved landscapes (terraced hillside, terraced farmland, and exclosure area) to non conserved landscapes (non terraced hillside, non terraced farmland, and open grazing land) using a one-way analysis of variance (ANOVA). Each landscape was sampled 24 times at a depth of 10-30 cm. They observed that mean bulk density was low on terraced slopes, non-terraced hillside, and exclosure land. At $P0.05$, the sand and clay composition of the six landscape groups differed significantly. The protected landscape has a greater mean organic matter content than the corresponding non-preserved region

Traore *et al.* (2017) investigated the impact of contour bunding on runoff, soil erosion, and crop output in Southern Mali and discovered that moisture was always greater in CB fields than NCB fields, while runoff rates varied from 39 to 43 percent in NCB fields and 24 to 26 percent in CB fields. They also discovered that rain-induced soil erosion varied from 0.329 to 6 t ha^{-1} in CB fields and 0.73 to 14 t ha^{-1} in NCB fields, as well as yield increases of 381 kg ha^{-1} (+24%) and 432 kg ha^{-1} (+49%) in cotton and millet fields treated with CB, respectively.

Asnahe *et al.* (2018) investigated the factors that influence the adoption of physical soil and water conservation techniques In the Ethiopian highlands. High-potential and low-potential areas were chosen as case study locations. Face-to-face interviews, focus groups, key informant interviews, and field observations were all used to gather data from 269 farmers. The data was analysed using a binary logistic regression model as well as descriptive statistics. The majority of the farmers interviewed (87%) used SWC structures, according to

the findings. Across the region, virtually all farmers in low-potential regions built and maintained the buildings 12 correctly, but 56 percent of farmers in high-potential areas did not. This disparity is due to strong governmental involvement and technical and financial support in low-potential areas, and as a result, farmers in those areas have a better understanding of the multiple uses of physical SWC structures than farmers in high-potential areas. To summarise, farmers in low-potential areas have a better understanding of the multiple uses of physical SWC structures than farmers in high-potential areas.

Birhanu *et al.* (2020) investigated the impact of contour bunding on agricultural production and erosion management in drought-prone regions of rural Mali. They discovered that practises of soil and water conservation technologies were beneficial in the face of repeated droughts. They used contour lines with agricultural ridges, agronomic experiments, and runoff and erosion data in their investigation. For three years (2015-2017), agronomic data on sorghum, maize, peanuts, and millets was gathered, and the findings were largely better because crop output was discovered to have increased and was shown to be a barrier to soil and water erosion rate. Contour bunding was shown to be beneficial because it conserved 162 mm of rainfall per year as soil moisture and on average 13090 kg per hectare of soil was lost from farm fields without CB, resulting in a 163 percent reduction in soil loss.

Deng *et al.* (2021) investigated the impact of terracing in land degradation issue regions in order to minimise erosion, conserve water, and boost agricultural productivity. They discovered that installing terracing in problem locations decreases runoff and sediment by 41.9 percent and 52 percent, respectively. Grain yield and moisture content both increased by 44.8 percent and 12.9 percent, respectively, according to the researchers.

2.2 Impact of soil and water structures on erosion

Gardener *et al.* (2003) investigated runoff and soil erosion on cultivated rainfed terraces in Nepal's Middle Hills, finding that runoff and soil erosion measurements from plots on outward-sloping rainfed agricultural terraces in the Likhu Khola drainage basin, Middle Hills, Nepal, for the pre-monsoon and monsoon periods of 1992 and 1993. Depending on the type of the rainfall event and the features of the terrace, runoff coefficients ranged from 5% to over 50%. The greatest degree of explanation for the variance in runoff was the total rainfall. In 1993, soil losses varied from 2.7 to 8.2 t ha⁻¹ and as high as 12.9 t ha⁻¹ in 1992. Red, finer-grained soils were related with greater losses. The findings imply that the degree of land degradation in these regions may need to be re-evaluated. The relationships between soil loss and rainfall parameters were very varied, but when plant cover was added, the

relationships improved significantly. This suggests that if runoff and erosion are to be reduced, some sort of ground cover should be maintained.

Barton *et al.* (2004) investigated the impact of soil conservation strategies on erosion rates and agricultural yield on subtropical Ultisols in Yunnan Province, China. A joint research project between Yunnan Agricultural University (YAU) and the University of Wolverhampton has been launched to investigate many potential soil protection strategies. On the YAU experimental farm, thirty runoff plots were utilised to test the effectiveness of five treatments: conventional tillage (control), no-tillage, straw mulch, polythene mulch, and intercropping. On seasons (May–October), 1993–1996 inclusive, plots were cropped with maize (*Zea mays*) planted either along the contour or downslope. In 1993, 1994, 1995, and 1996, the annual rainfall totals were 576.3, 768.3, 876.3, and 619.7mm, respectively. Seasonal mean erosion rates were 0.73, 4.00, 7.56, and 0.05 t ha, respectively. Straw mulch proved to be highly efficient at reducing erosion rates. Soil loss was 18, 66, 86, and 78 percent lower in the conventionally tilled plots in 1993, 1994, 1995, and 1996, respectively.

Sharda *et al.* (2013) investigated the influence of an intercrop-based conservation bench terrace system on resource conservation and crop yields in a sub-humid environment in India. They discovered that after using CBT, runoff and soil loss decreased by around 80% and 88 percent, respectively. They also discovered that initial abstraction was higher in CBT than in the typical sloping border system, with a value of 0.44 for CBT and 0.0156 for the usual sloping border system. It was also shown that the CBT system was 18% more productive than the traditional system due to greater in situ rainwater saving.

Islam *et al.* (2014) investigated the impact of Geojute and vegetation on hillside erosion management. For five sites, they employed the potential Geojute and Vegetation in hill slope management. Three locations on the Alikadam-Thanchi road have been chosen. Two of them were downhill (10.8 and 11.7 kilometres) while the other was upwards (11.8 and 11.7 kilometres) (14.75 km). They discovered that after the introduction of JGT in all three locations in April 2013, a native plant called Gyama, which was seeded shortly before the monsoon, grew well with little soil loss. They also discovered that after 1 month, 2 months, 3 months, and 1 year of planted, the root growth rate was 203 mm, 1219 mm, 1372 mm, and 1829–2438 mm, respectively.

Diyabalanage *et al.* (2017) investigated the influence of soil and water conservation strategies on soil erosion rate and sediment yields in a tropical watershed in Sri Lanka's central highlands. They have reported the largest sediment output in the upper Uma Oya, a

UMC sub catchment, and the worst soil erosion rate in certain reservoirs. From 1995 to 2005, the Mahaveli authorities implemented two soil and water conservation initiatives in the upper Uma Oya watershed, as well as stream sediment yield monitoring. After the introduction of conservation programmes in 1995, they discovered that the sediment yield measurement in the watershed had decreased by a factor of five. However, following conservation, erosion rates in stream loads were shown to be roughly ten times higher than the natural background rate.

Tu *et al.* (2018) investigated the impact of soil and water conservation methods in a southern Chinese orchard on sloping red soil and discovered that the efficacy of soil and water conservation measures is generally dependent on time, and that the trend in lowering runoff and sediment over time is a critical theoretical problem for evaluating SWCM performance. They've been studying the behaviour of runoff and sediment on citrus experimental plots for over 15 years, using one of four treatments: grass, strip intercropping, level terraces, and clean tillage. They discovered that the rate of soil erosion dropped below 500 t/km²/a. On the sediment curves, they discovered L-shaped fitting curves, while on the runoff curves, they discovered nearly horizontal lines. SWCMs were also observed to affect the runoff-sediment erosion connection but not the rainfall-runoff relationship.

Bugenimana *et al.* (2019) investigated the impact of bench terraces in Rwanda's Eastern region. They chose 180 bench terraces from 12 different locations to evaluate against technical requirements and models given by Rwanda's Ministry of Agriculture. Terraces were erected on land slopes with a slope of more than 90% and a height of more than 2.9m. The findings reveal a weak but substantial correlation coefficient ($r=0.194$) between field measurement and Agriculture Organization model calculated vertical intervals, as well as a weak but significant correlation coefficient ($r=0.194$) between terraces measured and model generated widths.

Chen *et al.* (2020) looked at how soil and water conservation techniques affected runoff and sediment formation in red soil slope agriculture in southern China under natural rainfall. They observed that maximum 30 minute rainfall intensity is positively related to runoff depth, soil erosion modulus, and sediment mean weight diameter. Average annual soil erosion moduli of slope tillage, hedgerows with slope tillage, contour tillage, and straw mulching with conventional tillage reduced by 59.33 percent, 91.29 percent, 97.17 percent, and 98.45 percent, respectively, as compared to bare land. They also discovered that as

compared to bare ground, average single rainy erosion sediment MWD reduced by 5.91 percent, 8.33 percent, 9.69 percent, and 13.32 percent, respectively.

Mohammad *et al.* (2020) investigated the effects of soil management on soil water erosion and runoff in Central Syria and discovered that inadequate land management is causing soil water erosion in the Mediterranean region of Syria. The main goal of this study was to track soil erosion and runoff after each rainy storm in Central Syria from September 2013 to April 2014 (rainy season), on two slopes with different gradients (4.7 percent ; 10.3 percent), and under three soil cover types (SCTs): bare soil (BS), metal sieve cover (MC), and strip cropping (SC). The significance of SCTs was determined using two statistical multivariate models: the general linear model (GLM) and the random forest regression (RFR). The results show that BS had the highest erosion rate and runoff, followed by MC and SC. Soil cover had a substantial influence on soil erosion ($p < 0.001$), although there was no significant difference between MC and SC.

Farahani *et al.* (2016) investigated the contour farming's impacts on runoff and soil erosion. The objective of contour farming is to decrease runoff and soil erosion on gentle slopes. In dry and semiarid locations, this method can also enhance crop production by retaining soil moisture. When compared to cultivation perpendicular to the slope, the results revealed that contour farming reduced yearly runoff by 10%. Cultivation and planting along contour lines also reduced soil and water losses by 49.5 and 32 percent, respectively, when compared to cultivation and planting on the slope.

2.3 Impact of soil and water conservation technologies on soil moisture and bulk density

Angew *et al.* (1995) conducted a study in the Middle East on the functioning of one sort of water harvesting technology, the mahafir, in the Badia area of Jordan. Mahafir are sediment-filled holes excavated into the playa surface in crescent and rectangular shapes. Their previous volumes were calculated using a topographical study of the earth mounds in the area. The mahafir was discovered to have an average depth of 3.2 metres, containing a total water volume of 111.619 m³ at Maharouta and 55.005 m³ at Anka.

Fu *et al.* (2003) investigated the impacts of land use on soil moisture fluctuation in the Danangou watershed of the Loess Plateau, China. To monitor soil moisture, he discovered changes in soil moisture in connection to land use patterns, five land use structures, and seven land use categories. From May to October 1998, soil moisture measurements were taken monthly at 26 sites in a small watershed on China's Loess Plateau. A Theta-Probe was used to

collect measurements at five different depths in the soil profile (0–5, 15–20, 25–30, 45–50, and 70–75 cm). For seven land use categories, these data were examined for soil moisture changes in location and time. During the growth season, three peaks and three troughs of soil moisture fluctuations were discovered. Shrubland had a substantially different impact on mean soil moisture within 0–70 cm than cropland, orchards, and intercropping land. There are three types of soil moisture variations in profile: rising, decreasing, and waving.

Abdelkdair and Schultz (2005) reported that water scarcity is the most significant restriction in Ethiopia's dry and semi-arid regions. They used micro catchments to supplement water storage by gently infiltrating into the soil. They studied the development of four multipurpose tree species intercropped with grass in micro catchments as part of an experiment. In 25m² and 100m² micro catchments, trees and grass were cultivated. They discovered that mean tree growth in the 100 m² micro catchment was 10% higher than in the 25 m² micro catchment. They also discovered that the diameter of the root collar and the survival rate both increased by 13% and 7.8%, respectively. In the 100 m² and 25 m² plots, the dry matter yield of grass (*Panicum maximum*) was above 12 tons/ha and 8 tons/ha, respectively. During the rainy and dry seasons, soil moisture content in micro catchments was found to be 31% and 24% higher than in control plots without harvesting devices, respectively.

Kahinda *et al.* (2007) investigated the influence of rainwater collection in Zimbabwe's semi-arid areas. They used a rainwater collection technology, analysed agro-hydrological functions, and calculated the influence on crop yield gaps and transpirational water production. They carried out a survey in six semi-arid districts and discovered that three factors (water supply, primary use, and storage capacity) can assist distinguish storage type RWH systems from conventional dams. They also utilised the Agricultural Production Simulator Model (APSIM) to model seven different treatments on alfisol deep sand for 30 years (control, RWH, Manure+RWH, inorganic nitrogen, and Inorganic Nitrogen+RWH). Supplemental irrigation alone not only decreases the probability of full crop failure (from 20% to 7% on average) for all treatments, but it also increases yield from 1.75 kg/m³ to 2.3 kg/m³ by reducing ISDS.

Al seekh *et al.* (2009) investigated the impact of water harvesting systems on runoff and sedimentation, as well as soil moisture content and characteristics. They conducted the research at three sites in the southern portion of the West Bank that represented different environmental conditions. The study looked at soil chemical and physical characteristics, soil

moisture at 30cm depth, surface runoff, and sedimentation at each location for each treatment. When compared to the control in the semi-humid site, runoff is reduced by 65-85% and sedimentation is reduced by 58-69 percent in stone terraces and semi-circle bunds. Moreover, in the dry location, stone terraces and contour ridges considerably reduced total runoff by 80 percent and 73 percent, respectively.

Abu-Zreig and Tamimi (2011) investigated the influence of water collecting techniques on rainfed agriculture in semi-arid areas. They tested the efficacy of a novel related water collecting approach by constructing twelve field plots of 10A mAA2A m in two neighbouring fields with slit loam soils but varying in soil depths, 0.75A m and 2A m, and slopes of 10% and 12 percent. At the downslope end of the plots, they placed a 130A L barrel to collect water and sediments at the end of each rain stream. They used duplicates of the three treatments (12 plots total): sand-ditch plots, in which a ditch measuring 2 metres long, 1 metre wide, and 0.8 metre deep was dug in the middle of plots across the slope. When compared to control plots, the average runoff and sediment reductions in the sand-ditch plots were 46 percent and 61 percent, respectively. Under the current experimental and climatic circumstances, sediment losses from compacted plots were roughly 2.2 and 6 times greater than control and sand-ditch plots, respectively, making soil compaction an unsatisfactory method for rainfall harvesting.

Enkova and Urik (2012) investigated the influence of soil moisture content on bulk density and porosity. They looked at three commonly used Mollic agricultural soils from various areas in western Slovakia. They used intact soil aggregates from the surface horizon and discovered that the aggregate hydraulic properties differ from the bulk material. They also discovered that aggregate bulk density increases from 1.75 to 1.93g/cm³ in mogmVRpe, from 1.46 to 1.83g/cm³ in haCH, from 1.52 to 1.82g/cm³ in ccmoFL, and aggregate porosity decreases as water content decreases.

Nsanzimfura *et al.* (2016) investigated the effect of agricultural methods on soil bulk density and total porosity on the experimental crop-News site of Kamboinse. The Agro Ecology Based Agriculture-Conservation Agriculture and Woody Amendments for Sub-Saharan Agriculture programmes started the study to improve soil restoration and increase yields. They assessed the test site and divided it into 25 pieces based on different farming methods. They took soil samples from 10cm to 60cm below the surface, which were then analysed for bulk density and total porosity in the laboratory. The soil at the experimental location is less dense near the surface in the first 20cm and denser in the last 20cm of depth,

according to the researchers. They also discovered that when *P. reticulatum* is planted in the parcels, the soil bulk density increases from 1.82 to 1.99g/cm³ throughout the depth (up to 60cm) and the total porosity increases from 24.95 to 31.19 percent. They also discovered that parcels without shrubs have lower bulk density ranging from 1.73 to 1.86g/cm³ and lower total porosity ranging from 34.81 percent to 29.72 percent.

2.4 Impact of soil and water conservation measures on crop productivity

Singh and Jain (2004) studied the Punjab's Kandi Watershed and Area Development Project (KWADP) and found that cultivated area increased from 19.4 to 55.3 acres, cropping intensity increased from 113.7 to 143.1 acres, and maize, wheat, and milk productivity increased from 1017 kg/ha, 1084 kg/ha, and 928 litre per milch cattle in 1979-80 to 1879 kg/ha, 2574 kg per ha, and 1233 litre per milch cattle in 2000-01. They also looked at the Integrated Watershed Development Project (IWDP hills) in Haryana for two years, 1990-91 and 2002-03, and found that cultivated area increased from 6.5 to 15.3, cropping intensity increased from 140.8 to 170.5, and maize and wheat productivity increased from 1070 kg/ha and 887 kg/ha in 1990-92 to 1396 kg/ha and 1722 kg/ha in 2002-03, respectively.

Nasurudeen and Mahesh (2006) studied the Cauvery delta, Karaikal region of Pondicherry and found that Paddy, black gramme, green gramme, sesamum, and groundnut were the primary crops produced in the watershed and traditional system. Cropping intensity was 2.01 and 1.78 in both systems, while main crop yields in the watershed system were 5625, 1500, 1400, 1550, and 3488 kg/ha greater than in the traditional technique, which was 5000, 1450, 1338, 1488, and 3150 kg/ha..

Bhattacharyya *et al.* (2008) conducted a study during 2000-04 to evaluate the impact of a soil conservation package including diversion drains for runoff and collection of rainwater in village water harvesting structures, crop diversification and improved production technologies on soil degradation in small agricultural watershed of Shivalik region and reported that the conservation measures along with crop 18 diversification and integrated nutrient management reduced the area weighed degradation index of the watershed from 2.11 to 1.29. Because of P fixation and nutrient-rich sediment deposition on low-lying undulating terrain, the nutrient value index for P and K rose from 1.57 to 2.27 and 2.08 to 2.12, respectively. Crop yield was aided by nitrogen enhancement. Due to the implementation of the project, yearly net profits per hectare increased from Rs 7448 to Rs 24590.

Regar *et al.* (2009) conducted a field experiment at the Central Arid Zone Research Institute, Regional Research Station, Pali-Marwar, from 1997–98 to 2001–02 to determine

the effects of field bunding, tillage, and straw mulch on taramira yield and water productivity. They found that field bunding increased mean taramira biological yield by 13.4% and seed yield by 18.1 over no bunding due to increased availability of soil moisture. Bunding also enhanced water usage efficiency by 0.6 kg/ha/mm as compared to no bunding. Deep tillage had a varied effect that was primarily determined on the amount and distribution of rainfall. During periods of periodic dryness, deep tillage successfully preserved soil moisture and 19 substantially enhanced taramira seed production. Straw mulching at 5 t/ha improved mean seed production by 25 percent compared to no mulch, while also increasing water usage efficiency by 1.8 kg/ha/mm. Field bunding, deep ploughing during the monsoon, and 5 t/ha straw mulching are advised for improving taramira seed production and water productivity through in-situ moisture conservation.

Manivannan *et al.* (2010) found that in-situ soil and water conservation techniques resulted in an increase of 0.2 to 1.3 g in each nut weight. The field experiment was done on lateritic soils in the mountainous area of Goa State to investigate the impact of various in-situ soil and water conservation techniques on cashew quality and yield (*Anacardium occidentale*). In comparison to the control, continuous contour trenches with live vegetative barriers increased apple weight by 13.2 g, while staggered contour trenches with vegetative barriers increased apple weight by 11.3 g. The in-situ soil and water conservation measures, which varied from 0.90B to 2.90B over control, resulted in a rise in TSS. The juice content rose by 6.7 when continuous contour trenches with live vegetative barriers were used, followed by staggered contour trenches with vegetative barriers (4.4). The results indicated that continuous contour trenches and staggered contour trenches with a mix of vegetative barriers may generate superior quality and yields of nuts and cashew apple.

Regar *et al.* (2010) conducting an experiment at the Central Arid Zone Research Institute, Regional Research Station, and found that field bunding increased mean chickpea grain yield by 18% and biological yield by 14% compared to no bunding, and that this was due to increased soil water availability in the profile. The influence of bunding, tillage, and straw mulch on chickpea yield and water productivity was studied in Pali-Marwar during the winter seasons (rabi) of 1997–98 to 2001–02. Deep tillage has a different influence on crop growth and production depending on total rainfall and its distribution. During periods of intermittent drought, deep tillage successfully saved rainfall while increasing chickpea grain output. Straw mulching at a rate of 5 t/ha enhanced chickpea grain production by 18% above no mulch, while also increasing water usage efficiency by 1.4 kg/ha/mm. In desert margins where the kharif crop fails, field bunding, deep ploughing during the monsoon, and straw

mulching @ 5 t/ha after germination throughout the winter are advised for enhanced chickpea grain yield and water productivity using in-situ rainwater conservation methods.

Rao *et al.* (2010) found that field bunding improved mean sorghum grain production by 10.5 and stover output by 10.7 compared to control in two years. In-situ rainwater conservation methods improved sorghum grain and stover yields substantially more than controls. IPRWH (inter paired row water harvesting) outperformed all other treatments. IPRWH had the highest mean grain production of 1320 kg/ha and the highest mean stover yield of 4.71 t/ha, which was 63 and 25 percent greater than flat bed, respectively. IPRWH outperformed other in-situ rainwater conservation methods in terms of harvest index, water usage efficiency, net returns, and B: C ratio. Field bunding and pair row sowing, along with in situ rainwater conservation practises, were shown to be promising for dual purpose sorghum production in this location. The field experiment was carried out in Pali, Rajasthan (India) during the kharif seasons of 2003–2005 to investigate the impact of rainwater conservation methods on sorghum [*Sorghum bicolor* (L.) Moench] grown under rainfed circumstances. Field bunding and no bunding (Control) were used in the experiment, as well as four rainwater conservation methods. The use of rainwater conservation methods greatly enhanced sorghum growth and production characteristics.

Adgo *et al.* (2013) investigated the effects of long-term soil and water conservation on agricultural output in Ethiopia's Anjenie watershed. Following the catastrophic drought of 1974, numerous soil conservation initiatives were conducted in Ethiopia. A study was undertaken in Ethiopia's Anjenie Watershed to examine fanya juu terraces and grass strips that were built in a pilot project in 1984 and are still functional 25 years later to capture long-term benefits of these activities. Data was gathered from official documents, on-the-ground observations, and 60 farmer questionnaire questionnaires. Half of the respondents had terraced farms in the previous project area of the watershed (with technology), while the other half lived outside the terraced area (without technology). Teff, barley, and maize were the crops tested. The economic advantages with and without terraces were determined using cost–benefit analyses, which included gross and net profit values, returns on labour, water productivity, and poverty implications. Soil and water conservation boosted agricultural yield, according to the findings. Teff, barley, and maize yielded 0.95 t ha⁻¹ (control 0.49), 1.86 t ha⁻¹ (control 0.61), and 1.73 t ha⁻¹ (control 0.77), respectively, on terraced fields. On terraced fields, the net benefit was substantially larger, with US\$ 20.9 (US\$ 112 control) for teff, US\$ 185 (US\$ 41 control) for barley, and US\$ 34.5 (US\$ 101 control) for maize ha⁻¹ yr⁻¹. For barley, teff, and maize cultivated on terraced plots, the returns on family labour were

2.33, 1.01, and 0.739 US\$ man-day¹, respectively, compared to US\$ 0.44, 0.27, and 0.16 man-day¹ for those produced without.

Lenka and Lal (2013) conducted a study between 2001 and 2006 to evaluate the impact of the techniques on SOC concentration and pool; losses of water, soil and 21 nutrients; soil moisture storage and agronomic yield on arable lands of 2–5% slope in eastern India. The study was taken in 5.95 ha area with six treatments and nine replications. Treatments consisted of two hedgerow species (*Gliricidia sepium* and *Indigofera teysmanni*) and a control, with or without grass filter strip (GFS) of a local species (*Saccharum* spp.). Using finger millet (*Eleusine coracana*) as the test crop, the hedgerow species were planted at 0.5 m × 0.5 m spacing in staggered double rows and the GFS in a single row at 0.3 m spacing. They found that addition of GFS significantly reduced the losses of water runoff, soil and nutrients in all the treatments, and increased SOC stock by 0.38–1.0 Mg ha⁻¹ in the 0.6 m soil profile. The GFS also improved soil moisture storage by 9–12 mm and 6–15 mm at 12 and 17 days of dry spell, respectively. As compared to the pre-treated initial, the SOC stock decreased by 60–112 kg ha⁻¹ yr⁻¹ in the control indicating on-going erosion process in unprotected lands. The study showed the C sink potential of erosion control measures in the sloping agricultural lands of eastern India

Mondal *et al.* (2013) conducted study in Bundelkhand region of Madhya Pradesh state of India. They collected data from 240 farmers, selected from eight watersheds and eight non-treated villages in the region using a multi-stage random sampling technique. Analysis of data indicated that implementation of watershed development programmes led to significant differences in productivity of major crops between watershed and non-watershed villages. Decomposition analysis of productivity difference between them indicated that the contribution of technological component was positive and higher than the contribution of input differentials.

Ngetich *et al.* (2014) evaluated the impact of various soil and water conservation strategies and tillage practises on runoff, sediment production, and maize yields in sub-humid and semi-arid settings in Kenya. In Kenya's central highlands, field experiments were held in Kigogo primary school in Meru South Sub-County, Tharaka Nithi County (sub-humid conditions) and Machang'a secondary in Mbeere South Sub-County, Embu County (semi-arid circumstances). The treatments were applied in runoff plots, and the experiment was set up as a randomised full block design. In the semi-arid zone, tied ridging (TR) was the most effective approach for minimising runoff and sediment production while simultaneously

increasing crop yields. During the research period, it reduced sediment yields by 94 percent ($p < 0.05$) when compared to conventional tillage (CT). During periods of below-average rainfall, the impacts were particularly significant (dry seasons). Grain yield under TR was 7 times greater than CT during the drier season of short rains 2010 (SR10) ($p < 0.01$).

Okeya *et al.* (2014) assessed three soil and water conservation strategies (mulching, low tillage, and tied ridging) over two cropping seasons (long rains 2011 and short rains 2011) at two locations in Kenya's central highlands. The researchers wanted to see how the technologies affected runoff, sediment production, and nutrient loads in sediment, as well as how they affected maize yields. The study used a randomised full block design with three treatments reproduced three times. At the start of the experiment, soil samples were taken from 0–15 cm depth and tested for pH, N, P, K, C, Ca, and Mg. Mulch was spread at a rate of 5 tonnes per hectare. Runoff was sampled, sediments were removed by drying in an oven at 105°C, and NPK and C loading were determined. The data were analysed using SAS 9.1.3, and the means were separated using Fishers' LSD at a 5% level of significance. The technology decreased nutrient losses, according to the findings. In Meru South, under mulching and minimal tillage, sediment output was reduced by 41 and 7% during long rains 2011 ($p = 0.03$), and by 71 and 68 percent during short rains 2011 ($p = 0.01$). Mulching had a favourable impact on both runoff and maize yields. Under soil and water conservation strategies, sediment production in Mbeere South was lower. When compared to control, tied ridging and mulching reduced runoff by 52 and 49 percent during heavy rains in 2011 and by 51 and 30 percent during short rains in 2011. Due to unpredictable rainfall in 2011, total crop loss occurred. When compared to control, tied ridging and mulching improved maize production by 94 and 75 percent, respectively, during the 2011 short rains. In response to falling food production, this study emphasises the necessity of studying soil and water conservation strategies within rain-fed agricultural systems and advocates an emphasis on tied ridging and mulching.

Patode *et al.* (2015) investigated how continuous contour trenches affected soil moisture in minor catchments. Four minor catchments split the region. B and D are not treated, whereas catchments A and C are treated with continuous contour trenches. Custard apple (*Annona squamosa*) is planted in catchments A and B, while atemoya (*Annona cherimola*) is planted in catchments C and D. During 2013-2014, the soil moisture condition at different depths of 0-10, 10-20, 20-30, 30-40, 40-50, 50-60, 60-70, and 70-80cm was monitored, and the leaf area index was computed for custard apple and atemoya plantations. It was discovered that CCTs aid in improved soil moisture conditions, which impacts plant

development and, as a result, the leaf area index of the plantation in CCT treated catchments was higher than in untreated catchments.

Rashid *et al.* (2016) investigated the impact of soil and water conservation terrace constructions on crop yield and soil productivity in a rainfed terraced system. In an uneven terrain in the rainfed region, they performed an experiment to analyse the efficiency of terraced systems related to runoff interception in order to conserve soil moisture and soil fertility for wheat production. Wheat was sown upstream of TS in an experiment comprising of two primary blocks: Recommended Rate of Fertilizer (RRF) and Farmer Practice (FP), both of which were divided into two sub blocks: with terrace structure (WTS) and without terrace structure (WTS) (WOTS). The investigation indicated that TS considerably enhanced wheat grain production (20%) by conserving soil moisture contents (16%) and soil fertility levels.

Araya *et al.* (2016) investigated the impact of seven years of resource-conserving agriculture on soil quality and crop yield in the Ethiopian drylands,. By minimising soil disturbance, retaining crop residue, using crop rotations, and adding in situ soil and water conservation tillage practises (terwah and derdero) in crop fields, resource-conserving agriculture (RCA) aims to improve soil quality and crop yield while maintaining or improving soil health. Intensive mining of soil resources, such as repeated tillage, complete crop residue removal at harvesting, overgrazing, and biomass burning in croplands, have amplified soil degradation in Ethiopia, and researchers have studied the impact of two RCA (derdero+ (DER+) and terwah+ (TER+) on long-term soil quality and crop productivity in permanently kept plots in northern Ethiopia 7 years after their inception. DER+ is a bed and furrow planting technique in which beds are left unploughed, furrows are tilled once at planting time, and 30% of crop residue is preserved. (ii) At planting, TER+ is ploughed once, furrows are constructed at 1.5 m intervals, fresh wide beds are created, and 30% crop residue is preserved. These RCA methods were compared to conventional tillage (CT), which involves at least three tillage operations and total crop residue clearance. Soil organic carbon (SOC), total soil N, available P, soil microbial biomass C (SMBC), time of ponding, aggregate stability index (SI), consistency index (CI), cone index, air capacity, and macroporosity were all found to increase significantly in soils subjected to the DER+ planting system when compared to the CT. Crop yields improved by 30 percent and 16 percent, respectively, when DER+ and TER+ were used instead of CT. As a result, from an agro-ecological standpoint, adopting improved local practises such as DER+ and TER+ planting systems that employ conservation agriculture principles have proven to be sustainable,

resource conserving alternatives and incentives should be provided to farmers in Ethiopia to encourage greater adoption.

Borse (2016) examined the impact of continuous trenches in most regions of Maharashtra, where the landscape was generally rough and uneven, limiting irrigation attempts. He discovered that just 18 percent of the agricultural land in the area was irrigated, which was eventually raised to 42 percent. CCT has been introduced, accepted, popularised, and practised in Maharashtra, and at the state level, this technique has been given more weightage because it is ideal for increasing rainwater infiltration, reducing runoff, reducing soil loss, and increasing ground water levels, and it has been found to be more beneficial for agricultural productivity and solving the problem of drinking water scarcity.

Trupti and Rathod (2017) studied impact of integrated watershed management programme on yield and economic parameters of farmers in Wardha district. For the impact study of Integrated Watershed Management Program (IWMP) on developmental parameters of farmers, descriptive design namely, ex-post facto research design was used. The impact was determined by the changes in developmental parameters of farmers before and after watershed development program. In the study, behavioral variables like knowledge and adaption were studied; however, yield parameters and income generating variables were also key points to study the impact of IWMP. Change in production and productivity was observed due to implementation of IWMP. Similarly, cropping intensity increased by 12.28%, while employment and income increased by 19.57 and 50.71%, respectively. Overall impact of IWMP on yield and economic parameters in Wardha district was 50.64%.

Melaku *et al.* (2018) used measurements and modelling to investigate the effects of Integrated impact assessment of soil and water conservation structures on runoff and sediment production in the Northern Ethiopian highlands. Soil and water conservation (SWC) has been practised to address this problem. Using the Geospatial Interface for the Water Erosion Prediction Project (GeoWEPP) model, an integrated measuring and modelling research was undertaken in the Gumara-Maksegnit sub watershed from 2012 to 2014 to examine the consequences of SWC structures on runoff and sediment production. The study was done in two neighbouring, smaller watersheds, with SWC buildings erected in one (treatment sub watershed) and no SWC structures in the other (control sub watershed) (untreated sub watershed). The treated sub watershed covers 27.1 hectares, whereas the untreated sub watershed covers 31.7 ha. On the basis of data and GeoWEPP model simulations, runoff and sediment output were compared. The daily runoff was adequately

predicted by the GeoWEPP model simulation results for both sub watersheds ($R^2 = 0.68$ and $NSE = 0.43$ for untreated and $R^2 = 0.61$ and $NSE = 0.84$ for treated sub watershed). Similarly, the model prediction for sediment yield was excellent ($R^2 = 0.61$ and $NSE = 0.59$ for untreated sub watershed and $R^2 = 0.57$ and $NSE = 0.81$ for treated sub watershed). SWC structures altered the flow buildup and lowered the slope gradient. The treated sub watershed surface runoff was decreased by around 19% when compared to the untreated sub watershed, according to the observation and simulation research. Similarly, the model predicted that SWC structures built in the treated sub watershed reduced overall soil loss above the specified target limit of 10 t ha⁻¹ y⁻¹ from 49 percent to 38 percent of the watershed area. In these Ethiopian highland watersheds, SWC has resulted in a considerable reduction in sediment production of 28 to 38 percent. The findings indicated that SWC buildings in Ethiopia's highlands had a substantial influence on preventing land degradation.

Nikalje *et al.* (2018) investigated the impact of continuous contour trenches in Maharashtra's problematic regions, where severe droughts and soil erosion are the two most serious concerns. They used the contour trenching technique in areas where there is a lot of water scarcity, and it was found to be effective because it extends the time of water concentration from the peak to the farthest point, which increases the rate of rainwater infiltration, reduces runoff, reduces soil loss, and raises ground water levels. This is beneficial for boosting agricultural output and addressing the issue of water scarcity. They also discovered that building continuous contour trenches in low-rainfall locations acted as ground water boosters since the trenches store the ground water.

Wolka *et al.* (2018) investigated the effects of soil and water conservation techniques on crop yield, runoff, and soil loss in Sub-Saharan Africa, and revealed that the implementation of various indigenous and cross slope barrier soil and water conservation (CSB-SWC) techniques, such as Fanya juu, soil bunds, stone bunds, bench terraces, vegetative barriers, and tied-ridges, had a positive impact on crop yield, runoff, and soil loss (SSA). It was found that using various CSB-SWC techniques reduced runoff and soil loss by 13–71 percent and 39–83 percent, respectively. More than 80% of the scientific research revealed a favourable influence on crop production, owing to nutrient and moisture retention.

Tanto and Leakemarian (2019) investigated the impact of soil and water conservation methods in Ethiopia, where soil erosion and land degradation are important issues that have a negative impact on soil fertility and agricultural output. They used soil and water

conservation technology on farmed fields in the Bashe micro-watershed, Wolaita zone, Southern Ethiopia, to combat land degradation. They discovered that using soil and water conservation methods lowered bulk density and raised pH (from 5.87 to 6.60), organic carbon (from 1.34 to 1.74 percent), and enhanced crop output by 72.8 percent over control.

2.5 Salient finding from the review of literature

Following are the some of the important points obtained from this chapter.

1. Soil and water conservation techniques provided a efficient way to preserve the soil moisture content in the soil by intercepting the runoff.
2. The crop productivity showed an interlinked relationship with the conservation technique and moisture content in the soil.
3. Soil conservation techniques were turned to be an efficient barriers to the erosion of the soil.

CHAPTER-3

MATERIALS AND METHODS

This chapter deals with procedures and methods adopted for evaluation of soil and water conservation measures on crop productivity for the rainfed area of Jammu district. The details for the evaluation of soil and water conservation measures followed by analysis of the data collected during the study have been presented in this chapter. The research evaluation was conducted at Kandi village of Akhnoor district, Jammu.

The methodology adopted in evaluation has been divided into following sections.

- 3.1 Profile of Jammu and Kashmir
- 3.2 General Description of the Study Area
- 3.3 Data Collection
- 3.4 Data Estimation
- 3.5 Statistical Analysis

3.1 Profile of Jammu and Kashmir

3.1.1 Geographical location

The erstwhile state of Jammu and Kashmir is one of the states of India is situated in the country's far north, between 32°15' and 37°05' North latitude and 72°35' and 80°20' East longitude. It is known as the "Crown on the Head of the Indian Subcontinent" due to its location in the far north of the country. It has a total geographical area of 2,22,236 sq.kms, of which 37,555 sq. kms are under illegal Chinese control in Leh (Ladakh District), 78114 sq. kms are under unlawful Pakistani occupation, and 5180 sq.kms were illegally handed over to China by Pakistan. As a result, the entire geographical area under its supervision is 101387 sq kms (DES, 2015), divided into three regions: Jammu, Kashmir, and Ladakh. The plains in the state are mostly alluvial, since water bodies including the Chenab, Tawi, and Ravi, as well as their tributaries, run through it. The outlying plains of Jammu division are extremely fertile, and the region's average temperature allows for year-round agricultural cultivation. Between the Ravi and Jhelum rivers, to the north of the Jammu plains, the youngest mountains, the Siwaliks, were discovered, which are covered with deciduous forest, grasses, and bushes. The geographical map of J&K state is presented in fig 3.1.

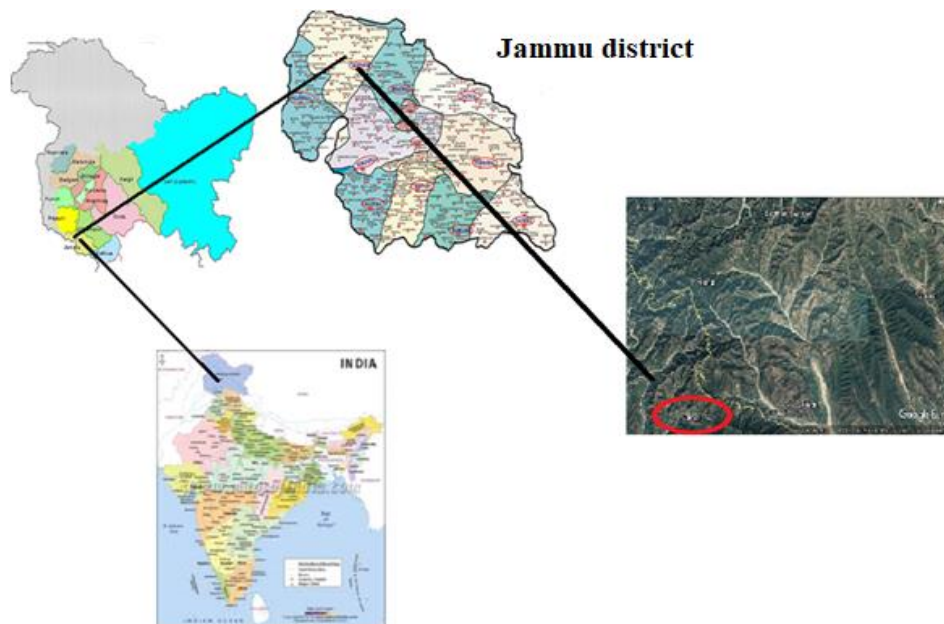


Fig. 3.1: Geographic location of study area

3.1.2 Soil of the district

The soils of the districts are varying in their colour, structure, texture, pH, water holding capacity and organic carbon content. The main soil problems in the district are soil salinity, soil sodicity and human carelessness. Most of the soils of this zone are also characterized by deficient zinc. The soils of the kandi belt shows the low water holding capacity, low organic carbon and low cation exchange capacity. The bare land of the kandi belt, as a highly terrain area, exhibits a lack of vegetative cover and crop development, posing a hazard to soil erosion and land degradation. Furthermore, especially in the months of May, June, October, and November, there is a water scarcity in the area. The conservation of soil and water is one of the region's most immediate concerns (Annual Report SKUAST, 1997).

3.1.3 Climate

The UT of Jammu and Kashmir shows the predominantly diversification in terms of climate as the two regions differ in latitude, longitude and altitude. The climate of Jammu is sub-tropical, temperate for Kashmir. since the two regions shows the variation in the climate, therefore the two regions possess the different cropping patterns. The major predominant crops of the two regions are as per details in table 3.1 below;

Table 3.1: Major crops of Jammu and Kashmir UT

Division	Major crops
Jammu	Wheat, Maize, Paddy, Pulses, Fodder and Oil Seeds
Kashmir	Paddy, Barley, Wheat, Maize, Vegetables, Barssem and Fodder

Source (DES,2015-16)

3.2 General description of the Study Area

3.2.1 Location

The present study was conducted at Kandi village of Akhnoor Tehsil of Jammu district. Kandi has an average latitude 32°59'34" N and 74°40'55" E longitude at an altitude of 773 m above sea level. It is situated 20 km away from sub district headquarter Akhnoor and 60 km from district headquarter Jammu. Total geographical area of the village is 563 ha.

3.2.2 Topography

The topography of the study area varies as the slope, drainage, shade cast etc which are main elements of the topography changes. The study in general is characterized with low hills, undulating topography, steep slopes, poor ground cover and erodible soils.

3.2.3 Soils

Three samples were collected randomly at the depth 0-15 cm, 15-30 cm, 30-45 cm. The soil samples were sieved and analysed in the laboratory of Soil Science Division of SKUAST-Jammu, to determine texture class, according to USDA system (Ditzler *et al.*, 2017). The soils of the study area are in textural class loamy sand. The texture of the soil depends upon the proportion of sand, silt and clay.

3.2.4 Climatic factors

The climate of the study area is subtropical with an average rainfall of 1154.52 mm (2003-2017) of which about 74% was received during June to September. The average temperature in the area varies from 4°C to 40°C. Total annual rainfall of the study area was irregular in nature. The maximum rainfall occurred during June to September months. The data pertaining to different weather parameters like rainfall, temperature and relative humidity during the crop growing season is depicted in Annexure-I.

3.2.5 Irrigation

In Jammu region, irrigation is done by two existing sources viz. Ranbir canal and New pratap canal. The New Pratap canal is the source of irrigation in the Akhnoor tehsil but in *Kandi* area , irrigation is not done by the above existing schemes rather irrigation is done by the ponds which plays an important role in the irrigation of the Kandi area (Census 2011). The study area of *Kandi* Village also feeds on the system of farm ponds as the system lies on the rainfed region region of the sub-tropical zone of Jammu district.

3.2.6 Crops and cropping pattern

The cropping pattern in the kandi village is uniform. During the kharif season maize, bajra and kulth crops are grown while in rabi season wheat and mustard crops are grown. In addition the vegetables like tomato, cauliflower, cabbage, knol-khol and okra are also grown in the village. Maize and wheat are the major crops grown during kharif and rabi season respectively.

3.3 Data Collection

3.3.1 Field studies

3.3.1.1 Collection of soil samples

The soil samples were collected from different locations with the help of soil auger from 0-15 cm, 15-30 cm, and 30-45 cm from the surface of soil. The soil samples were kept in polythene bags and were properly labeled (Burt,2009).

3.3.1.2 Infiltration study

The infiltration data was recorded with the help of mini disk infiltrometer in the field site. Total length of the mini disc infiltrometer is 32.7 cm, the sintered stainless steel has a diameter of 4.5 cm and thickness of 3 mm, the suction range is from-0.5 to-6 cm and the volume of water required to operate is 135 ml. Data obtained from the study area was entered in Microsoft Excel spreadsheet to get the curve of the cumulative infiltration versus time (Decagon, 2005).

3.3.1.3 Bulk density

During the investigation, the bulk density was measured using the core cutter technique. The most frequent approach for determining density in agricultural areas is the core sample method (Casanova *et al.*, 2016). To acquire a core sample, this approach entails hammering or pressing a solid ring or volumetric cylinder into the earth (Walter *et al.*, 2106).

The cylinder's interior volume is used to calculate the overall amount of dirt.. The weight of the soil is determined using a balance, and the bulk density is calculated by dividing the weight of the sample by the volume of soil. To get the dry density, samples are dried at 105°C for 24 hours after which the mass of the dry soil sample is measured and the soil density is calculated.

3.3.1.4 Crop productivity

Crop grains were taken from the four conservation measures viz. contour bund, contour trench, contour bund cum trench and from control from the plot size of 1m². Grains were dried up for some days and their weight was calculated using the weighing balance.

3.3.2 Laboratory studies

3.3.2.1 Drying of soil samples

The soil samples were dried in the oven for 24 hours under the temperature of 105°C. The dry weight is then calculated by using the weighing balance.

3.3.2.2 Particle size distribution

The mechanical analysis of the soil was done to find out the relative percentage of the sand, silt and clay fractions. This was carried out by Bouyoucos hydrometer method given by Bouyoucos (1962).

3.4 Data Estimation

3.4.1 Calculation of moisture content

The soil samples were collected randomly at 0-15, 15-30, 30-45 cm depth from the fields where adaption of contour bunds, contour trenches and combination of contour trenches and bunds takes place. Soil samples were taken using auger and the sample were kept in polythene bags. The fresh weight and oven dry weight was taken and soil moisture content was calculated using the formula.

$$\text{Percentage soil moisture} = \frac{W_w - W_d}{W_w} \times 100 \text{ (wet basis)}$$

Where;

W_w =Fresh weight of soil sample (g)

W_d =Oven dry weight of soil sample (g)

3.4.2 Calculation of infiltration rate

Infiltration rate is measured using the mini disk infiltrometer. The infiltrometer is placed at the surface of the soil assuming that it makes solid contact with the soil surface. Volume of water is recorded at regular intervals during the process of infiltration measurement to get the basic infiltration rate. The data is then put into the Microsoft Excel spreadsheet to calculate the slope of the curve of the cumulative infiltration vs. the square root of time based on the data gathered.

3.4.3 Calculation of bulk density

The core sampling method is used to calculate bulk density. The core cutter is hammered into the earth and the soil is collected in the rim of the core cutter in this manner. The dimensions of the rim is calculated using the vernier calliper and the volume is obtained as:

$$\text{Volume of soil taken} = \pi r^2 \times h$$

Where,

r = radius of core cutter (m)

h = height of soil section in the core cutter (m)

The bulk density is calculated as;

$$\text{Bulk density} = \frac{W_t}{V}$$

Where,

W_t = weight of the soil sample (g)

V = volume of actual soil sample (cm³)

3.4.4 Measurement of Crop Productivity

The samples were taken from the four conservation measures viz. contour bund cum trench, contour bund, contour trench, and from control plots. The samples were taken on the basis of quadrant method, in which samples were taken from 1m² area. The collected samples were dried for few days and the measurement of their weight were calculated of each obtained from the respective conservation measures.



Plate 3.1: Collection of soil samples



Plate 3.2: Measurement of Infiltration

3.4.5 Treatment details

The moisture content was measured on four conservative measures at three depths and three distances from the conservation measures. The four conservative measures are described below;

3.4.5.1 Contour bund cum trench

The contour bund cum trench (T_1) is the combination of the two conservative measures i.e. Bunding and Trenching (Plate 3.3). The shape of the contour trench and the contour bund is rectangular and trapezoidal respectively. In our study, the specifications for the above said conservative measure were;

Contour Bund	Specification
Top width	0.5 m
Bottom width	1 m
Height	0.6 m
Length	10-20 m
Contour trench	Specification
Width	0.8 m
Depth	0.5 m
Length	10-20 m

3.4.5.2 Contour bund

The contour bund (T_2) causes a water break which results in the reduction in the formation of rills and gullies at the time when there is heavy rainfall thus causing more water to infiltrate into the soil (Plate 3.3). In our study the contour bund had following specification.

Contour Bund	Specification
Top width	0.5 m
Bottom width	1 m
Height	0.6 m

3.4.5.3 Contour Trench

Contour trenches are the excavation work following the contour line so that the water flow comes across the trench (Plate 3.3). In our study the specifications of trench are given below

Contour trench	Specification
Width	0.8 m
Depth	0.5 m
Length	10-20 m

3.4.5.4 Control plot

The control plot is a simple agriculture field with no conservation measures adopted (Plate 3.3). In our study, the field of same area where above conservative measures field was observed and comparison was drawn with the conservative measures.

The details of the treatments adopted is presented in the Table 3.2 below

Table 3.2: Treatment details of the study

Independent Variables	Levels
Moisture Conservation Measures	T ₁
	T ₂
	T ₃
	T ₄
Depth	D ₁
	D ₂
	D ₃
Distance	L ₁
	L ₂
	L ₃

Where;

T₁: stands for the contour bund cum trench conservative measure

T₂: stands for contour bund conservative measure

T₃: stands for contour trench conservative measure

T₄: stands for control plots

D₁: depth of 0-15 cm

D₂: depth of 15-30 cm

D₃: depth of 30-45 cm

L₁: distance of 1m from conservation measure

L₂: distance of 2m from conservation measure

L₃: distance of 3m from conservation measure

3.4.6 Dependent variables

- Moisture content (%)
- Infiltration Rate (mm/h)
- Bulk density (g/cm³)
- Grain yield (q/ha)

3.5 Statistical Analysis

Number of Treatment combination	=	4×3×3
	=	36
Number of Replications	=	03
Total number of experiments	=	108

The data obtained during the study on various observations were tabulated and data analysis was done using 2-Way ANOVA.



Contour Trench cum Bund



Contour Bund



Contour Trench



Control Plot

Plate 3.3: Various Conservative measures

CHAPTER-4

RESULTS

A detailed investigation on the response of soil and water conservation measures and its impact has been carried out for the present study using the methodology discussed in the previous chapter. The results of the investigation in this chapter are presented under the following headings:

4.1 Effect of soil and water conservation measures on soil moisture content

4.2 Impact of soil and water conservation measures on crop productivity

4.3 Impact of soil and water conservation on bulk density

4.4 Impact of soil and water conservation on infiltration rate

4.5 Moisture dynamics during crop growth period

4.1 Effect of soil and water conservation measures on soil moisture content

The soil moisture pattern of the study area was obtained at the three conservation measures i.e. contour bunding cum trenching, contour bunding, contour trenching and in control plot (without any soil and water conservation measures). In addition to above mentioned conservation measures, the soil moisture regime was observed at the three distance i.e. 1 m, 2 m, 3 m away from the conservation measures and at the three depths viz. 0-15 cm, 15-30 cm and 30-45 cm from the surface. The data was collected on fortnight basis during the crop growing period of wheat from October to April of 2020-2021. The moisture content during the respective months is presented below.

4.1.1 Effect of conservation measures on moisture content with respect to distance and depth during 1st week of October 2020

The effect of conservation measures on moisture content at different depths and distances are presented in Table 4.1 and are graphically illustrated from Fig. 4.1 to 4.4. The effects of individual parameters on moisture content for 1st week of October are discussed below:

The effect of soil and water conservation measures i.e. contour bund cum trench (T_1), contour bund (T_2), contour trench (T_3) and control plot (T_4) were studied for moisture content at three depths and three distances respectively.

The moisture content for the conservation measures T_1 , T_2 , T_3 and T_4 for all treatment combinations under study ranged from 4.16 to 4.86, 3.39 to 4.39, 3.86 to 4.68 and 2.96 to 3.90

respectively. The maximum moisture content of 4.86 for T_1 was attained at treatment combination of L_3D_3 ($L_3 = 3$ m, $D_3 = 30$ to 45 cm) whereas minimum moisture content of 4.16 for T_1 was attained at a treatment combination of L_2D_1 ($L_2 = 2$ m, $D_1 = 0$ to 15 cm). The maximum and minimum moisture content 4.39 and 3.39 for the conservative measure T_2 were attained at a treatment combination of L_2D_3 and L_3D_1 . Similarly the maximum and minimum moisture content of 4.68 and 3.86 for T_3 was attained at treatment combinations of L_3D_3 and L_2D_1 respectively. Lastly the maximum (3.90) and minimum (2.96) moisture content for T_4 (control plot) were observed at a treatment combination of L_1D_3 and L_3D_1 .

The main effect of conservation measures on moisture content was statistically significant at 5% level of significance. The first level interaction $C \times L$ were statistically significant at 5% level of significance. The first order interaction $C \times D$ were significant and second order interaction $C \times L \times D$ was also significant at 5% level of significance.

4.1.1.1 Effect of depth

The effect of depth i.e. 0-15 cm (D_1), 15-30 cm (D_2) and 30-45 cm (D_3) on moisture content were studied at three distances and four conservative measures respectively.

The moisture content at the depths D_1 , D_2 and D_3 for all treatment combinations under study ranged from 2.96 to 4.86, 3.36 to 4.56 and 3.86 to 4.86 respectively. The maximum moisture content of 4.86 for D_1 was attained at treatment combination of L_3T_1 ($L_3 = 3$ m, $T_1 =$ contour bund cum trench) whereas minimum moisture content of 2.96 for D_1 was attained at a treatment combination of L_3T_4 ($L_2 = 2$ m, $T_4 =$ control plot). The maximum and minimum moisture content 4.56 and 3.36 for the depth D_2 (15-30 cm) were attained at a treatment combination of L_1T_1 and L_1T_4 . Similarly the maximum and minimum moisture content of 4.86 and 3.86 for D_3 was attained at treatment combinations of L_3T_1 and L_2T_4 respectively.

The main effect of depth on moisture content was statistically significant at 5% level of significance. The first level interaction $C \times D$ were statistically significant at 5% level of significance. The first order interaction $L \times D$ were significant and second order interaction $C \times L \times D$ was also significant at 5% level of significance.

4.1.1.2 Effect of distance

The effect of distance i.e. 1 m (L_1), 2 m (L_2) and 3 m (L_3) were studied for moisture content at three depths and four conservative measures respectively.

The moisture content at the distances L_1 , L_2 and L_3 for all treatment combinations under study ranged from 3.20 to 4.76, 3.35 to 4.65 and 2.96 to 4.86 respectively. The maximum moisture content of 4.76 for L_1 was attained at treatment combination of D_3T_1 (D_3 = 30-45 cm, T_1 = contour bund cum trench) whereas minimum moisture content of 3.20 for L_1 was attained at a treatment combination of D_1T_4 (D_1 = 0-15 cm, T_4 = control plot). The maximum and minimum moisture content 4.65 and 3.35 for the distance L_2 (2m) were attained at a treatment combination of D_3T_1 and D_1T_4 . Similarly the maximum and minimum moisture content of 4.86 and 2.96 for L_3 was attained at treatment combinations of D_3T_1 and D_1T_4 respectively.

The main effect of depth on moisture content was statistically significant at 5% level of significance. The first level interaction $C \times L$ were statistically significant at 5% level of significance. The first order interaction $L \times D$ were significant and second order interaction $C \times L \times D$ was also significant at 5% level of significance.

4.1.2 Effect of conservation measures on moisture content (%) with respect to distance and depth during 3rd week of October 2020

The effect of conservation measures on moisture content at different depths and distances are presented in Table 4.2 and are graphically illustrated from Fig. 4.5 to 4.8. The effects of individual parameters on moisture content for 3rd week of October are discussed below

The effect of soil and water conservation measures i.e. contour bund cum trench (T_1), contour bund (T_2), contour trench (T_3) and control plot (T_4) were studied for moisture content at three depths and three distances respectively.

The moisture content for the conservation measures T_1 , T_2 , T_3 and T_4 for all treatment combinations under study ranged from 4.11 to 4.78, 3.35 to 4.31, 3.90 to 4.54 and 3.07 to 3.87 respectively. The maximum moisture content of 4.78 for T_1 was attained at treatment combination of L_3D_3 (L_3 = 3 m, D_3 = 30 to 45 cm) whereas minimum moisture content of 4.11 for T_1 was attained at a treatment combination of L_2D_1 (L_2 = 2m, D_1 = 0 to 15 cm). The maximum and minimum moisture content 4.31 and 3.35 for the conservative measure T_2 were attained at a treatment combination of L_2D_3 and L_3D_1 . Similarly the maximum and minimum moisture content of 4.54 and 3.90 for T_3 was attained at treatment combinations of

L_3D_3 and L_1D_1 respectively. Lastly the maximum (3.87) and minimum (3.07) moisture content for T_4 (control plot) were observed at a treatment combination of L_1D_3 and L_1D_1 .

The main effect of conservation measures on moisture content was statistically significant at 5% level of significance. The first level interaction $C \times L$ were statistically significant at 5% level of significance. The first order interaction $C \times D$ were significant and second order interaction $C \times L \times D$ was also significant at 5% level of significance.

4.1.2.1 Effect of depth

The effect of depth i.e. 0-15 cm (D_1), 15-30 cm (D_2) and 30-45 cm (D_3) were studied for moisture content at three distances and four conservative measures respectively.

The moisture content at the depths D_1 , D_2 , and D_3 for all treatment combinations under study ranged from 3.07 to 4.27, 3.36 to 4.49 and 3.80 to 4.78 respectively. The maximum moisture content of 4.86 for D_1 was attained at treatment combination of L_1T_1 ($L_1 = 1\text{m}$, $T_1 = \text{contour bund cum trench}$) whereas minimum moisture content of 3.07 for D_1 was attained at a treatment combination of L_1T_4 ($L_1 = 1\text{ m}$, $T_4 = \text{control plot}$).

The maximum and minimum moisture content 4.49 and 3.36 for the depth D_2 (15-30 cm) were attained at a treatment combination of L_1T_1 and L_1T_4 . Similarly the maximum and minimum moisture content of 4.78 and 3.80 for D_3 was attained at treatment combinations of L_3T_1 and L_2T_4 respectively.

The main effect of depth on moisture content was statistically significant at 5% level of significance. The first level interaction $C \times D$ were statistically significant at 5% level of significance. The first order interaction $L \times D$ were significant and second order interaction $C \times L \times D$ was also significant at 5% level of significance.

4.1.2.2 Effect of distance

The effect of distance i.e. 1 m (L_1), 2 m (L_2) and 3 m (L_3) were studied for moisture content at three depths and four conservation measures respectively.

The moisture content at the distances L_1 , L_2 , and L_3 for all treatment combinations under study ranged from 3.07 to 4.68, 3.28 to 4.61 and 3.11 to 4.68 respectively. The

Table 4.1: Effect of soil and water conservation measures on moisture content (%) during 1st week of October

Distance Conservation Measures		Distance (m)			
	Depth(m)	L ₁	L ₂	L ₃	Sub Means
T ₁	D ₁	4.29	4.16	4.26	4.24
	D ₂	4.56	4.35	4.42	4.44
	D ₃	4.76	4.65	4.86	4.76
	Sub Means	4.54	4.39	4.51	4.48
T ₂	D ₁	3.75	3.53	3.39	3.56
	D ₂	3.86	3.75	3.67	3.76
	D ₃	4.12	4.39	4.35	4.29
	Sub Means	3.91	3.89	3.80	3.87
T ₃	D ₁	3.96	3.86	4.10	3.97
	D ₂	4.16	4.13	4.34	4.21
	D ₃	4.43	4.35	4.68	4.49
	Sub Means	4.18	4.11	4.37	4.22
T ₄	D ₁	3.20	3.35	2.96	3.17
	D ₂	3.36	3.43	3.48	3.42
	D ₃	3.90	3.86	3.87	3.88
	Sub Means	3.49	3.55	3.44	3.49
Factor Means	Conservation Measures	T ₁	T ₂	T ₃	T ₄
		4.48	3.87	4.22	3.49
	Distance	L ₁	L ₂	L ₃	
		4.03	3.98	4.03	
	Depth	D ₁	D ₂	D ₃	
		3.73	3.96	4.35	
C.D (p≤0.05)	Conservation Measures (T) =0.10				
	Distance (L) =0.12				
	Depth (D) =0.23				
	CxL =0.15				
	CxD =0.29				
	LxD =0.14				
	CxLxD =0.28				

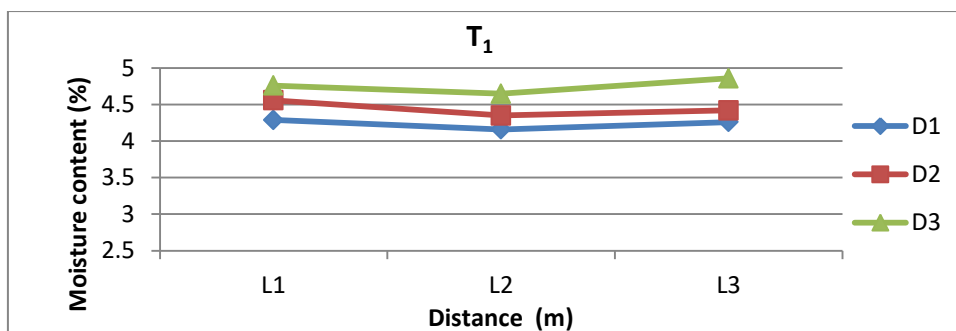


Fig 4.1: Effect of depth and distance on moisture content for Contour Bund cum trench during 1st week of October

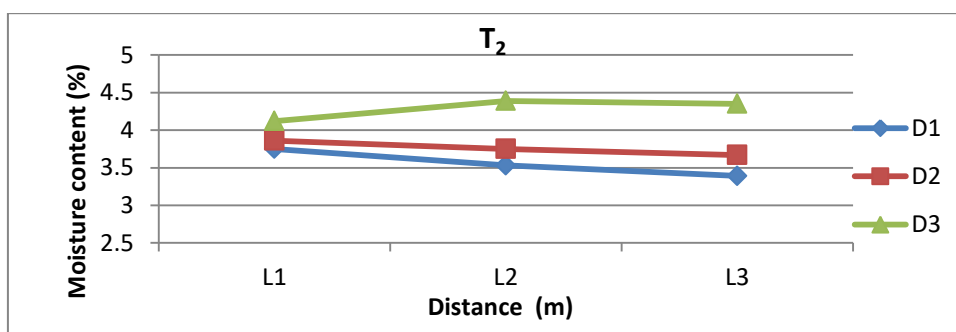


Fig 4.2: Effect of depth and distance on moisture content for Contour Bund during 1st week of October

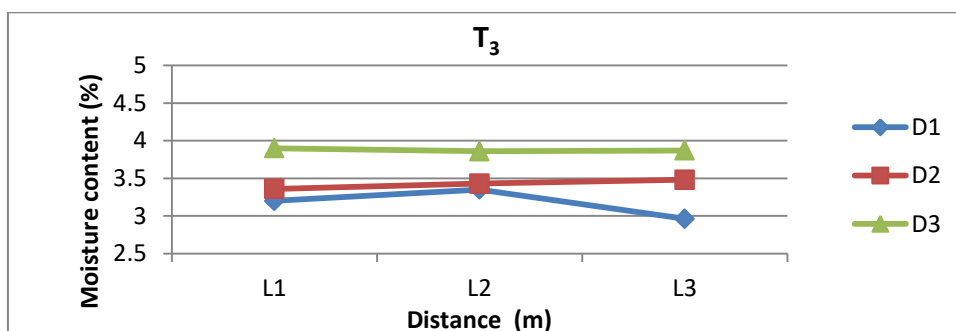


Fig 4.3: Effect of depth and distance on moisture content for Contour trench during 1st week of October

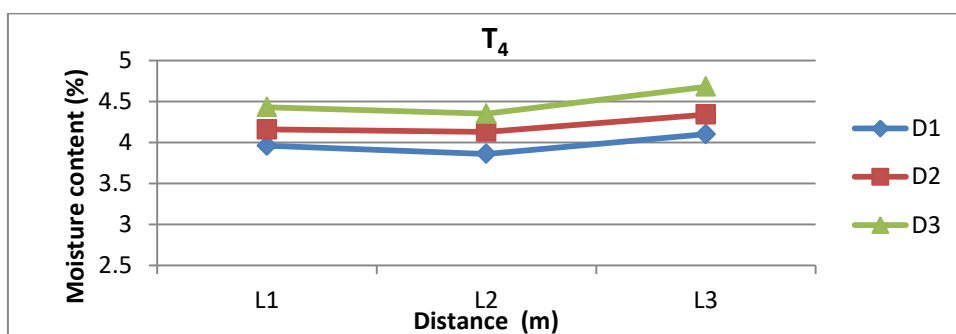


Fig 4.4: Effect of depth and distance on moisture content for Control plot during 1st week of October

maximum moisture content of 4.68 for L_1 was attained at treatment combination of D_3T_1 ($D_3 = 30-45$ cm, $T_1 =$ contour bund cum trench) whereas minimum moisture content of 3.07 for L_1 was attained at a treatment combination of D_1T_4 ($D_1 = 0-15$ cm, $T_4 =$ control plot). The maximum and minimum moisture content 4.61 and 3.28 for the distance L_2 (2m) were attained at a treatment combination of D_3T_1 and D_1T_4 . Similarly the maximum and minimum moisture content of 4.68 and 3.11 for L_3 was attained at treatment combinations of D_3T_1 and D_1T_4 respectively.

The main effect of depth on moisture content was statistically significant at 5% level of significance. The first level interaction $C \times L$ were statistically significant at 5% level of significance. The first order interaction $L \times D$ were significant and second order interaction $C \times L \times D$ was also significant at 5% level of significance.

4.1.3 Effect of conservation measures on moisture content (%) with respect to distance and depth during 1st week of November 2020

The effect of conservation measures on moisture content at different depths and distances are presented in Table 4.3 and are graphically illustrated from Fig. 4.9 to 4.12. The effects of individual parameters on moisture content for 1st week of November are discussed below

The effect of soil and water conservation measures i.e. contour bund cum trench (T_1), contour bund (T_2), contour trench (T_3) and control plot (T_4) were studied for moisture content at three depths and three distances respectively.

The moisture content for the conservation measures T_1 , T_2 , T_3 and T_4 for all treatment combinations under study ranged from 4.05 to 4.72, 3.28 to 3.98, 3.84 to 4.46 and 2.82 to 3.78 respectively. The maximum moisture content of 4.72 for T_1 was attained at treatment combination of L_3D_3 ($L_3 = 3$ m, $D_3 = 30$ to 45 cm) whereas minimum moisture content of 4.05 for T_1 was attained at a treatment combination of L_2D_1 ($L_2 = 2$ m, $D_1 = 0$ to 15 cm). The maximum and minimum moisture content 3.98 and 3.28 for the conservative measure T_2 were attained at a treatment combination of L_1D_3 and L_3D_1 . Similarly the maximum and minimum moisture content of 4.46 and 3.84 for T_3 was attained at treatment combinations of L_3D_3 and L_2D_1 respectively. Lastly the maximum (3.78) and minimum (2.82) moisture content for T_4 (control plot) were observed at a treatment combination of L_1D_3 and L_3D_1 .

The main effect of conservation measures on moisture content was statistically significant at 5% level of significance. The first level interaction $C \times L$ were statistically significant at 5% level of significance. The first order interaction $C \times D$ were significant and second order interaction $C \times L \times D$ was also significant at 5% level of significance.

4.1.3.1 Effect of depth

The effect of depth i.e. 0-15 cm (D_1), 15-30 cm (D_2) and 30-45 cm (D_3) were studied for moisture content at three distances and four conservative measures respectively.

The moisture content at the depths D_1 , D_2 , and D_3 for all treatment combinations under study ranged from 2.82 to 4.21, 3.28 to 4.38 and 3.74 to 4.72 respectively. The maximum moisture content of 4.21 for D_1 was attained at treatment combination of L_1T_1 ($L_1 = 1$ m, $T_1 =$ contour bund cum trench) whereas minimum moisture content of 2.82 for D_1 was attained at a treatment combination of L_3T_4 ($L_1 = 1$ m, $T_4 =$ control plot). The maximum and minimum moisture content 4.38 and 3.28 for the depth D_2 (15-30 cm) were attained at a treatment combination of L_1T_1 and L_3T_4 . Similarly the maximum and minimum moisture content of 4.72 and 3.74 for D_3 was attained at treatment combinations of L_3T_1 and L_2T_4 respectively.

The main effect of depth on moisture content was statistically significant at 5% level of significance. The first level interaction $C \times D$ were statistically significant at 5% level of significance. The first order interaction $L \times D$ were significant and second order interaction $C \times L \times D$ was also significant at 5% level of significance.

4.1.3.2 Effect of distance

The effect of distance i.e. 1 m (L_1), 2 m (L_2) and 3 m (L_3) were studied for moisture content at three depths and four conserve measures respectively.

The moisture content at the distances L_1 , L_2 , and L_3 for all treatment combinations under study ranged from 3.03 to 4.57, 3.19 to 4.53 and 2.82 to 4.72 respectively. The maximum moisture content of 4.57 for L_1 was attained at treatment combination of D_3T_1 ($D_3 = 30-45$ cm, $T_1 =$ contour bund cum trench) whereas minimum moisture content of 3.03 for L_1 was attained at a treatment combination of D_1T_4 ($D_1 = 0-15$ cm, $T_4 =$ control plot). The maximum and minimum moisture content 4.53 and 3.19 for the distance L_2 (2m) were attained at a treatment combination of D_3T_1 and D_1T_4 . Similarly the maximum and minimum

Table 4.2: Effect of soil and water conservation measures on moisture content (%) during 3rd week of October

Distance Conservation Measures		Distance (m)			
	Depth (m)	L ₁	L ₂	L ₃	Sub Means
T ₁	D ₁	4.27	4.11	4.19	4.19
	D ₂	4.49	4.30	4.39	4.39
	D ₃	4.68	4.61	4.78	4.69
	Sub Means	4.48	4.34	4.45	4.42
T ₂	D ₁	3.69	3.47	3.35	3.50
	D ₂	3.79	3.71	3.64	3.71
	D ₃	4.07	4.31	3.98	4.12
	Sub Means	3.85	3.83	3.66	3.78
T ₃	D ₁	3.90	3.94	4.05	3.96
	D ₂	4.08	4.11	4.21	4.13
	D ₃	4.27	4.38	4.54	4.40
	Sub Means	4.08	4.14	4.27	4.16
T ₄	D ₁	3.07	3.28	3.11	3.15
	D ₂	3.36	3.41	3.48	3.42
	D ₃	3.87	3.80	3.84	3.84
	Sub Means	3.43	3.50	3.48	3.47
Factor Means	Conservation Measures	T ₁	T ₂	T ₃	T ₄
		4.42	3.78	4.16	3.47
	Distance	L ₁	L ₂	L ₃	
		3.96	3.95	3.96	
	Depth	D ₁	D ₂	D ₃	
		3.70	3.91	4.26	
C.D (p≤0.05)	Conservation Measures (T) =0.09 Distance (L) =0.06 Depth (D) =0.11 CxL =0.13 CxD =0.17 LxD =0.14 CxLxD =0.21				

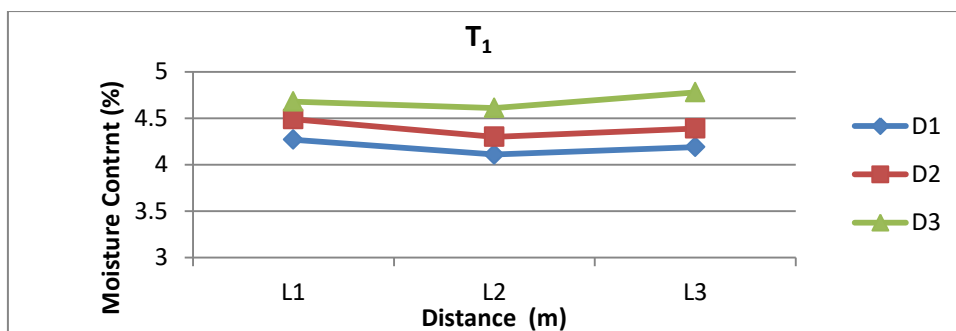


Fig 4.5: Effect of depth and distance on moisture content for Contour bund cum trench during 3rd week of October

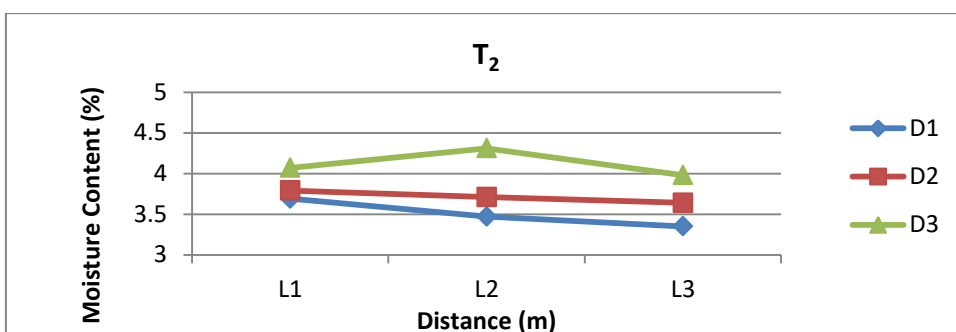


Fig 4.6: Effect of depth and distance on moisture content for Contour bund during 3rd week of October

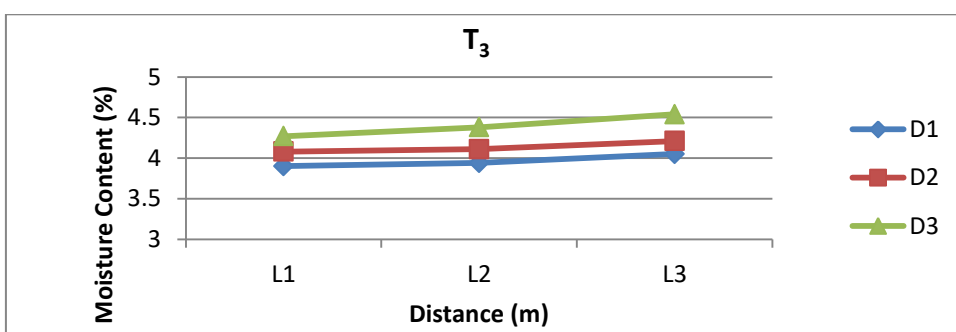


Fig 4.7: Effect of depth and distance on moisture content for Contour trench during 3rd week of October

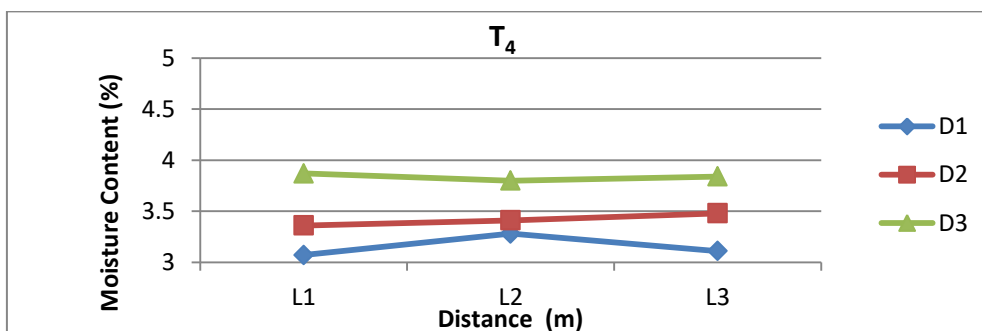


Fig 4.8: Effect of depth and distance on moisture content for Control plot during 3rd week of October

Table 4.3: Effect of soil and water conservation measures on moisture content (%)
during 1st week of November

Distance Conservation Measures		Distance (m)			
	Depth (m)	L ₁	L ₂	L ₃	Sub Means
T ₁	D ₁	4.21	4.05	4.11	4.12
	D ₂	4.38	4.24	4.31	4.31
	D ₃	4.57	4.53	4.72	4.61
	Sub Means	4.39	4.27	4.38	4.35
T ₂	D ₁	3.62	3.41	3.28	3.44
	D ₂	3.72	3.64	3.58	3.65
	D ₃	3.98	4.21	3.87	4.02
	Sub Means	3.77	3.75	3.58	3.70
T ₃	D ₁	3.91	3.84	3.96	3.90
	D ₂	4.01	4.06	4.16	4.08
	D ₃	4.29	4.21	4.46	4.32
	Sub Means	4.07	4.04	4.19	4.10
T ₄	D ₁	3.03	3.19	2.82	3.01
	D ₂	3.36	3.34	3.28	3.33
	D ₃	3.78	3.74	3.76	3.76
	Sub Means	3.39	3.42	3.29	3.37
Factor Means	Conservation Measures	T ₁	T ₂	T ₃	T ₄
		4.35	3.70	4.10	3.37
	Distance	L ₁	L ₂	L ₃	4.12
		3.91	3.87	3.86	
	Depth	D ₁	D ₂	D ₃	
		3.62	3.84	4.18	
C.D (p≤0.05)	Conservation Measures (T) =0.12 Distance (L) =0.04 Depth (D) =0.18 CxL =0.15 CxD =0.23 LxD =0.16 CxLxD =0.32				

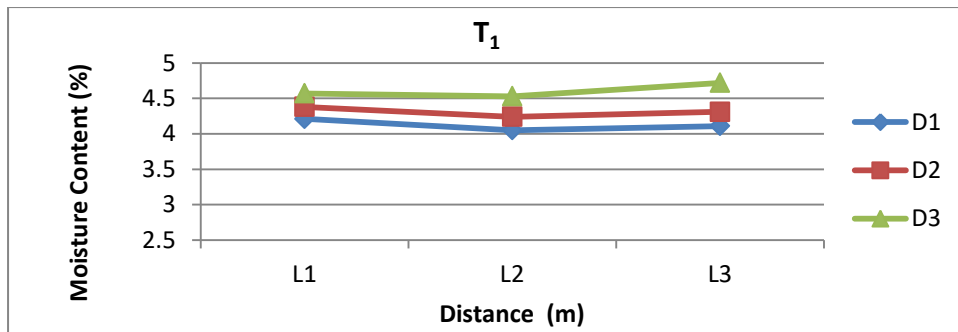


Fig 4.9: Effect of depth and distance on moisture content for Contour bund cum trench during 1st week of November

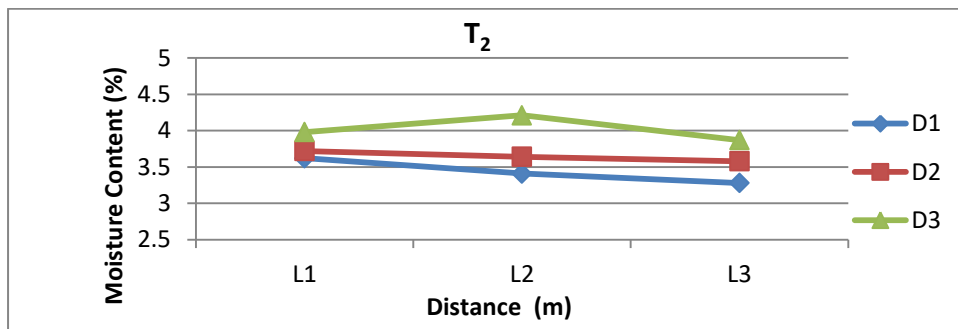


Fig 4.10: Effect of depth and distance on moisture content for Contour bund during 1st week of November

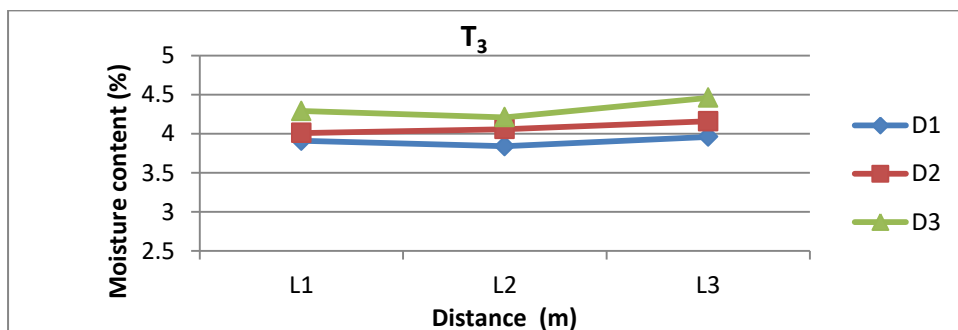


Fig 4.11: Effect of depth and distance on moisture content for Contour trench during 1st week of November

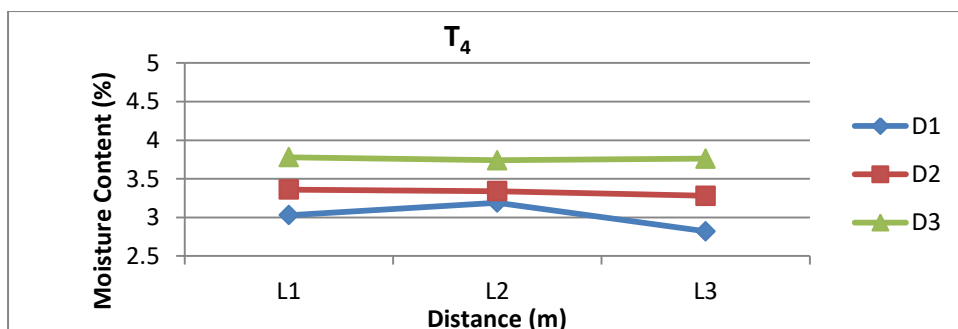


Fig 4.12: Effect of depth and distance on moisture content for Control plot during 1st week of November

moisture content of 4.72 and 2.82 for L_3 was attained at treatment combinations of D_3T_1 and D_1T_4 respectively.

The main effect of depth on moisture content was statistically significant at 5% level of significance. The first level interaction $C \times L$ were statistically significant at 5% level of significance. The first order interaction $L \times D$ were significant and second order interaction $C \times L \times D$ was also significant at 5% level of significance.

4.1.4 Effect of conservation measures on moisture content (%) with respect to distance and depth during 3rd week of November 2020

The effect of conservation measures on moisture content at different depths and distances are presented in Table 4.4 and are graphically illustrated from Fig. 4.13 to 4.16. The effects of individual parameters on moisture content for 3rd week of November are discussed below

The effect of soil and water conservation measures i.e. contour bund cum trench (T_1), contour bund (T_2), contour trench (T_3) and control plot (T_4) were studied for moisture content at three depths and three distances respectively.

The moisture content for the conservation measures T_1 , T_2 , T_3 and T_4 for all treatment combinations under study ranged from 9.05 to 10.35, 8.39 to 10.07, 9.01 to 10.15 and 8.01 to 9.02 respectively. The maximum moisture content of 10.35 for T_1 was attained at treatment combination of L_1D_1 ($L_1 = 3$ m, $D_1 = 0-15$ cm) whereas minimum moisture content of 9.05 for T_1 was attained at a treatment combination of L_3D_3 ($L_3 = 3$ m, $D_3 = 30-45$ cm). The maximum and minimum moisture content 10.07 and 8.39 for the conservative measure T_2 were attained at a treatment combination of L_1D_1 and L_3D_3 . Similarly the maximum and minimum moisture content of 10.15 and 9.01 for T_3 was attained at treatment combinations of L_1D_1 and L_3D_3 respectively. Lastly the maximum (9.02) and minimum (8.01) moisture content for T_4 (control plot) were observed at a treatment combination of L_1D_1 and L_3D_3 .

The main effect of conservation measures on moisture content was statistically significant at 5% level of significance. The first level interaction $C \times L$ were statistically significant at 5% level of significance. The first order interaction $C \times D$ were significant and second order interaction $C \times L \times D$ was also significant at 5% level of significance.

4.1.4.1 Effect of depth

The effect of depth i.e. 0-15 cm (D_1), 15-30 cm (D_2) and 30-45 cm (D_3) were studied for moisture content at three distances and four conservative measures respectively.

The moisture content at the depths D_1 , D_2 , and D_3 for all treatment combinations under study ranged from 9.01 to 10.35, 8.32 to 9.40 and 8.01 to 9.19 respectively. The maximum moisture content of 10.35 for D_1 was attained at treatment combination of L_1T_1 ($L_1 = 1$ m, $T_1 =$ contour bund cum trench) whereas minimum moisture content of 9.01 for D_1 was attained at a treatment combination of L_3T_4 ($L_1 = 1$ m, $T_4 =$ control plot). The maximum and minimum moisture content 9.40 and 8.32 for the depth D_2 (15-30 cm) were attained at a treatment combination of L_1T_1 and L_3T_4 . Similarly the maximum and minimum moisture content of 9.19 and 8.01 for D_3 was attained at treatment combinations of L_1T_3 and L_3T_4 respectively.

The main effect of depth on moisture content was statistically significant at 5% level of significance. The first level interaction $C \times D$ were statistically significant at 5% level of significance. The first order interaction $L \times D$ were significant and second order interaction $C \times L \times D$ was also significant at 5% level of significance.

4.1.4.2 Effect of distance

The effect of distance i.e. 1 m (L_1), 2 m (L_2) and 3 m (L_3) were studied for moisture content at three depths and four conserve measures respectively.

The moisture content at the distances L_1 , L_2 , and L_3 for all treatment combinations under study ranged from 8.22 to 10.35, 8.34 to 10.23 and 8.01 to 10.11 respectively. The maximum moisture content of 10.35 for L_1 was attained at treatment combination of D_1T_1 ($D_1 = 0-15$ cm, $T_1 =$ contour bund cum trench) whereas minimum moisture content of 8.22 for L_1 was attained at a treatment combination of D_3T_4 ($D_3 = 30-45$ cm, $T_4 =$ control plot). The maximum and minimum moisture content 10.23 and 8.34 for the distance L_2 (2m) were attained at a treatment combination of D_1T_1 and D_3T_4 . Similarly the maximum and minimum moisture content of 10.11 and 8.01 for L_3 was attained at treatment combinations of D_1T_1 and D_3T_4 respectively.

The main effect of depth on moisture content was statistically significant at 5% level of significance. The first level interaction $C \times L$ were statistically significant at 5% level of

significance. The first order interaction $L \times D$ were significant and second order interaction $C \times L \times D$ was also significant at 5% level of significance.

4.1.5 Effect of conservation measures on moisture content (%) with respect to distance and depth during 1st week of December 2020

The effect of conservation measures on moisture content at different depths and distances are presented in Table 4.5 and are graphically illustrated from Fig. 4.17 to 4.20 The effects of individual parameters on moisture content for 3rd week of November are discussed below

The effect of soil and water conservation measures i.e. contour bund cum trench (T_1), contour bund (T_2), contour trench (T_3) and control plot (T_4) were studied for moisture content at three depths and three distances respectively.

The moisture content for the conservation measures T_1 , T_2 , T_3 and T_4 for all treatment combinations under study ranged from 8.88 to 10.86, 8.88 to 9.97, 9.22 to 10.45 and 8.21 to 10.08 respectively. The maximum moisture content of 10.86 for T_1 was attained at treatment combination of L_1D_1 ($L_1 = 1$ m, $D_3 = 0-15$ cm) whereas minimum moisture content of 8.88 for T_1 was attained at a treatment combination of L_3D_3 ($L_3 = 3$ m, $D_3 = 30-45$ cm).

The maximum and minimum moisture content 9.97 and 8.88 for the conservative measure T_2 were attained at a treatment combination of L_1D_1 and L_3D_3 . Similarly the maximum and minimum moisture content of 10.45 and 9.22 for T_3 was attained at treatment combinations of L_3D_1 and L_1D_3 respectively. Lastly the maximum (10.08) and minimum (8.21) moisture content for T_4 (control plot) were observed at a treatment combination of L_2D_3 and L_2D_2 .

The main effect of conservation measures on moisture content was statistically significant at 5% level of significance. The first level interaction $C \times L$ were statistically significant at 5% level of significance. The first order interaction $C \times D$ were significant and second order interaction $C \times L \times D$ was also significant at 5% level of significance.

4.1.5.1 Effect of depth

The effect of depth i.e. 0-15 cm (D_1), 15-30 cm (D_2) and 30-45 cm (D_3) were studied for moisture content at three distances and four conservative measures respectively.

Table 4.4: Effect of soil and water conservation measures on moisture content (%) during 3rd week of November

Distance Conservation Measures		Distance (m)			
	Depth (m)	L ₁	L ₂	L ₃	Sub Means
T ₁	D ₁	10.35	10.23	10.11	10.23
	D ₂	9.40	9.36	9.25	9.34
	D ₃	9.18	9.10	9.05	9.11
	Sub Means	9.64	9.56	9.47	9.56
T ₂	D ₁	10.07	10.05	10.01	10.04
	D ₂	9.37	9.34	9.26	9.32
	D ₃	9.16	8.45	8.39	8.67
	Sub Means	9.53	9.28	9.22	9.34
T ₃	D ₁	10.15	10.06	10.03	10.08
	D ₂	9.35	9.31	9.28	9.31
	D ₃	9.19	9.05	9.01	9.08
	Sub Means	9.56	9.47	9.44	9.49
T ₄	D ₁	9.02	8.75	9.01	8.93
	D ₂	8.64	8.60	8.32	8.52
	D ₃	8.22	8.34	8.01	8.19
	Sub Means	9.20	9.56	8.45	9.07
Factor Means	Conservation Measures	T ₁	T ₂	T ₃	T ₄
		9.56	9.34	9.49	9.07
	Distance	L ₁	L ₂	L ₃	
		9.48	9.47	9.14	
	Depth	D ₁	D ₂	D ₃	
		9.82	9.12	8.76	
C.D (p≤0.05)	Conservation Measures (T) =0.08				
	Distance (L) =0.05				
	Depth (D) =0.19				
	CxL =0.15				
	CxD =0.24				
	LxD =0.35				
	CxLxD =0.47				

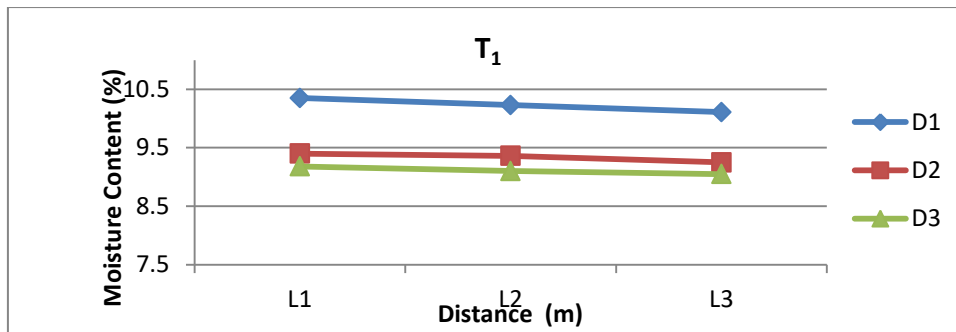


Fig 4.13: Effect of depth and distance on moisture content for Contour bund cum trench during 3rd week of November

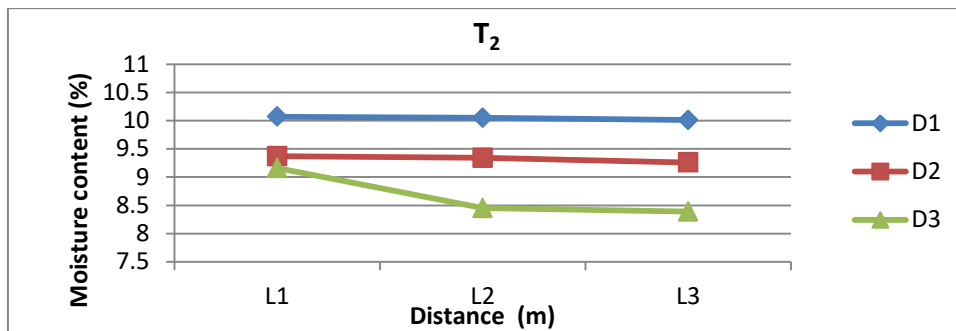


Fig 4.14: Effect of depth and distance on moisture content for Contour bund during 3rd week of November

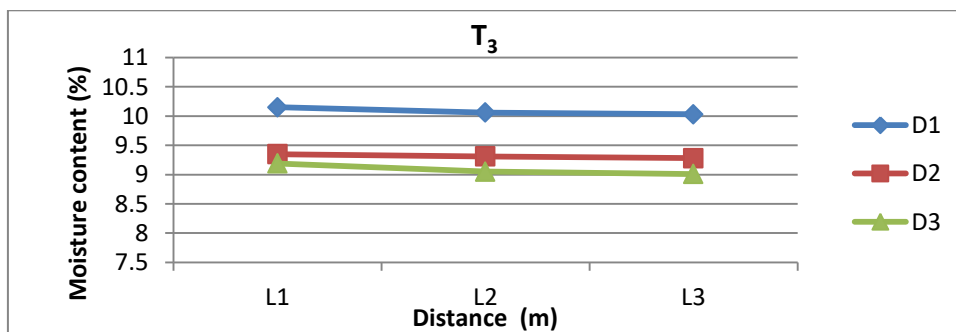


Fig 4.15: Effect of depth and distance on moisture content for Contour trench during 3rd week of November

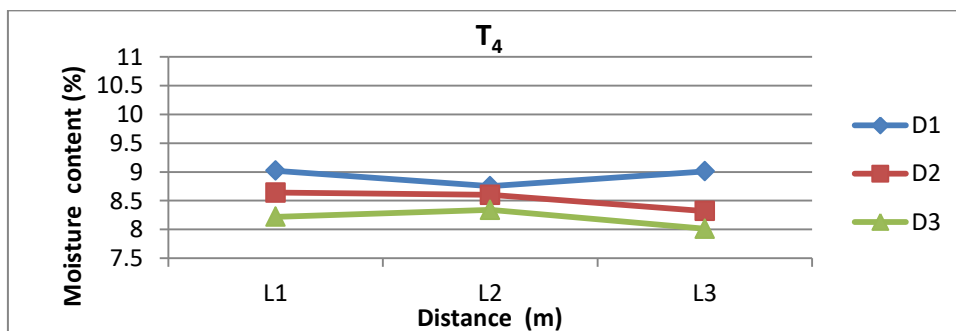


Fig 4.16: Effect of depth and distance on moisture content for Control plot during 3rd week of November

The moisture content at the depths D_1 , D_2 and D_3 for all treatment combinations under study ranged from 8.61 to 10.86, 8.21 to 10.16 and 8.33 to 10.08 respectively. The maximum moisture content of 10.86 for D_1 was attained at treatment combination of L_1T_1 ($L_1 = 1$ m, $T_1 =$ contour bund cum trench) whereas minimum moisture content of 8.61 for D_1 was attained at a treatment combination of L_2T_4 ($L_2 = 2$ m, $T_4 =$ control plot). The maximum and minimum moisture content 10.16 and 8.21 for the depth D_2 (15-30 cm) were attained at a treatment combination of L_1T_1 and L_2T_4 . Similarly the maximum and minimum moisture content of 10.08 and 8.33 for D_3 was attained at treatment combinations of L_2T_4 and L_2T_2 respectively.

The main effect of depth on moisture content was statistically significant at 5% level of significance. The first level interaction $C \times D$ were statistically significant at 5% level of significance. The first order interaction $L \times D$ were significant and second order interaction $C \times L \times D$ was also significant at 5% level of significance.

4.1.5.2 Effect of distance

The effect of distance i.e. 1 m (L_1), 2 m (L_2) and 3 m (L_3) were studied for moisture content at three depths and four conserve measures respectively.

The moisture content at the distances L_1 , L_2 and L_3 for all treatment combinations under study ranged from 8.23 to 10.86, 8.33 to 10.42 and 8.52 to 10.45 respectively. The maximum moisture content of 10.86 for L_1 was attained at treatment combination of D_1T_1 ($D_1 = 0-15$ cm, $T_1 =$ contour bund cum trench) whereas minimum moisture content of 8.23 for L_1 was attained at a treatment combination of D_2T_4 ($D_2 = 15-30$ cm, $T_4 =$ control plot). The maximum and minimum moisture content 10.42 and 8.33 for the distance L_2 (2m) were attained at a treatment combination of D_1T_1 and D_3T_2 . Similarly the maximum and minimum moisture content of 10.45 and 8.52 for L_3 was attained at treatment combinations of D_1T_3 and D_3T_4 respectively.

The main effect of depth on moisture content was statistically significant at 5% level of significance. The first level interaction $C \times L$ were statistically significant at 5% level of significance. The first order interaction $L \times D$ were significant and second order interaction $C \times L \times D$ was also significant at 5% level of significance.

4.1.6 Effect of conservation measures on moisture content (%) with respect to distance and depth during 3rd week of December 2020

The effect of conservation measures on moisture content at different depths and distances are presented in Table 4.6 and are graphically illustrated from Fig. 4.21 to 4.24. The effects of individual parameters on moisture content for 3rd week of November are discussed below

The effect of soil and water conservation measures i.e. contour bund cum trench (T_1), contour bund (T_2), contour trench (T_3) and control plot (T_4) were studied for moisture content at three depths and three distances respectively.

The moisture content for the conservation measures T_1 , T_2 , T_3 and T_4 for all treatment combinations under study ranged from 10.35 to 12.45, 9.34 to 11.12, 10.10 to 11.46 and 9.23 to 10.45 respectively. The maximum moisture content of 12.45 for T_1 was attained at treatment combination of L_1D_3 ($L_1 = 1$ m, $D_3 = 30-45$ cm) whereas minimum moisture content of 10.35 for T_1 was attained at a treatment combination of L_3D_1 ($L_3 = 3$ m, $D_1 = 0-15$ cm).

The maximum and minimum moisture content 11.12 and 9.34 for the conservative measure T_2 were attained at a treatment combination of L_2D_3 and L_2D_1 . Similarly the maximum and minimum moisture content of 11.46 and 10.10 for T_3 was attained at treatment combinations of L_3D_3 and L_3D_1 respectively. Lastly the maximum (10.45) and minimum (9.23) moisture content for T_4 (control plot) were observed at a treatment combination of L_3D_3 and L_3D_1 .

The main effect of conservation measures on moisture content was statistically significant at 5% level of significance. The first level interaction $C \times L$ were statistically significant at 5% level of significance. The first order interaction $C \times D$ were significant and second order interaction $C \times L \times D$ was also significant at 5% level of significance.

4.1.6.1 Effect of depth

The effect of depth i.e. 0-15 cm (D_1), 15-30 cm (D_2) and 30-45 cm (D_3) were studied for moisture content at three distances and four conservative measures respectively.

The moisture content at the depths D_1 , D_2 and D_3 for all treatment combinations under study ranged from 9.23 to 10.97, 9.60 to 11.67 and 10.10 to 12.45 respectively. The

Table 4.5: Effect of soil and water conservation measures on moisture content (%) during 1st week of December

Distance Conservation Measures		Distance (m)			
	Depth (m)	L ₁	L ₂	L ₃	Sub Means
T ₁	D ₁	10.86	10.42	10.36	10.55
	D ₂	10.16	9.50	9.38	9.68
	D ₃	9.60	9.11	8.88	9.20
	Sub Means	10.21	9.68	9.54	9.81
T ₂	D ₁	9.97	9.54	9.43	9.65
	D ₂	9.57	8.52	9.34	9.14
	D ₃	9.40	8.33	8.88	8.87
	Sub Means	9.36	9.56	9.22	9.38
T ₃	D ₁	10.25	10.12	10.45	10.27
	D ₂	9.67	9.78	9.56	9.67
	D ₃	9.22	9.23	9.34	9.26
	Sub Means	9.71	9.71	9.78	9.74
T ₄	D ₁	9.88	8.61	9.96	9.48
	D ₂	8.23	8.21	9.59	8.68
	D ₃	8.00	10.08	8.52	8.87
	Sub Means	8.70	8.97	9.36	9.01
Factor Means	Conservation Measures	T ₁	T ₂	T ₃	T ₄
		9.81	9.38	9.74	9.01
	Distance	L ₁	L ₂	L ₃	
		9.50	9.48	9.47	
	Depth	D ₁	D ₂	D ₃	
		9.99	9.29	9.05	
C.D (p≤0.05)	Conservation Measures (T) =0.23				
	Distance (L) =0.07				
	Depth (D) =0.20				
	CxL =0.33				
	Cx D =0.27				
	Lx D =0.19				
	CxLxD =0.36				

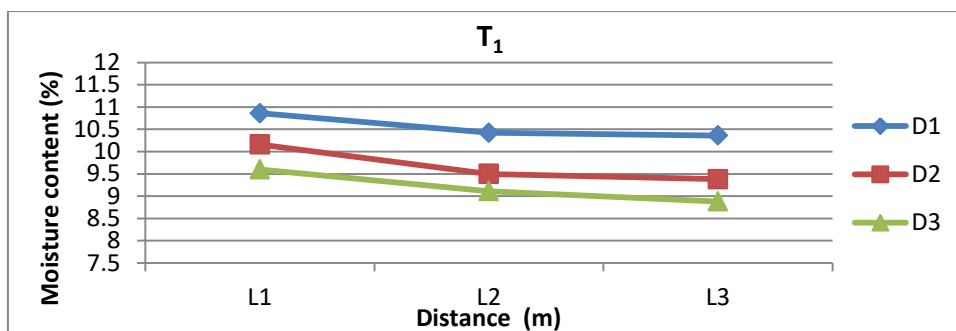


Fig 4.17: Effect of depth and distance on moisture content for Contour bund cum trench during 1st week of December

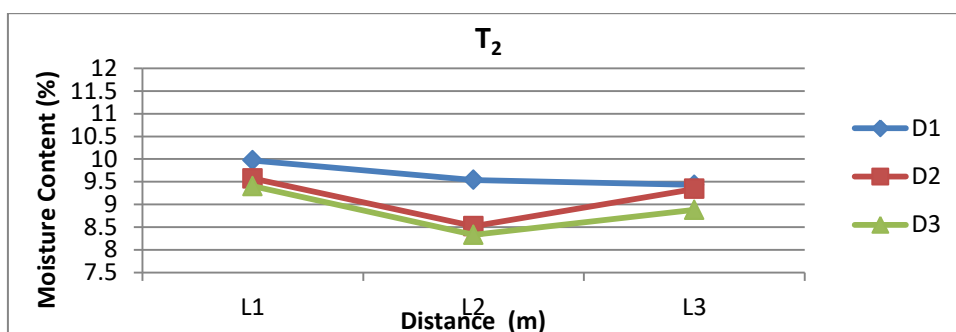


Fig 4.18: Effect of depth and distance on moisture content for Contour bund during 1st week of December

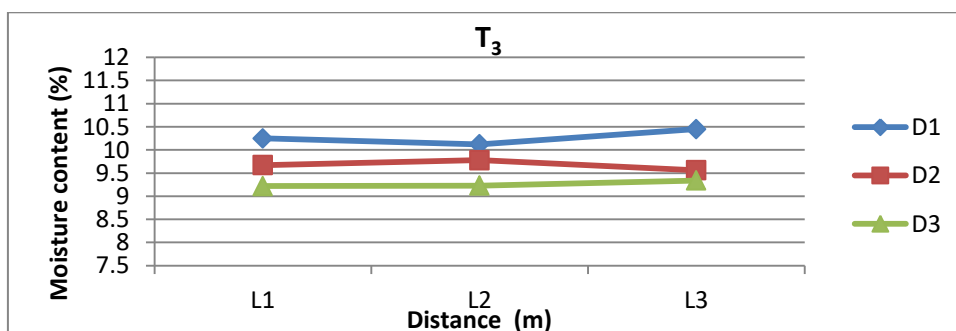


Fig 4.19: Effect of depth and distance on moisture content for Contour trench during 1st week of December

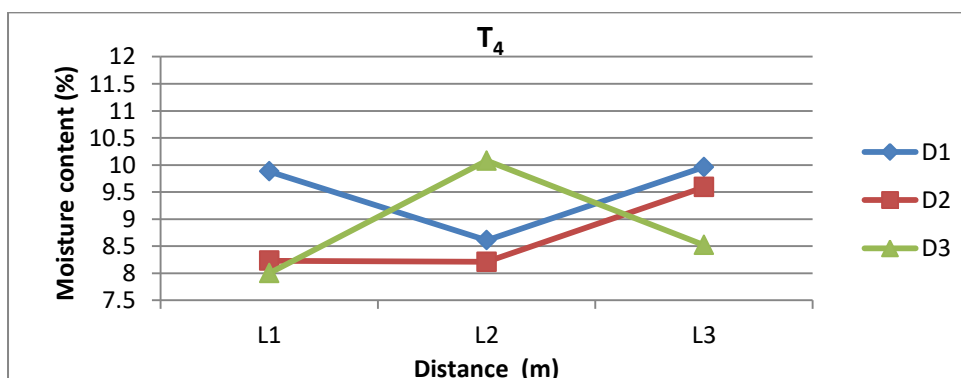


Fig 4.20: Effect of depth and distance on moisture content for Control plot during 1st week of December

maximum moisture content of 10.97 for D_1 was attained at treatment combination of L_1T_1 ($L_1 = 1$ m, $T_1 =$ contour bund cum trench) whereas minimum moisture content of 9.23 for D_1 was attained at a treatment combination of L_3T_4 ($L_3 = 3$ m, $T_4 =$ control plot). The maximum and minimum moisture content 11.67 and 9.60 for the depth D_2 (15-30 cm) were attained at a treatment combination of L_1T_1 and L_1T_4 . Similarly the maximum and minimum moisture content of 12.45 and 10.10 for D_3 was attained at treatment combinations of L_1T_1 and L_1T_4 respectively.

The main effect of depth on moisture content was statistically significant at 5% level of significance. The first level interaction $C \times D$ were statistically significant at 5% level of significance. The first order interaction $L \times D$ were significant and second order interaction $C \times L \times D$ was also significant at 5% level of significance.

4.1.6.2 Effect of distance

The effect of distance i.e. 1 m (L_1), 2 m (L_2) and 3 m (L_3) were studied for moisture content at three depths and four conserve measures respectively.

The moisture content at the distances L_1 , L_2 and L_3 for all treatment combinations under study ranged from 9.37 to 12.45, 9.34 to 12.37 and 9.23 to 12.01 respectively. The maximum moisture content of 12.45 for L_1 was attained at treatment combination of D_3T_1 ($D_3 = 30-45$ cm, $T_1 =$ contour bund cum trench) whereas minimum moisture content of 9.37 for L_1 was attained at a treatment combination of D_1T_4 ($D_1 = 0-15$ cm, $T_4 =$ control plot). The maximum and minimum moisture content 12.37 and 9.34 for the distance L_2 (2m) were attained at a treatment combination of D_3T_1 and D_1T_2 . Similarly the maximum and minimum moisture content of 12.01 and 9.23 for L_3 was attained at treatment combinations of D_3T_1 and D_1T_4 respectively.

The main effect of depth on moisture content was statistically significant at 5% level of significance. The first level interaction $C \times L$ were statistically significant at 5% level of significance. The first order interaction $L \times D$ were significant and second order interaction $C \times L \times D$ was also significant at 5% level of significance.

Table 4.6: Effect of soil and water conservation measures on moisture content (%) during 3rd week of December

Distance Conservation Measures		Distance (m)			
	Depth (m)	L ₁	L ₂	L ₃	Sub Means
T ₁	D ₁	10.97	10.73	10.35	10.68
	D ₂	11.67	11.50	11.60	11.59
	D ₃	12.45	12.37	12.01	12.28
	Sub Means	11.69	11.53	11.32	11.52
T ₂	D ₁	9.67	9.34	9.41	9.47
	D ₂	10.67	10.49	10.33	10.50
	D ₃	11.02	11.12	11.01	11.05
	Sub Means	10.45	10.32	10.25	10.34
T ₃	D ₁	10.45	10.12	10.10	10.22
	D ₂	11.34	10.45	10.39	10.73
	D ₃	11.45	10.56	11.46	11.16
	Sub Means	11.08	10.38	10.65	10.70
T ₄	D ₁	9.37	9.40	9.23	9.33
	D ₂	9.60	9.73	9.73	9.69
	D ₃	10.10	10.40	10.45	10.32
	Sub Means	9.69	9.84	9.80	9.78
Factor Means	Conservation Measures	T ₁	T ₂	T ₃	T ₄
		11.52	10.34	10.70	9.78
	Distance	L ₁	L ₂	L ₃	
		10.73	10.52	10.51	
	Depth	D ₁	D ₂	D ₃	
		9.93	10.63	11.20	
C.D (p≤0.05)	Conservation Measures (T) =0.21				
	Distance (L) =0.10				
	Depth (D) =0.35				
	CxL =0.24				
	CxD =0.29				
	LxD =0.35				
	CxLxD =0.49				

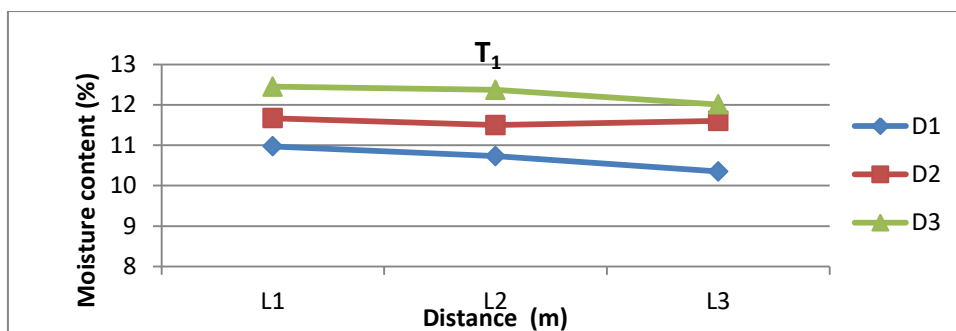


Fig 4.21: Effect of depth and distance on moisture content for Contour bund cum trench during 3rd week of December

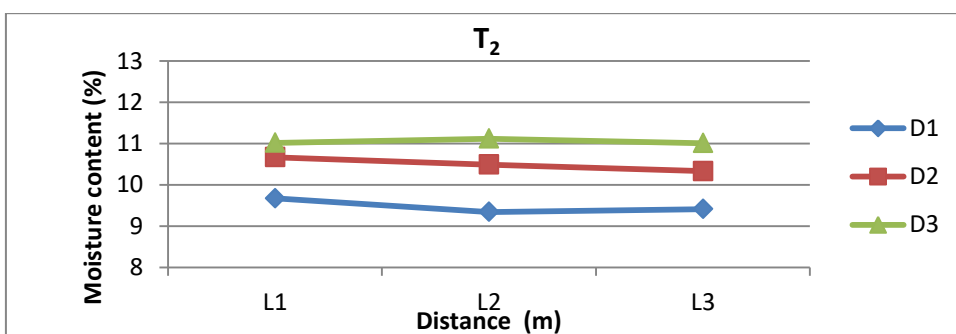


Fig 4.22: Effect of depth and distance on moisture content for Contour bund during 3rd week of December

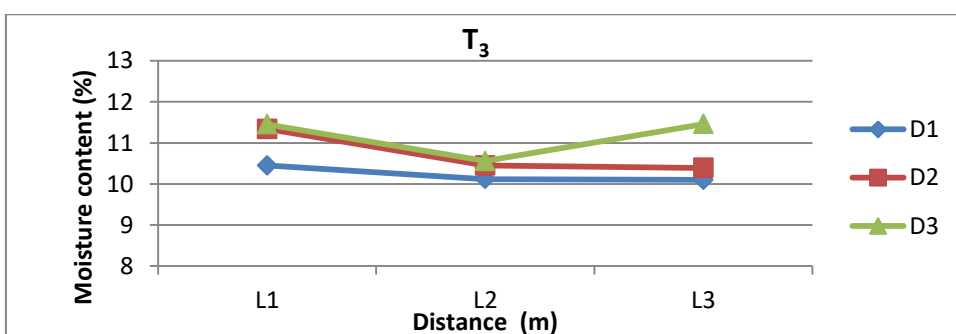


Fig 4.23: Effect of depth and distance on moisture content for Contour trench during 3rd week of December

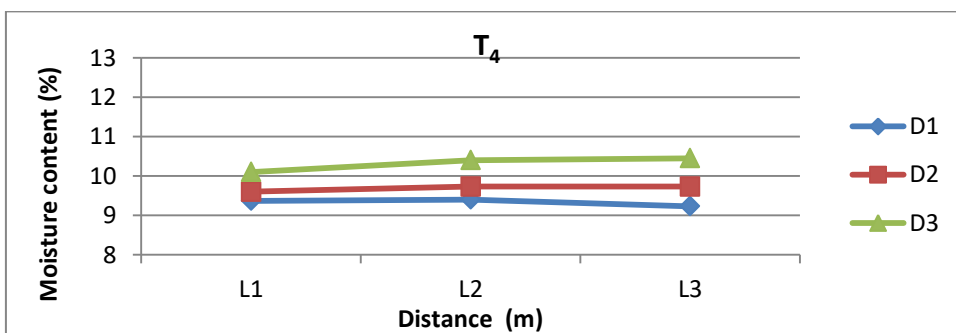


Fig 4.24: Effect of depth and Distance on moisture content for Control plot during 3rd week of December

4.1.7 Effect of conservation measures on moisture content (%) with respect to distance and depth during 1st week of January 2021

The effect of conservation measures on moisture content at different depths and distances are presented in Table 4.7 and are graphically illustrated from Fig. 4.25 to 4.28. The effects of individual parameters on moisture content for 3rd week of November are discussed below

The effect of soil and water conservation measures i.e. contour bund cum trench (T_1), contour bund (T_2), contour trench (T_3) and control plot (T_4) were studied for moisture content at three depths and three distances respectively.

The moisture content for the conservation measures T_1 , T_2 , T_3 and T_4 for all treatment combinations under study ranged from 8.96 to 10.73, 8.86 to 10.26, 8.96 to 10.17 and 8.34 to 9.31 respectively. The maximum moisture content of 10.73 for T_1 was attained at treatment combination of L_1D_1 ($L_1 = 1$ m, $D_1 = 0-15$ cm) whereas minimum moisture content of 8.96 for T_1 was attained at a treatment combination of L_3D_3 ($L_3 = 3$ m, $D_3 = 30-45$ cm).

The maximum and minimum moisture content 10.26 and 8.86 for the conservative measure T_2 were attained at a treatment combination of L_1D_1 and L_3D_3 . Similarly the maximum and minimum moisture content of 10.17 and 8.96 for T_3 was attained at treatment combinations of L_1D_1 and L_3D_3 respectively. Lastly the maximum (9.31) and minimum (8.34) moisture content for T_4 (control plot) were observed at a treatment combination of L_2D_1 and L_1D_3 .

The main effect of conservation measures on moisture content was statistically significant at 5% level of significance. The first level interaction $C \times L$ were statistically significant at 5% level of significance. The first order interaction $C \times D$ were significant and second order interaction $C \times L \times D$ was also significant at 5% level of significance

4.1.7.1 Effect of depth

The effect of depth i.e. 0-15 cm (D_1), 15-30 cm (D_2) and 30-45 cm (D_3) were studied for moisture content at three distances and four conservative measures respectively.

The moisture content at the depths D_1 , D_2 and D_3 for all treatment combinations under study ranged from 9.11 to 10.73, 8.84 to 9.86 and 8.34 to 9.76 respectively. The maximum moisture content of 10.73 for D_1 was attained at treatment combination of L_1T_1 ($L_1 = 1$ m, T_1

= contour bund cum trench) whereas minimum moisture content of 9.11 for D_1 was attained at a treatment combination of L_3T_4 ($L_3 = 3$ m, $T_4 =$ control plot). The maximum and minimum moisture content 9.86 and 8.84 for the depth D_2 (15-30 cm) were attained at a treatment combination of L_1T_2 and L_1T_4 . Similarly the maximum and minimum moisture content of 9.76 and 8.34 for D_3 was attained at treatment combinations of L_1T_2 and L_1T_4 respectively.

The main effect of depth on moisture content was statistically significant at 5% level of significance. The first level interaction $C \times D$ were statistically significant at 5% level of significance. The first order interaction $L \times D$ were significant and second order interaction $C \times L \times D$ was also significant at 5% level of significance.

4.1.7.2 Effect of distance

The effect of distance i.e. 1 m (L_1), 2 m (L_2) and 3 m (L_3) were studied for moisture content at three depths and four conserve measures respectively.

The moisture content at the distances L_1 , L_2 and L_3 for all treatment combinations under study ranged from 8.34 to 10.73, 8.70 to 10.46 and 8.54 to 10.12 respectively. The maximum moisture content of 10.73 for L_1 was attained at treatment combination of D_1T_1 ($D_1 = 0-15$ cm, $T_1 =$ contour bund cum trench) whereas minimum moisture content of 8.34 for L_1 was attained at a treatment combination of D_1T_4 ($D_1 = 0-15$ cm, $T_4 =$ control plot). The maximum and minimum moisture content 10.46 and 8.70 for the distance L_2 (2m) were attained at a treatment combination of D_1T_1 and D_1T_4 . Similarly the maximum and minimum moisture content of 10.12 and 8.54 for L_3 was attained at treatment combinations of D_1T_1 and D_1T_4 respectively.

The main effect of depth on moisture content was statistically significant at 5% level of significance. The first level interaction $C \times L$ were statistically significant at 5% level of significance. The first order interaction $L \times D$ were significant and second order interaction $C \times L \times D$ was also significant at 5% level of significance.

4.1.8 Effect of conservation measures on moisture content (%) with respect to distance and depth during 3rd week of January 2021

The effect of conservation measures on moisture content at different depths and distances are presented in Table 4.8 and are graphically illustrated from Fig. 4.29 to 4.32. The

effects of individual parameters on moisture content for 3rd week of November are discussed below

The effect of soil and water conservation measures i.e. contour bund cum trench (T₁), contour bund (T₂), contour trench (T₃) and control plot (T₄) were studied for moisture content at three depths and three distances respectively.

The moisture content for the conservation measures T₁, T₂, T₃ and T₄ for all treatment combinations under study ranged from 8.97 to 10.86, 8.27 to 9.34, 8.36 to 9.24 and 7.28 to 8.37 respectively. The maximum moisture content of 10.86 for T₁ was attained at treatment combination of L₃D₃ (L₃ = 3 m, D₃ = 30-45 cm) whereas minimum moisture content of 8.97 for T₁ was attained at a treatment combination of L₁D₁ (L₁ = 1 m, D₁ = 0-15 cm).

The maximum and minimum moisture content 9.34 and 8.27 for the conservative measure T₂ were attained at a treatment combination of L₁D₃ and L₃D₁. Similarly the maximum and minimum moisture content of 9.24 and 8.36 for T₃ was attained at treatment combinations of L₁D₃ and L₃D₁ respectively. Lastly the maximum (8.37) and minimum (7.28) moisture content for T₄ (control plot) were observed at a treatment combination of L₃D₃ and L₃D₁.

The main effect of conservation measures on moisture content was statistically significant at 5% level of significance. The first level interaction C×L were statistically significant at 5% level of significance. The first order interaction C×D were significant and second order interaction C×L×D was also significant at 5% level of significance.

4.1.8.1 Effect of depth

The effect of depth i.e. 0-15 cm (D₁), 15-30 cm (D₂) and 30-45 cm (D₃) were studied for moisture content at three distances and four conservative measures respectively.

The moisture content at the depths D₁, D₂ and D₃ for all treatment combinations under study ranged from 7.28 to 9.66, 7.53 to 10.23 and 8.23 to 10.86 respectively. The maximum moisture content of 9.66 for D₁ was attained at treatment combination of L₃T₁ (L₃ = 3 m, T₁ = contour bund cum trench) whereas minimum moisture content of 7.28 for D₁ was attained at a treatment combination of L₃T₄ (L₃ = 3 m, T₄ = control plot). The maximum and minimum moisture content 10.23 and 7.53 for the depth D₂ (15-30 cm) were attained at a treatment

Table 4.7: Effect of soil and water conservation measures on moisture content (%) during 1st week of January

Distance Conservation Measures		Distance (m)			
	Depth (m)	L ₁	L ₂	L ₃	Sub Means
T ₁	D ₁	10.73	10.46	10.12	10.44
	D ₂	9.84	9.65	9.35	9.61
	D ₃	9.23	9.05	8.96	9.08
	Sub Means	9.93	9.72	9.48	9.71
T ₂	D ₁	10.26	9.94	9.75	9.98
	D ₂	9.86	9.42	9.04	9.44
	D ₃	9.76	9.26	8.86	9.29
	Sub Means	9.96	9.54	9.22	9.57
T ₃	D ₁	10.17	9.67	9.21	9.68
	D ₂	9.84	9.46	9.06	9.45
	D ₃	9.53	9.24	8.96	9.24
	Sub Means	9.85	9.46	9.08	9.46
T ₄	D ₁	9.23	9.31	9.11	9.22
	D ₂	8.84	8.96	8.86	8.89
	D ₃	8.34	8.70	8.54	8.53
	Sub Means	8.80	8.99	8.84	8.88
Factor Means	Conservation Measures	T ₁	T ₂	T ₃	T ₄
		9.71	9.57	9.46	8.88
	Distance	L ₁	L ₂	L ₃	
		9.64	9.43	9.15	
	Depth	D ₁	D ₂	D ₃	
		9.83	9.35	9.04	
C.D (p≤0.05)	Conservation Measures (T) =0.08				
	Distance (L) =0.12				
	Depth (D) =0.24				
	CxL =0.17				
	CxD =0.38				
	LxD =0.19				
	CxLxD =0.41				

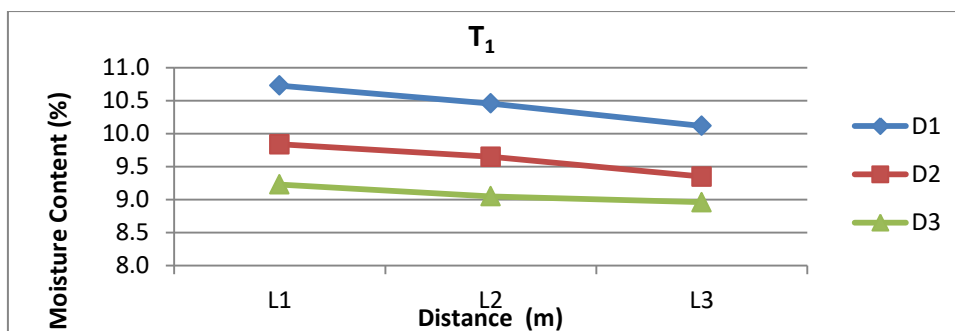


Fig 4.25: Effect of depth and distance on moisture content for Contour bund cum trench during 1st week of January

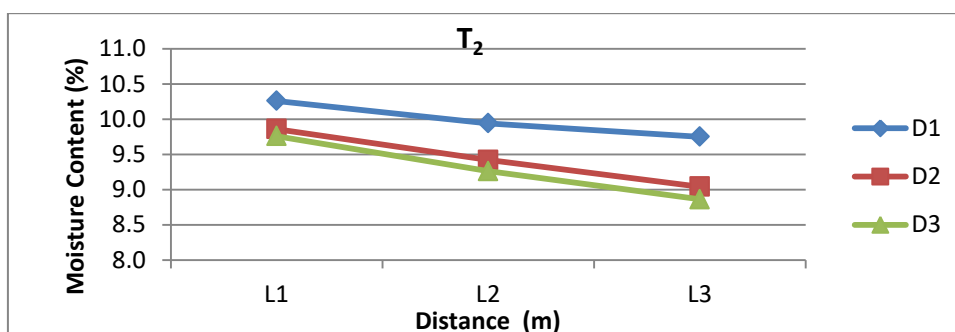


Fig 4.26: Effect of depth and distance on moisture content for Contour bund during 1st week of January

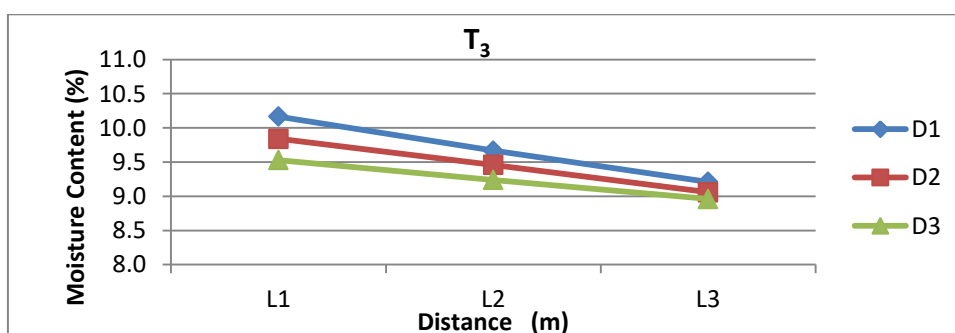


Fig 4.27: Effect of depth and distance on moisture content for Contour trench during 1st week of January

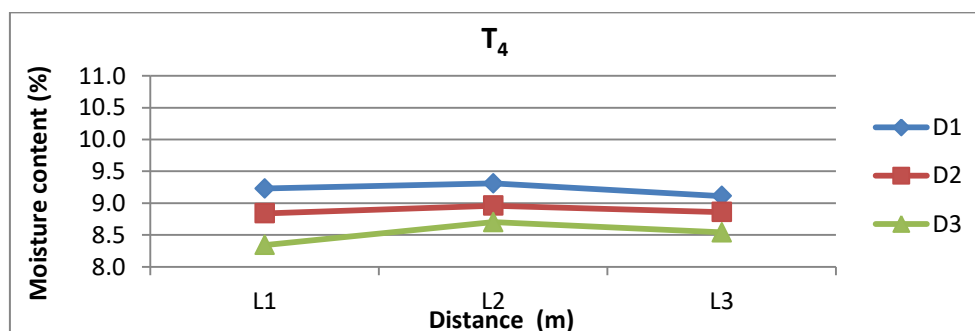


Fig 4.28: Effect of depth and distance on moisture content for Control plot during 1st week of January

combination of L_2T_1 and L_3T_4 . Similarly the maximum and minimum moisture content of 10.86 and 8.23 for D_3 was attained at treatment combinations of L_3T_1 and L_2T_4 respectively.

The main effect of depth on moisture content was statistically significant at 5% level of significance. The first level interaction $C \times D$ were statistically significant at 5% level of significance. The first order interaction $L \times D$ were significant and second order interaction $C \times L \times D$ was also significant at 5% level of significance.

4.1.8.2 Effect of distance

The effect of distance i.e. 1 m (L_1), 2 m (L_2) and 3 m (L_3) were studied for moisture content at three depths and four conserve measures respectively.

The moisture content at the distances L_1 , L_2 and L_3 for all treatment combinations under study ranged from 7.62 to 9.24, 7.35 to 10.44 and 7.28 to 10.86 respectively. The maximum moisture content of 9.24 for L_1 was attained at treatment combination of D_3T_1 (D_3 = 30-45 cm, T_1 = contour bund cum trench) whereas minimum moisture content of 7.62 for L_1 was attained at a treatment combination of D_1T_4 (D_1 = 0-15 cm, T_4 = control plot). The maximum and minimum moisture content 10.44 and 7.35 for the distance L_2 (2m) were attained at a treatment combination of D_3T_1 and D_1T_4 . Similarly the maximum and minimum moisture content of 10.86 and 7.28 for L_3 was attained at treatment combinations of D_3T_1 and D_1T_4 respectively.

The main effect of depth on moisture content was statistically significant at 5% level of significance. The first level interaction $C \times L$ were statistically significant at 5% level of significance. The first order interaction $L \times D$ were significant and second order interaction $C \times L \times D$ was also significant at 5% level of significance

4.1.9 Effect of conservation measures on moisture content (%) with respect to distance and depth during 1st week of February 2021

The effect of conservation measures on moisture content at different depths and distances are presented in Table 4.9 and are graphically illustrated from Fig. 4.33 to 4.36. The effects of individual parameters on moisture content for 1st week of february are discussed below

The effect of soil and water conservation measures i.e. contour bund cum trench (T_1), contour bund (T_2), contour trench (T_3) and control plot (T_4) were studied for moisture content at three depths and three distances respectively.

The moisture content for the conservation measures T_1 , T_2 , T_3 and T_4 for all treatment combinations under study ranged from 8.2 to 8.9, 7.3 to 7.78, 7.74 to 8.23 and 7.16 to 7.6 respectively. The maximum moisture content of 8.9 for T_1 was attained at treatment combination of L_1D_3 ($L_1 = 1$ m, $D_3 = 30-45$ cm) whereas minimum moisture content of 8.2 for T_1 was attained at a treatment combination of L_3D_1 ($L_3 = 3$ m, $D_1 = 0-15$ cm). The maximum and minimum moisture content 7.78 and 7.3 for the conservative measure T_2 were attained at a treatment combination of L_1D_3 and L_1D_1 . Similarly the maximum and minimum moisture content of 8.23 and 7.74 for T_3 was attained at treatment combinations of L_1D_3 and L_2D_1 respectively. Lastly the maximum (7.6) and minimum (7.16) moisture content for T_4 (control plot) were observed at a treatment combination of L_1D_3 and L_2D_1 .

The main effect of conservation measures on moisture content was statistically significant at 5% level of significance. The first level interaction $C \times L$ were statistically significant at 5% level of significance. The first order interaction $C \times D$ were significant and second order interaction $C \times L \times D$ was also significant at 5% level of significance

4.1.9.1 Effect of depth

The effect of depth i.e. 0-15 cm (D_1), 15-30 cm (D_2) and 30-45 cm (D_3) were studied for moisture content at three distances and four conservative measures respectively.

The moisture content at the depths D_1 , D_2 and D_3 for all treatment combinations under study ranged from 7.16 to 8.5, 7.37 to 8.76 and 7.54 to 8.90 respectively. The maximum moisture content of 8.5 for D_1 was attained at treatment combination of L_2T_1 ($L_2 = 2$ m, $T_1 =$ contour bund cum trench) whereas minimum moisture content of 7.16 for D_1 was attained at a treatment combination of L_2T_4 ($L_2 = 2$ m, $T_4 =$ control plot). The maximum and minimum moisture content 8.76 and 7.37 for the depth D_2 (15-30 cm) were attained at a treatment combination of L_2T_1 and L_2T_4 . Similarly the maximum and minimum moisture content of 8.90 and 7.54 for D_3 was attained at treatment combinations of L_1T_1 and L_2T_4 respectively.

The main effect of depth on moisture content was statistically significant at 5% level of significance. The first level interaction $C \times D$ were statistically significant at 5% level of

Table 4.8: Effect of soil and water conservation measures on moisture content (%) during 3rd week of January

Distance Conservation Measures		Distance (m)			
	Depth (m)	L ₁	L ₂	L ₃	Sub Means
T ₁	D ₁	8.97	9.34	9.66	9.32
	D ₂	9.53	10.23	9.96	9.90
	D ₃	9.24	10.44	10.86	10.18
	Sub Means	9.24	10.01	10.16	9.80
T ₂	D ₁	8.47	8.36	8.27	8.37
	D ₂	9.02	8.86	8.54	8.81
	D ₃	9.34	8.94	8.76	9.01
	Sub Means	8.94	8.72	8.52	8.73
T ₃	D ₁	8.49	8.43	8.36	8.43
	D ₂	8.99	8.71	8.56	8.75
	D ₃	9.24	9.10	9.01	9.12
	Sub Means	8.91	8.75	8.64	8.77
T ₄	D ₁	7.62	7.35	7.28	7.42
	D ₂	8.17	7.81	7.53	7.84
	D ₃	8.27	8.23	8.37	8.29
	Sub Means	8.02	7.80	7.73	7.85
Factor Means	Conservation Measures	T ₁	T ₂	T ₃	T ₄
		9.80	8.73	8.77	7.85
	Distance	L ₁	L ₂	L ₃	
		8.78	8.82	8.76	
	Depth	D ₁	D ₂	D ₃	
		8.38	8.83	9.15	
C.D (p≤0.05)	Conservation Measures (T) =0.10				
	Distance (L) =0.12				
	Depth (D) =0.23				
	CxL =0.15				
	CxD =0.29				
	LxD =0.14				
	CxLxD =0.28				

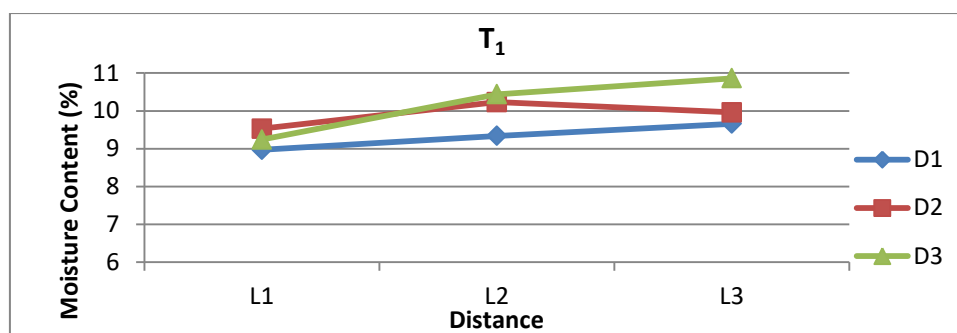


Fig 4.29: Effect of depth and distance on moisture content for Contour bund cum Trench during 3rd week of January

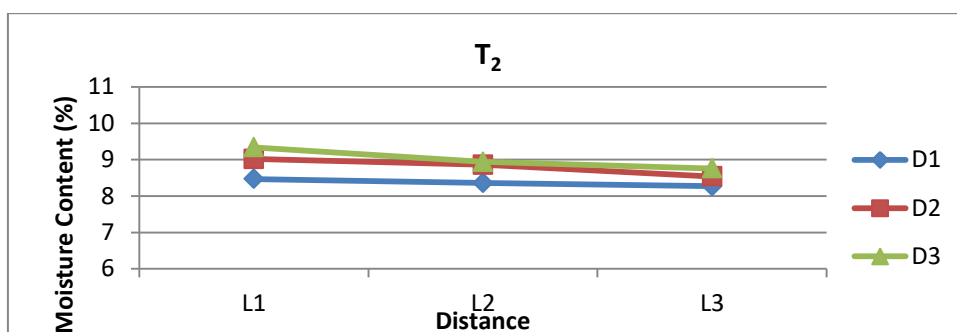


Fig 4.30: Effect of depth and distance on moisture content for Contour bund during 3rd week of January

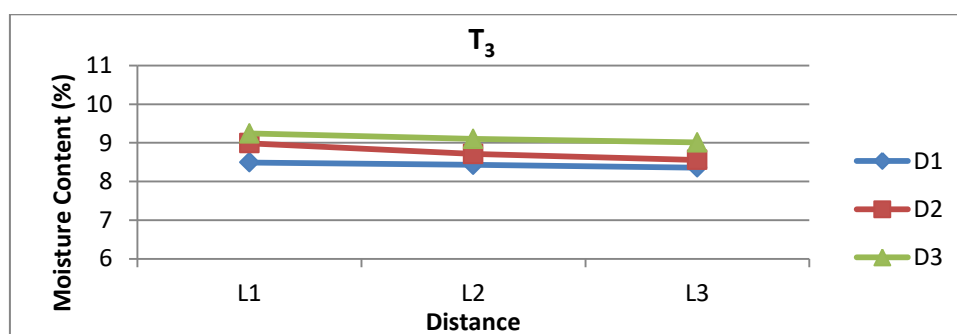


Fig 4.31: Effect of depth and distance on moisture content for Contour trench during 3rd week of January

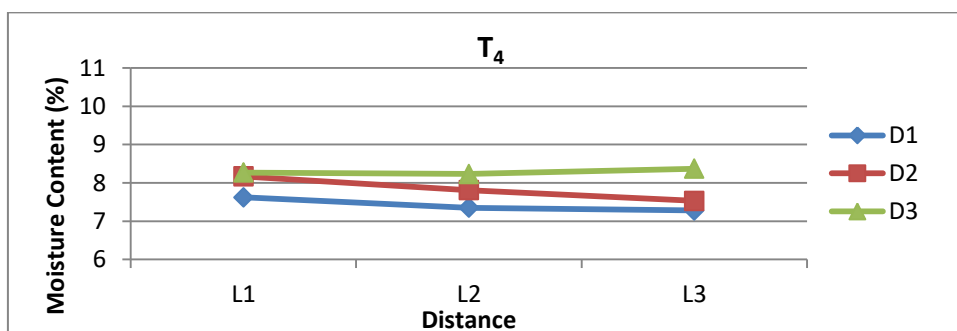


Fig 4.32: Effect of depth and distance on moisture content for Control plot during 3rd week of January

significance. The first order interaction $L \times D$ were significant and second order interaction $C \times L \times D$ was also significant at 5% level of significance.

4.1.9.2 Effect of distance

The effect of distance i.e. 1 m (L_1), 2 m (L_2) and 3 m (L_3) were studied for moisture content at three depths and four conserve measures respectively.

The moisture content at the distances L_1 , L_2 and L_3 for all treatment combinations under study ranged from 7.2 to 8.9, 7.16 to 8.84 and 7.31 to 8.74 respectively. The maximum moisture content of 8.9 for L_1 was attained at treatment combination of D_3T_1 ($D_3 = 30-45$ cm, $T_1 =$ contour bund cum trench) whereas minimum moisture content of 7.2 for L_1 was attained at a treatment combination of D_1T_4 ($D_1 = 0-15$ cm, $T_4 =$ control plot). The maximum and minimum moisture content 8.84 and 7.16% for the distance L_2 (2m) were attained at a treatment combination of D_3T_1 and D_1T_4 . Similarly the maximum and minimum moisture content of 8.74 and 7.31 for L_3 was attained at treatment combinations of D_3T_1 and D_1T_4 respectively.

The main effect of depth on moisture content was statistically significant at 5% level of significance. The first level interaction $C \times L$ were statistically significant at 5% level of significance. The first order interaction $L \times D$ were significant and second order interaction $C \times L \times D$ was also significant at 5% level of significance.

4.1.10 Effect of conservation measures on moisture content (%) with respect to distance and depth during 3rd week of February 2021

The effect of conservation measures on moisture content at different depths and distances are presented in Table 4.10 and are graphically illustrated from Fig. 4.37 to 4.40. The effects of individual parameters on moisture content for 3rd week of february are discussed below

The effect of soil and water conservation measures i.e. contour bund cum trench (T_1), contour bund (T_2), contour trench (T_3) and control plot (T_4) were studied for moisture content at three depths and three distances respectively.

The moisture content for the conservation measures T_1 , T_2 , T_3 and T_4 for all treatment combinations under study ranged from 7.77 to 8.4, 6.84 to 7.41, 7.61 to 8.21 and 6.76 to 7.15 respectively. The maximum moisture content of 8.4 for T_1 was attained at treatment

combination of L_1D_3 ($L_1 = 1$ m, $D_3 = 30-45$ cm) whereas minimum moisture content of 7.77 for T_1 was attained at a treatment combination of L_3D_1 ($L_3 = 3$ m, $D_1 = 0-15$ cm). The maximum and minimum moisture content 7.41 and 6.84 for the conservative measure T_2 were attained at a treatment combination of L_2D_3 and L_3D_1 . Similarly the maximum and minimum moisture content of 8.21 and 7.6 for T_3 was attained at treatment combinations of L_3D_3 and L_2D_1 respectively. Lastly the maximum (7.15) and minimum (6.76) moisture content for T_4 (control plot) were observed at a treatment combination of L_1D_3 and L_2D_1 .

The main effect of conservation measures on moisture content was statistically significant at 5% level of significance. The first level interaction $C \times L$ were statistically significant at 5% level of significance. The first order interaction $C \times D$ were significant and second order interaction $C \times L \times D$ was also significant at 5% level of significance

4.1.10.1 Effect of depth

The effect of depth i.e. 0-15 cm (D_1), 15-30 cm (D_2) and 30-45 cm (D_3) were studied for moisture content at three distances and four conservative measures respectively.

The moisture content at the depths D_1 , D_2 and D_3 for all treatment combinations under study ranged from 6.8 to 7.86, 6.88 to 8.16 and 7.1 to 8.4 respectively. The maximum moisture content of 7.86 for D_1 was attained at treatment combination of L_2T_1 ($L_2 = 2$ m, $T_1 =$ contour bund cum trench) whereas minimum moisture content of 6.8 for D_1 was attained at a treatment combination of L_1T_4 ($L_1 = 1$ m, $T_4 =$ control plot). The maximum and minimum moisture content 8.16 and 6.88 for the depth D_2 (15-30 cm) were attained at a treatment combination of L_3T_3 and L_3T_4 . Similarly the maximum and minimum moisture content of 8.4 and 7.1 for D_3 was attained at treatment combinations of L_1T_1 and L_2T_4 respectively.

The main effect of depth on moisture content was statistically significant at 5% level of significance. The first level interaction $C \times D$ were statistically significant at 5% level of significance. The first order interaction $L \times D$ were significant and second order interaction $C \times L \times D$ was also significant at 5% level of significance.

4.1.10.2 Effect of distance

The effect of distance i.e. 1 m (L_1), 2 m (L_2) and 3 m (L_3) were studied for moisture content at three depths and four conserve measures respectively.

Table 4.9: Effect of soil and water conservation measures on moisture content (%)
during 1st week of February

Distance Conservation Measures		Distance (m)			
	Depth (m)	L ₁	L ₂	L ₃	Sub Means
T ₁	D ₁	8.4	8.5	8.2	8.37
	D ₂	8.6	8.76	8.41	8.59
	D ₃	8.9	8.84	8.74	8.83
	Sub Means	8.63	8.7	8.45	8.59
T ₂	D ₁	7.3	7.38	7.46	7.38
	D ₂	7.67	7.61	7.54	7.61
	D ₃	7.78	7.74	7.69	7.74
	Sub Means	7.58	7.58	7.56	7.57
T ₃	D ₁	7.9	7.74	7.86	7.83
	D ₂	8.1	8.06	7.96	8.04
	D ₃	8.23	8.16	8.3	8.23
	Sub Means	8.08	7.99	8.04	8.03
T ₄	D ₁	7.2	7.16	7.31	7.22
	D ₂	7.41	7.37	7.42	7.4
	D ₃	7.6	7.54	7.61	7.58
	Sub Means	7.40	7.36	7.45	7.40
Factor Means	Conservation Measures	T1	T2	T3	T4
		8.59	7.57	8.03	7.40
	Distance	L ₁	L ₂	L ₃	
		7.92	7.91	7.88	
	Depth	D ₁	D ₂	D ₃	
		7.70	7.91	8.09	
C.D (p≤0.05)	Conservation Measures (T) =0.10				
	Distance (L) =0.12				
	Depth (D) =0.23				
	CxL =0.15				
	CxD =0.29				
	LxD =0.14				
	CxLxD =0.2				

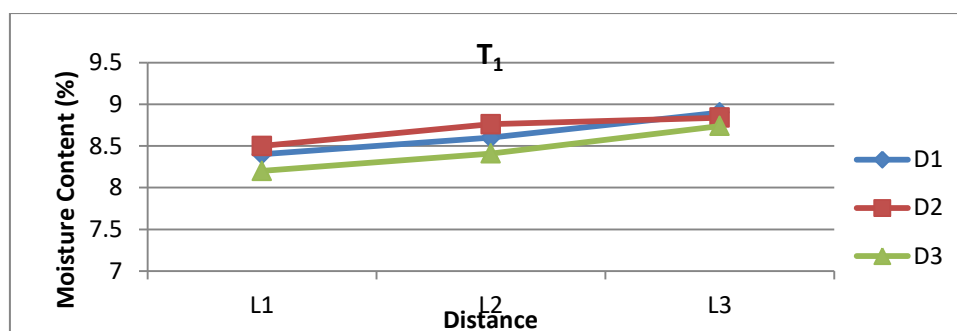


Fig 4.33: Effect of depth and distance on moisture content for Contour bund cum trench during 1st week of February

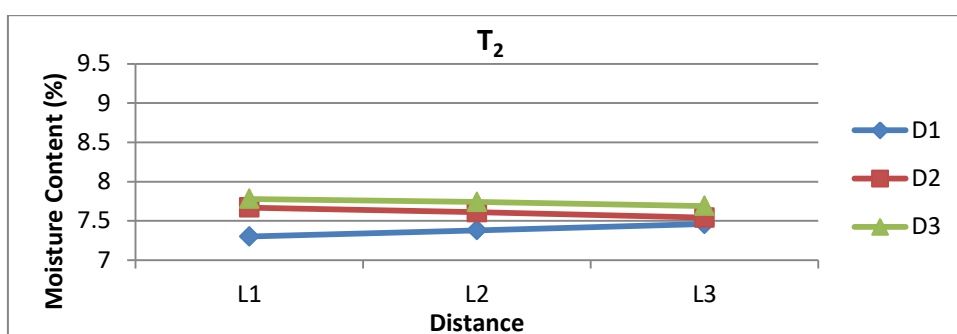


Fig 4.34: Effect of depth and distance on moisture content for Contour bund during 1st week of February

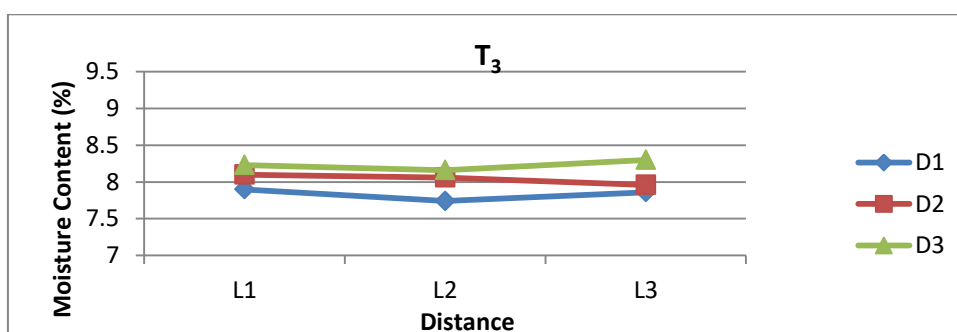


Fig 4.35: Effect of depth and distance on moisture content for Contour trench during 1st week of February

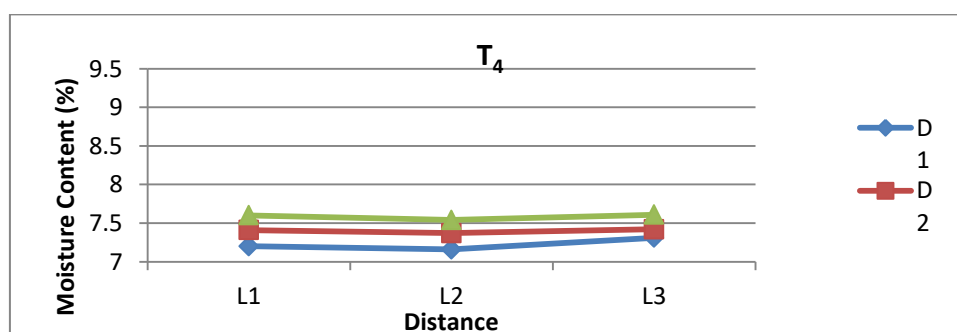


Fig 4.36: Effect of depth and distance on moisture content for Control plot during 1st week of February

The moisture content at the distances L_1 , L_2 and L_3 for all treatment combinations under study ranged from 6.8 to 8.4, 6.76 to 8.36 and 6.84 to 8.31 respectively. The maximum moisture content of 8.4 for L_1 was attained at treatment combination of D_3T_1 ($D_3 = 30-45$ cm, $T_1 =$ contour bund cum trench) whereas minimum moisture content of 6.8 for L_1 was attained at a treatment combination of D_1T_4 ($D_1 = 0-15$ cm, $T_4 =$ control plot). The maximum and minimum moisture content 8.36 and 6.76 for the distance L_2 (2m) were attained at a treatment combination of D_3T_1 and D_1T_4 . Similarly the maximum and minimum moisture content of 8.31 and 6.84 for L_3 was attained at treatment combinations of D_3T_1 and D_1T_4 respectively.

The main effect of depth on moisture content was statistically significant at 5% level of significance. The first level interaction $C \times L$ were statistically significant at 5% level of significance. The first order interaction $L \times D$ were significant and second order interaction $C \times L \times D$ was also significant at 5% level of significance.

4.1.11 Effect of conservation measures on moisture content (%) with respect to distance and depth during 1st week of March 2021

The effect of conservation measures on moisture content at different depths and distances are presented in Table 4.11 and are graphically illustrated from Fig. 4.41 to 4.44. The effects of individual parameters on moisture content for 1st week of March are discussed below

The effect of soil and water conservation measures i.e. contour bund cum trench (T_1), contour bund (T_2), contour trench (T_3) and control plot (T_4) were studied for moisture content at three depths and three distances respectively.

The moisture content for the conservation measures T_1 , T_2 , T_3 and T_4 for all treatment combinations under study ranged from 6.5 to 7.26, 6.1 to 6.48, 6.28 to 6.68 and 5.8 to 6.19 respectively. The maximum moisture content of 7.26 for T_1 was attained at treatment combination of L_2D_3 ($L_2 = 2$ m, $D_3 = 30-45$ cm) whereas minimum moisture content of 6.5 for T_1 was attained at a treatment combination of L_1D_1 ($L_1 = 1$ m, $D_1 = 0-15$ cm). The maximum and minimum moisture content 6.48 and 6.1 for the conservative measure T_2 were attained at a treatment combination of L_2D_3 and L_1D_1 . Similarly the maximum and minimum moisture content of 7.28 and 6.28 for T_3 was attained at treatment combinations of L_1D_3 and

L_2D_1 respectively. Lastly the maximum (6.19) and minimum (5.8) moisture content for T_4 (control plot) were observed at a treatment combination of L_3D_3 and L_1D_1 .

The main effect of conservation measures on moisture content was statistically significant at 5% level of significance. The first level interaction $C \times L$ were statistically significant at 5% level of significance. The first order interaction $C \times D$ were significant and second order interaction $C \times L \times D$ was also significant at 5% level of significance

4.1.11.1 Effect of depth

The effect of depth i.e. 0-15 cm (D_1), 15-30 cm (D_2) and 30-45 cm (D_3) were studied for moisture content at three distances and four conservative measures respectively.

The moisture content at the depths D_1 , D_2 and D_3 for all treatment combinations under study ranged from 5.8 to 6.61, 5.97 to 7.15 and 6.1 to 7.26 respectively. The maximum moisture content of 6.61 for D_1 was attained at treatment combination of L_2T_1 ($L_2 = 2$ m, $T_1 =$ contour bund cum trench) whereas minimum moisture content of 5.8 for D_1 was attained at a treatment combination of L_1T_4 ($L_1 = 1$ m, $T_4 =$ control plot). The maximum and minimum moisture content 7.15 and 5.97 for the depth D_2 (15-30 cm) were attained at a treatment combination of L_3T_1 and L_1T_4 . Similarly the maximum and minimum moisture content of 7.26 and 6.1 for D_3 was attained at treatment combinations of L_2T_1 and L_2T_4 respectively.

The main effect of depth on moisture content was statistically significant at 5% level of significance. The first level interaction $C \times D$ were statistically significant at 5% level of significance. The first order interaction $L \times D$ were significant and second order interaction $C \times L \times D$ was also significant at 5% level of significance.

4.1.11.2 Effect of distance

The effect of distance i.e. 1 m (L_1), 2 m (L_2) and 3 m (L_3) were studied for moisture content at three depths and four conserve measures respectively.

The moisture content at the distances L_1 , L_2 and L_3 for all treatment combinations under study ranged from 5.8 to 7.2, 5.86 to 7.26 and 5.78 to 7.18 respectively. The maximum moisture content of 7.2 for L_1 was attained at treatment combination of D_3T_1 ($D_3 = 30-45$ cm, $T_1 =$ contour bund cum trench) whereas minimum moisture content of 5.8 for L_1 was attained at a treatment combination of D_1T_4 ($D_1 = 0-15$ cm, $T_4 =$ control plot). The maximum and minimum moisture content 7.26 and 5.86 for the distance L_2 (2m) were attained at a

Table 4.10: Effect of soil and water conservation measures on moisture content (%)
during 3rd week of February

Distance Conservation Measures		Distance (m)			
	Depth (m)	L ₁	L ₂	L ₃	Sub Means
T ₁	D ₁	7.8	7.86	7.77	7.81
	D ₂	8.1	8.05	8.12	8.09
	D ₃	8.4	8.36	8.31	8.36
	Sub Means	8.1	8.09	8.07	8.09
T ₂	D ₁	6.9	6.98	6.84	6.91
	D ₂	7.2	7.27	7.16	7.21
	D ₃	7.35	7.41	7.32	7.36
	Sub Means	7.15	7.22	7.11	7.16
T ₃	D ₁	7.7	7.61	7.65	7.65
	D ₂	8.06	8.1	8.16	8.11
	D ₃	8.12	8.17	8.21	8.17
	Sub Means	7.96	7.96	8.01	7.98
T ₄	D ₁	6.8	6.76	6.84	6.8
	D ₂	6.97	6.93	6.88	6.93
	D ₃	7.15	7.1	6.98	7.08
	Sub Means	6.97	6.93	6.9	6.93
Factor Means	Conservation Measures	T ₁	T ₂	T ₃	T ₄
		8.09	7.16	7.98	6.93
	Distance	L ₁	L ₂	L ₃	
		7.55	7.55	7.52	
	Depth	D ₁	D ₂	D ₃	
		7.28	7.58	7.74	
C.D (p≤0.05)	Conservation Measures (T) =0.10 Distance (L) =0.12 Depth (D) =0.23 CxL =0.15 CxD =0.29 LxD =0.14 CxLxD =0.28				

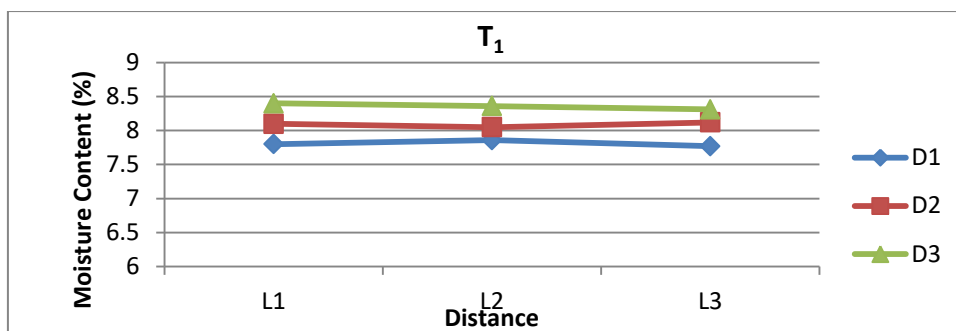


Fig 4.37: Effect of depth and distance on moisture content for Contour bund cum trench during 3rd week of February

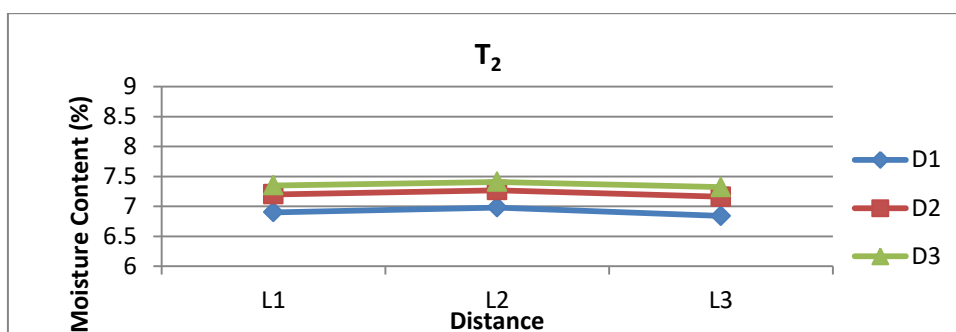


Fig 4.38: Effect of depth and distance on moisture content for Contour bund during 3rd week of February

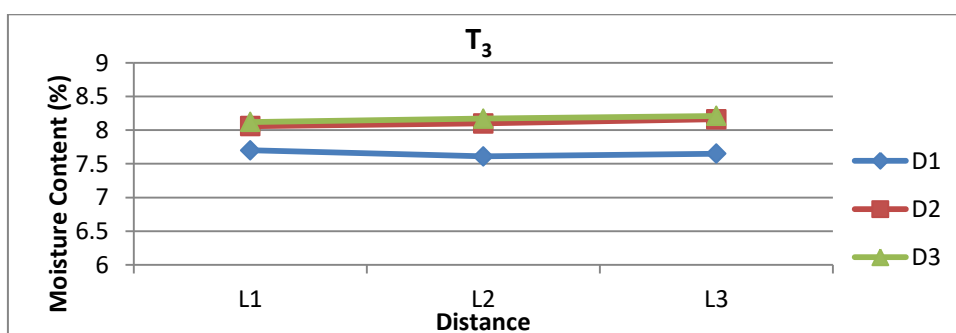


Fig 4.39: Effect of depth and distance on moisture content for Contour trench during 3rd week of February

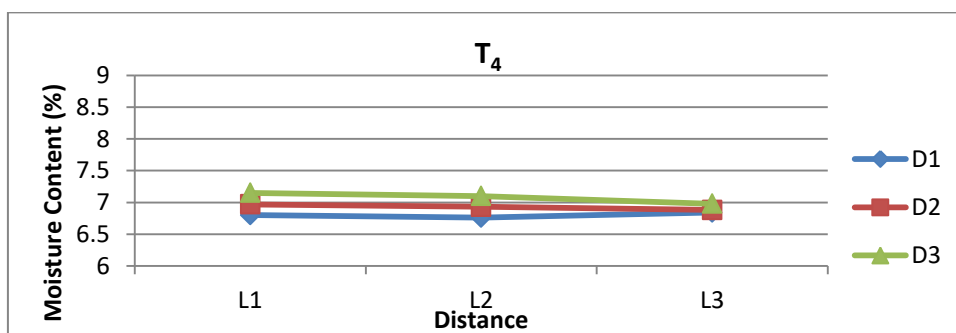


Fig 4.40: Effect of depth and distance on moisture content for Control plot during 3rd week of February

treatment combination of D_3T_1 and D_1T_4 . Similarly the maximum and minimum moisture content of 7.18 and 5.78 for L_3 was attained at treatment combinations of D_3T_1 and D_1T_4 respectively.

The main effect of depth on moisture content was statistically significant at 5% level of significance. The first level interaction $C \times L$ were statistically significant at 5% level of significance. The first order interaction $L \times D$ were significant and second order interaction $C \times L \times D$ was also significant at 5% level of significance.

4.1.12 Effect of conservation measures on moisture content (%) with respect to distance and depth during 3rd week of March 2021

The effect of conservation measures on moisture content at different depths and distances are presented in Table 4.12 and are graphically illustrated from Fig. 4.45 to 4.48. The effects of individual parameters on moisture content for 3rd week of March are discussed below

The effect of soil and water conservation measures i.e. contour bund cum trench (T_1), contour bund (T_2), contour trench (T_3) and control plot (T_4) were studied for moisture content at three depths and three distances respectively.

The moisture content for the conservation measures T_1 , T_2 , T_3 and T_4 for all treatment combinations under study ranged from 8.54 to 8.96, 8.11 to 8.63, 8.27 to 8.82 and 7.74 to 8.15 respectively. The maximum moisture content of 8.96 for T_1 was attained at treatment combination of L_1D_3 ($L_1 = 1$ m, $D_3 = 30-45$ cm) whereas minimum moisture content of 8.54 for T_1 was attained at a treatment combination of L_2D_1 ($L_2 = 2$ m, $D_1 = 0-15$ cm). The maximum and minimum moisture content 8.63 and 8.11 for the conservative measure T_2 were attained at a treatment combination of L_2D_3 and L_1D_1 . Similarly the maximum and minimum moisture content of 8.82 and 8.27 for T_3 was attained at treatment combinations of L_3D_3 and L_2D_1 respectively. Lastly the maximum (8.15) and minimum (7.74) moisture content for T_4 (control plot) were observed at a treatment combination of L_2D_3 and L_2D_1 . The main effect of conservation measures on moisture content was statistically significant at 5% level of significance. The first level interaction $C \times L$ were statistically significant at 5% level of significance. The first order interaction $C \times D$ were significant and second order interaction $C \times L \times D$ was also significant at 5% level of significance

4.1.12.1 Effect of depth

The effect of depth i.e. 0-15 cm (D_1), 15-30 cm (D_2) and 30-45 cm (D_3) were studied for moisture content at three distances and four conservative measures respectively.

The moisture content at the depths D_1 , D_2 and D_3 for all treatment combinations under study ranged from 7.74 to 8.64, 7.88 to 8.78 and 8.08 to 8.96 respectively. The maximum moisture content of 8.64 for D_1 was attained at treatment combination of L_3T_1 ($L_3 = 3$ m, $T_1 =$ contour bund cum trench) whereas minimum moisture content of 7.74 for D_1 was attained at a treatment combination of L_2T_4 ($L_2 = 2$ m, $T_4 =$ control plot). The maximum and minimum moisture content 8.78 and 7.88 for the depth D_2 (15-30 cm) were attained at a treatment combination of L_1T_1 and L_2T_4 . Similarly the maximum and minimum moisture content of 8.96 and 8.08 for D_3 was attained at treatment combinations of L_1T_1 and L_3T_4 respectively.

The main effect of depth on moisture content was statistically significant at 5% level of significance. The first level interaction $C \times D$ were statistically significant at 5% level of significance. The first order interaction $L \times D$ were significant and second order interaction $C \times L \times D$ was also significant at 5% level of significance.

4.1.12.2 Effect of distance

The effect of distance i.e. 1 m (L_1), 2 m (L_2) and 3 m (L_3) were studied for moisture content at three depths and four conserve measures respectively.

The moisture content at the distances L_1 , L_2 and L_3 for all treatment combinations under study ranged from 7.8 to 8.96, 7.74 to 8.90 and 7.84 to 8.92 respectively. The maximum moisture content of 8.96 for L_1 was attained at treatment combination of D_3T_1 ($D_3 = 30-45$ cm, $T_1 =$ contour bund cum trench) whereas minimum moisture content of 7.8 for L_1 was attained at a treatment combination of D_1T_4 ($D_1 = 0-15$ cm, $T_4 =$ control plot). The maximum and minimum moisture content 8.90 and 7.74 for the distance L_2 (2m) were attained at a treatment combination of D_3T_1 and D_1T_4 . Similarly the maximum and minimum moisture content of 8.92 and 7.84 for L_3 was attained at treatment combinations of D_3T_1 and D_1T_4 respectively.

The main effect of depth on moisture content was statistically significant at 5% level of significance. The first level interaction $C \times L$ were statistically significant at 5% level of

significance. The first order interaction $L \times D$ were significant and second order interaction $C \times L \times D$ was also significant at 5% level of significance.

4.1.13 Effect of conservation measures on moisture content (%) with respect to distance and depth during 1st week of April 2021

The effect of conservation measures on moisture content at different depths and distances are presented in Table 4.13 and are graphically illustrated from Fig. 4.49 to 4.52. The effects of individual parameters on moisture content for 1st week of April are discussed below

The effect of soil and water conservation measures i.e. contour bund cum trench (T_1), contour bund (T_2), contour trench (T_3) and control plot (T_4) were studied for moisture content at three depths and three distances respectively.

The moisture content for the conservation measures T_1 , T_2 , T_3 and T_4 for all treatment combinations under study ranged from 5.54 to 6.88, 5.12 to 5.87, 5.33 to 6.33 and 2.53 to 4.21 respectively. The maximum moisture content of 6.88 for T_1 was attained at treatment combination of L_3D_3 ($L_3 = 3$ m, $D_3 = 30-45$ cm) whereas minimum moisture content of 5.54 for T_1 was attained at a treatment combination of L_3D_1 ($L_3 = 3$ m, $D_1 = 0-15$ cm). The maximum and minimum moisture content 5.87 and 5.12 for the conservative measure T_2 were attained at a treatment combination of L_2D_3 and L_3D_1 . Similarly the maximum and minimum moisture content of 6.33 and 5.33 for T_3 was attained at treatment combinations of L_1D_2 and L_3D_1 respectively. Lastly the maximum (4.21) and minimum (2.53) moisture content for T_4 (control plot) were observed at a treatment combination of L_1D_3 and L_2D_1 .

The main effect of conservation measures on moisture content was statistically significant at 5% level of significance. The first level interaction $C \times L$ were statistically significant at 5% level of significance. The first order interaction $C \times D$ were significant and second order interaction $C \times L \times D$ was also significant at 5% level of significance

4.1.13.1 Effect of depth

The effect of depth i.e. 0-15 cm (D_1), 15-30 cm (D_2) and 30-45 cm (D_3) were studied for moisture content at three distances and four conservative measures respectively.

The moisture content at the depths D_1 , D_2 and D_3 for all treatment combinations under study ranged from 2.53 to 5.87, 3.30 to 6.33 and 3.78 to 6.88 respectively. The maximum

Table 4.11: Effect of soil and water conservation measures on moisture content (%) during 1st week of March

Distance Conservation Measures		Distance (m)			
	Depth (m)	L ₁	L ₂	L ₃	Sub Means
T ₁	D ₁	6.5	6.61	6.45	6.52
	D ₂	6.9	7.08	7.15	7.04
	D ₃	7.2	7.26	7.18	7.21
	Sub Means	6.87	6.98	6.93	6.93
T ₂	D ₁	6.1	6.17	6.23	6.17
	D ₂	6.23	6.31	6.2	6.25
	D ₃	6.41	6.48	6.37	6.42
	Sub Means	6.25	6.32	6.27	6.28
T ₃	D ₁	6.3	6.28	6.34	6.31
	D ₂	6.55	6.49	6.58	6.54
	D ₃	6.78	6.74	6.69	6.74
	Sub Means	6.54	6.50	6.54	6.53
T ₄	D ₁	5.8	5.86	5.78	5.81
	D ₂	5.97	6.05	6.12	6.05
	D ₃	6.14	6.1	6.19	6.14
	Sub Means	5.97	6.0	6.03	6.00
Factor Means	Conservation Measures	T ₁	T ₂	T ₃	T ₄
		6.93	6.28	6.53	6.00
	Distance	L ₁	L ₂	L ₃	
		6.41	6.45	6.44	
	Depth	D ₁	D ₂	D ₃	
		6.20	6.47	6.63	
C.D (p≤0.05)	Conservation Measures (T) =0.10				
	Distance (L) =0.12				
	Depth (D) =0.23				
	CxL =0.15				
	CxD =0.29				
	LxD =0.14				
	CxLxD =0.28				

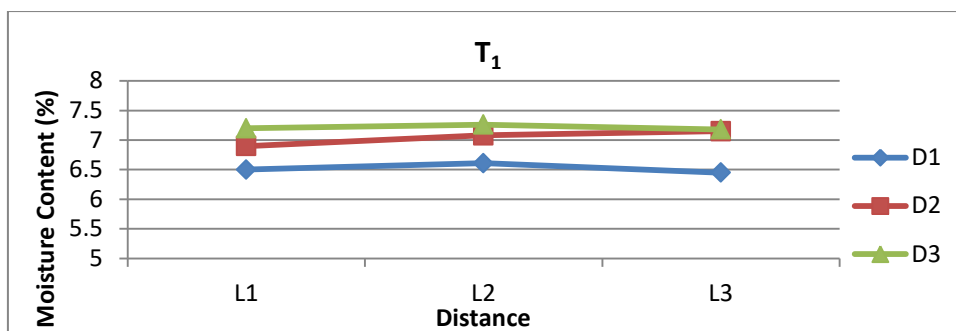


Fig 4.41: Effect of depth and distance on moisture content for Contour bund cum trench during 1st week of March

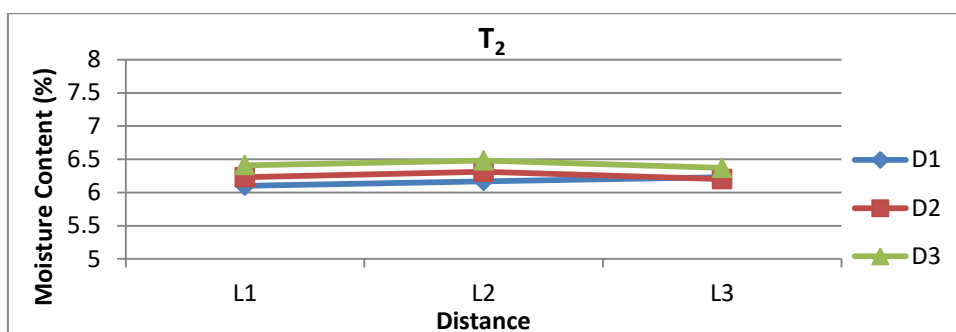


Fig 4.42: Effect of depth and distance on moisture content for Contour bund during 1st week of March

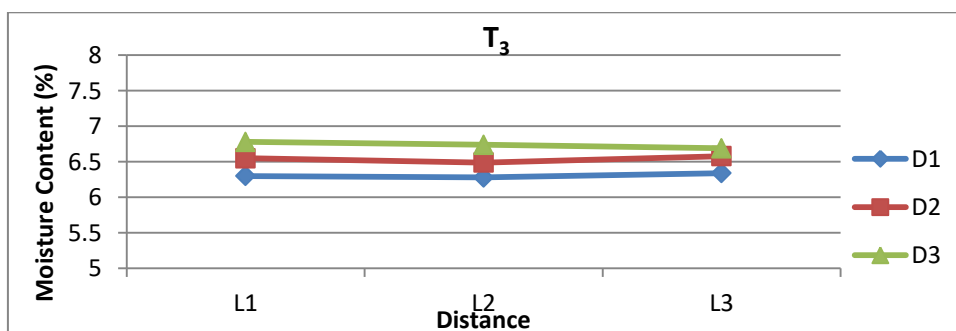


Fig 4.43: Effect of depth and distance on moisture content for Contour trench during 1st week of March

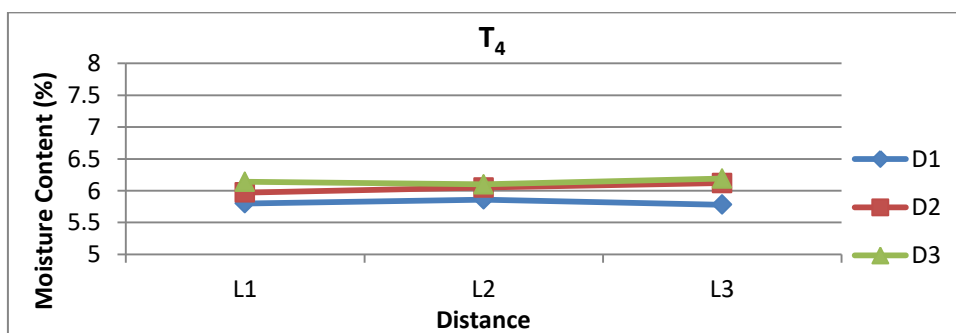


Fig 4.44: Effect of depth and distance on moisture content for Control plot during 1st week of March

Table 4.12: Effect of soil and water conservation measures on moisture content (%) during 3rd week of March

Distance Conservation Measures		Distance (m)			
	Depth (m)	L ₁	L ₂	L ₃	Sub Means
T ₁	D ₁	8.6	8.54	8.64	8.59
	D ₂	8.78	8.69	8.71	8.73
	D ₃	8.96	8.9	8.92	8.93
	Sub Means	8.78	8.71	8.76	8.75
T ₂	D ₁	8.11	8.17	8.14	8.14
	D ₂	8.35	8.39	8.3	8.35
	D ₃	8.58	8.63	8.61	8.61
	Sub Means	8.35	8.40	8.35	8.36
T ₃	D ₁	8.31	8.27	8.33	8.30
	D ₂	8.55	8.58	8.62	8.58
	D ₃	8.78	8.74	8.82	8.78
	Sub Means	8.55	8.53	8.59	8.56
T ₄	D ₁	7.8	7.74	7.84	7.79
	D ₂	7.96	7.88	7.91	7.92
	D ₃	8.12	8.15	8.08	8.12
	Sub Means	7.96	7.9	7.94	7.94
Factor Means	Conservation Measures	T ₁	T ₂	T ₃	T ₄
		8.75	8.36	8.56	7.94
	Distance	L ₁	L ₂	L ₃	
		8.41	8.39	8.41	
	Depth	D ₁	D ₂	D ₃	
		8.21	8.39	8.61	
C.D (p≤0.05)	Conservation Measures (T) =0.10				
	Distance (L) =0.12				
	Depth (D) =0.23				
	CxL =0.15				
	CxD =0.29				
	LxD =0.14				
	CxDxD =0.28				

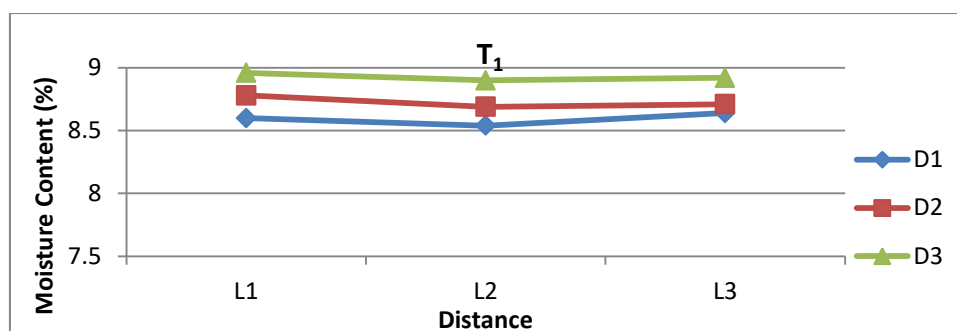


Fig 4.45: Effect of depth and distance on moisture content for Contour bund cum trench during 3rd week of March

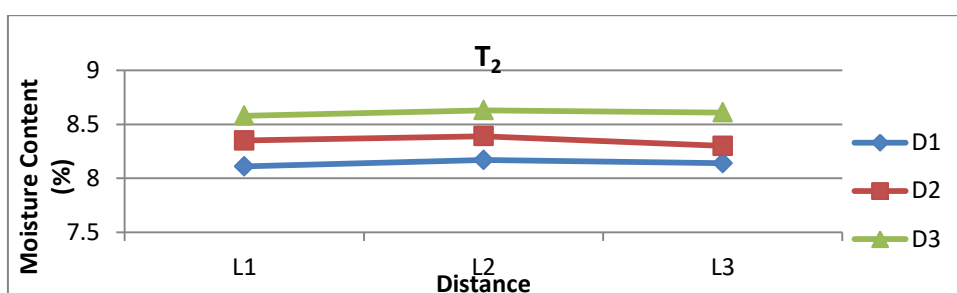


Fig 4.46: Effect of depth and distance on moisture content for Contour bund during 3rd week of March

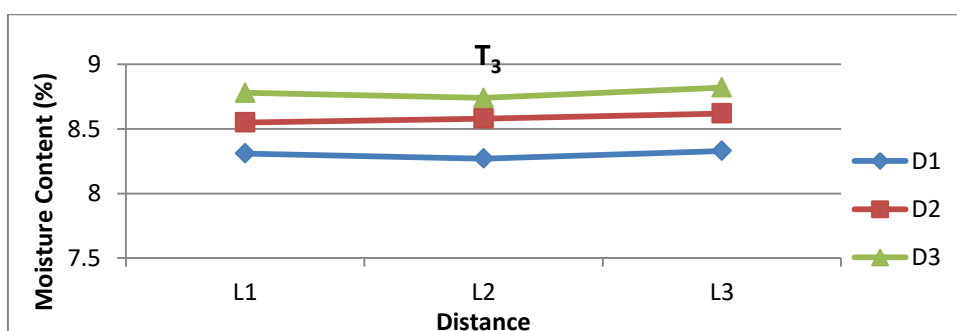


Fig 4.47: Effect of depth and distance on moisture content for Contour trench during 3rd week of March

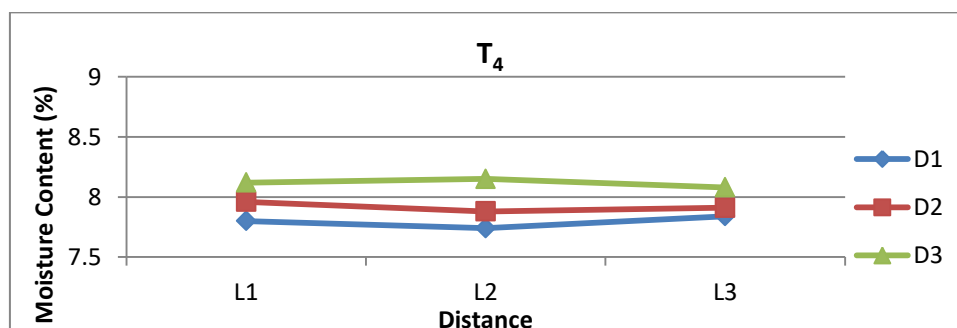


Fig 4.48: Effect of depth and distance on moisture content for Control plot during 3rd week of March

moisture content of 5.87 for D_1 was attained at treatment combination of L_1T_1 ($L_1 = 1$ m, $T_1 =$ contour bund cum trench) whereas minimum moisture content of 2.53 for D_1 was attained at a treatment combination of L_2T_4 ($L_2 = 2$ m, $T_4 =$ control plot). The maximum and minimum moisture content 6.33 and 3.30 for the depth D_2 (15-30 cm) were attained at a treatment combination of L_1T_3 and L_2T_4 . Similarly the maximum and minimum moisture content of 6.88 and 3.78 for D_3 was attained at treatment combinations of L_3T_1 and L_2T_4 respectively.

The main effect of depth on moisture content was statistically significant at 5% level of significance. The first level interaction $C \times D$ were statistically significant at 5% level of significance. The first order interaction $L \times D$ were significant and second order interaction $C \times L \times D$ was also significant at 5% level of significance.

4.1.13.2 Effect of distance

The effect of distance i.e. 1 m (L_1), 2 m (L_2) and 3 m (L_3) were studied for moisture content at three depths and four conserve measures respectively.

The moisture content at the distances L_1 , L_2 and L_3 for all treatment combinations under study ranged from 2.91 to 6.67, 2.53 to 6.26 and 2.81 to 6.88 respectively. The maximum moisture content of 6.67 for L_1 was attained at treatment combination of D_3T_1 ($D_3 = 30-45$ cm, $T_1 =$ contour bund cum trench) whereas minimum moisture content of 2.91 for L_1 was attained at a treatment combination of D_1T_4 ($D_1 = 0-15$ cm, $T_4 =$ control plot). The maximum and minimum moisture content 6.26 and 2.53 for the distance L_2 (2m) were attained at a treatment combination of D_3T_1 and D_1T_4 . Similarly the maximum and minimum moisture content of 6.88 and 2.81 for L_3 was attained at treatment combinations of D_3T_1 and D_1T_4 respectively.

The main effect of depth on moisture content was statistically significant at 5% level of significance. The first level interaction $C \times L$ were statistically significant at 5% level of significance. The first order interaction $L \times D$ were significant and second order interaction $C \times L \times D$ was also significant at 5% level of significance.

4.2 Impact of soil and water conservation measures on crop productivity

The impact of moisture content on the crop productivity for various conservative measures i.e. Contour bund cum trench (T_1), Contour bund (T_2), Contour trench (T_3) and

Table 4.13: Effect of soil and water conservation measures on moisture content (%) during 1st week of April

Distance Conservation Measures		Distance (m)			
	Depth (m)	L ₁	L ₂	L ₃	Sub Means
T ₁	D ₁	5.87	5.48	5.54	5.63
	D ₂	6.12	5.78	5.67	5.86
	D ₃	6.67	6.27	6.88	6.61
	Sub Means	6.22	5.84	6.03	6.03
T ₂	D ₁	5.12	5.23	5.12	5.16
	D ₂	5.44	5.34	5.23	5.34
	D ₃	5.71	5.87	5.67	5.75
	Sub Means	5.42	5.48	5.34	5.41
T ₃	D ₁	5.57	5.33	5.33	5.41
	D ₂	6.33	5.60	5.70	5.88
	D ₃	5.30	5.93	6.03	5.76
	Sub Means	5.73	5.62	5.69	5.68
T ₄	D ₁	2.91	2.53	2.81	2.75
	D ₂	3.52	3.30	3.33	3.38
	D ₃	4.21	3.78	3.96	3.98
	Sub Means	3.55	3.20	3.37	3.37
Factor Means	Conservation Measures	T ₁	T ₂	T ₃	T ₄
		6.03	5.41	5.68	3.37
	Distance	L ₁	L ₂	L ₃	
		5.29	4.67	4.77	
	Depth	D ₁	D ₂	D ₃	
		4.53	5.00	5.20	
C.D (p≤0.05)	Conservation Measures (T) =0.26				
	Distance (L) =0.10				
	Depth (D) =0.17				
	CxL =0.22				
	CxD =0.28				
	LxD =0.19				
	CxLxD =0.35				

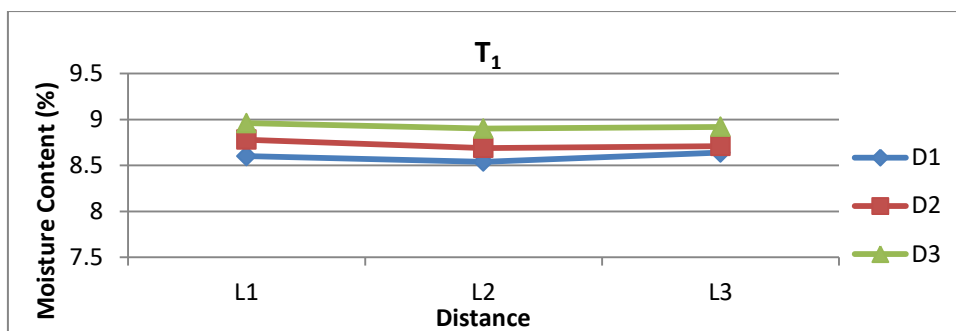


Fig 4.49: Effect of depth and distance on moisture content for Contour bund cum Trench during 1st week of April

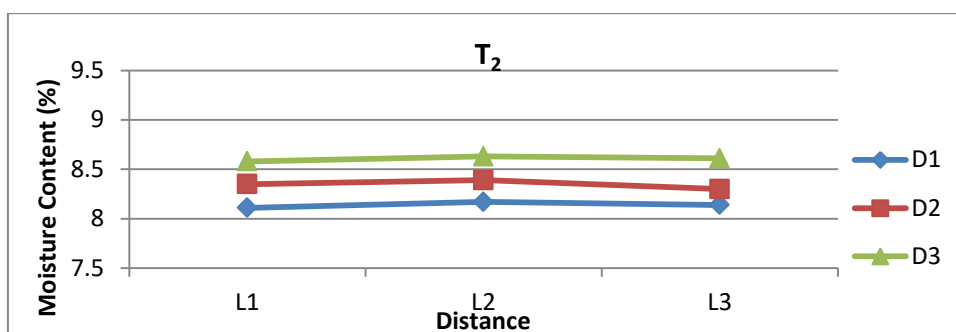


Fig 4.50: Effect of depth and distance on moisture content for Contour bund during 1st week of April

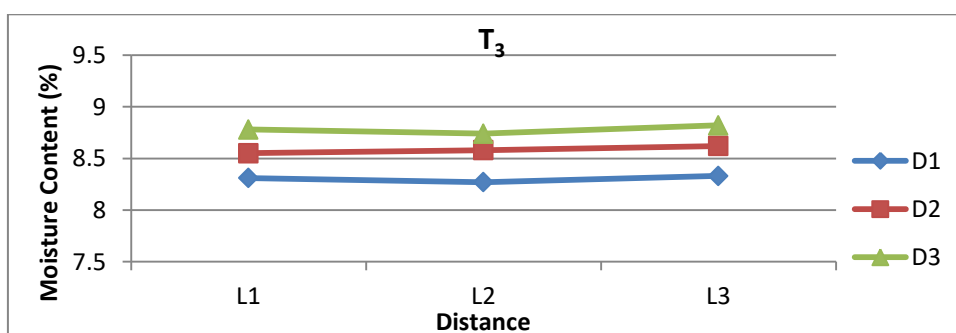


Fig 4.51: Effect of depth and distance on moisture content for Contour trench during 1st week of April

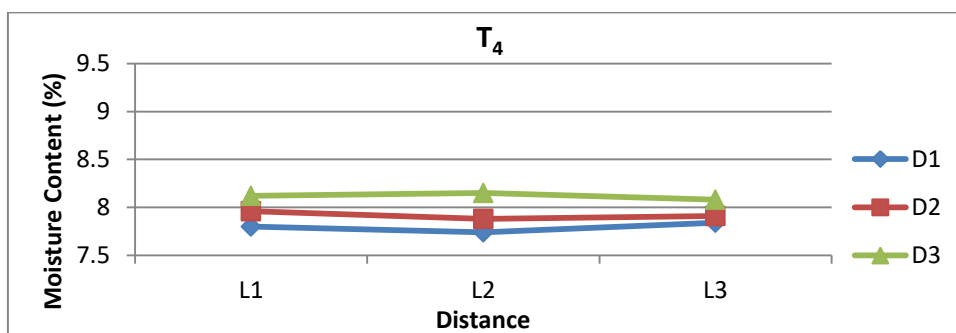


Fig 4.52: Effect of depth and distance on moisture content for Control plot during 1st week of April

Control plot (T₄) (without any conservative measure) at distances 1 m, 2 m and 3 m and at three depths i.e. 0-15, 15- 30 and 30 – 45 cm were recorded respectively. The crop productivity obtained during the experimental study is presented in the Table 4.14.

The productivity on an average was found maximum for the treatment T₁ with the average productivity of 20.5 q/ha followed by the T₃ (Contour trench) with an average productivity of 18.7 q/ha. In case of the contour bund and control the productivity was found to be 16.5 and 14.3 q/ha respectively.

4.3 Impact of soil and water conservation on bulk density

The bulk density was observed at three instants during the experimental study i.e. before the rainfall, after the rainfall and at the time of harvesting. The observations are documented in the tables 4.15 -4.17. The bulk density was found maximum after rainfall event with an average value of 1.57 g/cm³. The bulk density was found minimum with an average value of 1.52g/cm³ after the rainfall event.

4.4 Impact of soil and water conservation on infiltration rate

The infiltration rate during the study was found during three instants i.e. at the time of rainfall, before rainfall and at the time of harvesting of the crop. The study revealed that the infiltration was found maximum before the rainfall and was found after the rainfall event. The infiltration data obtained during the study is depicted in the tables 4.18-4.20 and the cumulative graphs are illustrated by figures from 4.53-4.55.

4.5 Moisture dynamics during crop growth period

The moisture dynamics during the crop growing period (October-April 2020-2021) for three depths and at three distances from the conservation measures is illustrated in graphs 4.56 to 4.61. During crop growth period, the depthwise moisture content was found maximum during the months of December and January for T₁, T₂, T₃ and distance wise moisture content was found maximum during the months of December and January for the treatment T₁ and T₃.

Table 4.14: Effect of soil and water conservation measures on the crop productivity of wheat (q/ha)

Distance Conservation Measure	Replication				
	Distance	R ₁	R ₂	R ₃	Sub Means
T ₁	L ₁	22.3	22.9	21.7	22.3
	L ₂	20.3	19.6	21.1	20.3
	L ₃	18.9	19.3	18.5	18.9
	Mean				20.5
T ₂	L ₁	17.2	17.0	17.5	17.2
	L ₂	16.5	16.2	16.8	16.5
	L ₃	15.9	15.8	15.4	15.7
	Mean				16.5
T ₃	L ₁	19.5	19.3	19.8	19.5
	L ₂	19.1	18.9	18.5	18.8
	L ₃	17.9	18.0	18.2	18.0
	Mean				18.7
T ₄	L ₁	14.1	14.0	14.3	14.1
	L ₂	14.6	14.1	14.8	14.5
	L ₃	13.9	14.7	14.2	14.2
	Mean				14.3

Table 4.15: Bulk density before the rainfall

Conservation measures	Bulk density(g/cm ³)
T ₁	1.61
T ₂	1.55
T ₃	1.58
T ₄	1.54

Table 4.16: Bulk density after the rainfall

Conservation measures	Bulk density(g/cm ³)
T ₁	1.54
T ₂	1.52
T ₃	1.53
T ₄	1.50

Table 4.17: Bulk density at the time of harvesting of wheat crop

Conservation measures	Bulk density(g/cm ³)
T ₁	1.56
T ₂	1.54
T ₃	1.55
T ₄	1.48

Table 4.18: Effect of soil and water conservation measures on the infiltration rate before the rainfall event

Time (min)	Infiltration(cm)	Infiltration rate(mm/sec)	Infiltration rate(mm/h)	Cumulative infiltration(mm)
1	0.25	0.042	150.9	2.5
5	0.75	0.025	90.5	10.0
10	1.26	0.021	75.5	22.6
15	1.70	0.019	67.9	39.6
30	1.82	0.010	36.5	57.8
45	1.95	0.007	26.0	77.3
60	2.45	0.007	24.5	101.8
75	3.08	0.007	24.6	132.7
90	3.71	0.007	24.7	169.8
120	3.96	0.006	19.8	209.4
150	4.21	0.005	16.9	251.5
180	4.34	0.004	14.5	294.9
210	4.40	0.003	12.6	338.9
240	4.40	0.003	11.0	382.9
280	4.40	0.003	9.8	426.9

Table 4.19: Effect of soil and water conservation measures on the infiltration rate after the rainfall event

Time (s)	Infiltration(cm)	Infiltration rate(mm/sec)	Infiltration rate(mm/h)	Cumulative infiltration(mm)
1	0.13	0.021	75.45	1.3
5	0.63	0.021	75.45	7.6
10	1.13	0.019	67.91	18.9
15	1.57	0.017	62.88	34.6
30	1.70	0.009	33.95	51.6
45	1.82	0.007	24.31	69.8
60	2.33	0.006	23.26	93.1
75	2.96	0.007	23.64	122.7
90	3.58	0.007	23.89	158.5
120	3.84	0.005	19.18	196.8
150	4.09	0.005	16.35	237.7
180	4.21	0.004	14.04	279.8
210	4.28	0.003	12.22	322.6
240	4.28	0.003	10.69	365.4
280	4.28	0.003	9.50	408.1

Table 4.20: Effect of soil and water conservation measures on the infiltration rate at the time of harvesting

Time (min)	Infiltration(cm)	Infiltration rate(mm/sec)	Infiltration rate(mm/h)	Cumulative infiltration(mm)
1	0.19	0.031	113.18	1.9
5	0.63	0.021	75.45	8.17
10	0.94	0.016	56.59	17.61
15	1.76	0.020	70.42	35.21
30	2.01	0.011	40.24	55.33
45	2.33	0.009	31.02	78.60
60	2.64	0.007	26.41	105.00
75	2.89	0.006	23.14	133.93
90	3.52	0.007	23.47	169.14
120	3.90	0.005	19.49	208.12
150	4.09	0.005	16.35	248.99
180	4.21	0.004	14.04	291.12
210	4.28	0.003	12.22	333.87
240	4.28	0.003	10.69	376.63
280	4.28	0.003	9.50	419.38

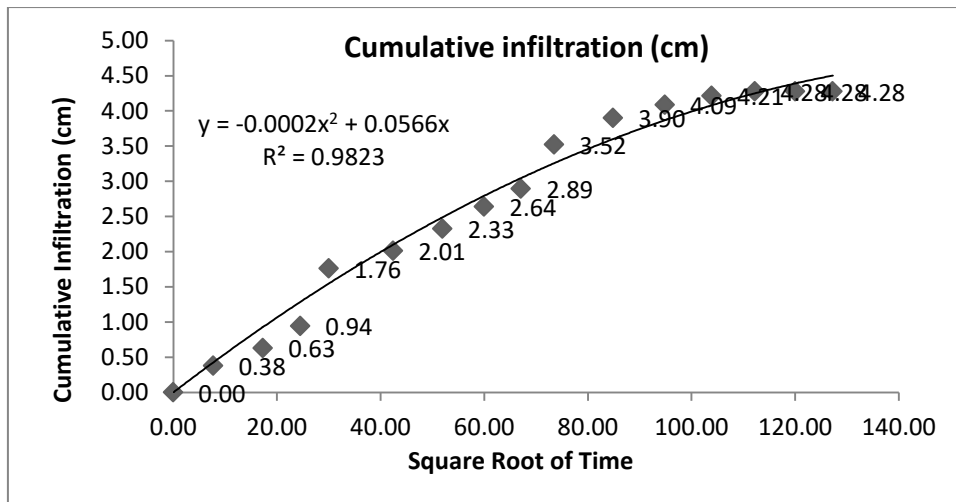


Fig 4.53: Cumulative infiltration (cm) before the rainfall event

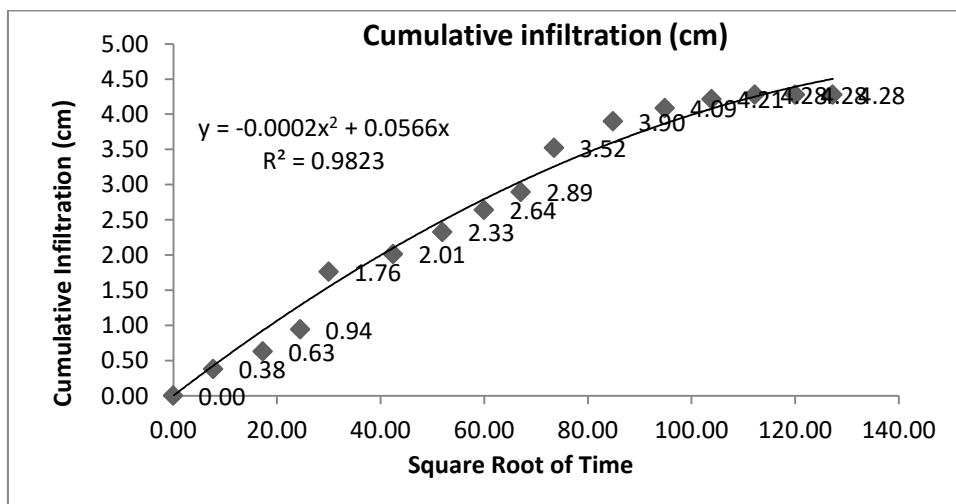


Fig 4.54: Cumulative infiltration (cm) after the rainfall event

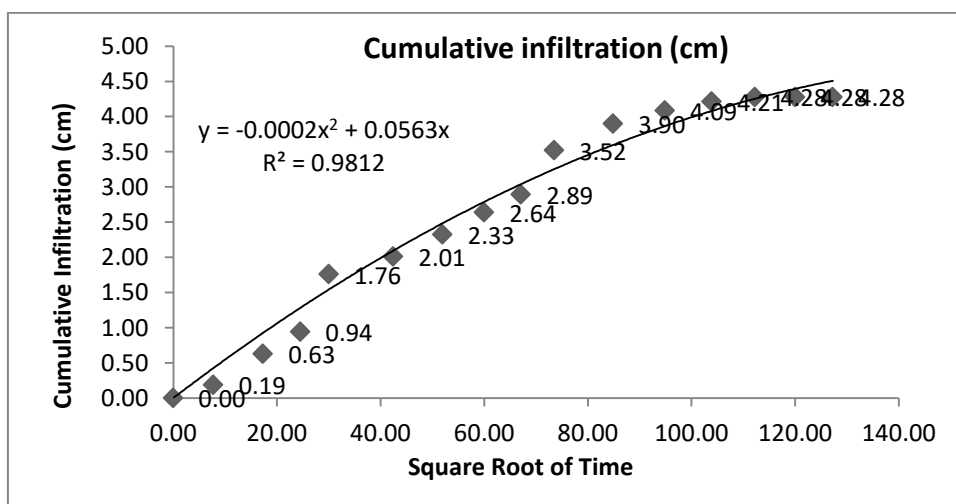


Fig 4.55: Cumulative infiltration (cm) at the time of harvesting

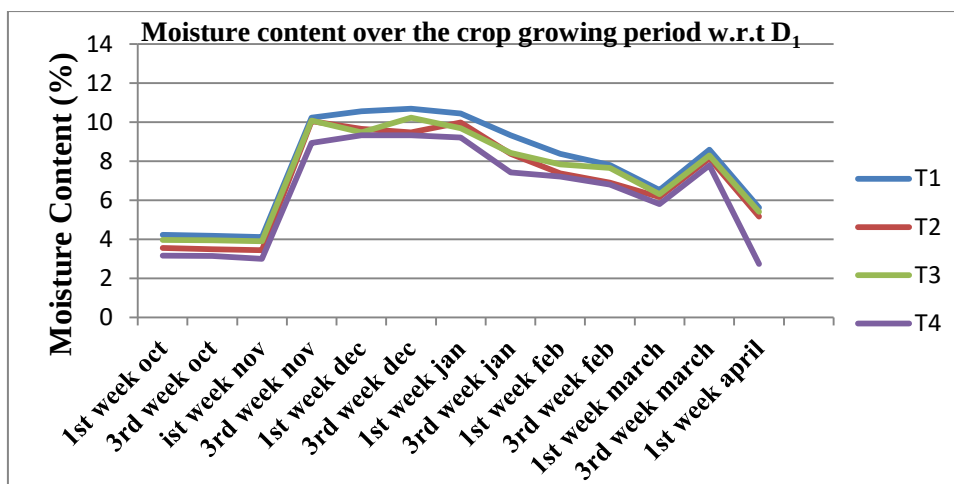


Fig 4.56: . Moisture content over the crop growing period w.r.t D_1

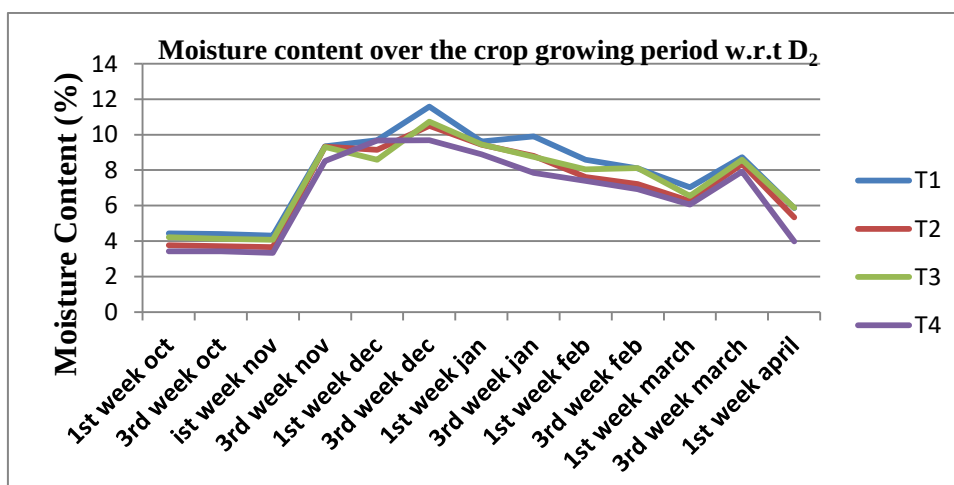


Fig 4.57: . Moisture content over the crop growing period w.r.t D_2

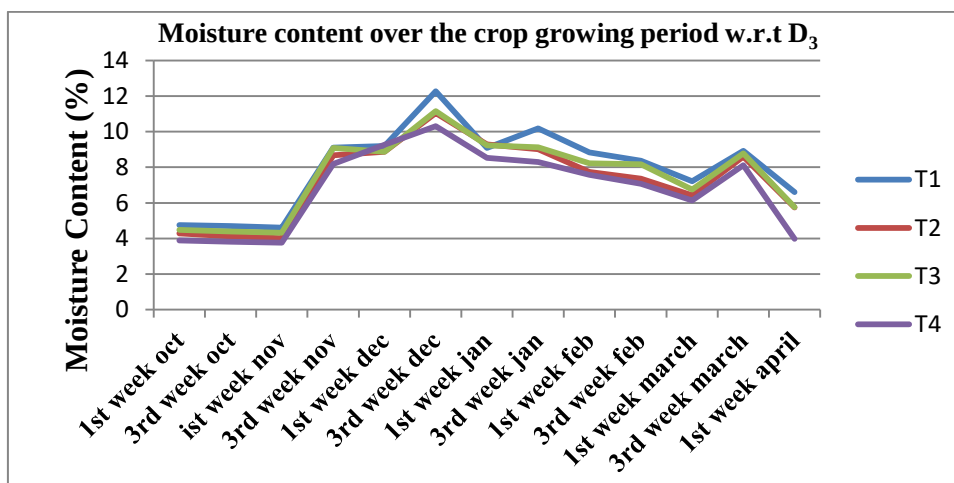


Fig 4.58: Moisture content over the crop growing period w.r.t D_3

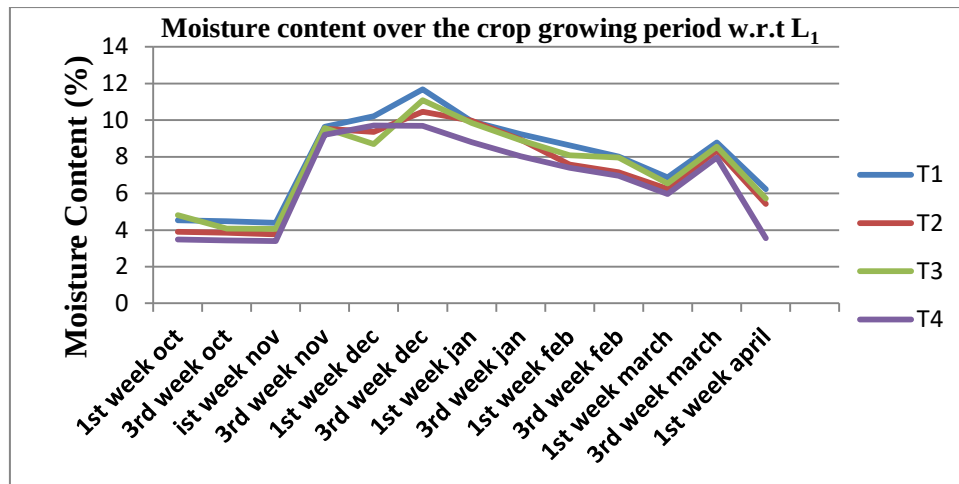


Fig 4.59: Moisture content over the crop growing period w.r.t L_1

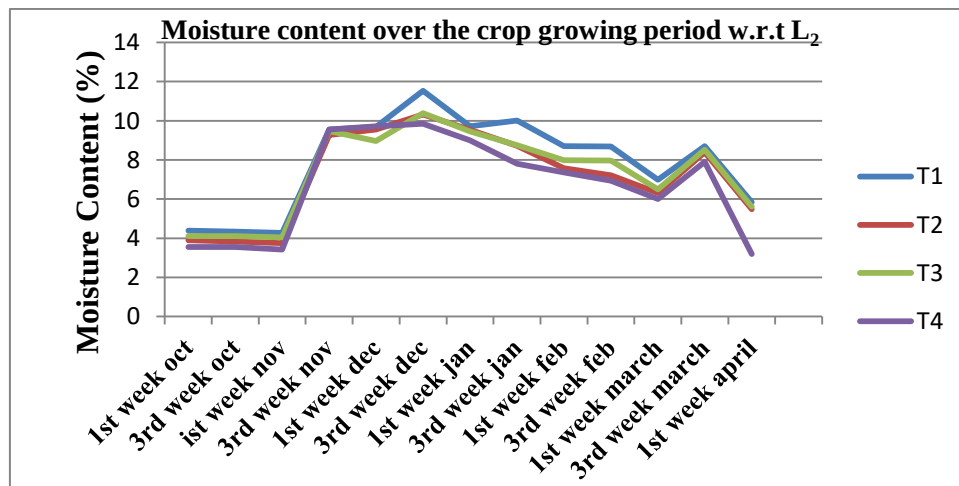


Fig 4.60: Moisture content over the crop growing period w.r.t L_2

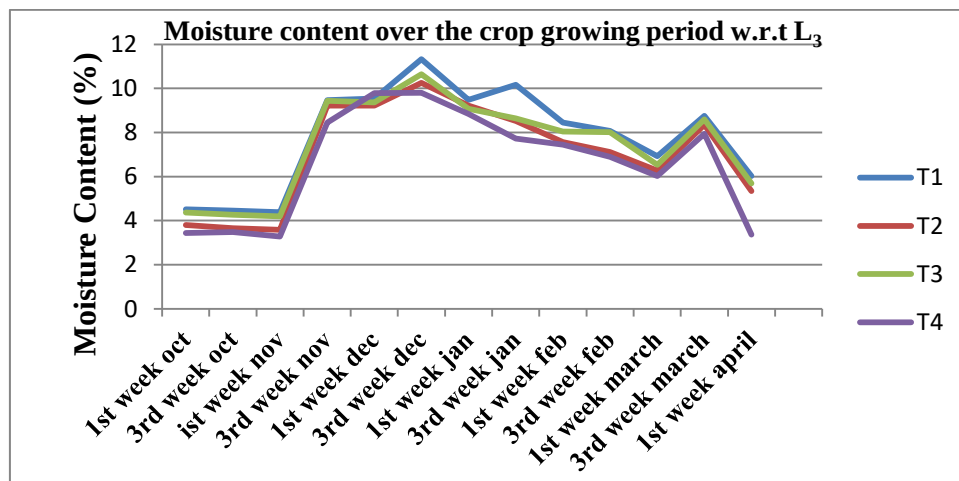


Fig 4.61: Moisture content over the crop growing period w.r.t L_3

CHAPTER-5

DISCUSSION

The experimental findings of the investigation entitled “**Response of Soil and Water Conservation Technologies on Soil Moisture Dynamics in Rainfed Area of Jammu District**” embodied in the preceding chapters are being discussed in this chapter with the help of observations recorded in the present study. The results of the study are discussed below:

5.1. Soil characterization

The soil texture in the study area was found to be loamy sand. The pH of the soil, according to chemical analysis, ranges from 5.35 to 7.3, with a mean value of 6.36. The pH values of the soil exhibited minimal fluctuation and ranged from acidic to neutral in response, which might be attributed to the larger number of basic cations present in the soil surface combined with the high level of organic matter

Sand content varies from 78.72 to 94.36 percent, while silt content ranged from 6.03 to 17.0 percent and clay content was 0.83 to 6.50 percent. The existence of a high sand content might be related to the parent material's richness as well as its fraction.

5.2 Moisture content of the study area in the different months

The moisture content of the study area at various conservation practices were estimated during the crop growing period of the wheat from the October 2020 to the April 2021. During the experimental study the observational data was collected fortnightly in the subsequent months during crop growth period. The effect of rainfall during study period was also considered while studying moisture dynamics at varying distances and depths. The fortnightly moisture dynamics of the study area during period is represented in subsequent headings below;

5.2.1 Effect of conservation measures on the moisture content (%) w.r.t distance and depth in the 1st week of October

The moisture content of the study area for various conservation practices viz. contour bund cum trench (T₁), contour bund (T₂), contour trench (T₃) and control plots (T₄) in the first week of October was found maximum at the T₁ followed by T₃, T₂ and T₄ with the values of 4.48, 4.22, 3.87, 3.49 respectively. It was observed that moisture content shows significant

difference with the varying distance. However the moisture content increased while going to the lower depths with the values of D_3 (4.35), D_2 (3.96) and D_1 (3.73). The minimum value of moisture content at higher depths may be due to evaporative loss from the upper layer of the soil.

5.2.2 Effect of conservation measures on the moisture content (%) w.r.t distance and depth in the 3rd week of October

The study revealed that the moisture content in the 3rd week of October was found low as compared to the moisture content of the first week of October. The maximum moisture content was found at conservation measure of T_1 than T_3 , T_2 and lastly T_4 i.e. 4.42, 4.16, 3.78 and 3.44 respectively. It was observed that moisture content shows slight significant difference with the varying distance. But in case of depth, the moisture content goes on increasing as move from upper to lower depth i.e. D_3 (4.42) and D_1 (3.70). The reason for increment of moisture with depth may be due to less evaporative losses from the lower depths as compared to the upper surface.

5.2.3 Effect of conservation measures on the moisture content (%) w.r.t distance and depth in the 1st week of November

In the 1st week of November the moisture content showed continuous decline in comparison to previous months. The moisture content was found maximum in T_1 followed by T_3 , T_2 and T_4 with values of 4.35, 4.10, 3.70 and 3.37. During the study the moisture content does not show any variation w.r.t to the distance. However with increment in the depth the moisture content also increased i.e. D_1 (3.62) and D_3 (4.18). The reason for the increment of the moisture content along the depth may be due to evaporative losses at the surface.

5.2.4 Effect of conservation measures on the moisture content (%) w.r.t distance and depth in the 3rd week of November

The moisture content was observed after the rainfall event. During the study it was observed that the overall moisture content ranged from 9.07 to 9.56 with the minimum value in control plots (T_4) and maximum in contour bund cum trench (T_1) respectively. The overall moisture content for 3rd week of November was observed higher than the previous months of the study period because a day prior to the observation rainfall event occurred. A gradual decrease in the moisture content was observed in relation to the distance from the conservation measures. The decreasing trend may be due to the interception of runoff which was held by trenches and thereby enhanced the soil moisture content. However the soil

moisture content was found more at D₁ as compared to the D₃ which may be due to the earlier event of rainfall.

5.2.5 Effect of conservation measures on the moisture content (%) w.r.t distance and depth in the 1st week of December

The moisture content was observed in the first week of December after the rainfall event having almost the same trend as in the month of November but shows slightly higher moisture content with maximum moisture content in the T₁ (9.81) followed by T₃ (9.74), T₂ (9.38) and T₁ (9.01). In relation to the distance from the conservation measures a gradual decreasing trend was found with the distance L₁, L₂ and L₃. The maximum moisture content was found in L₁ and minimum in L₃ with the values of 9.50 and 9.47 respectively. The decreasing trend may be due to the decreasing effect of conservation measure to store moisture. Also it was observed that moisture content in the upper depths were found maximum as compared to the lower depths. The maximum moisture content in the upper depths may be due to occurrence of rainfall prior to observation during the study.

5.2.6 Effect of conservation measures on the moisture content (%) w.r.t distance and depth in the 3rd week of December

The moisture content was observed in 3rd week of December was highest during the study period. The maximum moisture content was observed in T₁ followed by T₃, T₂ and T₄ with the values of 11.52, 10.70, 10.34 and 9.78 respectively. The higher moisture content observed was due to heavy rainfall prior to observation in all treatments as well as in the control plots. In respect to the distance, the moisture content in the L₁ was found more than L₂ and L₃ with the values 10.73, 10.52 and 10.51 respectively. The maximum values of moisture content near the conservation measures may be due to the surplus moisture stored in the conservation measures. It was also observed that moisture content was maximum in the lower depths as compared to the upper depths i.e moisture content at the D₃ was found maximum followed by D₂ and D₁ with the values of 11.20, 10.63 and 9.93 respectively. The comparatively minimum moisture content in the upper depths may be due to the evaporation losses and thereby reducing the moisture content.

5.2.7 Effect of conservation measures on the moisture content (%) w.r.t distance and depth in the 1st week of January

It was observed that precipitation in the month of January has increased the moisture content in the three treatments as well as in the control plots with the values of 9.71, 9.57,

9.46 and 8.88 in the T_1 , T_2 , T_3 and T_4 respectively. It was also observed that moisture content across the distances shows the decreasing trend as moving from L_1 to L_3 with the values ranged from 9.64 to 9.15 respectively. The reason being the seepage process from the conservation measures thereby increases the moisture content near the conservation measures of contour trench and contour trench cum bund however no such trend is observed in control plots as there is neither adoption of contour bund and contour trench. It was also observed that moisture content in the upper depths were found maximum as compared to the lower depths as the values 9.83, 9.35 and 9.04 respectively in the D_1 , D_2 and D_3 . It may be due to the seepage processes that enhanced the moisture content near the conservation measures.

5.2.8 Effect of conservation measures on the moisture content (%) w.r.t distance and depth in the 3rd week of January

Moisture content pattern was observed in the 3rd week of January when no precipitation was occurred and hence the moisture content pattern was slightly lower as compared to the 1st week of January. It was observed that moisture content was more in T_1 followed by T_3 , T_2 and T_4 with the values of 9.80, 8.77, 8.73 and 7.85 respectively. The moisture content pattern doesnot show any trend across the distance i.e L_1 (8.78), L_2 (8.72) and L_3 (8.76). In relation to depth, it was observed that the moisture content was found higher in lower depths i.e D_3 (9.15) was found more than D_2 (8.83) and D_1 (8.38). The reason may be due to the evaporation losses which has reduced the moisture content in the upper surfaces.

5.2.9 Effect of conservation measures on the moisture content (%) w.r.t distance and depth in the 1st week of February

During the first week of february i.e few days after the rainfall, it was observed the maximum moisture content is recorded in T_1 followed by T_3 , T_2 and minimum in T_4 . The moisture content along the distance doesnot show any variation i.e L_1 , L_2 , and L_3 have values of 7.92, 7.92 and 7.88 respectively. It was also observed that moisture content was found maximum in the lower depths as compared to the upper depths with the values of 8.09, 7.91 and 7.70 in the D_3 , D_2 and D_1 respectively as the upper depths were undergone through the evaporation process which resulted in the lower moisture content in the upper depths.

5.2.10 Effect of conservation measures on the moisture content (%) w.r.t distance and depth in the 3rd week of February

It was observed that in all the three treatments including the control plots showed not much variation in moisture content i.e. 8.09, 7.98, 7.16 and 6.93 of the T₁, T₃, T₂ and T₄ respectively. During the experimental study the lower depths conserved more moisture as compared to the upper depths with the values of 7.74, 7.58 and 7.28 respectively of the D₃, D₂ and D₁. It may be due to the evaporation losses from the upper surface.

5.2.11 Effect of conservation measures on the moisture content (%) w.r.t distance and depth in the 1st week of March

It was observed that moisture content pattern in the three treatments along with control plots were found same as there was no precipitation in the 1st week of march. Among the three treatments the T₁ shows the maximum moisture content followed by T₃, T₂ and T₄ with the values of 6.93, 6.53, 6.28 and 6.14 respectively. In terms of depth, the moisture content was found in lower depths as compared to the upper depths with the values of 6.63, 6.47 and 6.20 respectively of the D₃, D₂ and D₁.

5.2.12 Effect of conservation measures on the moisture content (%) w.r.t distance and depth in the 3rd week of March

Due to the precipitation in the month of March which resulted in increase in the moisture content in three treatments as well as in the control plots as depicted in the previous chapter 4 with the values of 8.75, 8.56, 8.36 and 7.94 in the T₁, T₂, T₃ and T₄ respectively. The moisture content was found maximum in the lower depths as compared to the upper depths with the values of 8.61, 8.39 and 8.21 in the D₃, D₂ and D₁ respectively as the upper depths were undergone through the evaporation processes and subsequently has reduced the moisture content in the upper depths. The moisture content along the distances does not show any variation.

5.2.13 Effect of conservation measures on the moisture content (%) w.r.t distance and depth in the 1st week of April

The study revealed that the moisture content in the 1st week of April was found at conservation measure of T₁, T₃, T₂ and lastly T₄ i.e. 6.03, 5.68, 5.41 and 3.37 respectively. It was observed that moisture content does not show any significant difference with the varying distance. But in case of depth, the moisture content goes on increasing as move from upper to lower depth i.e. D₃ (5.20) and D₁ (4.53). The reason for increment of moisture with depth may be due to less evaporative losses from the lower depths as compared to the upper surface.

5.3 Impact of soil and conservation measures on crop productivity

The crop productivity was estimated for all treatment combination i.e. T₁, T₂, T₃ and T₄ at different depths and distances from the conservation measures. The results obtained during the study are mentioned in section 4.3 of previous chapter.

The results revealed that T₁ (contour bund cum trench) had the highest crop productivity, whereas the control plot with no conservation measure had the lowest. The highest productivity in contour bund cum trench (T₁) is attributable to moisture conservation owing to trenching and bunding. However, in the case of the control plot (T₄), which has the lowest output in all treatments, this is owing to a lack of conservative moisture storage methods, which has a direct impact on crop yield.

5.4 Impact of soil and water conservation on Bulk density

The bulk density was observed on three instants during the study period i.e. before rainfall event, after rainfall event and at the time of the harvest. The detailed data acquired during the study is given section 4.3 of previous chapter.

The bulk density was found to be at its maximum before the rainfall, with an average value of 1.57 g/cm³, and at its minimum after the rainfall, with an average value of 1.52 g/cm³. The drop in bulk density following rainfall might be attributed to an increase in the volume of soil as the gaps are filled by the water, resulting in a subsequent decrease in bulk density. The similar pattern was reported by Enkova and Martin Urik (2012).

5.5 Impact of soil and water conservation on Infiltration rate

The infiltration rate was observed at three instants i.e, before the rainfall event, after the rainfall event and at the time of the harvest. The detailed data of the infiltration is presented in table 4.18 to 4.20 of the previous chapter.

It was observed that the infiltration rate was maximum before the rainfall which ranged from 150.9 mm/h to 9.8mm/h (basic infiltration rate). The high infiltration rate may be due to presence of unsaturated voids. The infiltration rate after rainfall was observed lower as compared with before rainfall. The initial infiltration rate of 75.45 mm/h and basic infiltration rate of 9.50 mm/h was observed. The decrease in the infiltration rate after rainfall may be due to the saturation of the soil with the rainfall. At time of harvest, the infiltration was again found of higher rate. The higher infiltration rate may be due to the unsaturated state of soil and also due to the presence of plants roots which may increases the infiltration rate.

5.6 Moisture dynamics during crop growth period

The moisture dynamics over the crop growing period of wheat i.e. October 2020 to April 2021 is mentioned in section 4.5 of the previous chapter. The complete trend of moisture dynamics with respect to depth and distance are illustrated in 4.56 to 4.58 and 4.59 to 4.61 respectively.

From the graphs 4.56 and 4.58 it was clearly observed that the maximum moisture content was found for all treatments in the 3rd week of December with highest in T₁ followed T₃, T₂ and T₄. The moisture was found maximum due to occurrence of rainfall at that instant of time. Similarly, in case of moisture dynamics over a crop growing period with respect to distance, the moisture content again was found maximum in the 3rd week of December for all treatment combination.

The moisture variation throughout the growing period of wheat crop with respect to depth of soil under study was found improved in treatment T₁ followed by T₃, T₂. It may be due to runoff water got more opportunity time to get infiltrate into the soil mass.

The moisture variation throughout the growing period of wheat crop with respect to distance from conservation measures was found enhanced in treatment T₁ followed by T₃, T₂. It may be due to decrease of runoff from the micro catchment with above said conservation measures.

CHAPTER-6

SUMMARY AND CONCLUSIONS

Soil and water conservation techniques have shown to be an effective way of reversing land degradation and limiting additional damage to land resources. Depletion of soil moisture and nutrients is a significant concern in many sections of Jammu district's sloppy rainfed tract, notably in the study area of Kandi village. The study was undertaken to evaluate various conservation measures (contour bund cum trench, contour bund, contour trench and control plot) to study the behaviour of moisture content in Kandi rainfed village of Akhnoor tehsil of Jammu district. The various parameters were calculated over the course of crop growing period i.e. October 2020 to April 2021. The soil samples were collected from farmers field on fortnightly basis to calculate the moisture content by gravimetric method throughout the crop growth period of wheat. In addition to it, bulk density, infiltration, texture and yield were recorded during the crop growing period of wheat. The method used to calculate the bulk density and infiltration were core cutter method and by using mini disk infiltrometer respectively. The effect on moisture content at three depths and three distances was observed during the experimental study on fortnight basis. At the end of the crop growing period, the crop productivity at various conservation measures at three distances was recorded and compared.

On the basis of the results obtained from the experiment, following conclusion are drawn;

1. The soil in the study region was found to be loamy sand
2. The moisture content was found maximum in the 3rd week of December with the values of 11.52, 10.34, 10.70, 9.87 % for Contour bund cum trench, Contour bund, Contour trench and Control respectively.
3. The increase in the soil moisture content in contour bund cum trench was found to be 16.7% in comparison to control. In case of contour bund and contour trench, the increase in the soil moisture content in comparison of control plot were 4.7% and 8.4% respectively in the month of december.
4. The moisture content was found minimum in the 1st week of November with the values of 4.35, 3.70, 4.10 and 3.37 % for Contour bund cum trench, Contour bund, Contour trench and Control respectively.
5. The moisture content was found higher at the depth of D₃ (30-45 cm) before rainfall and was found more at the depth of D₁ (0-15 cm) after rainfall.

6. The overall moisture content was found to be more in contour bund cum trench even before and after rainfall.
7. The bulk density was recorded maximum before the rainfall with an average value of 1.57g/cm^3 in comparison to 1.52g/cm^3 and 1.53g/cm^3 which are respective values of bulk density after the rainfall and at the time of harvesting.
8. The infiltration rate was found maximum before rainfall and minimum after the rainfall with the corresponding range of 150 to 9.8 mm/h and 75 to 9.50 mm/hr respectively.
9. The crop productivity was found to be highest in contour bund cum trench followed by contour trench, bund and control with the value of 20.5, 18.7, 16.5 and 14.3 q/ha respectively.
10. The increase in the crop productivity in contour bund cum trench was found to be 43.3% in comparison to control. In case of contour bund and contour trench, the increase in the crop productivity in comparison of control plot were 15.3% and 30.7% respectively.
11. The moisture variation throughout the growing period of wheat crop with respect to depth of soil under study was found improved in treatment T_1 (Contour bund cum trench) followed by T_3 (Contour trench), T_2 (Contour bund).
12. The moisture variation throughout the growing period of wheat crop with respect to distance from conservation measures was found enhanced in treatment T_1 (Contour bund cum trench) followed by T_3 (Contour trench), T_2 (Contour bund).

Suggestions for the future work

- ✓ Rainfall intensity data can be further more useful in studying moisture dynamics for different duration of the rainfall events.
- ✓ Impact of community pond can be studied for moisture conservation and ground water recharge within the study area.

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Appendix-I**Weekly observed actual Standard Meteorological Weekly (SMW) data for Rabi 2020-21**

Week No.	Max.T	Min.T	Rh1	Rh2	R.F
40	33.9	18.2	76.3	39.6	0.0
41	33.5	18.0	81.4	40.0	0.0
42	32.4	14.4	90.3	31.9	0.0
43	30.3	12.4	89.9	34.4	0.0
44	28.7	10.8	85.7	32.4	0.0
45	27.9	9.6	88.4	39.6	0.0
46	23.2	9.8	92.7	58.0	27.8
47	20.6	8.5	91.9	55.9	0.0
48	23.7	7.4	92.4	48.3	8.0
49	23.3	9.8	92.1	57.9	0.8
50	18.5	8.3	93.7	65.9	27.6
51	17.6	3.0	93.9	61.7	0.0
52	15.0	2.9	95.4	73.5	8.8
1	18.8	8.4	93.3	72.6	88.2
2	14.9	8.7	93.7	79.7	0.0
3	17.9	6.0	95.3	72.7	0.0
4	17.8	5.0	92.4	62.7	3.8
5	19.8	6.0	89.3	50.1	0.0
6	21.1	6.9	92.1	52.7	0.0
7	21.5	10.4	95.9	67.9	0.0
8	25.9	10.5	92.0	49.6	0.0
9	26.5	10.4	84.4	50.4	0.0
10	28.6	11.7	80.1	39.3	0.0
11	27.1	12.3	86.1	50.7	3.6
12	26.7	13.4	80.4	47.7	15.2
13	31.0	13.7	72.9	34.7	0.0
14	30.8	12.0	62.0	27.3	1.6
15	33.7	14.3	56.9	20.7	1.6
16	28.9	15.5	63.0	41.7	11.0
17	35.6	15.3	59.3	20.0	8.0

Weekly observed normal Standard Meteorological Weekly (SMW) data for *Rabi* 2020-21

Week	Max.T	Min.T	Rh1	Rh2	R.F
40	32.7	20.3	83	53	4.6
41	31.9	18.4	80	47	7.3
42	30.6	16.6	82	47	6.3
43	30.0	15.5	82	47	1.8
44	29.3	14.3	82	46	1.3
45	28.0	13.0	85	45	1.7
46	26.9	11.7	84	42	3.7
47	25.6	10.6	86	42	0.8
48	24.1	9.1	87	45	3.7
49	23.2	8.7	88	45	0.9
50	21.6	8.5	89	51	7.1
51	20.6	7.9	90	56	2.4
52	19.0	6.9	91	58	12.6
1	17.4	5.5	88	63	9.4
2	18.0	5.6	89	60	8.6
3	17.8	5.8	87	60	10.1
4	19.4	5.9	86	52	14.0
5	20.5	6.9	85	51	10.7
6	20.8	7.7	84	54	12.1
7	21.6	8.5	84	52	13.4
8	22.1	9.0	84	52	17.9
9	23.9	10.0	82	50	14.4
10	26.1	11.2	80	46	11.8
11	26.9	12.3	80	47	21.2
12	27.6	13.2	77	43	23.8
13	29.3	14.4	75	42	8.1
14	30.0	15.1	73	39	9.9
15	32.2	16.3	67	34	7.7
16	33.9	17.5	66	32	6.6
17	35.5	18.9	60	30	6.3

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CERTIFICATE- IV

Certified that all necessary corrections as suggested by the external examiner and advisory committee have been duly incorporated in the thesis entitled "Response of Soil and Water Conservation Technologies on Soil Moisture Dynamics in Rainfed Area of Jammu District", submitted by Er. Zubair Ahmad Khan, Registration No. J-19-M-701.



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