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Effect of Animal Manure Application Rates on Soil Moisture Conservation at, Somali Regional State, Ethiopia

Tekilil Wolde

Department of Soil and Water Conservation Engineering, Wolikte University, Ethiopia

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Email: woldetekilil@gmail.com

Abstract: The Ethiopian economy is mainly agrarian. It employs 85% of the population and contributes 45% of the gross domestic product and 90% of the national export earnings but agriculture in Ethiopia is dominated by rainfed farming with low productivity specially dry land part of the country like Somali region. As a result, crops have severe moisture stress through their growth stages. Therefore, a field experiment was conducted at Somali region of sandy clay loam soil in the year 2012/13 to assess the effectiveness of different manure applications rate, enhancing soil moisture and thereby productivity. The experiment was arranged in a random complete block design RCBD with three replications; and three rates-of-manure applications 0 tons/ha, 3 tons/ha and 6 tons/ha having a total of nine treatments plot were tested. The analysis of variance for the results of the study indicated that the significant differences were observed in soil bulk density, porosity and available moisture content due to different levels of animal manure applications. Soil moisture content at different soil depths at an interval of 15 days also showed a significant difference due to animal manure. The maximum (35.67%) average soil moisture content was recorded due to 6 tons of manure as compared to the moisture content recorded from without manure (31.10%). Therefore, 6 tons of animal manure may be recommended to reduce the risk of moisture stress and to fetch a good yield in the study area. The application of manure results to high soil infiltration rate and it could be important approach for dry land farmers.

Keywords: Animal Manure, Soil and Water Conservation

Introduction

About 95% of the world's population growth occurs in tropical developing countries whose rural economy is based on rainfed agriculture (Rockström *et al.*, 2003). Small-scale farming is the main source of food and income in semi-arid and dry sub-humid sub-Saharan African countries. In Sub-Sahara Africa, rainfed agriculture is likely to remain the dominant source of food production for the next foreseeable future since more than 95% of the agricultural farmland is under rainfed agriculture (Rockström, 2000). The Ethiopian economy is mainly agrarian. It employs 85% of the population and contributes 45% of the gross domestic product and 90% of the national export earnings. The population of the country is increasing at alarming rate of 3.3% annually and it is expected to reach 117.2 million by the year 2030. Food deficit in the whole country, in general and in the dry land areas in particular, is increasing mainly due to drought (Kidane and Abuhay, 2000).

Agriculture in Ethiopia is dominated by rainfed farming with low productivity. The average annual grain production as 7 million tons is too low to support national food demands (Eyasu, 2005). Land degradation in the form of soil erosion and declining soil quality is a serious challenge to agricultural productivity and economic growth (Mulugeta *et al*., 2005). Since rainfall is scarce and erratic in eastern Ethiopia including Somali Region, there is strong moisture stress, limiting the productivity of rainfed agriculture. The Somali Regional State (SRS) of Ethiopia covers 281,900 km^2. It is the second largest regional state in Ethiopia and the area is dominated by arid and semi arid range land vegetation which is not suitable for agricultural practices (World Bank, 2001). The dry land of Ethiopia accounts for more than 66.6% of the total land mass. In the dry land areas, the major constraint to agricultural production is moisture stress. The main causes of moisture stress are low and erratic rainfall, runoff losses due to poor water retention and high evapo-transpiration losses caused by high temperature, strong wind and weeds (Asmare, 2012). Low soil fertility and shallow in depth along with the use of improper tillage implements stand next to soil moisture stress. Moreover weed competition, poor seedling emergence; compaction is important constraints in dry land areas (Kidane and Abuhay, 2000). Agriculture in Somali region is dependent on small scale irrigation as the only source of water. The soil types in arid and semi-arid areas of Ethiopia are also diverse, most of them are shallow and with low organic matter, resulting in poor water holding capacity. The precipitation is less likely to be available to the crop, thus water conservation must be a unique practice. But the land use pattern of Somali Regional State (SRS) indicates that more than 80% of the total land provides the natural feed base for the livestock production (SPSS, 1996). This shows that most of the people are engaged in pastoral way of living and no attention on soil conservations activities. Although drought is the major reason causing famine in Ethiopia, low level of agricultural productivity due to poor management of the available resources is a very important factor that has rendered the country sensitive to even tolerable shortage of rainfall. Efforts made to develop improved crop varieties alone have not been successful and it has recently been recommended that improving the management aspect will be a better option for the dry land areas (Kidane and Abuhay, 2000). Improved management factors focus not only on improving crop yield but also on maintaining and improving the soil productivity for a sustainable agriculture. Soil and water conservation should also be integrated with other improved agronomic practices so that the soil water retained could be used effectively. Soil moisture also ensured through the use of different conservation tillage to reduce risk levels sufficiently and investments in fertilizers, weed control and improved agronomic practices must be made. Thus, the interaction between the high yielding potential of the cultivars and favorable agronomic conditions was realized, leading to substantial yield increase (Kidane and Abuhay, 2000).

The major constraints to agricultural production in study area are; moisture stress, low soil fertility and the use of improper tillage implements. The main causes of moisture stress are; low and erratic rainfall, runoff losses due to poor water retention and high evapotranspiration losses caused by high temperature, strong wind. Since the study area has a problem of low, erratic and uneven rainfall distribution and the farmers in study area are mostly involved in pastoral ways of living, then the area has a potential of manure. Thus, the study was conducted; to investigate the effects of different levels of farm yard manure application on soil moisture conservation; instead of dropping anywhere.

Materials and Methods

Description of the Study Area

The experiment was conducted at Gode, in Somali Regional State located at 1225 km south east of Addis Ababa and which is center of the Region. The experimental site is situated at latitude of 5°95’-6°12’N, longitude of 44°95’-45°21’E and altitude of 295 m above sea level. The farmers in the study area are mainly engaged in livestock production but produce low quantities of fruit (papaya, mango and banana), vegetables (onion, tomato and pepper) and cereals (maize and sorghum, mainly for animal feed at immature stage) by using small scale irrigation. The experiment site is bordered on the south-west by the Adadle district, on the south-east by the Kelafo district, on the east by the Korahe zone and on the north by the Danan district. The Wabe Shebele river forms the southern and eastern boundaries of the study area.

The Region is climatically characterized as arid to semi-arid agro-ecology, where the average annual rainfall is around 150-250 mm and mean annual temperature is 33.3°C with maximum and minimum temperature of 38°C and 32°C, respectively. The topography of study area is an extensive flat to gently sloping. Areas with steep to very steep topography are very small and accounts about 2.4% of the total area. Several soil types exist in the Region. The predominant soil types are Calcic xerosols, Gypsic yemosols and Fluvisols (Ayele, 2005).

Treatments and Experimental Design

A field experiment was carried out at Gode in Somali regional sate to investigate the effects of different levels of animal (cattle) manure application on soil moisture conservation. The experiment consists of three animals (cattle) manure application rates and three replications; nine total treatment plots arranged in Random Complete Block Design (RCBD). The nine treatments plots include, three different levels of animal manure with three replication like without manure 0 ton per ha (t1), 3 tons per hectare (t2) and 6 tons per hectare (t3). Each treatment was applied on an effective plot size of 5×2 m (10 m^2) and separated by a distance of 1 m between blocks and 1m within plots (Fig. 1).

Farm Yard Manure

Different levels of air dried animal manure was broadcasted one month before bed preparation to each respective plot to facilitate decomposition and incorporated into the soil. Broadcast application of manure was strictly followed because local concentration of manure has a risk of burning of the crops and unnecessary wastage. The experiment was started at the beginning of November (08/2012) to May (08/2013) since these months are dry season for study area and important to analyze moisture difference due to manure application.

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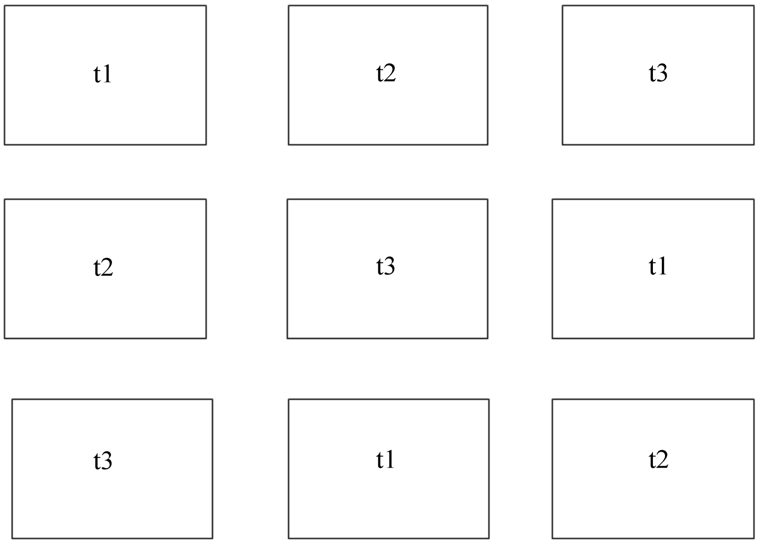

Fig. 1: Layout of the experiment

Data Collection

Soil Sampling and Measurements of Soil Parameters

Using an auger, disturbed composite surface soil samples (0-20 cm) were collected from the experimental field for determination of soil physiochemical properties just before any input application. Root zone depth of most crops around study area were expected as 40-60 cm, but most water and nutrient uptake occurs from the top 30 cm of soil (Abebe, 1998). Moreover, disturbed soil samples were collected up to (0-60 cm) depth at an interval of 20 cm with the help of hand auger from each plot with an interval of 15 days for moisture determination throughout the experimenting season. In addition, undisturbed soil samples were also collected using core sampler from each plot for the determinations of bulk density, field capacity, permanent wilting point and available soil moisture of the soil. The disturbed surface soil samples were air-dried and sieved using 2mm sieve in preparation for laboratory analysis. Roots and coarse materials were removed during sieving operation. The fraction less than 2 mm in diameter was used for laboratory analysis of selected physical and chemical properties of the soil samples.

Infiltration Rate of Soil

For the infiltration rate determination, the procedure for installing the double ring infiltrometer was used by selecting possible sites properly to prevent unusual surface disturbance, by animal burrows, stones that might damage the cylinder, etc. Then, the cylinder was set in place and pressed firmly into the soil, after which the driving plate had been placed over the cylinder and altered with the driving hammer until the cylinder was driven to a depth of about 15 cm. The outside ring is used for water infiltrating vertically and can control lateral flow and to preserve the integrity of the measurement. The measurement was done at two randomly placed infiltrometer within experimental site (FAO, 1989).

Soil Analysis

Particle size distribution was determined by bouyoucos hydrometer method using sodium hexa metaphosphate as dispersing agent (Brady and Weil, 2000). Soil pH was measured electrometrically by means of pH meter in a suspension of 1:2.5 soils to water ratio as described by Olsen *et al*. (1954). Organic carbon was determined following the wet digestion method as described by Walkley and Black (1934) while total nitrogen was determined using the macro-Kjeldahl method (Bremner and Mulvaney, 1982). Available phosphorus was determined using spectrophotometer from extracts following the Olsen extraction method (Olsen *et al*., 1954). And available potassium was determined using ammonium acetate/acetic acid solution method. Exchangeable K^+ and Na were extracted with 1M ammonium acetate at pH 7.0. Exchangeable Ca and Mg were also measured from the extract with atomic absorption spectrophotometry while Cation Exchange Capacity (CEC) of the soil was determined from ammonium acetate saturated samples that was subsequently replaced by Na from a percolated sodium chloride solution. The excess salts were removed by washing with alcohol and the ammonium that was replaced by sodium was measured using the Kjeldahl method as described by Bremner and Mulvaney (1982) and reported as CEC.

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Bulk Density

Soil bulk density (ρb) was determined from undisturbed soil sample which is the ratio of the oven dry mass of soil and the bulk volume (Baruah and Barthakur, 1997). This method involves taking a soil sample by core sampler from the desired depth and determines the mass of solids soil, after drying it to constant weight in an oven at 105°C; and reweighing after cooling:

$$\rho b = \frac{dry\,soil\,weight}{volume\,of\,core\,ring} \tag{2.1}$$

Particle Density

Particle density was determined by collecting disturbed soil sample and passed through 2 mm sieve. It was estimated by determining the mass and volume of soil solids. The mass of soil solid was determined by weighing the oven dry soil with required amount and the volume of the soil solid was determined by using replacement method. The weighed soil was poured into the water and the air bubbles were eliminated by stirring with a rod. The change in volume of water in the cylinder was taken as volume of soil particles then finally the soil particle density was calculated by the expression:

$$\rho s = \frac{dry\,soil\,weight}{volume\,of\,soil\,particle} \tag{2.2}$$

Porosity

Total porosity (n) of the soil sample was estimated on the basis of measured dry bulk density (ρb) and particle density (ρs) as:

$$n = \left(1 - \frac{\rho b}{\rho s}\right) * 100 \tag{2.3}$$

Soil Moisture Content (SMC) Determination

The wet soil samples were weighed and placed in an oven at 105°C till constant weight attainment and then the weight of dry samples were measured. The following formula was used to calculate the soil moisture content for every sampling period:

$$SMC = \frac{Ww - Wd}{Wd} * 100 \tag{2.4}$$

Where:
SMC = Soil moisture content on mass basis (%)
Ww = Weight of the wet soil (g)
Wd = Weight of the dry soil (g)

The volumetric soil moisture content, θ (%) was determined by considering the density of the soil water as 1 g/cm³ (ρw):

$$\theta = W * \rho_b / \rho w \tag{2.5}$$

Where:
W = Soil moisture content on mass base (%)
ρ_b = Bulk density (g/cm³) of the soil

Field capacity and permanent wilting point were determined at -0.33 and -15 bar pressure respectively using standard laboratory procedures on undisturbed soil samples. The suction range between 1 to 4.2 pF was determined with pressure plate apparatus and the equation (Eq. 2.6) was proposed by (Baruah and Barthakur, 1997). To express the energy or tension with which the water was retained to the soil which was important to develop soil moisture characteristics curve:

$$pF = \mathrm{Log}_{10}\left[H\right] \tag{2.6}$$

where, H = height of water column (m).

The water retained by an initially wet soil sample was drained to equilibrium, at a suction of -1/3 bar on 0-1 bar pressure plate equipment and the gravimetric water content of the soil corresponding to the point of equilibrium was reported as the estimated Field Capacity (FC). The Permanent Wilting Point (PWP) was determined by subjecting the sample to a -15 bar pressure equilibrium in pressure plate apparatus (Baruah and Barthakur, 1997).

Data Analysis

Data were subjected to analysis of variance following a procedure appropriate to the design of the experiment (Gomez and Gomez, 1984) using Gen Stat edition 13rd. The treatment means that were different at 5% levels of significance were separated using Duncan's Multiple Range Test (DMRT).

Results

Rainfall Amount and Distribution during the Cropping Season

As observed, there was serious shortage of rainfall throughout the year in study area. But little rainfall was experienced during cropping season of 2013 in the months of March and April. Hence, the total rainfall (3.1 mm) was recorded over the period of the cropping season. Rain pattern of study area is characterized by two rainy seasons and two dry seasons. The main rainy season extends from October to December and April to June and short rainy season stretches from July to September and January to March. The average annual rainfall is around 100-250 mm. Long year experience of average monthly rainfall distribution in study area can be located by Fig. 2.

Characterization of Soil at Experimental Site

Soil physiochemical characterization of the experimental site was carried out on disturbed and undisturbed surface and subsurface soil samples during experimental season. The laboratory analysis results of soil before any input application presented and discussed in the following sub sections.

Soil Analysis Before Any Input Application

Composition of clay, silt and sand percentages were found to be 21.98%, 9.14% and 68.12% respectively (Table 1). Thus as per the USDA soil textural classification, the soil was classified as sandy clay loam soil with nearly alkaline in reaction (pH as 7.73). The organic matter content, available phosphors, exchangeable K, exchangeable Na, exchangeable Ca, exchangeable Mg, C.E.C and total nitrogen of the soil were found to be 0.836, 8.60, 0.49, 0.76, 9.63, 3.374, 18.1 and 0.102 respectively (Table 1). According to the soil test values all most all chemical properties considered in the laboratory analysis indicate that the soils of the study area are poor in natural soil fertility. Moreover, the soils are low in organic matter content which in turn influenced significantly many of the most important soil physical properties.

Soil Analysis After/End of Experiment

After/end of experiment, disturbed soil samples were collected from each respective plot for chemical analysis to assess the effect of manure on specified soil properties. As indicated in Table 2, there is significant difference ($p \leq 0.05$) in chemical properties of the soil due to manure application and increased the residual amount of essential nutrients of the soil as compared to the control treatment. Application of 6 and 3 tons of manure per hectare increased the residual amount of the organic matter by (3.78%, 2.62%), phosphors (6.38%, 3.38%), Ca (13.48%, 10.64%), C.E.C (6.87%, 5.19%) and total nitrogen (10.28%, 7.11%) respectively in the soil as compared to the plots not treated with manure.

However, there was depletion of potassium (20.26%, 19.01%) in the soil by the applications of 6 ton and 3 ton manure per hectare and there is almost no significant change in magnesium and sodium. There was also reduction of available phosphorus in the control plot as compared to the soil before input application this may be due to high utilization of organic manure by the crop. The similar work was reported by Girma (2011) in Somali region and indicated that the application of 10 tons of manure /ha, has a significant effect on different soil chemical properties and organic matter content.

Soil Bulk Density and Porosity After Harvesting

The analysis of the soil data on bulk density and porosity (Table 3) was highly significant ($P<0.01$). Differences were visible in different levels of animal manure as compared to the plot which was not treated. This may be due to the effect of manure on soil aggregates formation and soil pore space increment. The same result was reported by Sultani *et al.* (2007). According to their observation, a maximum reduction of 7% in soil bulk density and an increase of 11% in total soil porosity were observed in plots where animal manure was incorporated. The mean data (Table 3) indicates that the application of 6 and 3 tons/ha of animal manure decreased the bulk density significantly by 6% and 2.6% and significantly increased porosity of the soil as compared to the plot which was not treatment by 6.03% and 3.16% respectively.

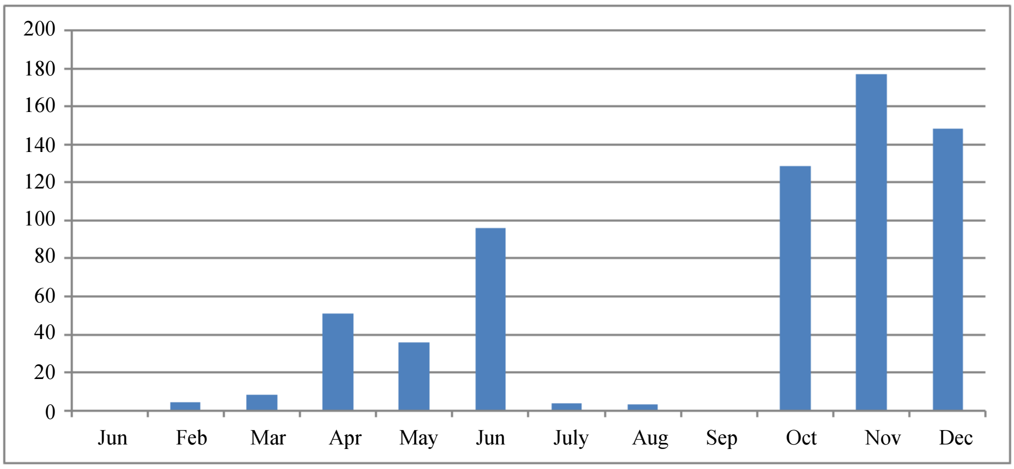

Fig. 2: Average monthly rainfall (mm) of study area from 2005-2013

Table 1: Soil physiochemical properties of experimental site before input application

Soil properties	value
Sand (%)	68.12
Silt (%)	9.14
Clay (%)	21.98
Textural class	Sandy clay loam
Bulk density (gm /cm^3)	1.20
Particle density (gm /cm^3)	2.72
Porosity (%)	56.00
PH (1.25 H_2O)	7.73
Total nitrogen (%)	0.10
Organic matter (%)	0.84
Exchangeable K (cmol(+)/kg)	0.49
Exchangeable Mg (cmol(+)/kg)	3.37
Exchangeable Ca (cmol(+)/kg)	9.63
Exchangeable Na (cmol(+)/kg)	0.76
Available Phosphorus (ppm)	8.60
Cation exchangeable capacity (meq/100g soil)	18.10

Table 2: Selected soil chemical properties of the surface soil of the experimental plots after/end of experiment.

Treatments	T.N %	O.M%	Ex.K Cmol(+)kg^{-1}	Ex.Mg Cmol(+) kg^{-1}	ex.Ca Cmol(+)kg^{-1}	ex.Na Cmol(+) kg^{-1}	av.P PPM	C.E.C Meq/100 gm soil
Tons man.0 (t1)	0.10^a	1.39^a	0.481^a	3.569^a	9.628^a	0.760	7.794^a	18.204^a
Tons man.3 (t2)	0.13^b	1.46^b	0.284^b	3.724^b	13.677^c	0.757	8.670^b	21.430^b
Tons man.6 (t3)	0.14^b	1.51^c	0.271^b	3.757^b	14.759^b	0.796	9.448^c	22.473^b

Note: Treatment means within a column followed by the same letter are not significantly different at $p \leq 0.05$

Table 3: Soil bulk density and porosity

	Bulk density (gm/cm^3)		Porosity (%)	
Treatment	Mean ± SE	CV %	Mean ± SE	CV%
Tons manure 0 (t1)	1.16^a±0.044	1.12	56.71^a±0.16	0.85
Tons manure 3 (t2)	1.05^b±0.038	1.00	58.44^b±0.14	0.73
Tons manure 6 (t3)	1.03^c±0.064	1.71	59.50^c±0.23	1.18

Note: Treatment means within a column followed by the same letter are not significantly different at $p \leq 0.01$

Field Capacity (FC) and Permanent Wilting Point (PWP) at Different Soil Depths

Application of 6 ton/ha and 3 ton/ha had a significant ($p<0.05$) impact on field capacity at soil depths of 0-20 and 40-60 cm. However, there was no significant effect on field capacity at a soil depth of 20-40 cm as compare with 0 ton/ha manure. The application of 6 tons of animal manure shows a significant field capacity increment as compared to application of 3 tons and the plot which was not treated (Table 4). The application of 3 tons of animal manure also had a significant field capacity increment as compared to without manure plot. The maximum field capacity (36.60%) was recorded due to 6 tons of manure treatment followed by 3 tons of manure (32.80%) and the lowest (29.10%) was recorded for the treatments which had not received any animal manure (Table 4) in 0-20 cm and 40-60 cm soil depth respectively. Here, it can be said that the application of manure improves soil physical properties by increasing the distribution and stability of soil aggregates and decreasing soil bulk density. In addition, the application of animal manure did not have any significant impact on permanent wilting point at soil depths of 40-60 cm. This indicates that at wilting point the pore space does not have critical effect on the soil moisture due to holding of water under high tension in the soil particles. But a significant PWP ($p \leq 0.05$) increment was observed due to both (6 and 3 ton/ha) levels of animal manure application at a soil depth of 0-20 and 20-40 as compared to without manure.

Significant ($p<0.05$) available soil moisture content differences were observed due to different levels of animal manure applied at 0-20 and 20-40 cm soil depths. But there was no significant available moisture difference due to animal manure application at a soil depth of 40-60 cm. Application of 6 tons manure shows significant available moisture increment over 0 ton at the specified soil depths. The maximum (16.90% and 14.21%) available moisture was recorded due to 6 tons of manure at soil depths of 0-20 and 20-40 cm respectively followed by (13.20% and 12.71%) due to 3 tons of manure at 0-20 and 20-40 cm depths respectively (Table 4).

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Infiltration Rate

The basic infiltration rate of the soils of the study area was observed as 17.61 mm/hr (Appendix 1). This value was less than 30 mm/hr (Fig. 3) which is in an expected range for sandy soil. The infiltration data was used as an input data for CROPWAT model.

Soil Moisture Content at 15 Days of Experiment

The analysis of variance shows that the application of animal manure had brought about a significant difference ($p \leq 0.01$) at all depths. Moreover, at this sampling time the Table 5 shows that the moisture retaining structures (tillage method) and different levels of animal manure have no any significant interaction effect ($p > 0.01$) at all soil depths. This may be due to lack of enough time to decompose the farm yard manure in the soil. Soil moisture determined at all soil depths, 6 tons of animal manure influenced soil moisture content significantly ($p \leq 0.01$) as compared to control treatment and 3 tons of animal manure treatment (Table 5). This could be due to the ability of animal manure to hold more moisture and to reduce evaporation losing. The soil moisture content observed at the depths of 0-20 and 40-60 cm also has significant difference between 3 tons of animal manure.

Soil Moisture Content at 30 Days of Experiment

The analysis of variance (Table 6) also shows that the application of animal manure had brought about a significant difference ($p \leq 0.01$) at all depths. The highest soil moisture content was observed at 20-40 cm sample depth in all applied treatments but there was no moisture difference at 0-20 and 40-60 cm sample depth. The moisture content increment due to the application of 6 tons and 3 tons of animal manure were found as 35.77% and 31.38% at a depth of 20-40 cm, 33.23% and 30.91% at a soil depth of 40-60 cm and 33.37% and 29.99% at 0-20 cm soil depths respectively. The second sampling period had better moisture increment than the first sampling period at all soil depths. The highest (35.77%) moisture was observed at 20-40 cm depth and 32.95% soil moisture also recorded at 0-20 cm on the second and first sampling period respectively. This could be due to well incorporation of manure with the soil and reduction of evaporation losses by ground cover.

Soil Moisture Content at 45 Days of Experiment

The analysis of variance also shows that the application of animal manure had brought about significant difference ($p \leq 0.01$) soil moisture in compared to plot which is without manure (Table 7). The highest value of soil moisture content was observed at 20-40 cm sample depth in all applied treatment but the lowest soil moisture was recorded at sample depth of 0-20 cm. Application of 6 tons manure had better increment in soil moisture than 3 tons manure at all sample depths, but there was no significant moisture different at 0-20 and 40-60 cm. The highest moisture content due to the application of 6 tons and 3 tons of animal manure were found as 38.73% at 20-40 cm depth and 33.33% at a depth of 40-60 cm respectively.

Generally, gravimetric soil moisture at the third sampling period had a significant increment than the second 30 days of experiment as well as the first 15 days of experiment sampling period. The highest moisture content 36.82% at 0-20 cm depth, 35.77% at 20-40 cm depth and 32.95% at 0-20 cm soil depth were observed on the third, second and first sampling period in 6 ton /ha manure application. This could be due to well incorporation of manure with the soil and reduction of evaporation loses by ground cover.

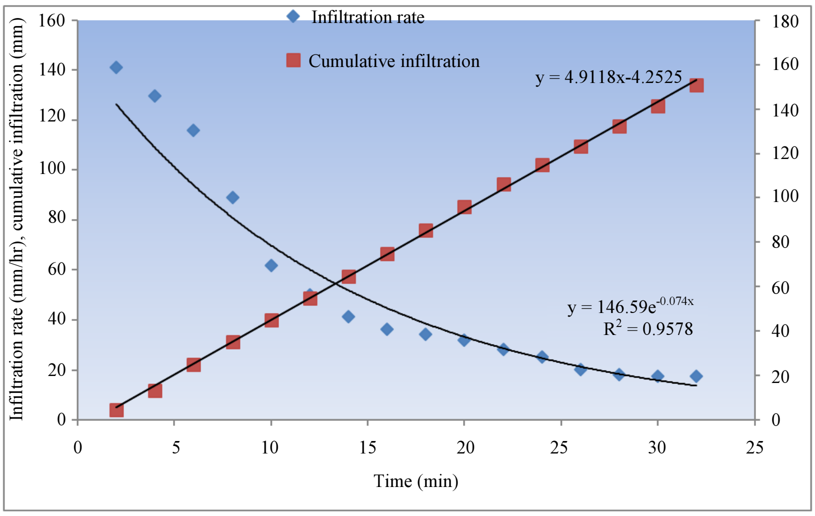

Fig. 3: Infiltration characteristics of the soil of experimental site

Table 4: Field capacity, PWP and AWC analysis

	Field capacity%						Permanent welting point%						Available moisture content%					
	0-20		20-40		40-60		0-20		20-40		40-60		0-20		20-40		40-60	
Treatment	Mean ± SE	CV%	Mean ± SE	CV%	Mean ± SE	CV%	Mean ± SE	CV%	Mean ± SE	CV%	Mean ± SE	CV%	Mean ± SE	CV%	Mean ± SE	CV%	Mean ± SE	CV%
0 tons (t1)	29.6c±0.15	1.51	31.1a±0.38	3.85	29.1c±0.27	2.79	18.8a±0.03	1.57	17.7a±0.10	1.82	17.2a±0.12	2.13	11.7a±0.14	3.60	12.3a±0.32	7.99	12.1a±0.36	8.8
3 tons (t2)	32.8b±0.06	1.55	31.5a±0.23	2.28	30.8a±0.29	2.82	18.6a±0.17	2.62	18.7a±0.18	2.87	18.6a±0.28	4.62	13.2c±0.11	2.65	12.7c±0.13	4.16	12.1a±0.24	6.1
6 tons (t3)	36.6a±0.11	1.97	32.5a±0.16	2.50	31.7b±0.21	2.06	19.7b±0.14	2.14	19.3b±0.19	3.03	18.7a±0.18	2.92	16.9b±0.15	3.19	14.2a±0.21	4.90	13.0b±0.13	3.2

Note: Treatment means within a column followed by the same letter are not significantly different at $P \leq 0.05$

Table 5: Moisture content references at 15 days of experiment

	Sampling depth (cm)					
	0-20		20-40		40-60	
Treatment	Mean ± SE	CV%	Mean ± SE	CV%	Mean ± SE	CV%
Ton man.0 (t1)	$26.07^{b}\pm1.07$	12.41	$26.66^{b}\pm0.99$	11.16	$26.58^{ab}\pm1.16$	13.17
Tonsman.3 (t2)	$27.51^{b}\pm1.03$	11.22	$28.96^{a}\pm0.99$	10.35	$29.36^{c}\pm0.850$	8.72
Tonsman.6 (t3)	$32.92^{a}\pm1.02$	10.20	$30.84^{c}\pm0.98$	9.60	$30.16^{c}\pm0.940$	9.36

Note: Treatment means within a column followed by the same letter are not significantly different at $p \leq 0.01$

Soil Moisture Content at 60 Days of Experiment

A perusal of the data on the soil moisture content at the fourth fifteen days after days of experiment (Table 8) revealed that there was significant differences ($p \leq 0.01$) due to the application of animal manure had significant change ($p \leq 0.01$) in soil moisture content as compared to plot which was untreated. The highest and lowest values of soil moisture contents were observed at 0-20 and 40-60 cm sample depths respectively. The highest moisture contents due to the application of 6 tons and 3 tons of animal manure were found as 41.42% at 0-20 cm depth and 38.68% at a depth of 20-40 cm respectively. Soil moisture at this sampling period had a significant increment than the previous sampling time. The highest moisture content (41.55%) at 0-20 cm depth, (36.82%) at 0-20 cm depth, (35.77%) at 20-40 cm depth and (32.95%) at 0-20 cm soil depth were recorded on the fourth, third, second and first sampling period in 6 ton/ha manure application respectively.

Soil Moisture Content at 75 Days of Experiment

The Table 9 indicates that the application of 6 tons of manure had a significant change ($p \leq 0.01$) in soil moisture compared to plot which was untreated and with 3 tons of manure at all soil depths except 40-60 cm depth. The highest value of soil moisture content was observed at 20-40 cm sample depth where as the lowest soil moisture was recorded at sample depth of 0-20 cm. The highest moisture content due to the application of 6 tons of animal manure was found as 39.47% at 0-20 cm depth. The highest moisture content (40.05%) at 0-20 cm depth, (41.55%) at 0-20 cm depth, (36.82%) at 0-20 cm depth, (35.77%) at 20-40 cm depth and (32.95%) at 0-20 cm soil depth, were recorded on the fifth, fourth, third, second and first sampling period in 6 ton/ha manure application respectively. Soil moisture at this sampling period had better increment than the first two sampling periods, but did not have a significant ($p > 0.01$) increment than the third sampling period and significantly reduced as compared to 60 days sampling time.

Soil Moisture Content at 90 Days of Experiment

Table (10) the analysis of variance shows that the application of animal manure had brought about significant difference ($p \leq 0.01$) in soil moisture as compared to plots which were held without manure. The highest value of soil moisture content was observed at 0-20 cm sample depth in all applied treatments but the lowest soil moisture was recorded at sample depth of 40-60 cm. Application of 6 tons of manure had better increment in soil moisture than application of 3 tons of manure at all sample depths and brought significant moisture differences at 0-20 and 20-40 cm depths but no significant differences difference at 40-60 cm depth as compared to the upper two depths and the plots which were not treated with manure. The application of 3 tons /ha manure had also a significant difference in moisture than that of plot which was not treated with manure but there was no difference in moisture within a depth on both treatments. The highest moisture content due to the application of 6 tons, 3 tons and 0 ton of animal manure were found as 42.65%, 40.06% and 38.81% at a depth of 0-20 cm respectively.

Soil Moisture Content at 105 Days of Experiment

The analysis of variance (Table 11) shows that the application of 6 tons/ha animal manure had brought about a significant difference ($p \leq 0.01$) in moisture content as compared to 3 tons of manure application and untreated plot at two depths (0-20 and 20-40 cm) but no significant different at a depth of 40-60 cm. Application of 3 tons/ha animal manure did not have any significant moisture change was found with 0 ton/ha manure at all soil depths and with 6 tons ha manure at 40-60 cm depth of soil. The highest and lowest soil moisture contents-were observed at 20-40 cm and 40-60 cm sample depth in all applied treatments. The moisture content increment due to the application of 6 tons/ha of animal manure was found as 37.72% at a depth of 20-40 cm. The highest moisture content (37.72%) at 20-40 cm depth, (42.65%) at 0-20 cm depth, (39.87%) at 20-40 cm depth, (41.55%) at 0-20 cm depth, (36.82%) at 0-20 cm depth, (35.77%) at 20-40 cm depth and (32.95%) at 0-20 cm soil depth were recorded on the seventh, sixth, fifth, fourth, third, second and first sampling period respectively.

Table 6: Moisture content references at 30 days of experiment

	Sampling depth (cm)					
	0-20		20-40		40-60	
Treatment	Mean ± SE	CV%	Mean ± SE	CV%	Mean ± SE	CV%
0 tonsmanure (t1)	28.20^{b}±1.44	15.30	29.13^{b}±1.27	13.14	29.86^{b}±1.28	12.94
3 tonsmanure (t2)	29.99^{b}±1.25	12.50	31.38^{a}±1.18	11.73	30.91^{b}±1.48	14.37
6 tonsmanure (t3)	33.37^{a}±1.19	11.45	35.77^{c}±1.16	10.73	33.23^{a}±1.23	11.16

Note: Treatment means within a column followed by the same letter are not significantly different at p≤0.01

Table 7: Moisture content references at 45 days of experiment

	Sampling depth (cm)					
	0-20		20-40		40-60	
Treatment	Mean ± SE	CV%	Mean ± SE	CV%	Mean ± SE	CV%
0 tonsmanure (t1)	29.57^{b}±1.10	10.47	30.52^{b}±0.93	9.21	31.04^{c}±0.95	9.26
3 tonsmanure (t2)	32.09^{ba}±1.25	11.72	33.14^{ba}±1.24	11.27	33.33^{b}±1.35	12.23
6 tonsmanure (t3)	36.82^{a}±1.03	8.89	35.77^{a}±0.950	8.04	35.19^{a}±1.00	8.36

Note: Treatment means within a column followed by the same letter are not significantly different at p≤0.01

Table 8: Moisture content references at the 60 days of experiment

	Sampling depth (cm)					
	0-20		20-40		40-60	
Treatment	Mean ± SE	CV%	Mean ± SE	CV%	Mean ± SE	CV%
0 tonsmanure (t1)	36.65^{b}±0.77	6.38	37.34^{b}±0.62	4.98	37.50^{b}±0.48	3.86
3 tonsmanure (t2)	37.85^{b}±0.74	5.88	38.68^{b}±0.61	4.79	38.32^{b}±1.43	11.21
6 tonsmanure (t3)	41.42^{a}±0.66	5.07	40.05^{a}±0.68	5.09	39.76^{c}±0.66	4.92

Note: Treatment means within a column followed by the same letter are not significantly different at p≤0.001

Table 9: Moisture content references in the 75 days of experiment

	Sampling depth (cm)					
	0-20		20-40		40-60	
Treatment	Mean ± SE	CV%	Mean ± SE	CV%	Mean ± SE	CV%
0 tonsmanure (t1)	36.72^{b}±0.77	6.35	37.38^{b}±0.63	5.06	37.01^{b}±0.46	3.69
3 tonsmanure (t2)	37.95^{b}±0.72	5.74	38.73^{b}±0.61	4.72	38.51^{a}±0.65	5.00
6 tonsmanure (t3)	39.47^{a}±0.66	5.08	39.81^{a}±0.66	5.00	38.72^{a}±0.61	4.56

Note: Treatment means within a column followed by the same letter are not significantly different at p≤0.01

Table 10: Moisture content references at 90 days of experiment

	Sampling depth (cm)					
	0-20		20-40		40-60	
Treatment	Mean ± SE	CV%	Mean ± SE	CV%	Mean ± SE	CV%
0 tonsmanure (t1)	38.81^{c}±0.66	5.10	38.15^{c}±0.58	4.63	37.67^{c}±0.57	4.54
3 tonsmanure (t2)	40.06^{b}±0.97	7.20	39.39^{b}±0.86	6.49	39.36^{b}±0.87	6.60
6 tonsmanure (t3)	42.65^{a}±0.48	3.41	41.44^{a}±0.56	4.08	41.09^{a}±0.58	4.30

Note: Treatment means within a column followed by the same letter are not significantly different at p≤0.001

Table 11: Moisture content references at 105 days of experiment

	Sampling depth (cm)					
	0-20		20-40		40-60	
Treatment	Mean ± SE	CV%	Mean ± SE	CV%	Mean ± SE	CV%
0 tonsmanure (t1)	35.86^{b}±0.54	4.59	35.91^{b}±0.44	3.80	34.22^{b}±0.49	4.34
3 tonsmanure (t2)	36.64^{b}±0.59	4.73	36.70^{b}±0.39	3.23	35.77^{b}±0.28	2.50
6 tonsmanure (t3)	37.41^{a}±0.63	4.99	37.72^{a}±0.56	4.50	36.72^{b}±0.33	2.75

Note: Treatment means within a column followed by the same letter are not significantly different at p≤0.001

Table 12: Moisture content references at 120 days of experiment

	Sampling depth (cm)					
	0-20		20-40		40-60	
Treatment	Mean ± SE	CV%	Mean ± SE	CV%	Mean ± SE	CV%
0 tonsmanure (t1)	34.21^{b}±0.12	1.12	34.14^{b}±0.12	1.10	33.70^{a}±0.21	1.90
3 tonsmanure (t2)	34.70^{b}±0.27	2.39	34.06^{b}±0.20	1.76	33.07^{a}±0.27	2.44
6 tonsmanure (t3)	35.91^{a}±0.26	2.21	35.05^{a}±0.15	1.32	34.14^{b}±0.19	1.70

Note: Treatment means within a column followed by the same letter are not significantly different at p≤0.0

Soil Moisture Content at 120 Days of Experiment

The Table 12 indicates that the application of 3 tons of manure had no significant change (p≤0.01) in soil moisture compared to plot which was untreated at all soil depths whereas application of 6 tons of manure had a significant change (p≤0.01) in soil moisture compared to plot which was untreated and that of 3 tons of manure. The highest value of soil moisture content was observed at 0-20 cm sample depth in all treatments where as the lowest soil moisture was recorded at sample depth of 40-60 cm. The highest moisture content due to the application of 6 tons and 3 tons of animal manure were found as 35.91% and 34.70% at a depth of 0-20 cm respectively.

Conclusion and Recommendation

In dry land areas, small amount of rainfall with erratic and uneven distribution pattern affect crop production. For this reason, there must be some sort of land preparation practices needed like soil moisture conservation techniques. Land preparation is defined as different moisture conservation tillage methods that increase the amount of water stored in the soil profile by trapping or holding the applied water. The determination of soil moisture and all other parameters were carried out by direct field experiment and by using computer software for data analysis. The soil of the study area was sandy clay loam, nearly alkaline in reaction (pH in H_2O of 7.73), with poor in organic matter and total nitrogen contents. As observed in the soil dynamics, soil moisture content decreased with depth but there was some moisture increments at 20-40 cm soil depth. Due to manure application some soil physical properties and nutrient status of the soil had improved. Therefore, it could be concluded that ensured soil moisture availability through the use of 6 tons of animal manure would reduce risk levels sufficiently to make investments on any crop production in the semi-arid areas of the region. Further investigations should be required to know the residual effect of this experiment to bring and recommend better soil moisture conservation techniques to the community accordingly.

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Ethics

I, the author of this manuscript have agreed and read to its content and accountable for all aspects of the accuracy and integrity of the manuscript. The article I submit is original, has not already been published in a journal, and is not currently under consideration by another journal. I agreed to the terms of the American Journal of Agricultural and Biological Science Copyright and License Agreement.

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