Evaluating benefits of rainwater harvesting using infiltration pits in rain- fed cropping systems: Rushinga district, Zimbabwe

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INTRODUCTION

- There is general consensus that there is need to improve **food security** in Sub-Saharan Africa (SSA).
- Food security can be achieved by adopting **high yielding and sustainable cropping systems.**
- About 41% of SSA region is semi-arid.
- In these semi-arid areas food security is threatened by frequent droughts, dry spells and infertile soils.

Rockström and Falkenmark, 2000; Wallace, 2000; Sanchez, 2002; Rockström et al., 2002; Cai and Rosegrant, 2003; Kauffman et al., 2003; Steiner et al., 2003; SIWI, 2001;Rockström et al., 2003; Stroosnijder and Slegers, 2008

- Crop water productivity can be improved by:
  - ✓**optimising** use of rainwater water,
  - ✓mitigating dry spells and,
  - ✓maximizing plants' water uptake capacity.
- In rain-fed agriculture *in-situ* rainwater harvesting (RWH) can help to improve crop yields by bridging the gap between rainfall events.
- In this study, we **focused** on **infiltration pits**,
- Infiltration pits are trenches excavated at intervals in the channels of contour ridges for collecting runoff water (Figure. 1).

Figure 1. Picture of a infiltration pit in a contour ridge two days after a heavy rain storm in Ward 12, Rushinga, Zimbabwe

- ***Why infiltration pits?***
- Benefits claimed by farmers
- Need to quantify benefits if nay.
- Infiltration pits were combined with planting pits.

(Nyagumbo, 1999).

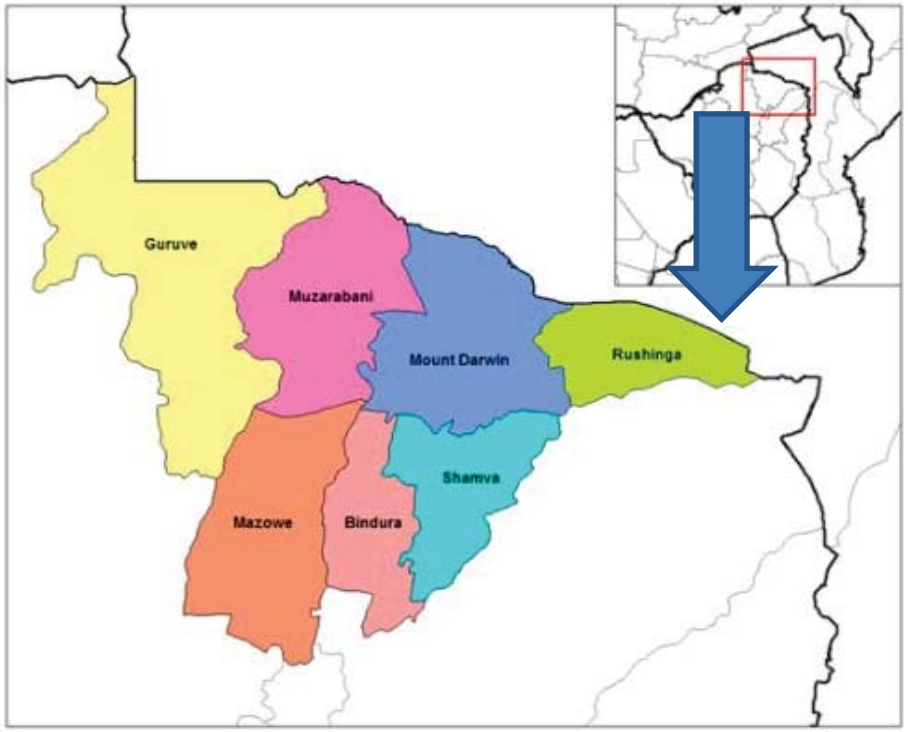
Figure 2. Planting pits two days after a heavy rain storm in Chongoma Village, Rushinga, Zimbabwe

Objective of study

- Our objective was to evaluate the benefits for:
  - ✓soil moisture improvement, and
  - ✓maize yield of combining infiltration pits and planting pits.

METHODOLOGY

Study Area



- Rushinga District, 730 m a.s.l. level ;
- mean annual rainfall 650 mm; mean minimum and maximum temperatures of 14.1 °C and 28.6 °C.

Research Design

- A split-plot design was used at two sites: Ward 11 and Ward 12.
- Major plots were distinguished by the presence/absence of infiltration pits
- Minor plots were distinguished by two tillage methods:
  - ✓conventional tillage
  - ✓ planting pits
- There were three blocks 60 m x 20 m separated by buffer zones of 5 m
- Treatments were replicated in an adjoining upper field
- A single treatment was applied in the downslope direction

Installation of Access Tubes

- Access tubes were installed at Ward 12, in one block, in two treatments:
  - ✓infiltration pits plus conventional tillage (two lines)
  - ✓and conventional tillage only (one line)
- Access tubes that were equidistant and in the same direction from the centre of the contour ridge channel or infiltration pit were given the same number:
  - ✓- A1 = 1 m upslope
  - ✓ A0 = centre
  - ✓ A1 is 1 m downslope (on ridge)
  - ✓ A2 is 2 m downslope (edge of ridge)
  - ✓ A11 is 11 m downslope (centre of field)
  - ✓ A15.7 is 15.7 m downslope (last quarter)

Crop management

- SC513, an early-maturing white maize cultivar, was planted
- Crop management was done according to local recommendations.
- Fertilizer application rates uses are for 3 to 5 t/ha yield potential

Data Collection

- Soil moisture content was measured weekly using the TRIME-PICO IPH moisture probe.
- In Ward 11 six samples were taken up to 0.8 m for determining gravimetric soil moisture content.
- Maize yield was measured from net harvest plots of 10 m × 10 m.
- Harvest index was calculated as the ratio of the grain yield to the total above-ground biomass.

Panigrahi and Panda, 2003;Hallauer et al., 1988

Data analysis

We used SPSS for Windows to do:

- ✓ Graphic trends analysis for soil moisture content
- ✓ ANOVA and the LSD test for maize grain yield, stover yield, and Harvest indices

Site Characteristics

Table 1. Characteristics of Ward 12 and Ward 11 sites

	Ward 12 site	Ward 11 site
Slope (%)	6	6
Soil texture (0.0-0.2 m)	mSaL	mSaL
Soil texture (0.2-1.0 m)	mSaL	mSaCL
Soil pH (0.01M$CaCl_2$)	6.2	5.6
Ca/Mg ratio	±1 to ≥4	2

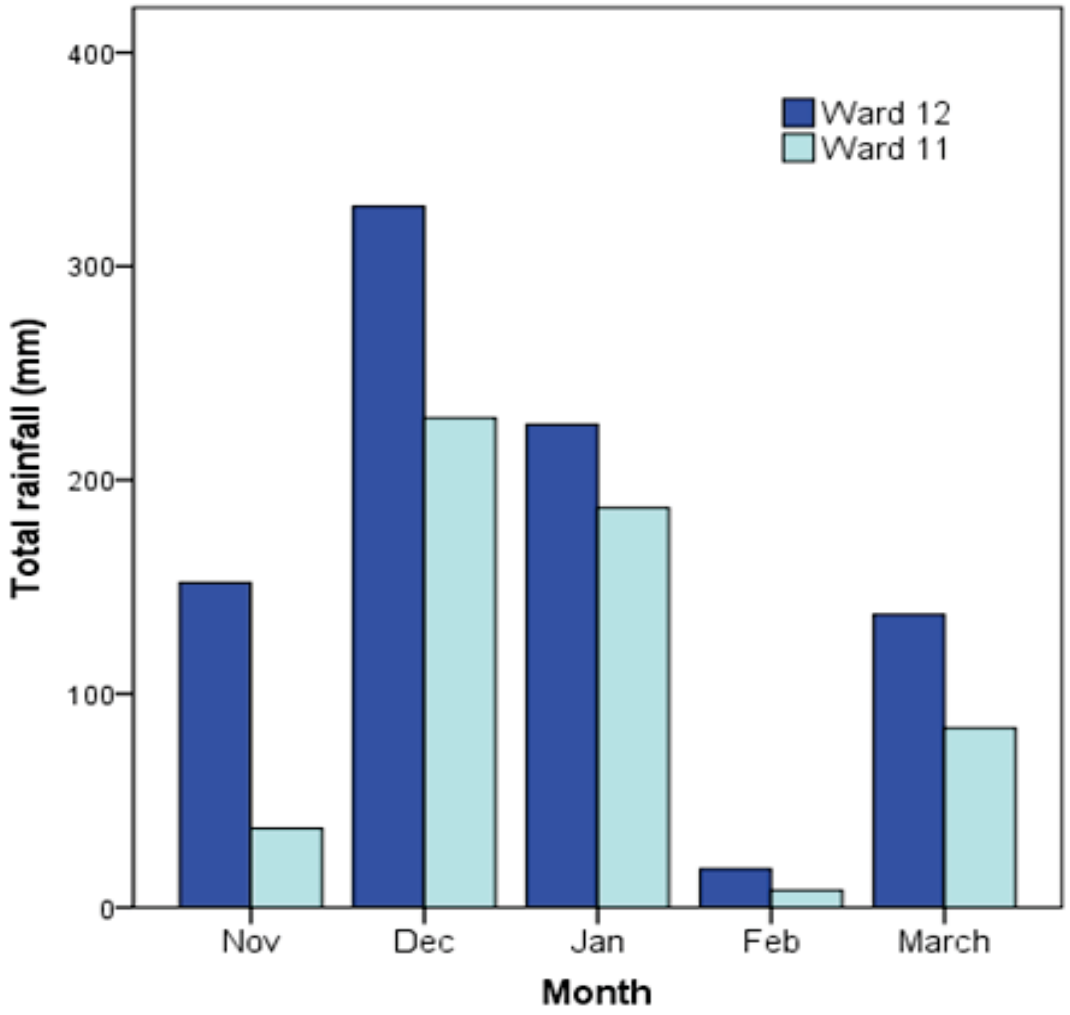


Figure 4. Monthly rainfall for the 2010/11 rainy season

- Ward 12 received 861 mm, Ward 11 received 545 mm
- ET_0 during this period was 515 mm.

RESULTS

Soil Moisture Content Measurements

For position A0, depth 0.8 – 1.2 m sections with infiltration pits had higher moisture content levels than those without

For positions -A1 and A1 to A15.7 depth 0.0 - 0.4 m, soil moisture content levels were similar for sections with infiltration pits and those without.

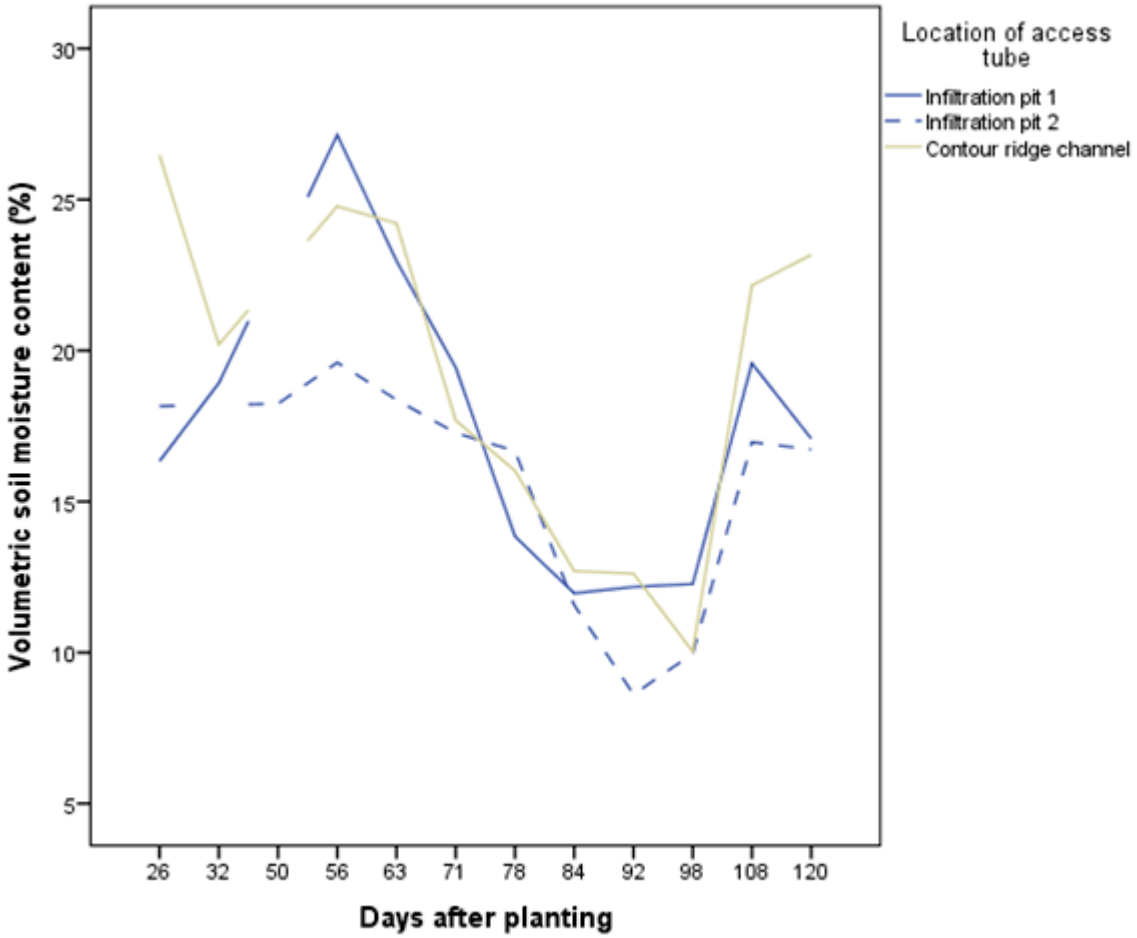


Figure 5 (a) Soil moisture content trends at position A11 (field centre) depth 0.0 – 0.2 m

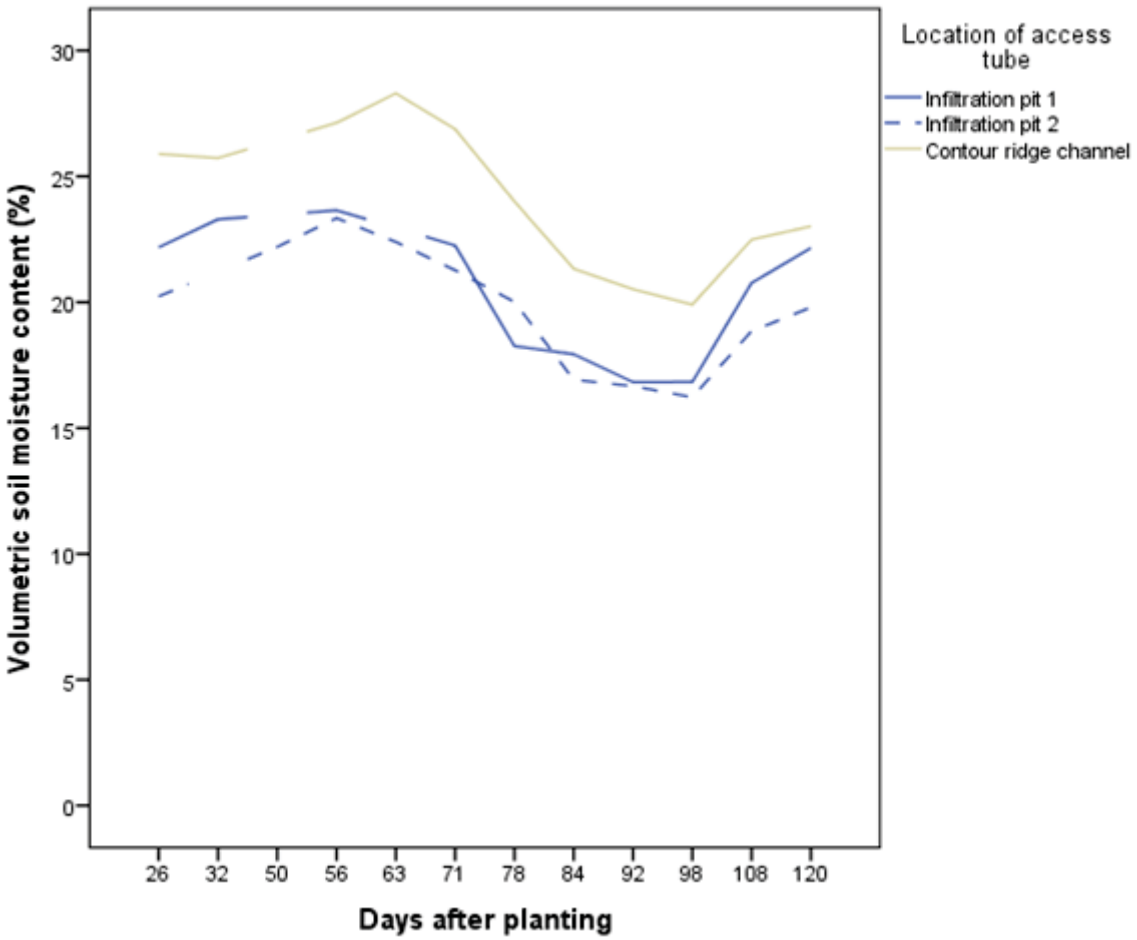


Figure 5 (b) Soil moisture content trends at position A11 depth 0.2 – 0.4 m

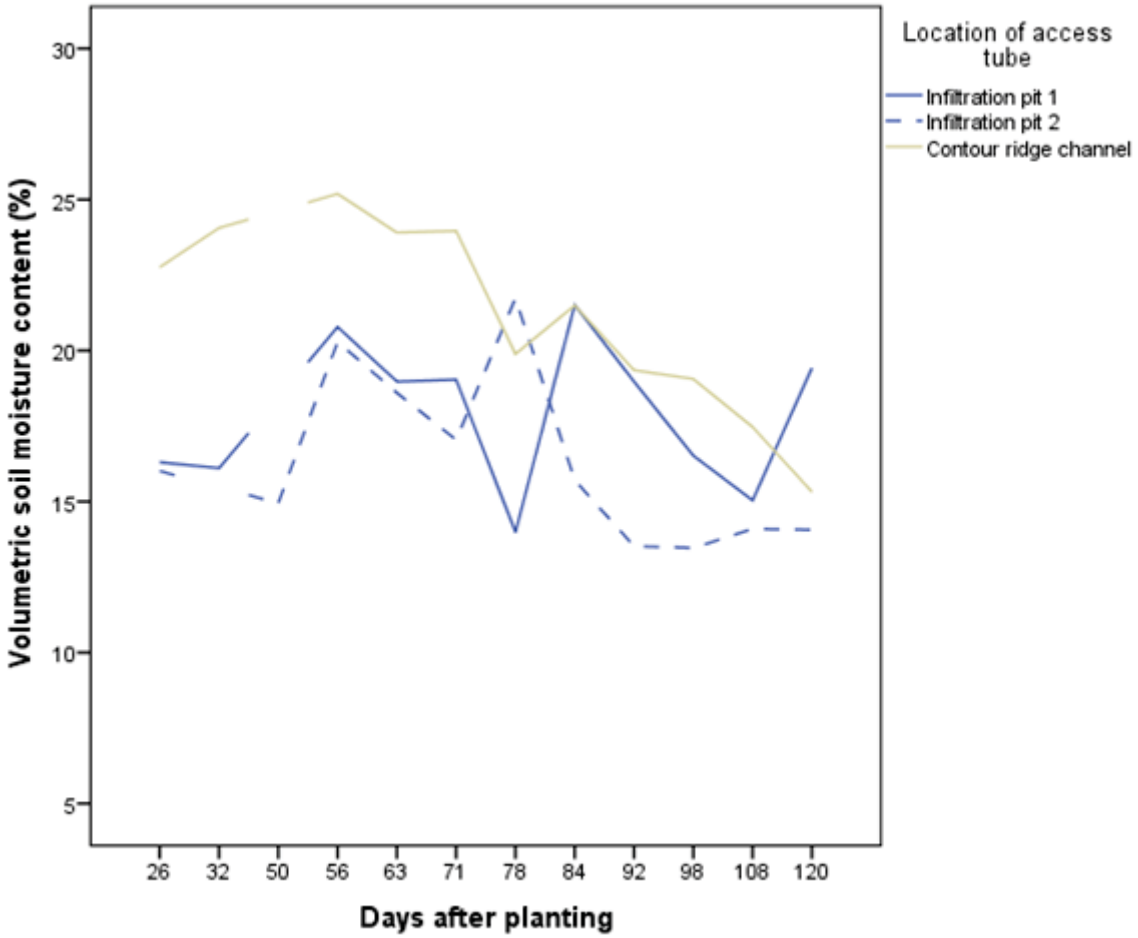


Figure 5 (c) Soil moisture content trends at position A11 depth 0.4 – 0.6 m

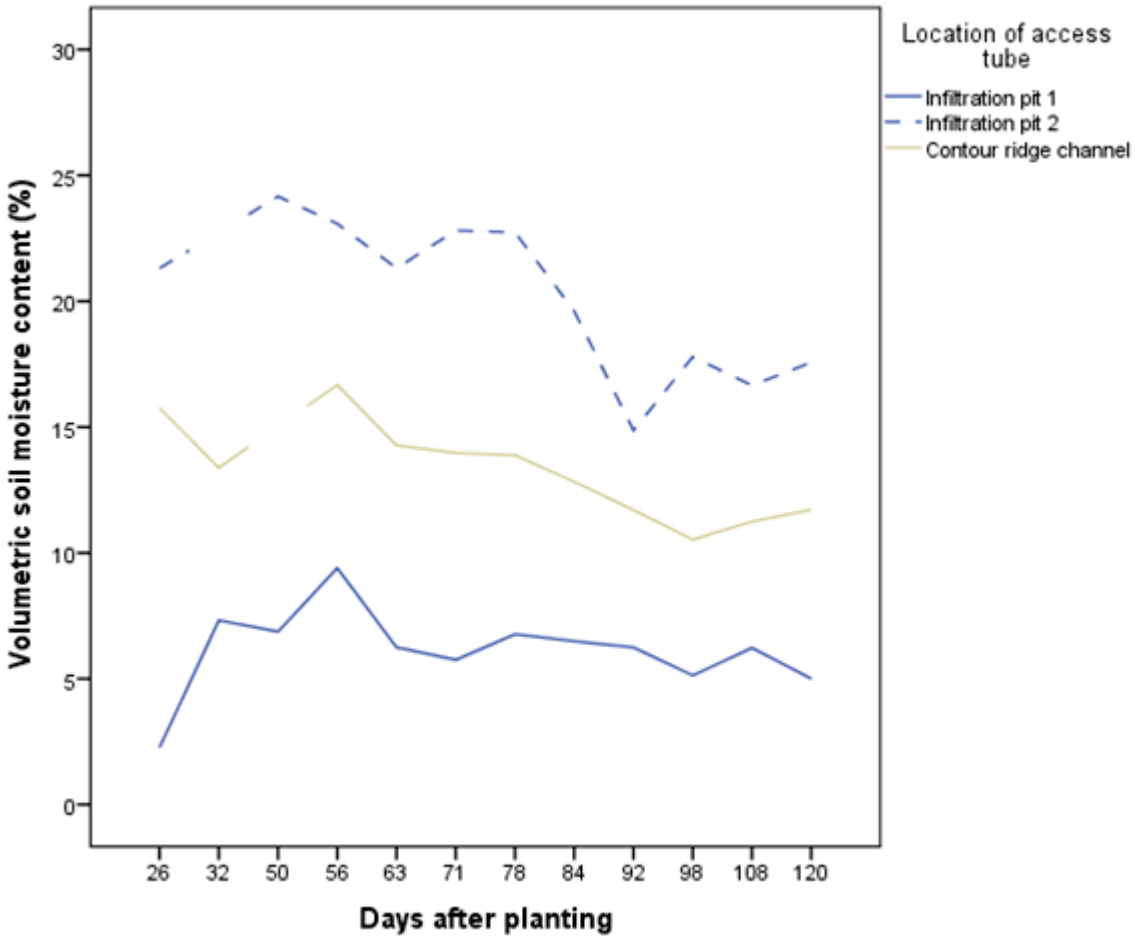


Figure 5 (d) Soil moisture content trends at position A11 depth 0.6 – 0.8 m

- For A1, Ward 12, roots of a herbaceous plant distorted soil moisture content, therefore, we considered Ward 11 results.
- For depth 0.0 – 0.8 m the section with infiltration pits had higher moisture content levels than one without.

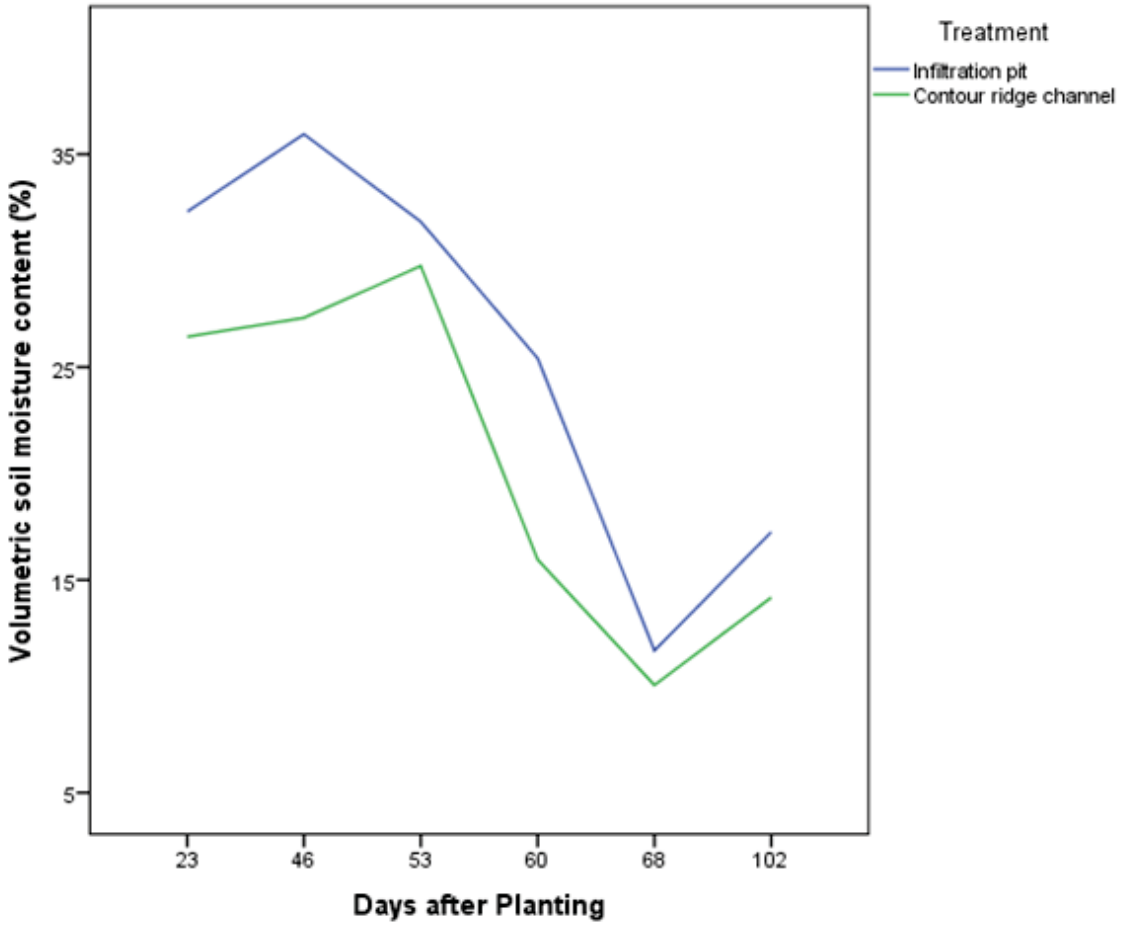


Figure 6 (a) Soil moisture content trends at position A1 depth 0.0 – 0.2 m

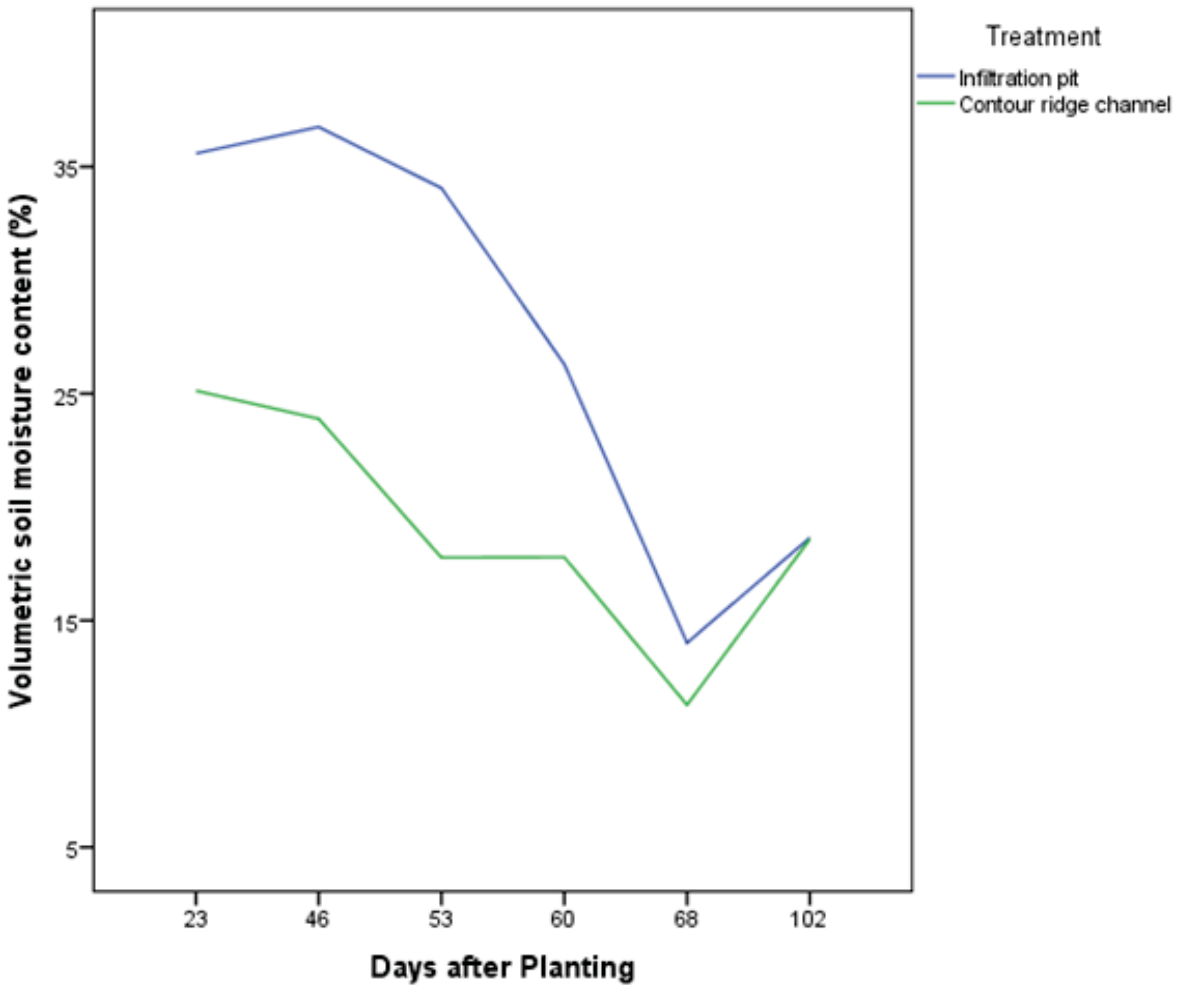


Figure 6(b). Soil moisture content trends at position A1 depth 0.2 – 0.4 m

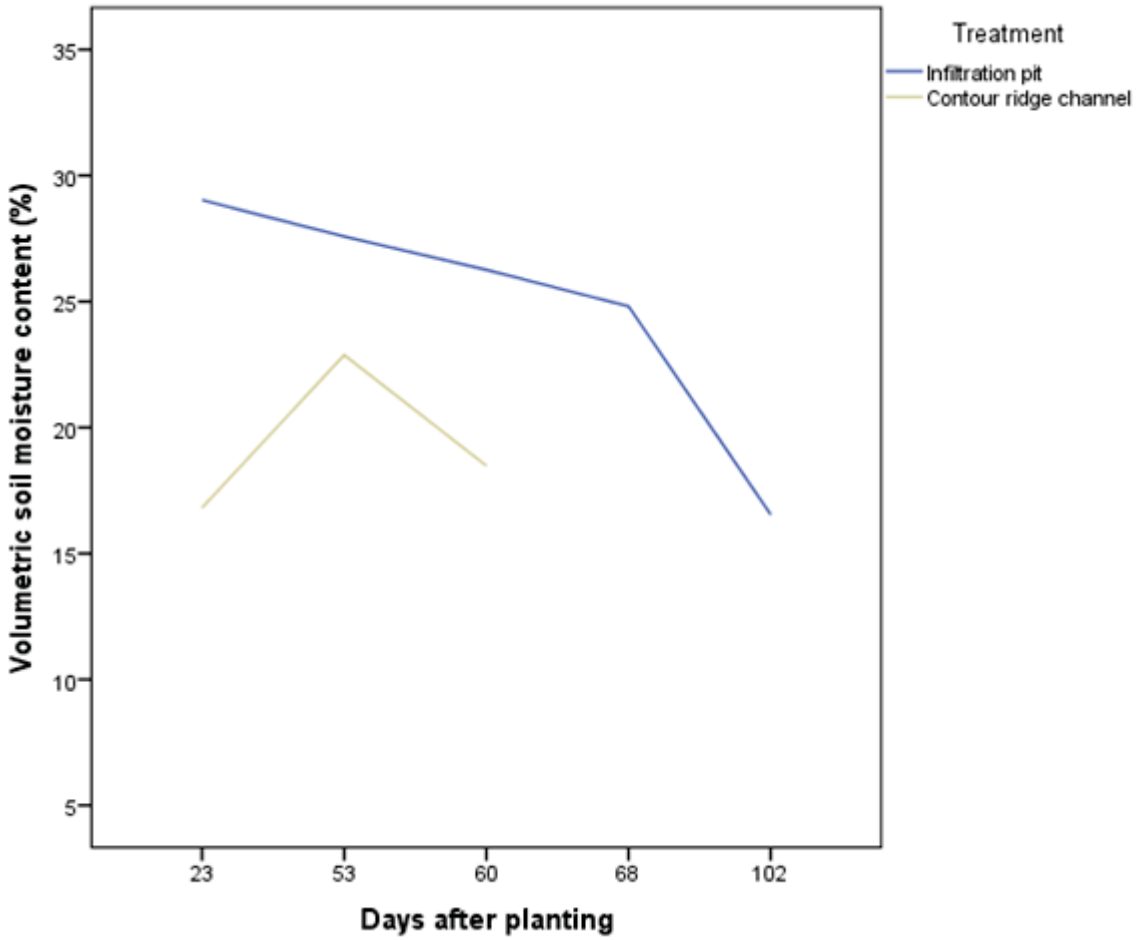


Figure 6(c) Soil moisture content trends at position A1 depth 0.4 – 0.6 m

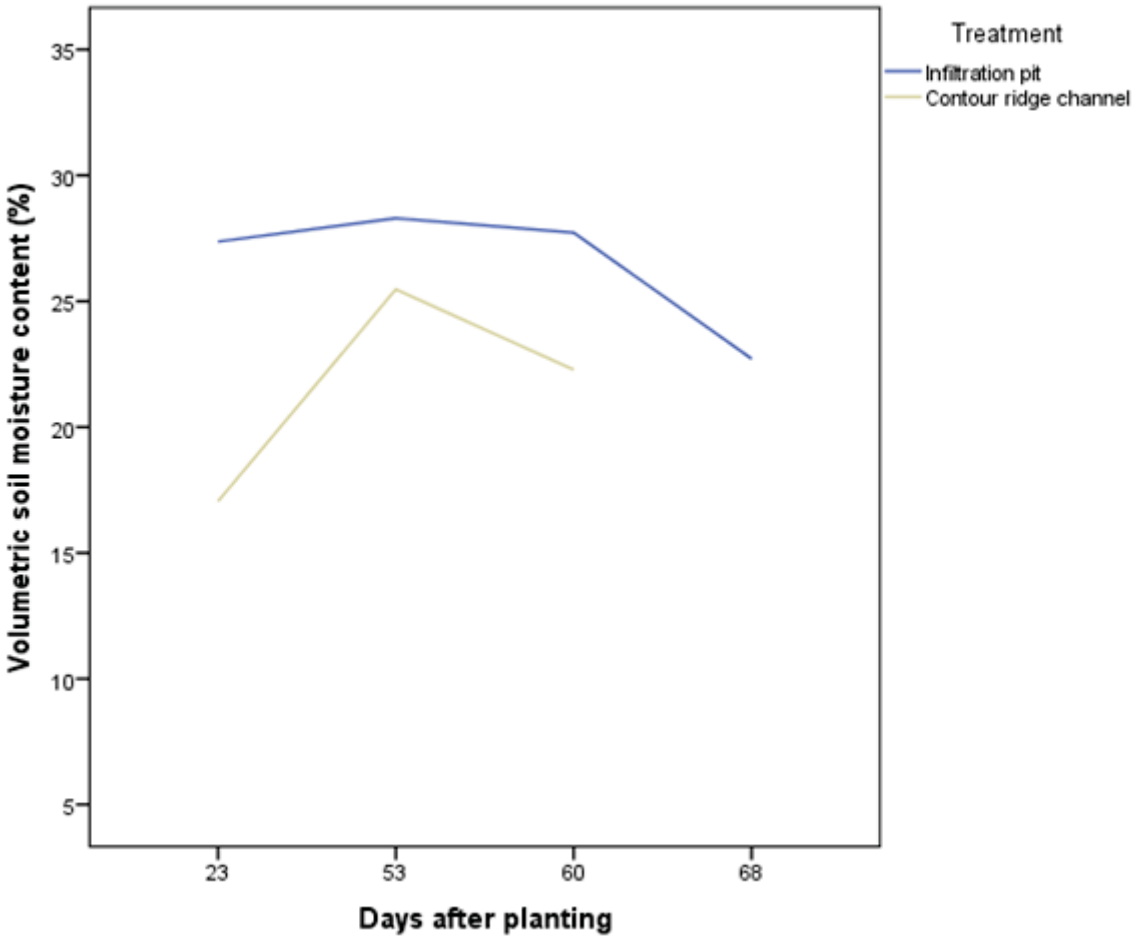


Figure 6 (d) Soil moisture content trends at position A1 depth 0.6 – 0.8 m

For position A2, Ward 12, depths (m): 0.4 – 0.6, 0.6 – 0.8, 0.8 – 1.0 , sections with infiltration pits had higher moisture content levels than those without.

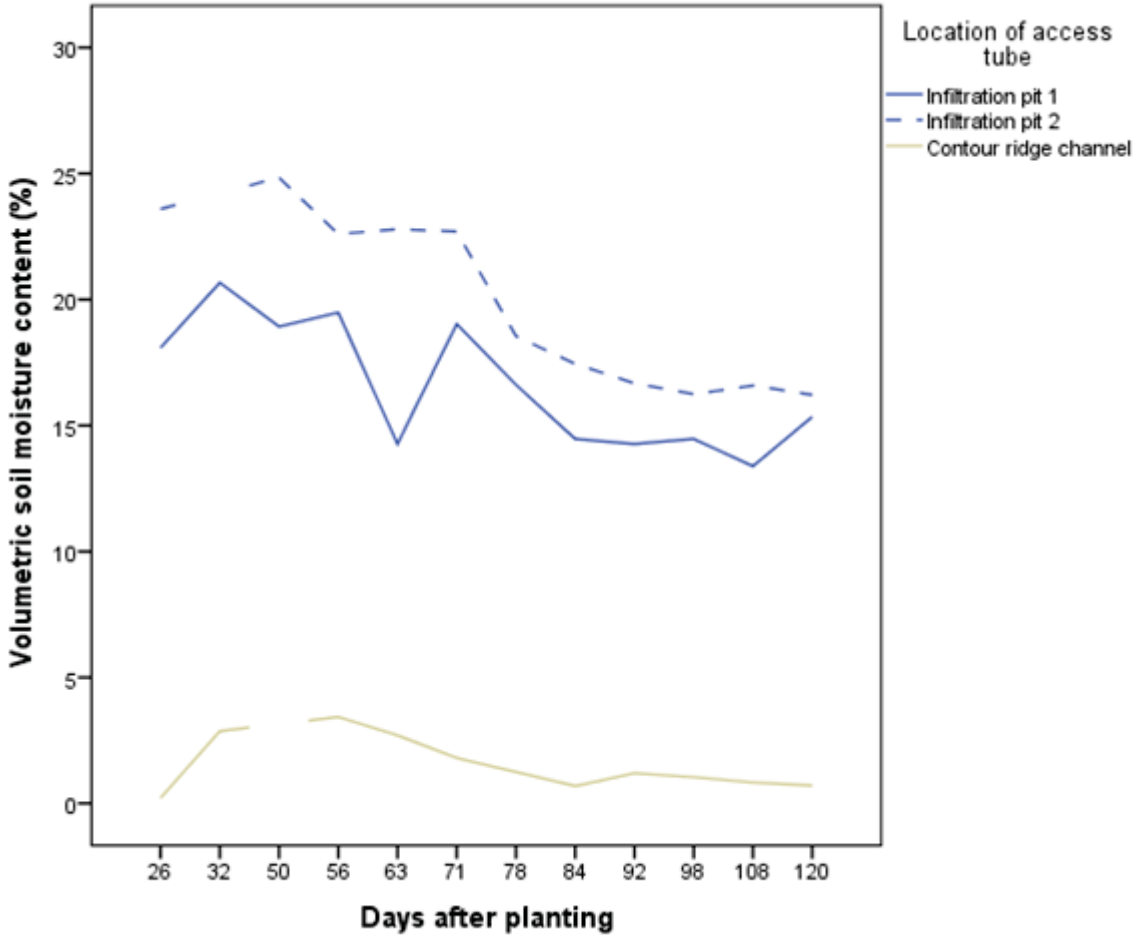


Figure 7 (a) Soil moisture content trends at position A2 depth 0.4 – 0.6 m

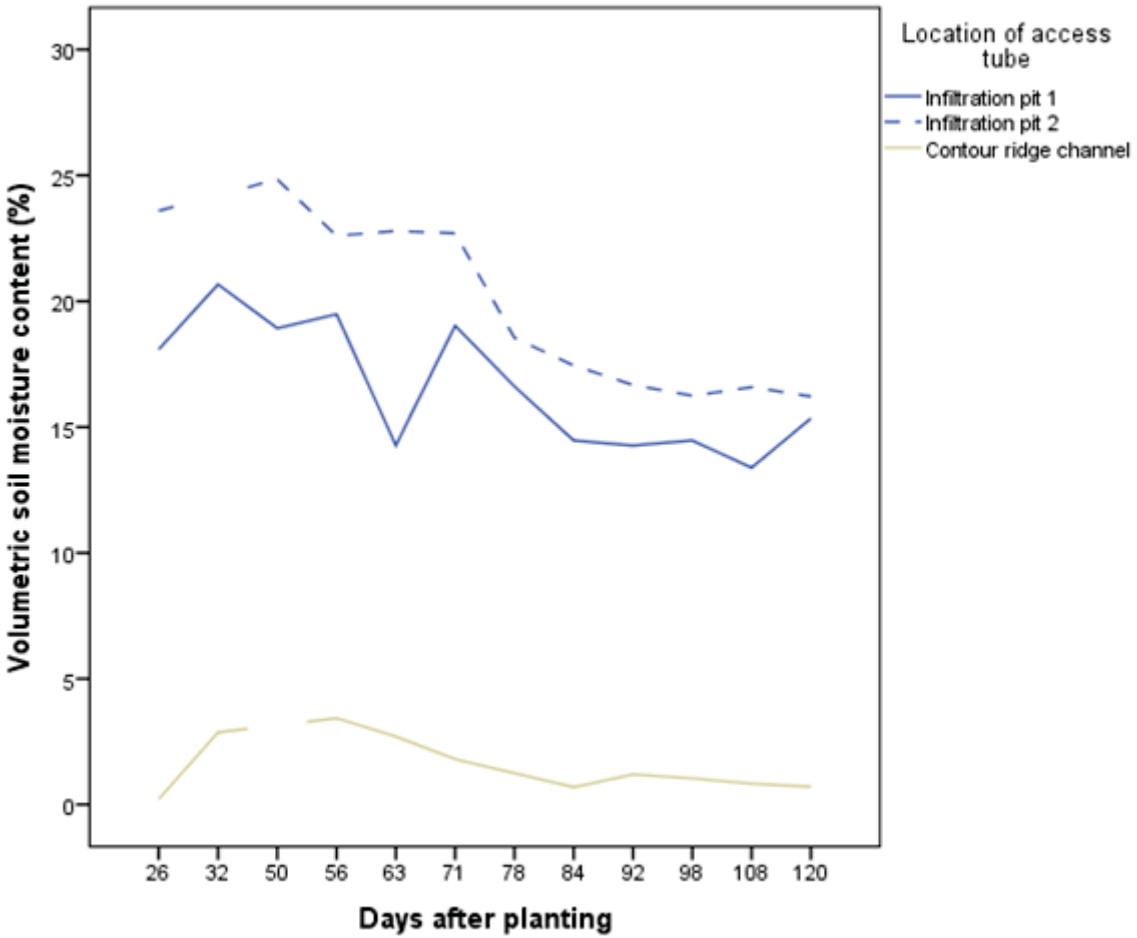


Figure 7 (b) Soil moisture content trends at position A2 depth 0.6 – 0.8 m

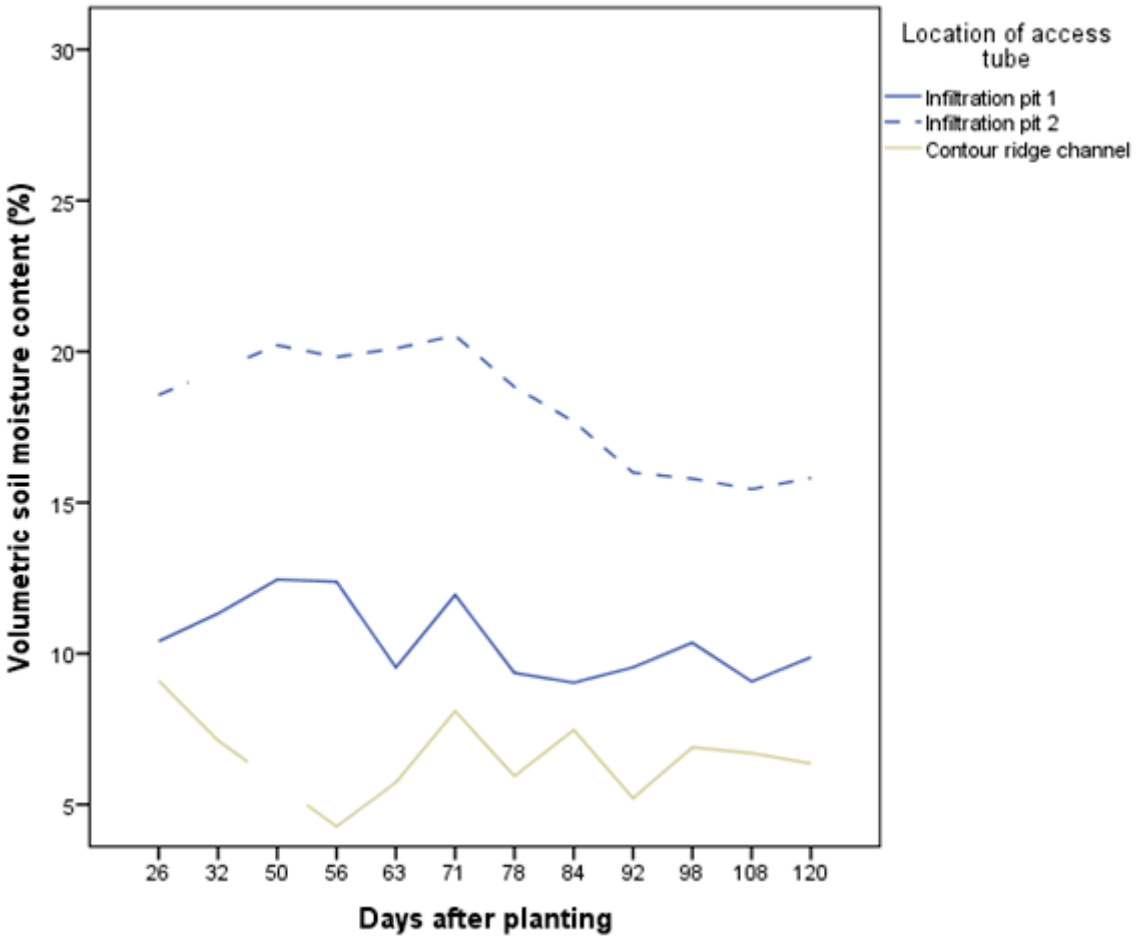


Figure 7 (c) Soil moisture content trends at position A2 depth 0.8 – 1.0 m

Maize Yield

- Harvest indices, 0.30 for Ward 12 and 0.24 for Ward 11 are below the normal value of 0.50
- Maize yields at both sites were below the yield potential of 3 to 5 t/ha for the fertilizer application levels used.

Hallauer et al., 1988

- For Ward 12, there was no difference ($p > 0.05$) among treatments for both maize grain and maize stover yields

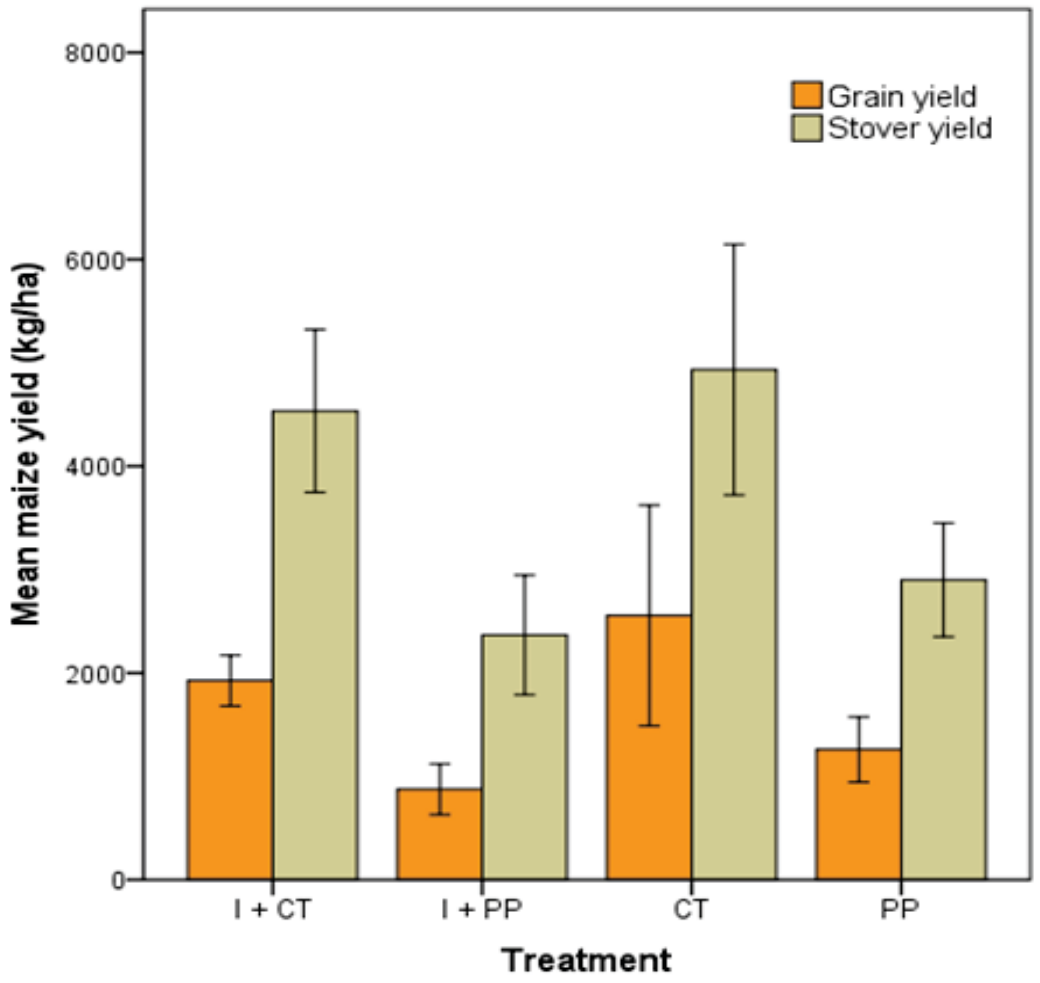


Figure 8 (a) Maize grain and stover yields for Ward 12 site for the 2010/2011season. (Error bars represent standard deviations).

For Ward 11, there were differences ($p < 0.05$) in maize grain and maize stover yields among treatments: I + CT = CT > I+PP = PP

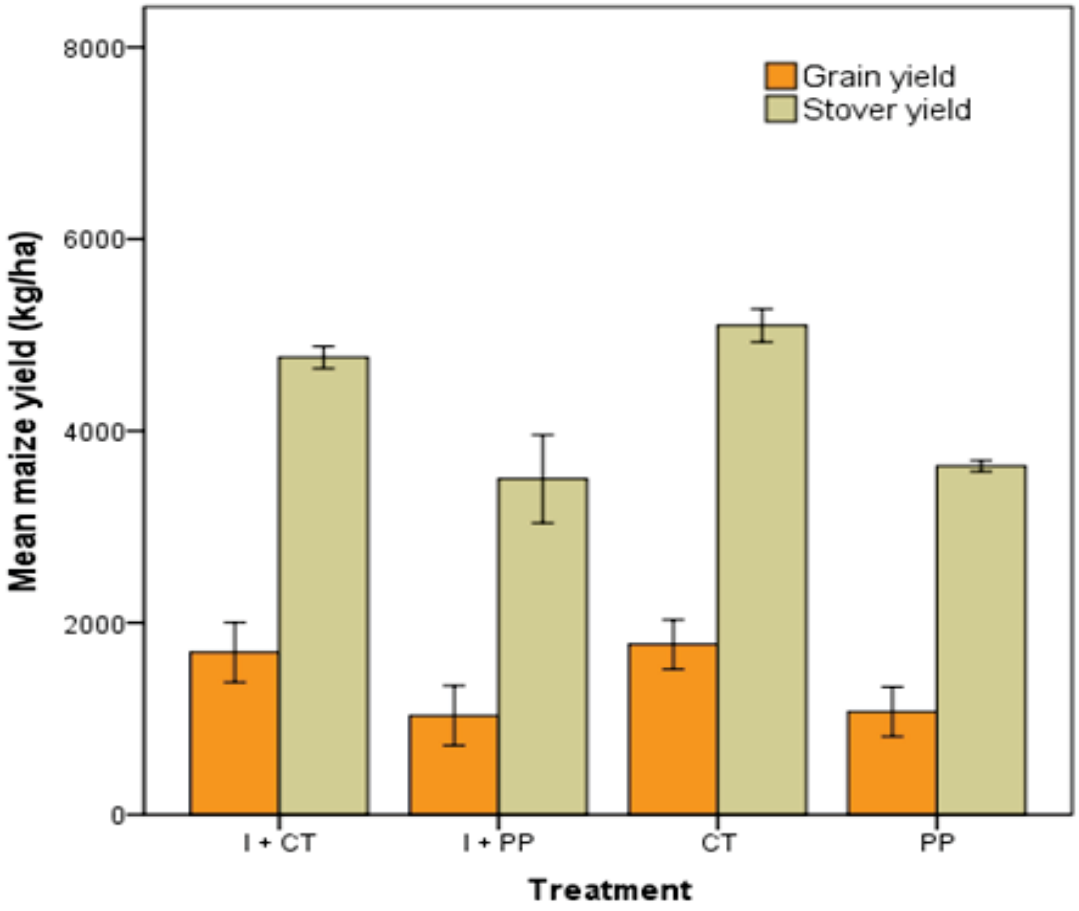


Figure 7 (b) Maize grain and stover yields for Ward 11 site for the 2010/2011season. (Error bars represent standard deviations).

Conclusions

- Our objective was to assess the benefits in terms of soil moisture and maize yield, of infiltration pits and planting pits.
- Results show no evidence of:
  - ✓ soil moisture benefits in the cropping area,
  - ✓ maize yield improvement
- Soil moisture content benefits were observed within 2m downslope from the centre of infiltration pits.
- Farmers should include crops that use water inside and close to the infiltration pits.
- We recommend perennials that use heavy rains at the beginning of the season when annual field crops are still at initial growth stages.

Thank you for your attention.