



# Adaptation and Performance Water Harvesting Technologies

***(WAHARA Project)***

***By: WAHARA Team***

# Outline

1. Introduction
2. Adaptation Processes
3. WHT selected and adapted
4. Performance of WHT
5. Lessons learned

# 1. Introduction

- WAHARA: Water Harvesting for Rainfed Africa: investing in dryland agriculture for growth and resilience.
- **5 year project**: from March 1<sup>st</sup> 2011 – Feb 29<sup>th</sup> 2016.
- **Project budget: € 2,6 Million** (€2.0 Million from the EU).
- **EU project 265570, FP7-AFRICA-2010.**

**Objectives:** Develop innovative appropriate WH technologies for different geographical regions of rainfed Africa.

- **Emphasis 1: WHT design** that have synergies with existing rainfed farming systems.
- **Emphasis 2: WHT impact** on-site and downstream impact.
- **Emphasis 3: WHT integration** which includes developing criteria for sustainable impact on improving livelihoods
- **Emphasis 4: WHT learning and action.**

## Study sites:

- **Tunisia** in the North,
- **Burkina Faso** in the West,
- **Zambia** in the South and
- **Ethiopia** in the East.



## 2. Adaptation Process

It involved:

- Inventory: Watersheds and existing WHT.
- Participatory selection of WHT.
- Developing participatory monitoring protocols.
- Implementation of the adaptation.
- Facilitation and documentation of adaptation.
- Award competition for the best documentation.
- Participatory monitoring and evaluation.

### 3. WHT Selected and Adapted

#### **Burkina Faso:**

1. Zai
2. Stone lines
3. Magoye Ripper
4. Talya Tray

#### **Ethiopia:**

1. Percolation/sediment storage ponds with hand dug wells
2. Check dams
3. Series of Hillside Cistern with bench terraces
4. Soil improvement methods (EM, Mulching, Compost, etc)

#### **Tunisia:**

1. Jessour
2. Gabion check dam
3. Tabia
4. Cistern
5. Recharge well

#### **Zambia:**

1. Zai pits
2. Magoye ripper
3. Ox-drawn strip tillage
4. Ox-drawn zero tillage with the GART planter

## **4. Performance of WHT**

4.1 WHT in Tunisia

4.2 WHT in Burkina Faso

4.3 WHT in Zambia

4.4 WHT in Ethiopia



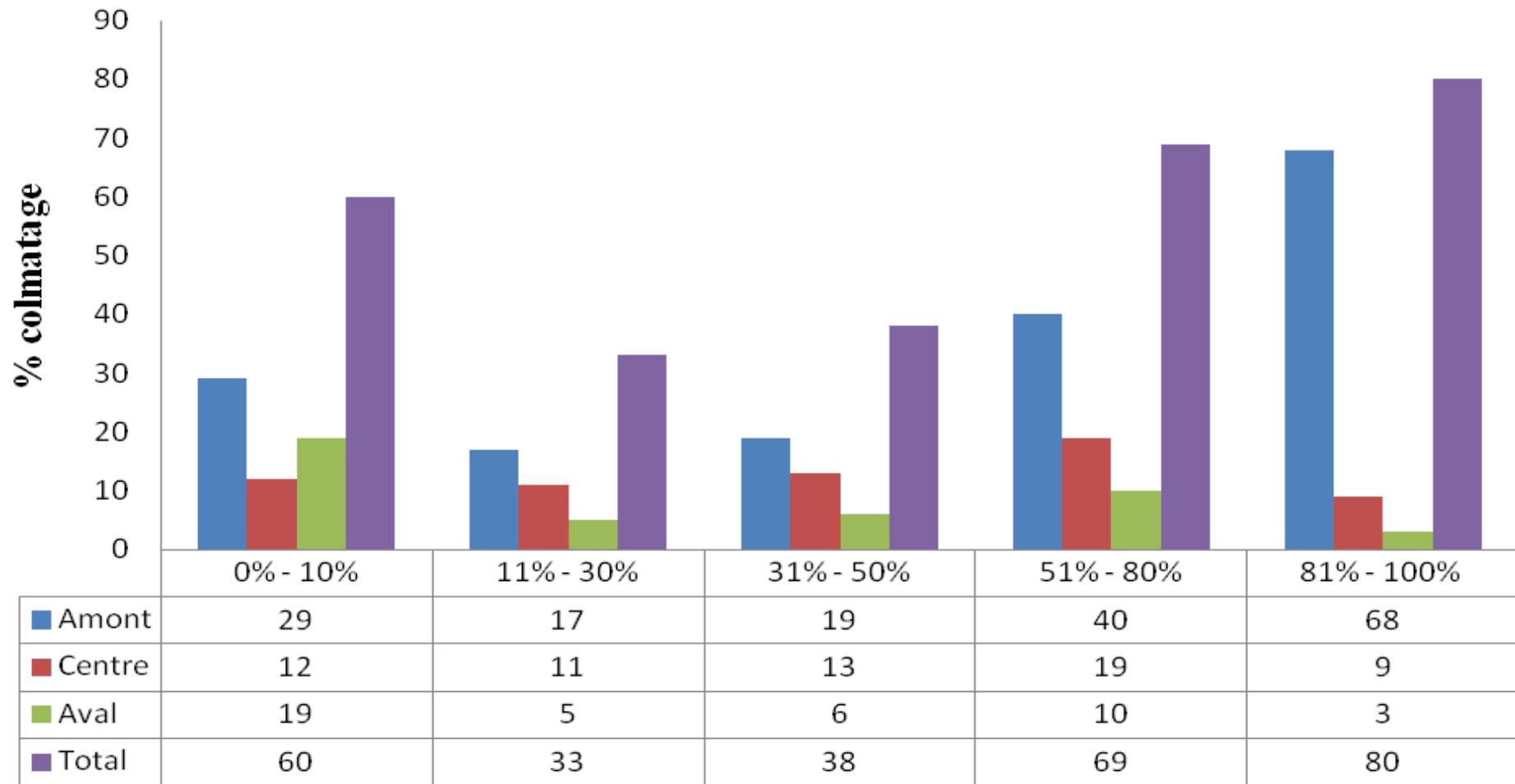
## 4.1 Performance of WHT in Tunisia

The monitoring have concerned:

- Climate,
- Water balance,
- Hydraulic characterization of gabion check dams,
- Gabion check dams silting up,
- Assessment and evaluation of WHT,
- Groundwater pollution risks.



# Silting up of gabion check-dams



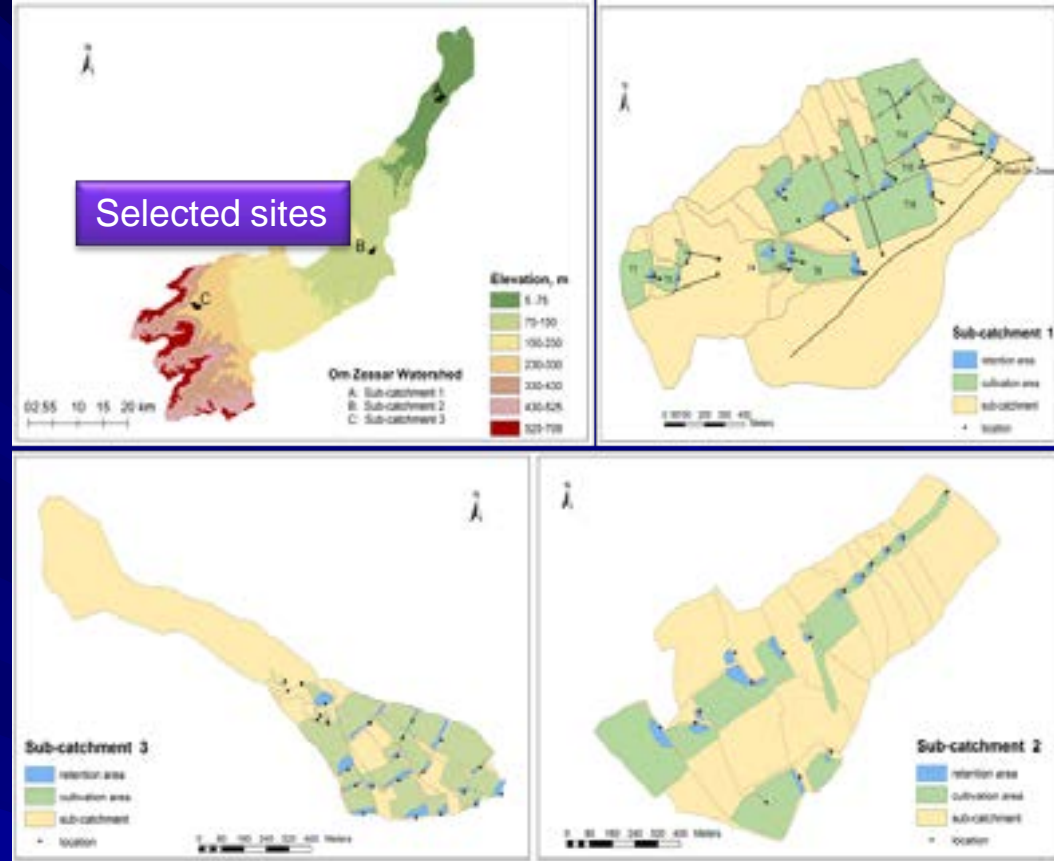
***Silting up percentage of the gabion check dams in the main sections***

Topographic surveys and systematic inventory of 283 units.

# Evaluation of WHT

## Criteria for evaluation:

- Engineering,
- Biophysical,
- Socio-economic



## Based on the criteria selected:

- 60% of the assessed sites received scores indicating moderate performance;
- 36% of the sites showed low performance;
- 4% received good performance scores.

**Table 1. Average yield with and without WHT (kg/ha/year) (Source: Surveys).**

Crop	location	Dry year			average year			rainfall year		
		Without WHT	with WHT	% change	Without WHT	with WHT	% change	Without WHT	with WHT	% change
Olive	Bénikhdéche	0	0	0%	0	55	100%	0	120	100%
	Médenine Nord	0	0	0%	0	28	100%	0	38	100%
	Sidi Makhlouf	0	20	100%	50	50	0%	0	75	100%
	Overall	0	20	100%	50	47	-6%	0	91	100%
Almond	Bénikhdéche	0	0	0%	0	20	100%	0	58	100%
	Médenine Nord	0	0	0%	0	20	100%	0	32	100%
	Sidi Makhlouf	0	0	0%	0	20	100%	0	50	100%
	Overall	0	0	0%	0	20	100%	0	48	100%
Fig	Bénikhdéche	0	0	0%	0	22	100%	0	45	100%
	Médenine Nord	0	0	0%	0	33	100%	0	70	100%
	Sidi Makhlouf	0	5	100%	0	16	100%	0	41	100%
	Overall	0	3	100%	0	20	100%	0	47	100%
Cereal	Bénikhdéche	0	0	0%	150	150	0%	450	380	-16%
	Médenine Nord	0	0	0%	35	29	-17%	60	65	8%
	Sidi Makhlouf	0	0	0%	0	60	100%	0	207	100%
	Overall	0	0	0%	92	67	-27%	255	226	-11%

## 4.2 Performance of WHT in Burkina Faso

### (a) Stones bunds and Zaï compared with Magoye ripper

*Table 4.1 Results for Ziga site for experiment 1*

	T0	T1	T2	T3
Grain (Kg/ha)	471	742	1036	773
Straw (Kg/ha)	2791	4258	5138	4778

*Treatments:*

*T0= Control= no WHT, no fertilization*

*T1= stones bunds + 5 tons of compost manure+ microdosing*

*T2= Zaï + 5 tons of compost manure+ microdosing*

*T3= Magoye + 5 tons of compost manure+ microdosing*

## (b) Soil fertility management: Zaï is WHT

*Table 4.2 Results for Ziga site experiment 2*

	T0	T1	T2	T3
Grain (Kg/ha)	545	795	855	1054
Straw (Kg/ha)	3405	4135	4515	4975

*Treatments:*

*T0= Control= no WHT, no fertilization*

*T1= Zaï + 5 tons of compost manure (common practice in the region)*

*T2= Zaï + 5 tons of compost manure+ microdosing*

*T3= Zaï + 5 tons of compost manure+ recommended fertilizer*



## (c) Cowpea varieties: for women

*Table 4.3 Results for Ziga site experiment 3*

	T1	T2	T3
Grain (Kg/ha)	620	377	506
Straw (Kg/ha)	521	339	479



*Experiment:*

*T1= K VX 775*

*T2= local variety*

*T3= K VX 442*

Table 4.4 Sorghum grain and straw yield ( $\text{kg} \cdot \text{ha}^{-1}$ ) at Somyaga, Burkina Faso.

Traitements	Year 2011		Year 2012		Year 2013	
	Grain	Straw	Grain	Straw	Grain	Straw
T1	28c	179d	336 c	1288c	268c	1212d
T2	433b	1326c	1079 b	2755b	787b	2169c
T3	1018a	2857b	1588 a	4621a	1253a	2972b
T4	1142a	3589a	1857 a	4837a	1400a	3486a

*T1=control treatment; T2=Zai+5t.ha<sup>-1</sup>of compost manure; T3=Zai +5t.ha<sup>-1</sup>of compost manure+62kg.ha<sup>-1</sup>of NPKSB+50kg.ha<sup>-1</sup>of urea; T4 = Zai +5t.ha<sup>-1</sup> of compost manure +100kg.ha<sup>-1</sup> NPKSB +50 kg.ha<sup>-1</sup> of urea.*



Table 4.5 Sorghum grain and straw yield (kg.ha<sup>-1</sup>) at Ziga, Burkina Faso.

Traitements	Year 2011		Year 2012		Year 2013	
	Grain	Straw	Grain	Straw	Grain	Straw
T1	72c	409c	408c	1382c	341d	1321c
T2	316b	1275b	926b	2468b	819c	2346b
T3	827a	2988a	1422a	2892a	1114b	3478a
T4	908a	3017a	1609a	2958a	1552a	3631a

*T1=control treatment; T2=Zaï+5t.ha<sup>-1</sup> of compost manure; T3=Zaï +5t.ha<sup>-1</sup> of compost manure+62kg.ha<sup>-1</sup> of NPKSB+50kg.ha<sup>-1</sup> of urea; T4 = Zaï +5t.ha<sup>-1</sup> of compost manure +100kg.ha<sup>-1</sup> NPKSB +50 kg.ha<sup>-1</sup> of urea.*

## (d) Using banka (Run off capturing)

*Table 4.6 Grain yield of maize in kg/ha (Banka grains) at Ziga, northwestern Burkina Faso.*

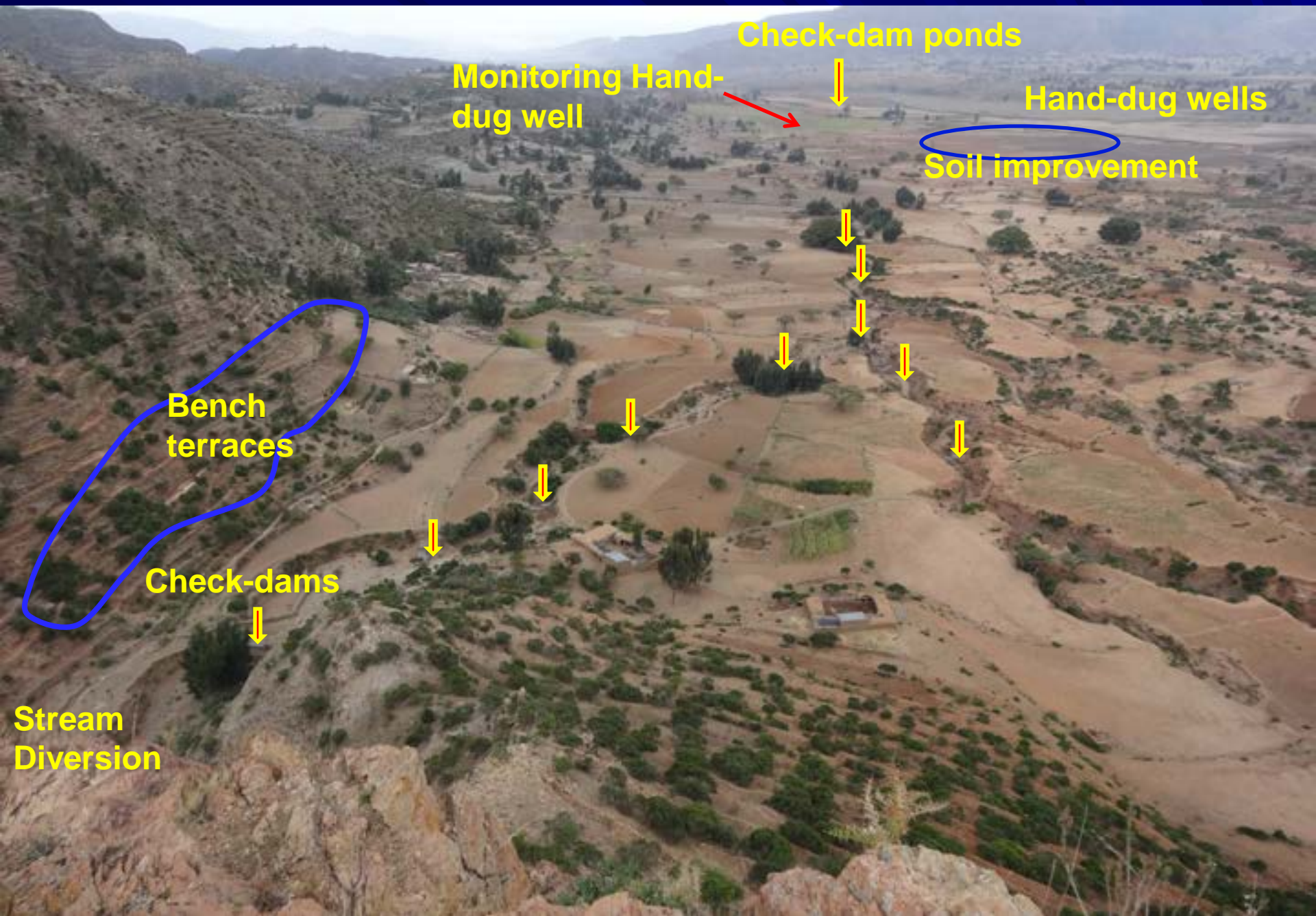
Site	Producer	Mode	T1 (Control)	T2 (Zai)	T3 (Magoye Ripper)
Ziga	Ouedraogo Boukari	Non- irrigated	653	4000	4520
Ziga	Ouedraogo Boukari	Irrigated	2640	7367	8667

*T1 : Control (0 soil ploughing) : Organic matter : 0 kg + NPK : 0 + Urea : 0*

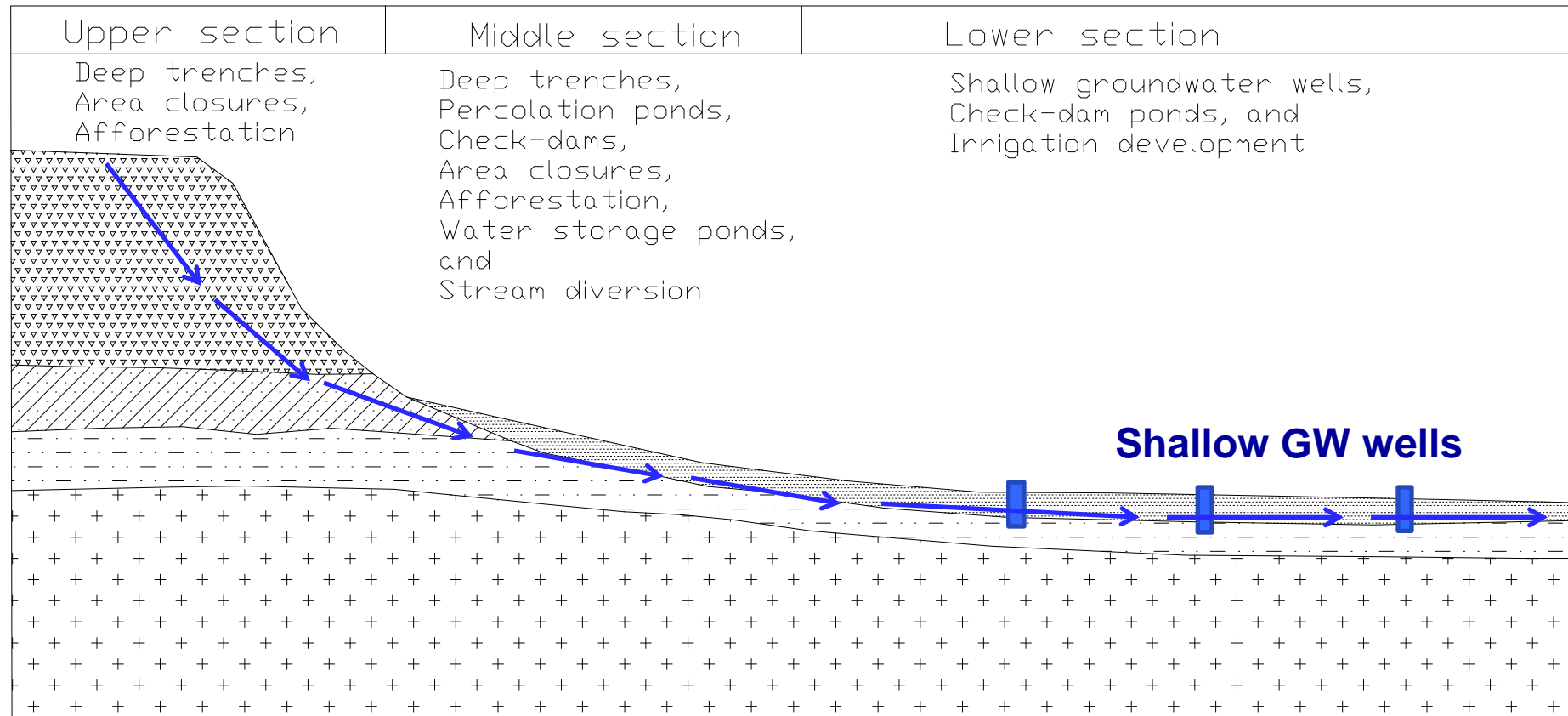
*T2 : Zai : Organic matter : 5t/ha + 200 kg/ha NPK in micro-dosing + 50 kg/ha Urea.*

*T3 : Magoye : Organic matter : 5t/ha + 200 kg/ha NPK in micro-dosing + 50 kg/ha Urea.*

## 4.3 Performance of WHT in Ethiopia



# (a) Geohydrological Model and WHT at different levels of the landscape, Gule watershed, Ethiopia



Symbol					
Rock/Soil type	Adigrat Sandstone	Siltstone, Claystone	Tillite	Metavolcanic/ Metasediment	Soil (silt and sand)
Permeability	High	Low	Low	Moderate to low	High

**Arrow indicates the overall shallow groundwater flow path along the landscape, Gule watershed, Tigray, Ethiopia**



## Effects of the interventions:

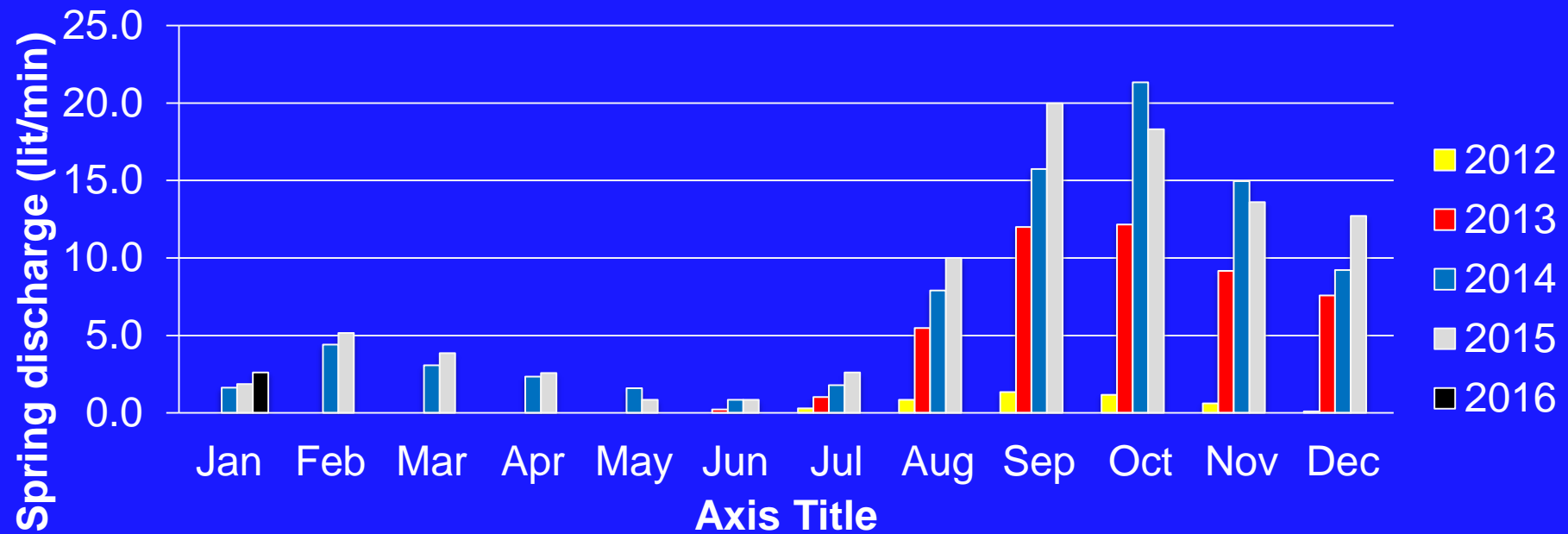
- Increase in groundwater recharge;
- Increase in spring discharge;
- Reduction in sediment concentration in streams;
- Cessation of gully expansion;
- Increase in crop productivity;
- Expanded irrigation development in the watershed.

# Percolation Ponds

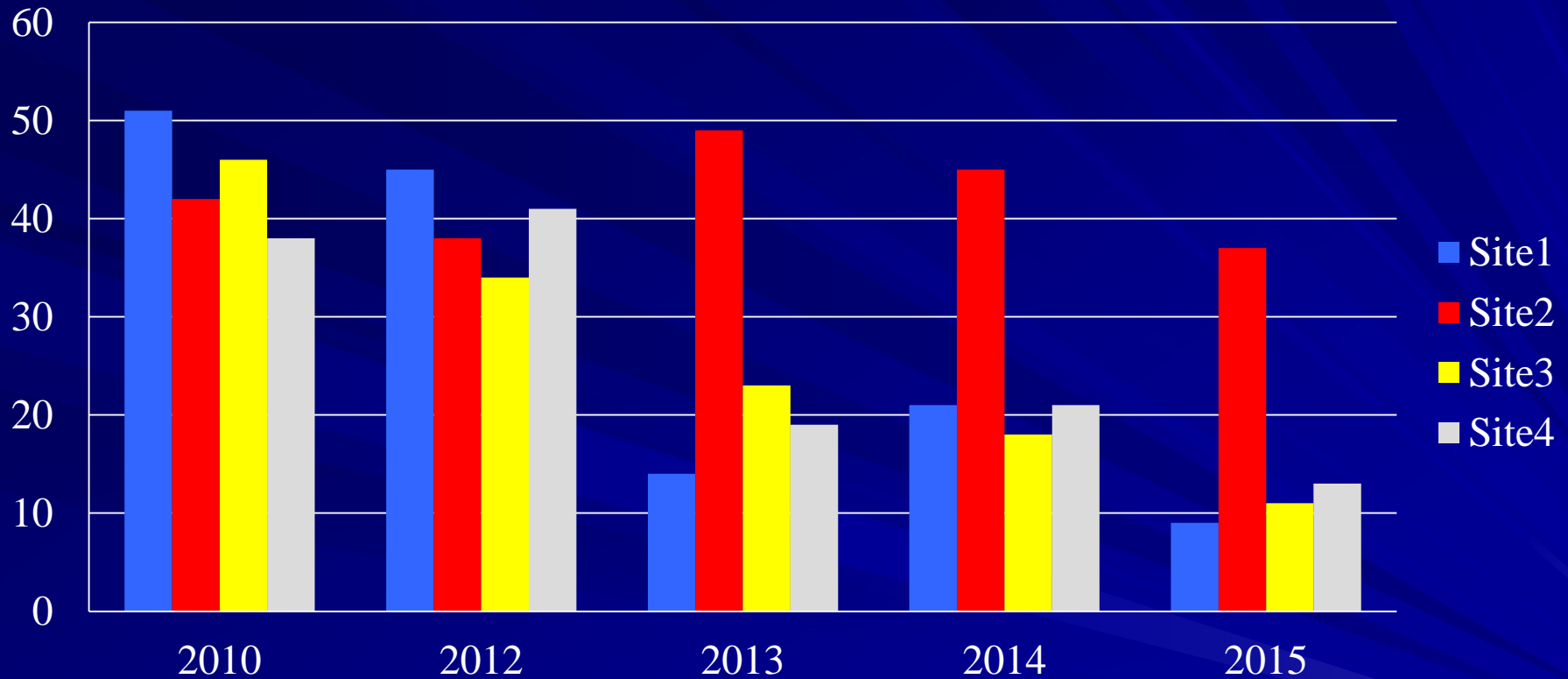


*Percolation pond (20m long, 15m wide and 2.5m deep) constructed to recharge the shallow groundwater system and enhance spring discharge at downstream areas which could be used for small-scale irrigation.*

# (a) Effects of Percolation Systems on spring discharge



### (c) Variation in maximum sediment concentration in flood water from selected streams in Gule sub-watershed



*Site1: Downstream of the treated gully*

*Site2: Downstream of un-treated gully*

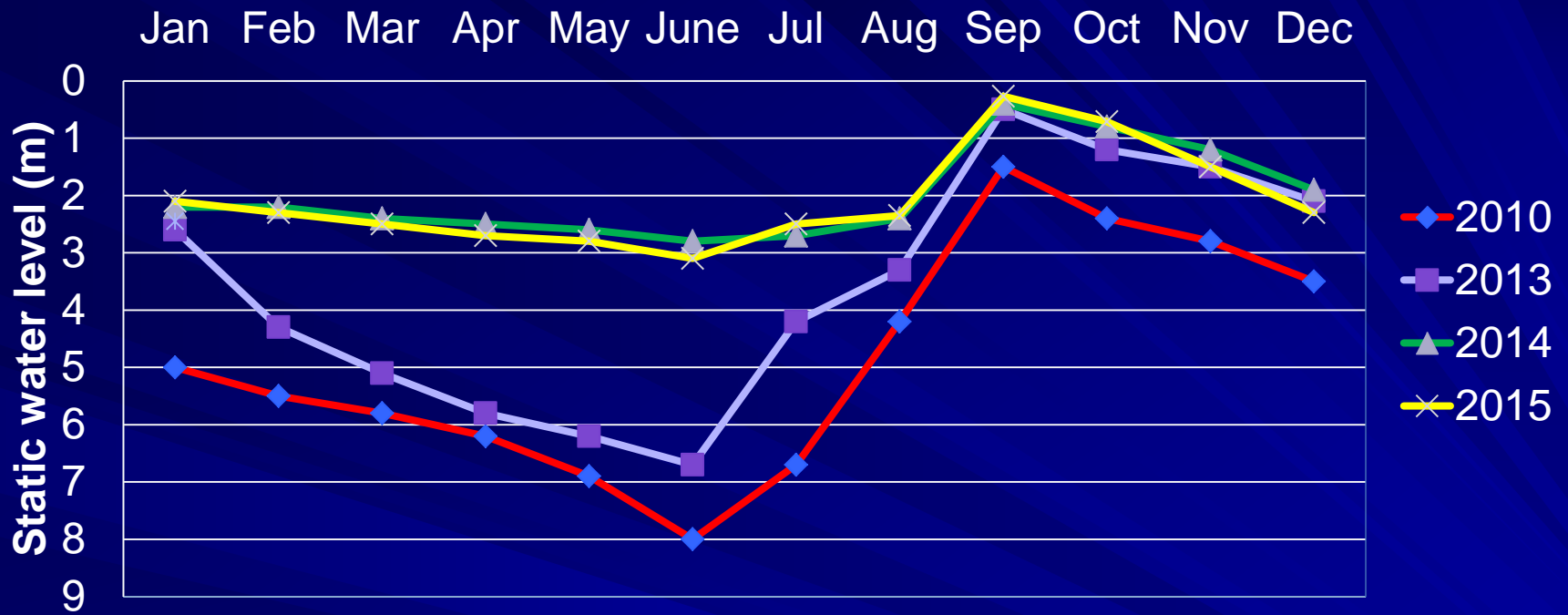
*Site3: Downstream of percolation pond*

*Site4: Downstream of the treated and untreated stream (main outlet)*

**Note: intervention done in 2013 (starting January 2013)**

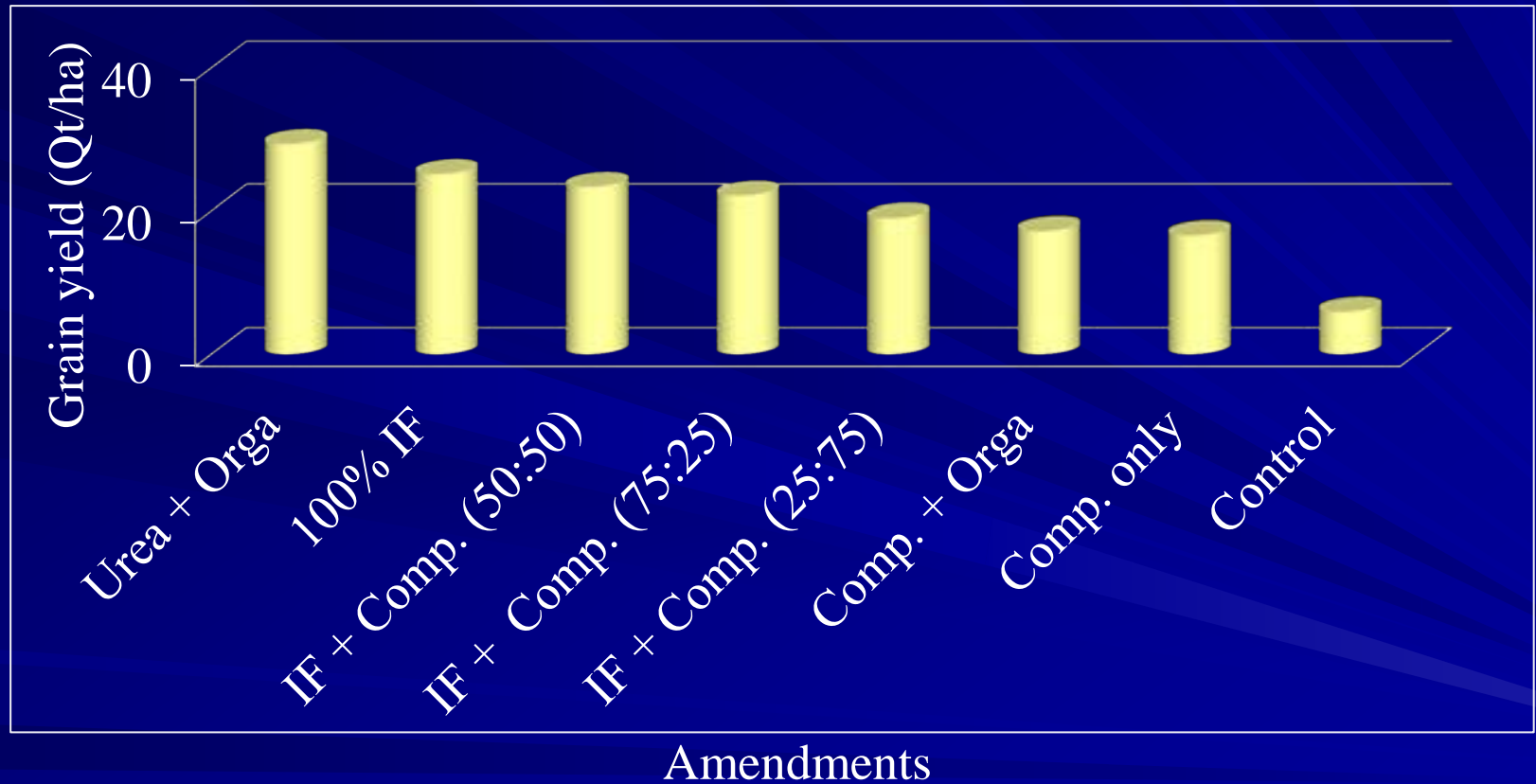


## (d) Effects on groundwater level (m)

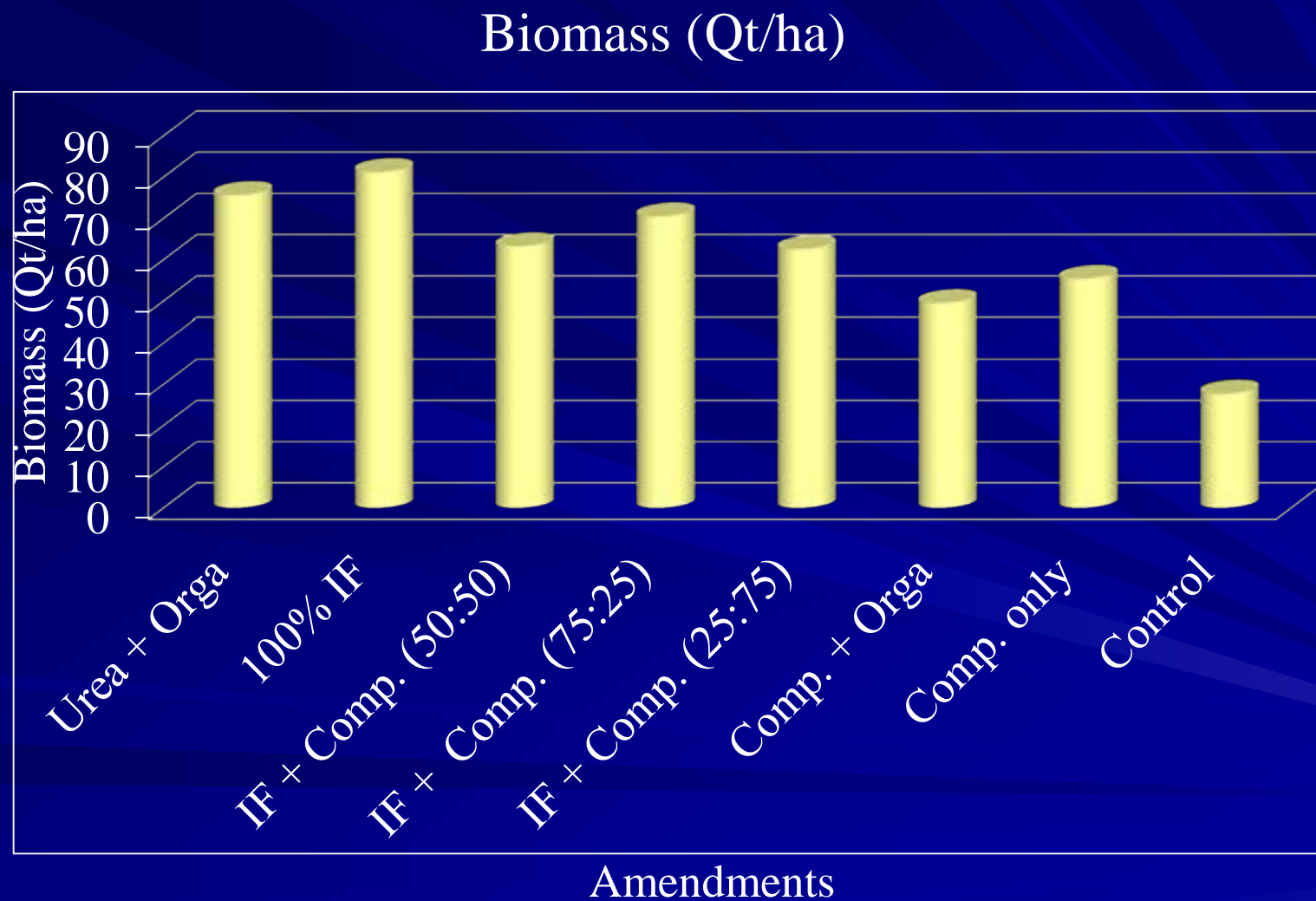


## (e) Effects of soil improvement on grain yield, Gule watershed, Ethiopia

Grain yield for various amendments



## (f) Effects of soil improvement on biomass yield, Gule watershed, Ethiopia







## g. Bench terraces

*First Bench Terrace in Tigray (Zata area, Tigray, Ethiopia)*



*Second Bench Terrace in Tigray (Maychew area, Tigray, Ethiopia)*

# ***Typical Example of Bench Terraces, Ethiopia***

***Before (Photo: TBoARD, 2012)***

***After (Photo: Kifle Woldearegay, 2013)***



***Bench Terrace in Maychew, Tigray, Ethiopia***

## 4.4 Performance of WHT in Zambia

Monitoring of the WHTs started in 2013/2014 farming season and the following data has been collected:

- **Soil properties:** soil pH, soil texture, S.O.M, soil respiration, bulk density and soil water infiltration rate.
- **Economic data:** production costs (labour input, weeding, fertilizer and seed inputs, harvesting costs and transportation costs), and yield data.
- **Timing of operations:** land preparation, planting, weeding and harvesting.
- **Rainfall data:** days of rainfall and amounts (mm).





(a)

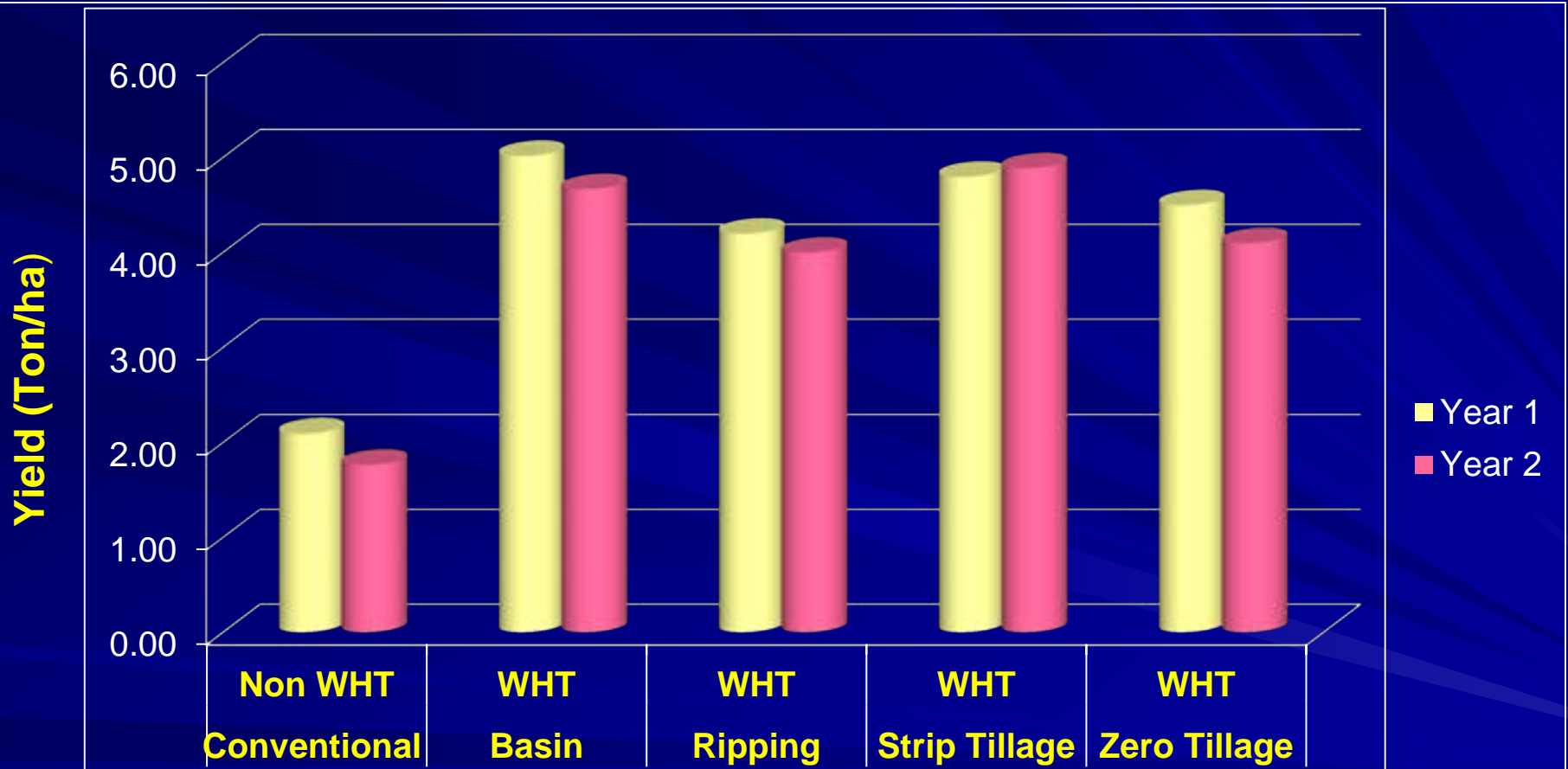


(b)

*Results of the adaptation: (a) maize crop in the zero till field, and (b) maize from the WHT Plot bagged separate from the main crop.*



(a) Maize yield with respect to the different water harvesting implemented in Zambia.



# 5. Key findings

## 5.1 Results from Tunisia

- Jessour and tabias play a significant role in ensuring crop production but recourse to supplemental irrigation will be needed in case of prolonged droughts.
- Combined Zai with jessour/tabia help the installation of young trees.
- Recharge structures have a positive impact on groundwater replenishment but accumulation of silt can reduce significantly this effect.

## 5.2 Results from Burkina Faso

- **Zai with compost manure + microdosingwa** is found to be the best technology.
- The **magoye ripper** introduced gave significant results on grain yield compared to control and stones bunds.
- The **cowpea experiment** was well appreciated by the women during the post evaluation of the experiment.
- **Runoff water harvesting using Banka** coupled with improved seed variety and proper soil management resulted in an increase in grain yield from 2640 Kg/ha to 7367Kg/ha in supplementary irrigated case.

## 5.3 Results from Ethiopia

- Integrated with water sources, bench terraces have a great potential to benefit communities;
- Check-dams have great contribution in reducing gully erosion, enhancing groundwater recharge, storing sediments and buffering moisture and enhancing moisture availability at landscapes.
- Integrated, landscape level of WHT a key to address rainfall variability;
- Soil improvement have a good potential for enhancing productivity.

## 5.4 Results from Zambia

- Implementation of WHT is one of the best options to enhance productivity.
- Water and soil conservative measures employed enabled the crop to withstand long dry spells experienced during the second year of monitoring.

## 6. Acknowledgement

The project received funding from the European Union's Seventh Framework Programme (FP7/2007-2013) under grant agreement n° 265570 (WAHARA project).

The consortium would like to acknowledge EU for the financial support.



*A hand-dug well which was productive before gully development is now dry because of the gully expansion, Tigray, Ethiopia*

## **Lessons:**

**Water security is all about land and water management.**

*New groundwater created after the construction of a check-dam, Gule area, Tigray, Ethiopia.*



**Thank You**