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WADIS-MAR
Water harvesting and Agricultural techniques in Dry lands: an Integrated and Sustainable model in MAghreb Regions

Sustainable Water Integrated Management (SWIM) Demonstration Project

# ASSESSMENT OF ON-FARM VEGETABLE CROP RESPONSE TO DRIP- IRRIGATION SCHEDULING WITH SALINE WATER IN THE SOUTHERN TUNISIA

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# Presentation outlines

1. Introduction
2. Objectives
3. Materials and methods
4. Results
   - Soil salinity
   - Crop yield
   - Water supply and productivity
   - Economic evaluation
5. Conclusions

# Introduction

Limited supply of good quality water is a major constraint to crop production in the Mediterranean region of Tunisia → Highly use saline water to intensify agriculture

**Most of irrigated lands**
→ were located around shallow wells having ECi > 3 dS/m.
→ Vegetables have an important place

**Farmer's practices**

Fixed amount approach used → water losses & water deficits

**Vegetable crops** → grown during autumn to spring periods

Coincide with the rainy season in the arid regions of Tunisia

# Introduction

The optimal irrigation management strategy is to maximize yield by supplying the irrigation requirement of the crop (CWR).

How to make irrigation more efficient?

- ❑ Irrigation methods: micro-irrigation (drip irrigation)
- ❑ Irrigation volume based on CWR and soil characteristics (Full irrigation)
- ❑ Reduction in the volume (deficit irrigation) based on crop salinity and drought tolerance.

# Objectives

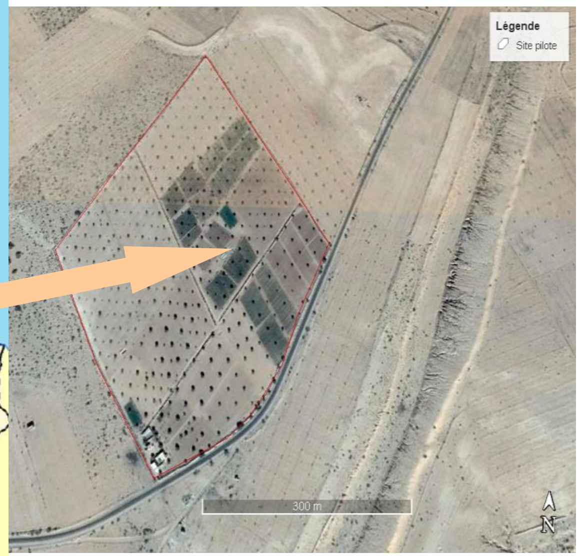
- Determine irrigation water requirements of vegetable crops and assess yield response to different irrigation regimes using saline waters

- Identify the best irrigation strategy that allow water saving with reduced effect on soil salinity and crop productivity under the arid Mediterranean conditions of southern Tunisia.

# Materials and Methodes

## Field experiments

Location of the study site


- Two years (2012-2014) in farmer field in Médenine, Southern Tunisia
- Vegetable crops cultivate over contrasting seasons
- Average rainfall: 153 mm/year
- Climate typical of arid areas according to annual rainfall (<200 mm) and ETo (>1400 mm/year)
- Water source: Shallow well having an ECi of 6 dS/m
- Sandy soil texture (Clay: 6.77%, Loam: 12.68% & Sand: 80.55%) having low organic manure (<0.8%)

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# Materials and Methodes




# Materials and Methodes

## Field experiments

- Vegetable crops: potato, carrot, green bean and pepper
- Irrigation system: Drip irrigation method

- Before planation, Organic manure, potassium ($K_2O$) and phosphate ($P_2O_5$) were supplied as basal doses.

- Nitrogen was divided and delivered with the irrigation water for all treatments during early vegetative growth

# Materials and Methodes

## Irrigation scheduling methods

Two irrigation treatments based on the use SWB to estimate irrigation amounts and timing were compared to farmer practice.

- SWB methods consist in replacement of cumulated ETc when readily available water is depleted with levels of 100% (FI100) and 70% (DI70)
- Farmer method (FM) consists in giving fixed amounts of irrigation water with fixed intervals from planting till harvest.

# Materials and Methodes

Crop evapotranspiration        ETc = Kc ETo

- Reference evapotranspiration ETo:  FAO-56 Penman-Monteith method (Allen et al.. 1998)

- Crop coefficient Kc:  Dual Kc approach ⟶ Kc= KcbKs+Ke

Irrigation scheduling ► SWB model

- Daily basis
- Water balance components
- Information on irrigation when RAW (% of TAW) has been depleted

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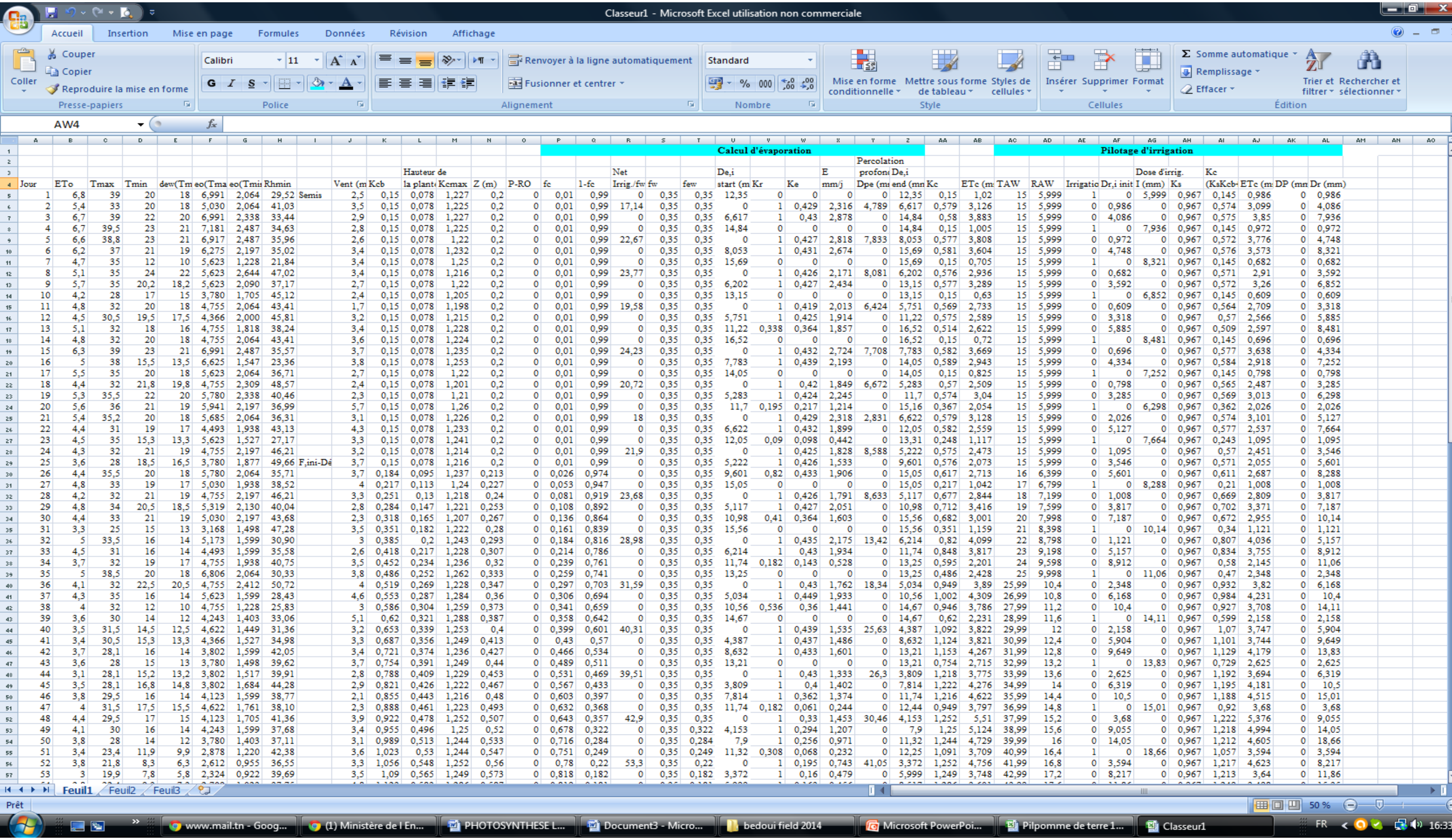
# Materials and Methodes



Calcul d'évaporation / Pilotage d'irrigation

| Jour | ETo | Tmax | Tmin | dew(Tm | eo(Tma | eo(Tmi | Rhmin | | Vent (m | Kcb | Hauteur de la plant | Kcmax | Z (m) | P-RO | fc | 1-fc | Net Irrig./fw | fw | few |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 6,8 | 39 | 20 | 18 | 6,991 | 2,064 | 29,52 | Semis | 2,5 | 0,15 | 0,078 | 1,227 | 0,2 | 0 | 0,01 | 0,99 | 0 | 0,35 | 0,35 |
| 2 | 5,4 | 33 | 20 | 18 | 5,030 | 2,064 | 41,03 | | 3,5 | 0,15 | 0,078 | 1,225 | 0,2 | 0 | 0,01 | 0,99 | 17,14 | 0,35 | 0,35 |
| 3 | 6,7 | 39 | 22 | 20 | 6,991 | 2,338 | 33,44 | | 2,9 | 0,15 | 0,078 | 1,227 | 0,2 | 0 | 0,01 | 0,99 | 0 | 0,35 | 0,35 |
| 4 | 6,7 | 39,5 | 23 | 21 | 7,181 | 2,487 | 34,63 | | 2,8 | 0,15 | 0,078 | 1,225 | 0,2 | 0 | 0,01 | 0,99 | 0 | 0,35 | 0,35 |
| 5 | 6,6 | 38,8 | 23 | 21 | 6,917 | 2,487 | 35,96 | | 2,6 | 0,15 | 0,078 | 1,22 | 0,2 | 0 | 0,01 | 0,99 | 22,67 | 0,35 | 0,35 |
| 6 | 6,2 | 37 | 21 | 19 | 6,275 | 2,197 | 35,02 | | 3,4 | 0,15 | 0,078 | 1,232 | 0,2 | 0 | 0,01 | 0,99 | 0 | 0,35 | 0,35 |
| 7 | 4,7 | 35 | 12 | 10 | 5,623 | 1,228 | 21,84 | | 3,4 | 0,15 | 0,078 | 1,25 | 0,2 | 0 | 0,01 | 0,99 | 0 | 0,35 | 0,35 |
| 8 | 5,1 | 35 | 24 | 22 | 5,623 | 2,644 | 47,02 | | 3,4 | 0,15 | 0,078 | 1,216 | 0,2 | 0 | 0,01 | 0,99 | 23,77 | 0,35 | 0,35 |
| 9 | 5,7 | 35 | 20,2 | 18,2 | 5,623 | 2,090 | 37,17 | | 2,7 | 0,15 | 0,078 | 1,22 | 0,2 | 0 | 0,01 | 0,99 | 0 | 0,35 | 0,35 |
| 10 | 4,2 | 28 | 17 | 15 | 3,780 | 1,705 | 45,12 | | 2,4 | 0,15 | 0,078 | 1,205 | 0,2 | 0 | 0,01 | 0,99 | 0 | 0,35 | 0,35 |
| 11 | 4,8 | 32 | 20 | 18 | 4,755 | 2,064 | 43,41 | | 1,7 | 0,15 | 0,078 | 1,198 | 0,2 | 0 | 0,01 | 0,99 | 19,58 | 0,35 | 0,35 |
| 12 | 4,5 | 30,5 | 19,5 | 17,5 | 4,366 | 2,000 | 45,81 | | 3,2 | 0,15 | 0,078 | 1,215 | 0,2 | 0 | 0,01 | 0,99 | 0 | 0,35 | 0,35 |
| 13 | 5,1 | 32 | 18 | 16 | 4,755 | 1,818 | 38,24 | | 3,4 | 0,15 | 0,078 | 1,228 | 0,2 | 0 | 0,01 | 0,99 | 0 | 0,35 | 0,35 |
| 14 | 4,8 | 32 | 20 | 18 | 4,755 | 2,064 | 43,41 | | 3,6 | 0,15 | 0,078 | 1,224 | 0,2 | 0 | 0,01 | 0,99 | 0 | 0,35 | 0,35 |
| 15 | 6,3 | 39 | 23 | 21 | 6,991 | 2,487 | 35,57 | | 3,7 | 0,15 | 0,078 | 1,235 | 0,2 | 0 | 0,01 | 0,99 | 24,23 | 0,35 | 0,35 |
| 16 | 5 | 38 | 15,5 | 13,5 | 6,625 | 1,547 | 23,36 | | 3,8 | 0,15 | 0,078 | 1,253 | 0,2 | 0 | 0,01 | 0,99 | 0 | 0,35 | 0,35 |
| 17 | 5,5 | 35 | 20 | 18 | 5,623 | 2,064 | 36,71 | | 2,7 | 0,15 | 0,078 | 1,22 | 0,2 | 0 | 0,01 | 0,99 | 0 | 0,35 | 0,35 |
| 18 | 4,4 | 32 | 21,8 | 19,8 | 4,755 | 2,309 | 48,57 | | 2,4 | 0,15 | 0,078 | 1,201 | 0,2 | 0 | 0,01 | 0,99 | 20,72 | 0,35 | 0,35 |
| 19 | 5,3 | 35,5 | 22 | 20 | 5,780 | 2,338 | 40,46 | | 2,3 | 0,15 | 0,078 | 1,21 | 0,2 | 0 | 0,01 | 0,99 | 0 | 0,35 | 0,35 |
| 20 | 5,6 | 36 | 21 | 19 | 5,941 | 2,197 | 36,99 | | 5,7 | 0,15 | 0,078 | 1,26 | 0,2 | 0 | 0,01 | 0,99 | 0 | 0,35 | 0,35 |
| 21 | 5,4 | 35,2 | 20 | 18 | 5,685 | 2,064 | 36,31 | | 3,1 | 0,15 | 0,078 | 1,226 | 0,2 | 0 | 0,01 | 0,99 | 18 | 0,35 | 0,35 |
| 22 | 4,4 | 31 | 19 | 17 | 4,493 | 1,938 | 43,13 | | 4,3 | 0,15 | 0,078 | 1,233 | 0,2 | 0 | 0,01 | 0,99 | 0 | 0,35 | 0,35 |
| 23 | 4,5 | 35 | 15,3 | 13,3 | 5,623 | 1,527 | 27,17 | | 3,3 | 0,15 | 0,078 | 1,241 | 0,2 | 0 | 0,01 | 0,99 | 0 | 0,35 | 0,35 |
| 24 | 4,3 | 32 | 21 | 19 | 4,755 | 2,197 | 46,21 | | 3,2 | 0,15 | 0,078 | 1,214 | 0,2 | 0 | 0,01 | 0,99 | 21,9 | 0,35 | 0,35 |
| 25 | 3,6 | 28 | 18,5 | 16,5 | 3,780 | 1,877 | 49,66 | F,ini-Dé | 3,7 | 0,15 | 0,078 | 1,216 | 0,2 | 0 | 0,01 | 0,99 | 0 | 0,35 | 0,35 |
| 26 | 4,4 | 35,5 | 20 | 18 | 5,780 | 2,064 | 35,71 | | 3,7 | 0,184 | 0,095 | 1,237 | 0,213 | 0 | 0,026 | 0,974 | 0 | 0,35 | 0,35 |
| 27 | 4,8 | 33 | 19 | 17 | 5,030 | 1,938 | 38,52 | | 4 | 0,217 | 0,113 | 1,24 | 0,227 | 0 | 0,053 | 0,947 | 0 | 0,35 | 0,35 |
| 28 | 4,2 | 32 | 21 | 19 | 4,755 | 2,197 | 46,21 | | 3,3 | 0,251 | 0,13 | 1,218 | 0,24 | 0 | 0,081 | 0,919 | 23,68 | 0,35 | 0,35 |
| 29 | 4,8 | 34 | 20,5 | 18,5 | 5,319 | 2,130 | 40,04 | | 2,8 | 0,284 | 0,147 | 1,221 | 0,253 | 0 | 0,108 | 0,892 | 0 | 0,35 | 0,35 |
| 30 | 4,4 | 33 | 21 | 19 | 5,030 | 2,197 | 43,68 | | 2,3 | 0,318 | 0,165 | 1,207 | 0,267 | 0 | 0,136 | 0,864 | 0 | 0,35 | 0,35 |
| 31 | 3,3 | 25 | 15 | 13 | 3,168 | 1,498 | 47,28 | | 3,5 | 0,351 | 0,182 | 1,222 | 0,28 | 0 | 0,161 | 0,839 | 0 | 0,35 | 0,35 |
| 32 | 5 | 33,5 | 16 | 14 | 5,173 | 1,599 | 30,90 | | 3 | 0,385 | 0,2 | 1,243 | 0,293 | 0 | 0,184 | 0,816 | 28,98 | 0,35 | 0,35 |
| 33 | 4,5 | 31 | 16 | 14 | 4,493 | 1,599 | 35,58 | | 2,6 | 0,418 | 0,217 | 1,228 | 0,307 | 0 | 0,214 | 0,786 | 0 | 0,35 | 0,35 |
| 34 | 3,7 | 32 | 19 | 17 | 4,755 | 1,938 | 40,75 | | 3,5 | 0,452 | 0,234 | 1,236 | 0,32 | 0 | 0,239 | 0,761 | 0 | 0,35 | 0,35 |
| 35 | 5 | 38,5 | 20 | 18 | 6,806 | 2,064 | 30,33 | | 3,8 | 0,486 | 0,252 | 1,262 | 0,333 | 0 | 0,259 | 0,741 | 0 | 0,35 | 0,35 |
| 36 | 4,1 | 32 | 22,5 | 20,5 | 4,755 | 2,412 | 50,72 | | 4 | 0,519 | 0,269 | 1,228 | 0,347 | 0 | 0,297 | 0,703 | 31,59 | 0,35 | 0,35 |
| 37 | 4,3 | 35 | 16 | 14 | 5,623 | 1,599 | 28,43 | | 4,6 | 0,553 | 0,287 | 1,284 | 0,36 | 0 | 0,306 | 0,694 | 0 | 0,35 | 0,35 |
| 38 | 4 | 32 | 12 | 10 | 4,755 | 1,228 | 25,83 | | 3 | 0,586 | 0,304 | 1,259 | 0,373 | 0 | 0,341 | 0,659 | 0 | 0,35 | 0,35 |
| 39 | 3,6 | 30 | 14 | 12 | 4,243 | 1,403 | 33,06 | | 5,1 | 0,62 | 0,321 | 1,288 | 0,387 | 0 | 0,358 | 0,642 | 0 | 0,35 | 0,35 |
| 40 | 3,5 | 31,5 | 14,5 | 12,5 | 4,622 | 1,449 | 31,36 | | 3,2 | 0,653 | 0,339 | 1,253 | 0,4 | 0 | 0,399 | 0,601 | 40,31 | 0,35 | 0,35 |
| 41 | 3,4 | 30,5 | 15,3 | 13,3 | 4,366 | 1,527 | 34,98 | | 3,3 | 0,687 | 0,356 | 1,249 | 0,413 | 0 | 0,43 | 0,57 | 0 | 0,35 | 0,35 |
| 42 | 3,7 | 28,1 | 16 | 14 | 3,802 | 1,599 | 42,05 | | 3,4 | 0,721 | 0,374 | 1,236 | 0,427 | 0 | 0,466 | 0,534 | 0 | 0,35 | 0,35 |
| 43 | 3,6 | 28 | 15 | 13 | 3,780 | 1,498 | 39,62 | | 3,7 | 0,754 | 0,391 | 1,249 | 0,44 | 0 | 0,489 | 0,511 | 0 | 0,35 | 0,35 |
| 44 | 3,1 | 28,1 | 15,2 | 13,2 | 3,802 | 1,517 | 39,91 | | 2,8 | 0,788 | 0,409 | 1,229 | 0,453 | 0 | 0,531 | 0,469 | 39,51 | 0,35 | 0,35 |
| 45 | 3,5 | 28,1 | 16,8 | 14,8 | 3,802 | 1,684 | 44,28 | | 2,9 | 0,821 | 0,426 | 1,222 | 0,467 | 0 | 0,567 | 0,433 | 0 | 0,35 | 0,35 |
| 46 | 3,8 | 29,5 | 16 | 14 | 4,123 | 1,599 | 38,77 | | 2,1 | 0,855 | 0,443 | 1,216 | 0,48 | 0 | 0,603 | 0,397 | 0 | 0,35 | 0,35 |
| 47 | 4 | 31,5 | 17,5 | 15,5 | 4,622 | 1,761 | 38,10 | | 2,3 | 0,888 | 0,461 | 1,223 | 0,493 | 0 | 0,632 | 0,368 | 0 | 0,35 | 0,35 |
| 48 | 4,4 | 29,5 | 17 | 15 | 4,123 | 1,705 | 41,36 | | 3,9 | 0,922 | 0,478 | 1,252 | 0,507 | 0 | 0,643 | 0,357 | 42,9 | 0,35 | 0,35 |
| 49 | 4,1 | 30 | 16 | 14 | 4,243 | 1,599 | 37,68 | | 3,4 | 0,955 | 0,496 | 1,25 | 0,52 | 0 | 0,678 | 0,322 | 0 | 0,35 | 0,322 |
| 50 | 3,8 | 28 | 14 | 12 | 3,780 | 1,403 | 37,11 | | 3,1 | 0,989 | 0,513 | 1,244 | 0,533 | 0 | 0,716 | 0,284 | 0 | 0,35 | 0,284 |
| 51 | 3,4 | 23,4 | 11,9 | 9,9 | 2,878 | 1,220 | 42,38 | | 3,6 | 1,023 | 0,53 | 1,244 | 0,547 | 0 | 0,751 | 0,249 | 0 | 0,35 | 0,249 |
| 52 | 3,8 | 21,8 | 8,3 | 6,3 | 2,612 | 0,955 | 36,55 | | 3,3 | 1,056 | 0,548 | 1,252 | 0,56 | 0 | 0,78 | 0,22 | 53,3 | 0,35 | 0,22 |
| 53 | 3 | 19,9 | 7,8 | 5,8 | 2,324 | 0,922 | 39,69 | | 3,5 | 1,09 | 0,565 | 1,249 | 0,573 | 0 | 0,818 | 0,182 | 0 | 0,35 | 0,182 |

| Jour | De,i start (m | Kr | Ke | E mm/j | Percolation profond Dpe (m | De,i end (mn | Kc | ETc (m | TAW | RAW | Irrigatio | Dr,i init | Dose d'irrig. I (mm) | Ks | Kc (KsKcb+ | ETc (m | DP (mn | Dr (mm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 12,35 | 0 | 0 | 0 | 0 | 12,35 | 0,15 | 1,02 | 15 | 5,999 | 1 | 0 | 5,999 | 0,967 | 0,145 | 0,986 | 0 | 0,986 |
| 2 | 0 | 1 | 0,429 | 2,316 | 4,789 | 6,617 | 0,579 | 3,126 | 15 | 5,999 | 0 | 0,986 | 0 | 0,967 | 0,574 | 3,099 | 0 | 4,086 |
| 3 | 6,617 | 1 | 0,43 | 2,878 | 0 | 14,84 | 0,58 | 3,883 | 15 | 5,999 | 0 | 4,086 | 0 | 0,967 | 0,575 | 3,85 | 0 | 7,936 |
| 4 | 14,84 | 0 | 0 | 0 | 0 | 14,84 | 0,15 | 1,005 | 15 | 5,999 | 1 | 0 | 7,936 | 0,967 | 0,145 | 0,972 | 0 | 0,972 |
| 5 | 0 | 1 | 0,427 | 2,818 | 7,833 | 8,053 | 0,577 | 3,808 | 15 | 5,999 | 0 | 0,972 | 0 | 0,967 | 0,572 | 3,776 | 0 | 4,748 |
| 6 | 8,053 | 1 | 0,431 | 2,674 | 0 | 15,69 | 0,581 | 3,604 | 15 | 5,999 | 0 | 4,748 | 0 | 0,967 | 0,576 | 3,573 | 0 | 8,321 |
| 7 | 15,69 | 0 | 0 | 0 | 0 | 15,69 | 0,15 | 0,705 | 15 | 5,999 | 1 | 0 | 8,321 | 0,967 | 0,145 | 0,682 | 0 | 0,682 |
| 8 | 0 | 1 | 0,426 | 2,171 | 8,081 | 6,202 | 0,576 | 2,936 | 15 | 5,999 | 0 | 0,682 | 0 | 0,967 | 0,571 | 2,91 | 0 | 3,592 |
| 9 | 6,202 | 1 | 0,427 | 2,434 | 0 | 13,15 | 0,577 | 3,289 | 15 | 5,999 | 0 | 3,592 | 0 | 0,967 | 0,572 | 3,26 | 0 | 6,852 |
| 10 | 13,15 | 0 | 0 | 0 | 0 | 13,15 | 0,15 | 0,63 | 15 | 5,999 | 1 | 0 | 6,852 | 0,967 | 0,145 | 0,609 | 0 | 0,609 |
| 11 | 0 | 1 | 0,419 | 2,013 | 6,424 | 5,751 | 0,569 | 2,733 | 15 | 5,999 | 0 | 0,609 | 0 | 0,967 | 0,564 | 2,709 | 0 | 3,318 |
| 12 | 5,751 | 1 | 0,425 | 1,914 | 0 | 11,22 | 0,575 | 2,589 | 15 | 5,999 | 0 | 3,318 | 0 | 0,967 | 0,57 | 2,566 | 0 | 5,885 |
| 13 | 11,22 | 0,338 | 0,364 | 1,857 | 0 | 16,52 | 0,514 | 2,622 | 15 | 5,999 | 0 | 5,885 | 0 | 0,967 | 0,509 | 2,597 | 0 | 8,481 |
| 14 | 16,52 | 0 | 0 | 0 | 0 | 16,52 | 0,15 | 0,72 | 15 | 5,999 | 1 | 0 | 8,481 | 0,967 | 0,145 | 0,696 | 0 | 0,696 |
| 15 | 0 | 1 | 0,432 | 2,724 | 7,708 | 7,783 | 0,582 | 3,669 | 15 | 5,999 | 0 | 0,696 | 0 | 0,967 | 0,577 | 3,638 | 0 | 4,334 |
| 16 | 7,783 | 1 | 0,439 | 2,193 | 0 | 14,05 | 0,589 | 2,943 | 15 | 5,999 | 0 | 4,334 | 0 | 0,967 | 0,584 | 2,918 | 0 | 7,252 |
| 17 | 14,05 | 0 | 0 | 0 | 0 | 14,05 | 0,15 | 0,825 | 15 | 5,999 | 1 | 0 | 7,252 | 0,967 | 0,145 | 0,798 | 0 | 0,798 |
| 18 | 0 | 1 | 0,42 | 1,849 | 6,672 | 5,283 | 0,57 | 2,509 | 15 | 5,999 | 0 | 0,798 | 0 | 0,967 | 0,565 | 2,487 | 0 | 3,285 |
| 19 | 5,283 | 1 | 0,424 | 2,245 | 0 | 11,7 | 0,574 | 3,04 | 15 | 5,999 | 0 | 3,285 | 0 | 0,967 | 0,569 | 3,013 | 0 | 6,298 |
| 20 | 11,7 | 0,195 | 0,217 | 1,214 | 0 | 15,16 | 0,367 | 2,054 | 15 | 5,999 | 1 | 0 | 6,298 | 0,967 | 0,362 | 2,026 | 0 | 2,026 |
| 21 | 0 | 1 | 0,429 | 2,318 | 2,831 | 6,622 | 0,579 | 3,128 | 15 | 5,999 | 0 | 2,026 | 0 | 0,967 | 0,574 | 3,101 | 0 | 5,127 |
| 22 | 6,622 | 1 | 0,432 | 1,899 | 0 | 12,05 | 0,582 | 2,559 | 15 | 5,999 | 0 | 5,127 | 0 | 0,967 | 0,577 | 2,537 | 0 | 7,664 |
| 23 | 12,05 | 0,09 | 0,098 | 0,442 | 0 | 13,31 | 0,248 | 1,117 | 15 | 5,999 | 1 | 0 | 7,664 | 0,967 | 0,243 | 1,095 | 0 | 1,095 |
| 24 | 0 | 1 | 0,425 | 1,828 | 8,588 | 5,222 | 0,575 | 2,473 | 15 | 5,999 | 0 | 1,095 | 0 | 0,967 | 0,57 | 2,451 | 0 | 3,546 |
| 25 | 5,222 | 1 | 0,426 | 1,533 | 0 | 9,601 | 0,576 | 2,073 | 15 | 5,999 | 0 | 3,546 | 0 | 0,967 | 0,571 | 2,055 | 0 | 5,601 |
| 26 | 9,601 | 0,82 | 0,433 | 1,906 | 0 | 15,05 | 0,617 | 2,713 | 16 | 6,399 | 0 | 5,601 | 0 | 0,967 | 0,611 | 2,687 | 0 | 8,288 |
| 27 | 15,05 | 0 | 0 | 0 | 0 | 15,05 | 0,217 | 1,042 | 17 | 6,799 | 1 | 0 | 8,288 | 0,967 | 0,21 | 1,008 | 0 | 1,008 |
| 28 | 0 | 1 | 0,426 | 1,791 | 8,633 | 5,117 | 0,677 | 2,844 | 18 | 7,199 | 0 | 1,008 | 0 | 0,967 | 0,669 | 2,809 | 0 | 3,817 |
| 29 | 5,117 | 1 | 0,427 | 2,051 | 0 | 10,98 | 0,712 | 3,416 | 19 | 7,599 | 0 | 3,817 | 0 | 0,967 | 0,702 | 3,371 | 0 | 7,187 |
| 30 | 10,98 | 0,41 | 0,364 | 1,603 | 0 | 15,56 | 0,682 | 3,001 | 20 | 7,998 | 0 | 7,187 | 0 | 0,967 | 0,672 | 2,955 | 0 | 10,14 |
| 31 | 15,56 | 0 | 0 | 0 | 0 | 15,56 | 0,351 | 1,159 | 21 | 8,398 | 1 | 0 | 10,14 | 0,967 | 0,34 | 1,121 | 0 | 1,121 |
| 32 | 0 | 1 | 0,435 | 2,175 | 13,42 | 6,214 | 0,82 | 4,099 | 22 | 8,798 | 0 | 1,121 | 0 | 0,967 | 0,807 | 4,036 | 0 | 5,157 |
| 33 | 6,214 | 1 | 0,43 | 1,934 | 0 | 11,74 | 0,848 | 3,817 | 23 | 9,198 | 0 | 5,157 | 0 | 0,967 | 0,834 | 3,755 | 0 | 8,912 |
| 34 | 11,74 | 0,182 | 0,143 | 0,528 | 0 | 13,25 | 0,595 | 2,201 | 24 | 9,598 | 0 | 8,912 | 0 | 0,967 | 0,58 | 2,145 | 0 | 11,06 |
| 35 | 13,25 | 0 | 0 | 0 | 0 | 13,25 | 0,486 | 2,428 | 25 | 9,998 | 1 | 0 | 11,06 | 0,967 | 0,47 | 2,348 | 0 | 2,348 |
| 36 | 0 | 1 | 0,43 | 1,762 | 18,34 | 5,034 | 0,949 | 3,89 | 25,99 | 10,4 | 0 | 2,348 | 0 | 0,967 | 0,932 | 3,82 | 0 | 6,168 |
| 37 | 5,034 | 1 | 0,449 | 1,933 | 0 | 10,56 | 1,002 | 4,309 | 26,99 | 10,8 | 0 | 6,168 | 0 | 0,967 | 0,984 | 4,231 | 0 | 10,4 |
| 38 | 10,56 | 0,536 | 0,36 | 1,441 | 0 | 14,67 | 0,946 | 3,786 | 27,99 | 11,2 | 0 | 10,4 | 0 | 0,967 | 0,927 | 3,708 | 0 | 14,11 |
| 39 | 14,67 | 0 | 0 | 0 | 0 | 14,67 | 0,62 | 2,231 | 28,99 | 11,6 | 1 | 0 | 14,11 | 0,967 | 0,599 | 2,158 | 0 | 2,158 |
| 40 | 0 | 1 | 0,439 | 1,535 | 25,63 | 4,387 | 1,092 | 3,822 | 29,99 | 12 | 0 | 2,158 | 0 | 0,967 | 1,07 | 3,747 | 0 | 5,904 |
| 41 | 4,387 | 1 | 0,437 | 1,486 | 0 | 8,632 | 1,124 | 3,821 | 30,99 | 12,4 | 0 | 5,904 | 0 | 0,967 | 1,101 | 3,744 | 0 | 9,649 |
| 42 | 8,632 | 1 | 0,433 | 1,601 | 0 | 13,21 | 1,153 | 4,267 | 31,99 | 12,8 | 0 | 9,649 | 0 | 0,967 | 1,129 | 4,179 | 0 | 13,83 |
| 43 | 13,21 | 0 | 0 | 0 | 0 | 13,21 | 0,754 | 2,715 | 32,99 | 13,2 | 1 | 0 | 13,83 | 0,967 | 0,729 | 2,625 | 0 | 2,625 |
| 44 | 0 | 1 | 0,43 | 1,333 | 26,3 | 3,809 | 1,218 | 3,775 | 33,99 | 13,6 | 0 | 2,625 | 0 | 0,967 | 1,192 | 3,694 | 0 | 6,319 |
| 45 | 3,809 | 1 | 0,4 | 1,402 | 0 | 7,814 | 1,222 | 4,276 | 34,99 | 14 | 0 | 6,319 | 0 | 0,967 | 1,195 | 4,181 | 0 | 10,5 |
| 46 | 7,814 | 1 | 0,362 | 1,374 | 0 | 11,74 | 1,216 | 4,622 | 35,99 | 14,4 | 0 | 10,5 | 0 | 0,967 | 1,188 | 4,515 | 0 | 15,01 |
| 47 | 11,74 | 0,182 | 0,061 | 0,244 | 0 | 12,44 | 0,949 | 3,797 | 36,99 | 14,8 | 1 | 0 | 15,01 | 0,967 | 0,92 | 3,68 | 0 | 3,68 |
| 48 | 0 | 1 | 0,33 | 1,453 | 30,46 | 4,153 | 1,252 | 5,51 | 37,99 | 15,2 | 0 | 3,68 | 0 | 0,967 | 1,222 | 5,376 | 0 | 9,055 |
| 49 | 4,153 | 1 | 0,294 | 1,207 | 0 | 7,9 | 1,25 | 5,124 | 38,99 | 15,6 | 0 | 9,055 | 0 | 0,967 | 1,218 | 4,994 | 0 | 14,05 |
| 50 | 7,9 | 1 | 0,256 | 0,971 | 0 | 11,32 | 1,244 | 4,729 | 39,99 | 16 | 0 | 14,05 | 0 | 0,967 | 1,212 | 4,605 | 0 | 18,66 |
| 51 | 11,32 | 0,308 | 0,068 | 0,232 | 0 | 12,25 | 1,091 | 3,709 | 40,99 | 16,4 | 1 | 0 | 18,66 | 0,967 | 1,057 | 3,594 | 0 | 3,594 |
| 52 | 0 | 1 | 0,195 | 0,743 | 41,05 | 3,372 | 1,252 | 4,756 | 41,99 | 16,8 | 0 | 3,594 | 0 | 0,967 | 1,217 | 4,623 | 0 | 8,217 |
| 53 | 3,372 | 1 | 0,16 | 0,479 | 0 | 5,999 | 1,249 | 3,748 | 42,99 | 17,2 | 0 | 8,217 | 0 | 0,967 | 1,213 | 3,64 | 0 | 11,86 |

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# Materials and Methodes

## Measured parameters

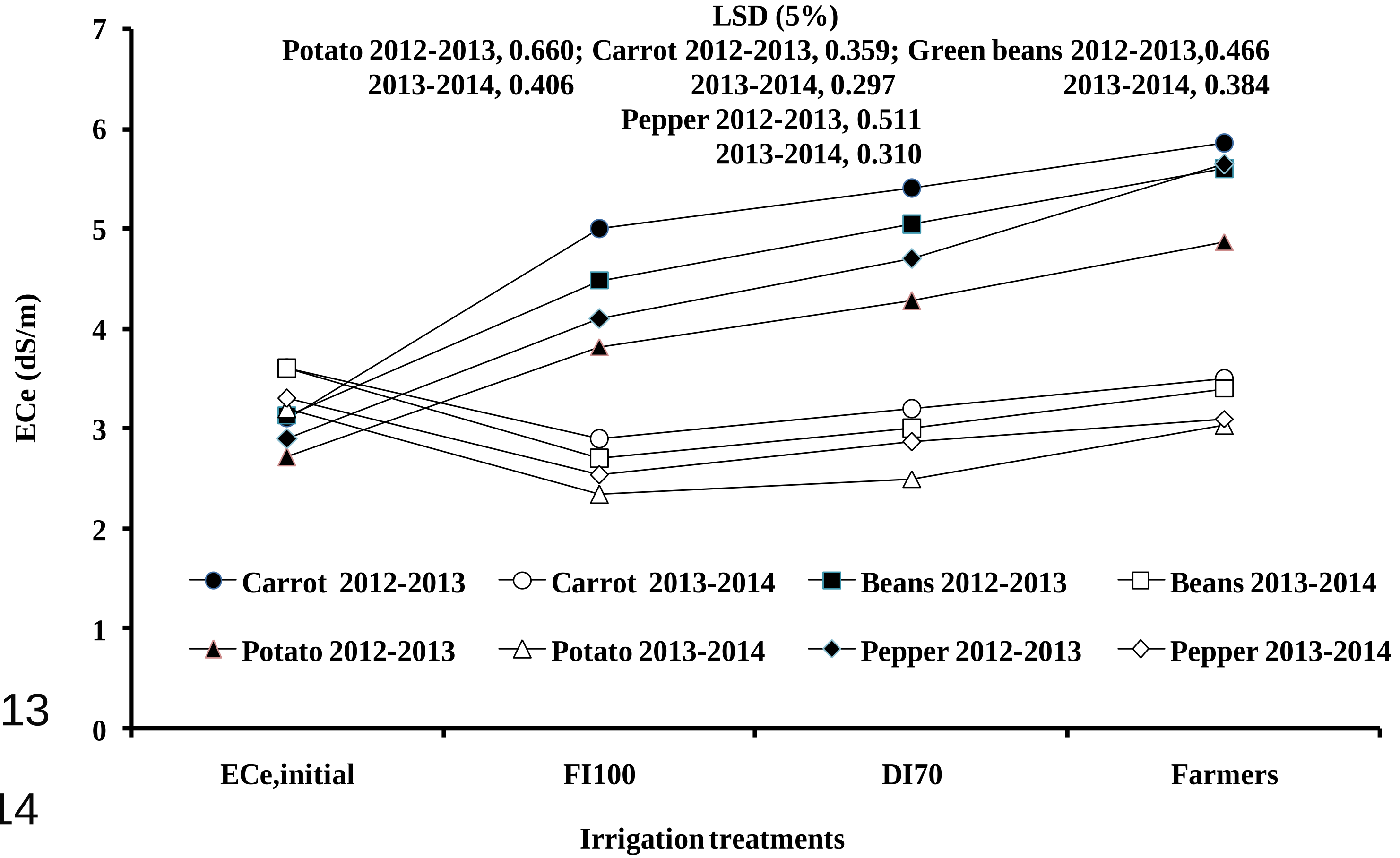
- Soil salinity
- Crop Yield
- Water supply and productivity

WP (kg/m$^3$) = Yield (kg/ha) / irrigation water (m$^3$/ha)

- Economic evaluation

# Results

## Soil salinity




↑ ECe in 2012-2013

↓ ECe in2013-2014

35-107 mm received during growing periods ➤ leaching of salts

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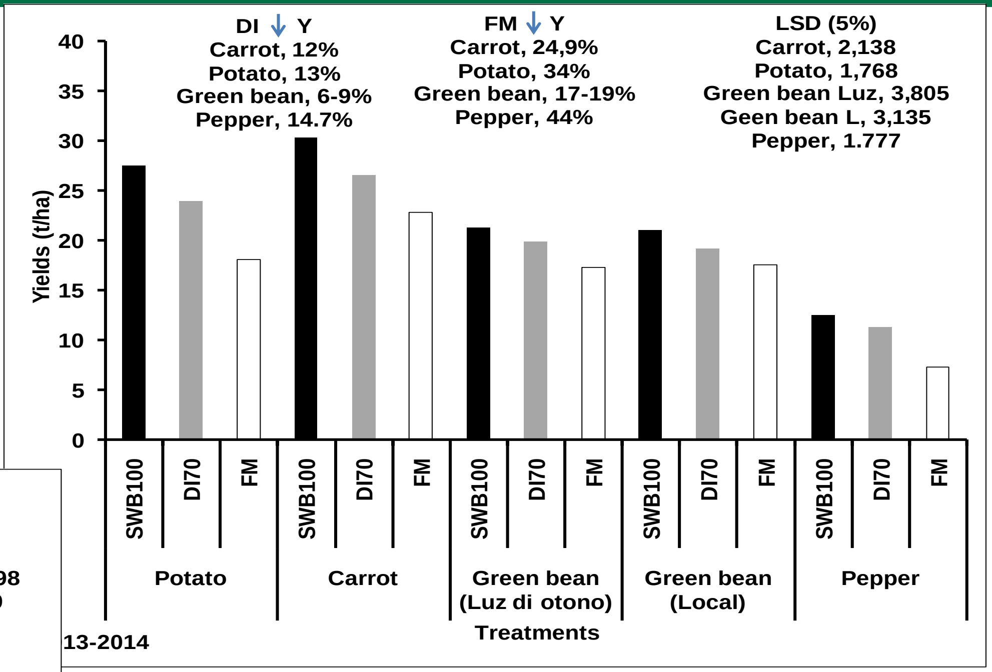
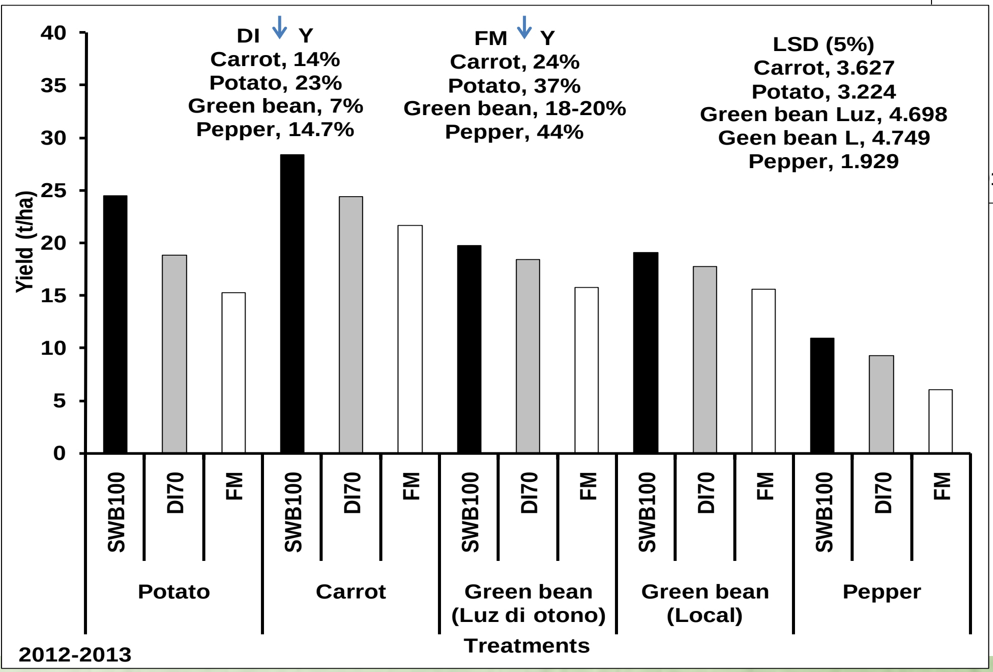
# Results

## Crop yield

The highest yield registered in the second season ➤ to low soil salinity and the higher rainfall amounts

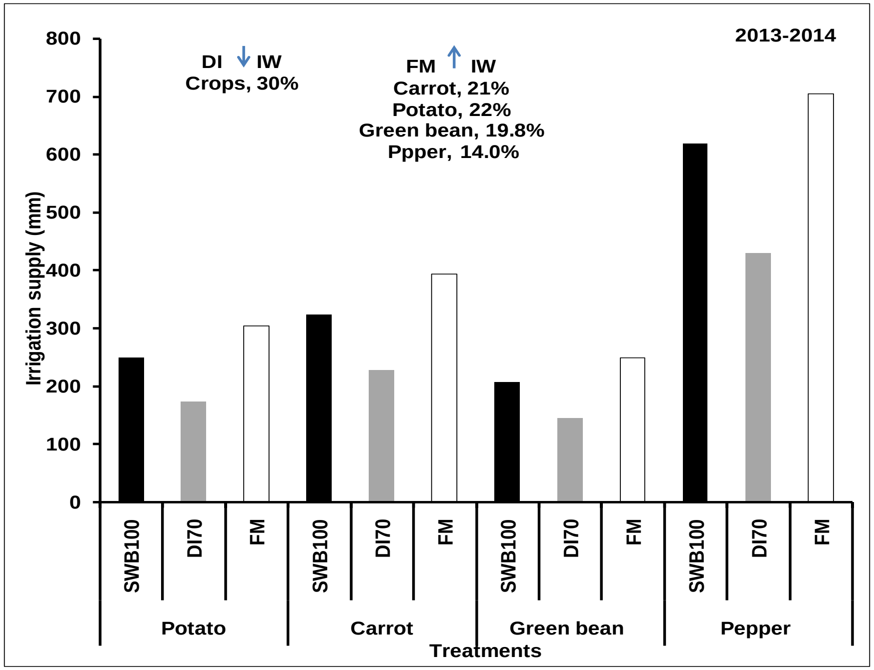


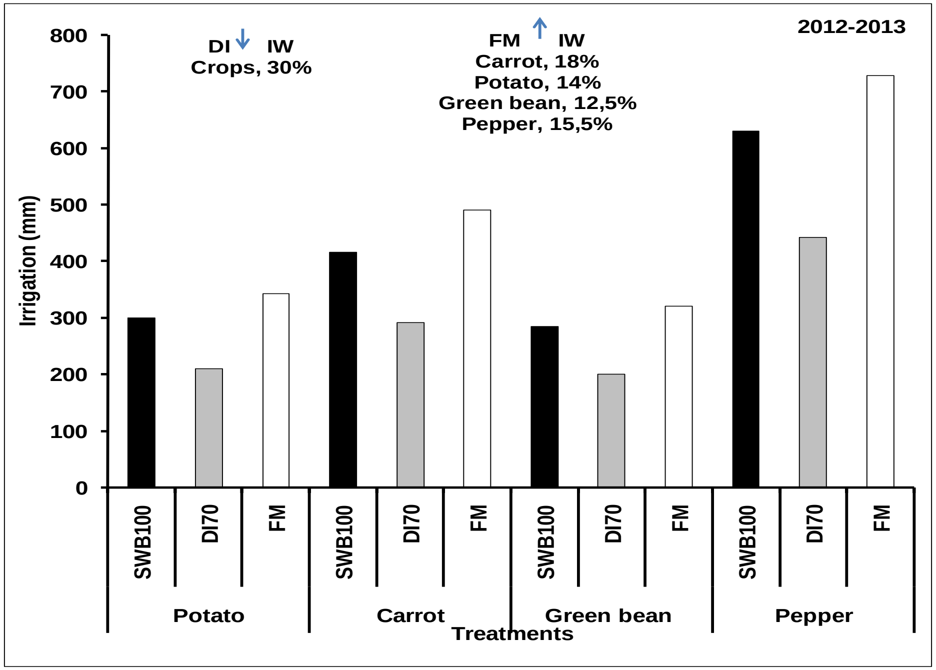




The higher soil salinity levels associated with farmer's method induced substantial yield reduction of crops

# Results

## Water supply

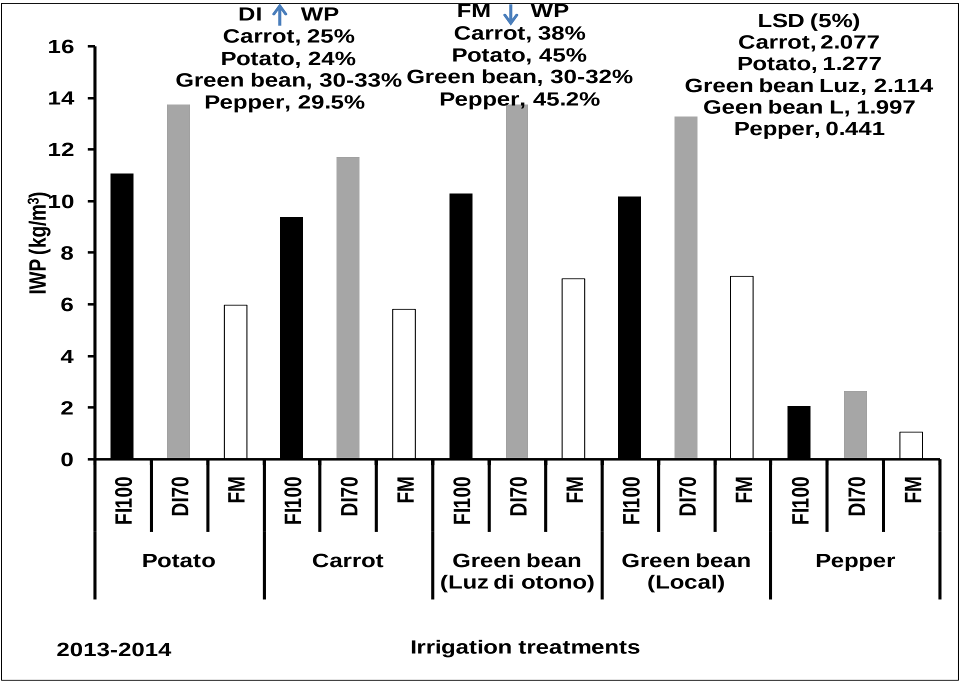


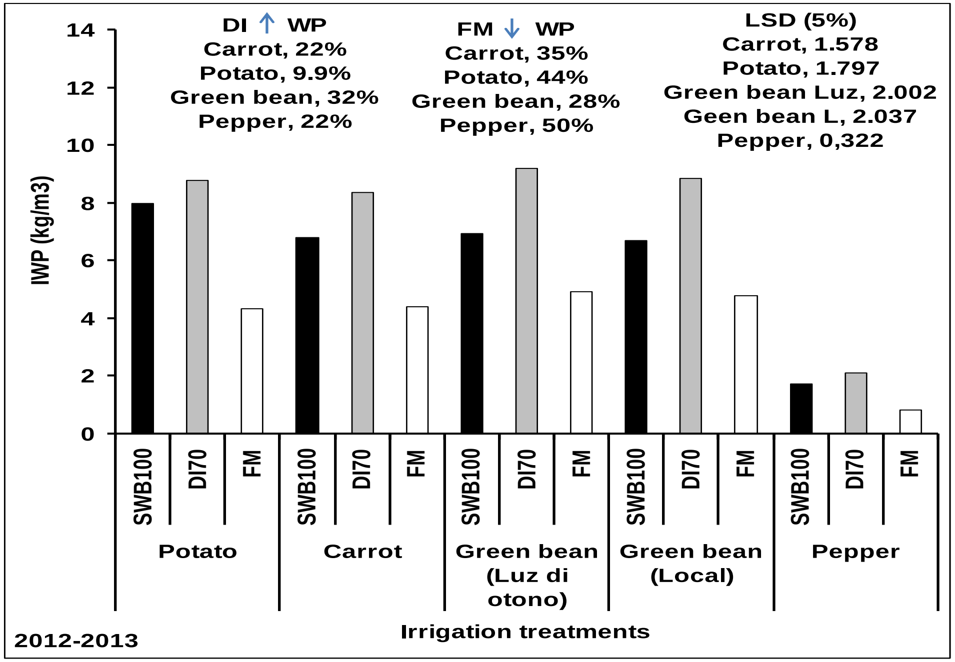



# Results

## Irrigation Water Productivity (IWP)

Highest IWP are obtained in 2013-2014




Lowest IWP values were obtained with FM

Yield reduction and higher irrigation water use.

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# Results

## Economic evaluation

| Treatment | Production costs($) | Gross return($) | Net income($) |
|---|---|---|---|
| | FI100 | | |
| Potato | 3634 | 9411 | 5777 |
| Green bean | 4292 | 6510 | 2217 |
| Carrot | 2987 | 7309 | 4322 |
| Pepper | 5604 | 27625 | 22020 |
| | DI70 | | |
| Potato | 3576 | 7867 | 4290 |
| Green bean | 4242 | 6006 | 1764 |
| Carrot | 2912 | 6326 | 3414 |
| Pepper | 5485 | 24312 | 18827 |
| | FM | | |
| Potato | 3667 | 6062 | 2394 |
| Green bean | 4337 | 5366 | 1028 |
| Carrot | 3036 | 5555 | 2519 |
| Pepper | 5665 | 15676 | 10010 |

# Conclusions

- SWB scheduling technique (FI100) provides the highest yield and net income with more water saving compared to FM.

- Deficit irrigation (DI70) reduced vegetable yields that caused net profit decrease. However, this strategy allowed to improve IWP with 30% water saving and small impact on soil salinization compared to full irrigation strategy.

- FM caused yield reduction as results of soil salinity increase

- FI scheduling technique based on SWB recommended for irrigation of vegetable crops

Implementation of demonstration pilot on farm field assisted farmers to evaluate their local irrigation practices and selected the most useful irrigation strategy through their continuous interaction during the experimental period.

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