# Nitrate leaching losses from a recently developed intensive horticultural system in a previously disadvantaged region

*R.B. Thompson[1], M.R. Granados[2], J.C. Gazquez[2], J.S. Rodríguez-López[1], M.D. Fernandez[2], M.G. Gallardo[1], C. Martínez-Gaitan[1], C. Gimenez[3]*

[1]Dpto. Producción Vegetal, Universidad de Almería, 04120 La Cañada, Almería, Spain. [2]Cajamar Estación Experimental "Las Palmerillas", Apdo. 250, 04080 Almería, Spain. [3]Dpto. Agronomía, Universidad de Córdoba, 14080 Córdoba, Spain

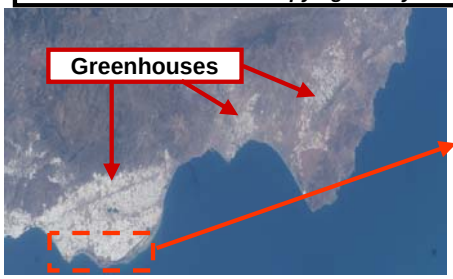
## Background

Greenhouse-based vegetable production in Almeria, Spain

- 27,000 ha simple plastic greenhouses; 10,000 ha more in adjoining provinces
- 80% cropping in soil; 20% in "open" hydroponic systems
- System has developed in last 30 years; responsible for local economic miracle
- ***Was very poor region; now has highest per capita income in Spain***
- Aquifers have ***massive nitrate contamination*** (see Fig 1)
- ***Considerable interest in copying this system in numerous other countries***

## Objectives

To measure and characterise $NO_3^-$ leaching from this system from:
(a) "open" hydroponic crops, and
(b) cropping sequences in soil



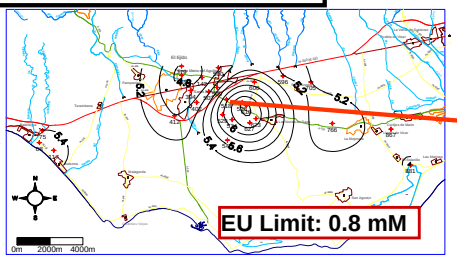




***Fig. 1 $NO_3^-$ concentration (mM) in superficial aquifer***

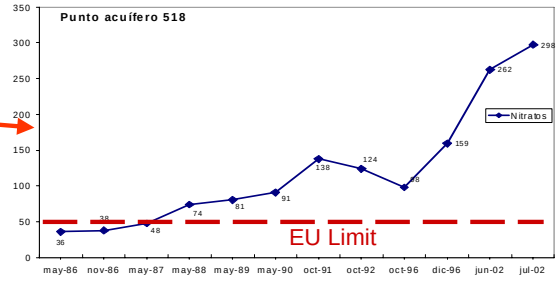



***Fig. 2 $NO_3^-$ concentration (mM) in one well with time***

## Materials & methods

***General***:

- Crops grown in plastic greenhouses in Almería
- Management consistent with local practice
- Complete nutrient solutions (10-14 mM $NO_3^-$, 1.0-1.5 mM $NH_4^+$) in most irrigations
- Drainage collected daily, and analysed for $NO_3^-$ and $NH_4^+$

***"Open" hydroponic crops***

- Drainage collected in trays, each with 2 x 40 L substrate bags, and 6 plants per bag.

1) Pepper grown in perlite (21 Jul.04 to 6 Jan.05) , drainage in two trays
2) Tomato grown in rockwool (6 Mar. to 6 Jul.05), drainage in four trays

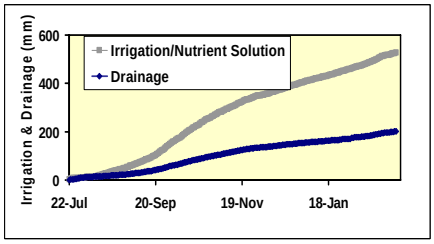
***Cropping sequences in soil***

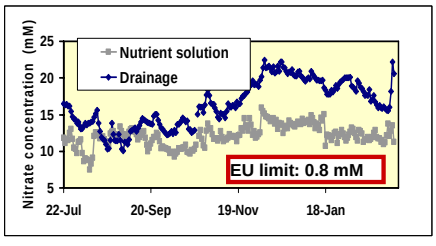
- Drainage collected in free-draining, re-packed lysimeters (2 x 4 x 0.7 m deep), two reps.
- Irrigation manage. with tensiometers (-15 - –35 kPa) after establishment
- Clay loam texture

1) manure (1,200 kg N $ha^{-1}$) on 10 Jun.03, 40 mm water (30 Jun.03), curtailed pepper (25 Jul. to 22 Aug.03), pepper (27 Sep.03 to 2 Jan.04), 80 mm irrigation to leach salts (9 Jan.04)
2) chemical disinfection (20&27 Jul.04), curtailed tomato (25 to 30 Aug.04), tomato (27 Sep.04 to 2 Mar.05). Only $H_2O$ applied to 13 Oct.04

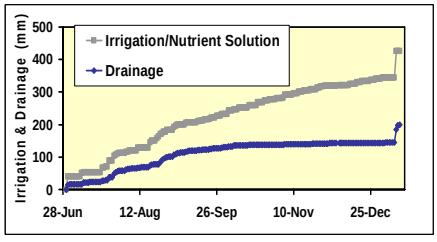
## Results

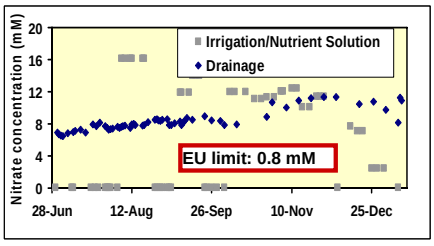
**Pepper grown in perlite**



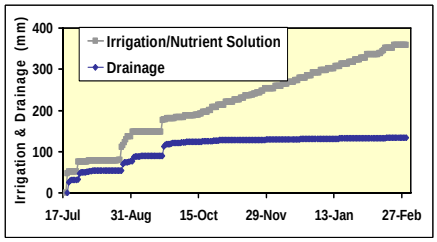



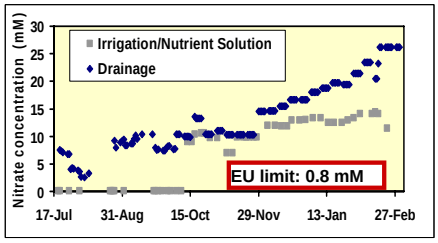

**Pepper in soil cropping sequence**




**Tomato in soil cropping sequence**




**Pepper grown in perlite**: 452 kg $NO_3^-$-N $ha^{-1}$ lost in drainage, from 950 kg N applied $ha^{-1}$ (93% as $NO_3^-$); average $NO_3^-$ concentration of 995 mg $NO_3^-$ $L^{-1}$; 201 mm of drainage, from 526 mm of irrigation, *i.e.* 38% drainage fraction

**Tomato grown in rockwool**: 162 kg $NO_3^-$-N $ha^{-1}$ lost in drainage, from 555 kg N applied $ha^{-1}$ (94% as $NO_3^-$); average $NO_3^-$ concentration of 944 mg $NO_3^-$ $L^{-1}$ 76 mm of drainage from 316 mm of irrigation, *i.e.* 24% drainage fraction

**Cropping sequences in soil**:Substancial drainage associated with (a) crop establishment and (b) large soil management irrigations *e.g.* soil (chemical) disinfection and salt leaching

Drainage water generally had >6 mM $NO_3^-$ (>370 mg $NO_3^-$ $L^{-1}$), even when only water applied

**Discussion Point:** Given that this agricultural system is largely responsible for rapidly enriching this region, it will be extremely difficult to introduce "restrictive" crop management practices that effectively reduce the massive $NO_3^-$ contamination that is occurring. This has implications for disadvantaged regions where intensive horticultural systems are currently being introduced.