



Sustainable Use of Wastewater in Agriculture

Agronomic Aspects

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Benefits of wastewater use in agriculture

- Wastewater provides
 - Water
 - Nutrients
 - Organic matter



Sustainable Irrigation

- Maintenance of
 - Soil quality
 - Crop production and quality
 - Environmental quality



Irrigation & Water Quality

- Parameters to assess water quality for irrigation are;
 - Salinity - EC, TDS
 - Water infiltration rate
 - Specific ion toxicity
 - Chloride
 - Boron
 - Trace elements
 - Miscellaneous effects – Nitrogen, bicarbonate, pH, residual chlorine.



Irrigation & Water Quality for Domestic waste

- Contaminants of concern for human health are;
 - bacterial pathogens
 - helminths
 - protozoa
 - viruses
- WHO recommendation
 - coliform count no more than 100/100 mL in 80% of samples.



Treatment is needed prior to irrigation

- AIMS:
 - Acceptable BOD
 - Acceptable microbiological quality
 - Acceptable salinity (shandyng with low salinity water)



Soil Quality

- Salinity
- Sodicity
- Erosion
- Waterlogging
- Soil structure
- Nutrient Status
- pH



Crop growth

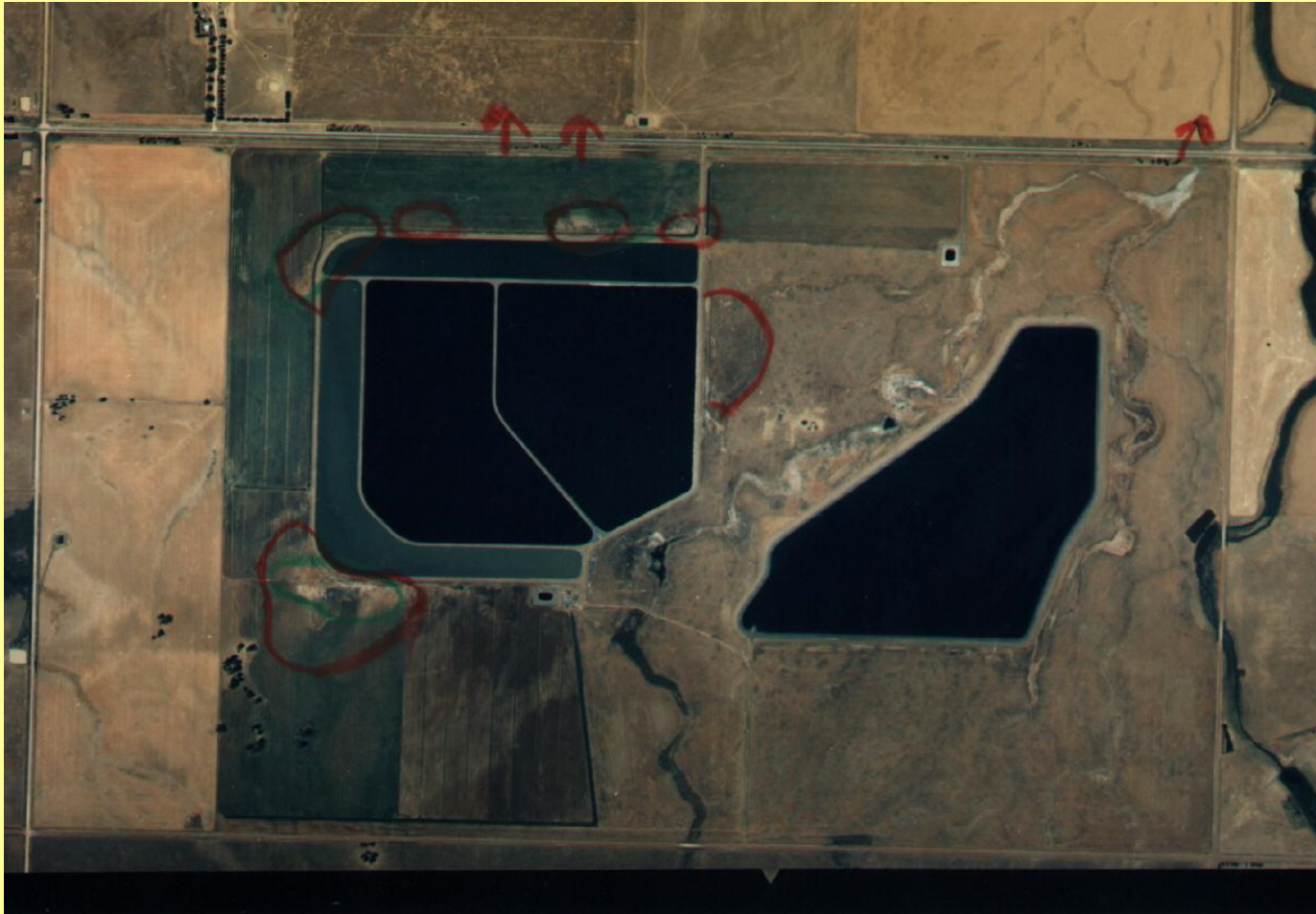
- Nutrient input
- Toxicity effects
- Water availability (salinity)



Environmental impacts

- Must take local climatic factors into account
- Must consider local groundwater conditions
 - (Echuca Sewage Treatment Farm)

Echuca Sewage Irrigation Farm





Removal of inputs

- Plant uptake
 - Water, nutrients, heavy metals
- Fixation/Precipitation
 - Nutrients, heavy metals
- Leaching
 - Water, salts, pH
- Degradation and transformation
 - Organic matter, nitrogen, phosphorus
- Other
 - Evaporation of water



Water is a scarce resource - wastewater must replace good water

- Wastewater = Water + Impurities
- What is the fate of Impurities in the soil?
- Let's look at the Werribee Sewage Farm west of Melbourne
 - Heavy metals from industrial processes in sewage
 - There are other factors, e.g. phosphate, salts, etc.



Conditions at Werribee

- Oldest very large sewage farm for Melbourne (now over 100 years of irrigation)
- Annual rainfall about 500 mm
- Annual evaporation about 1400 mm
- Heavy clay soils: (A) Low permeability clay on basalt and (B) moderately permeable clay soil on alluvial delta



Methods of irrigation

- **Soil A:**
- Overland flow on graded pasture land, called “Grass filtration”. Effluent at the downstream end suitable for disposal in Port Phillip Bay
- **Soil B:**
- Shallow ponding in level basins, called “Land filtration”. Soil provides final treatment as leachate water joins groundwater
- **Soil A & B:** Water lost by plant water use



Pasture utilisation

- Grazing by cattle
- Meat carefully tested for parasites and cysts
- Plans for leasing the land to farmers and selling them the treated effluent

Heavy Metal Concentrations in Irrigated and Non-irrigated Soil at Werribee (from Evans et al., 1978)

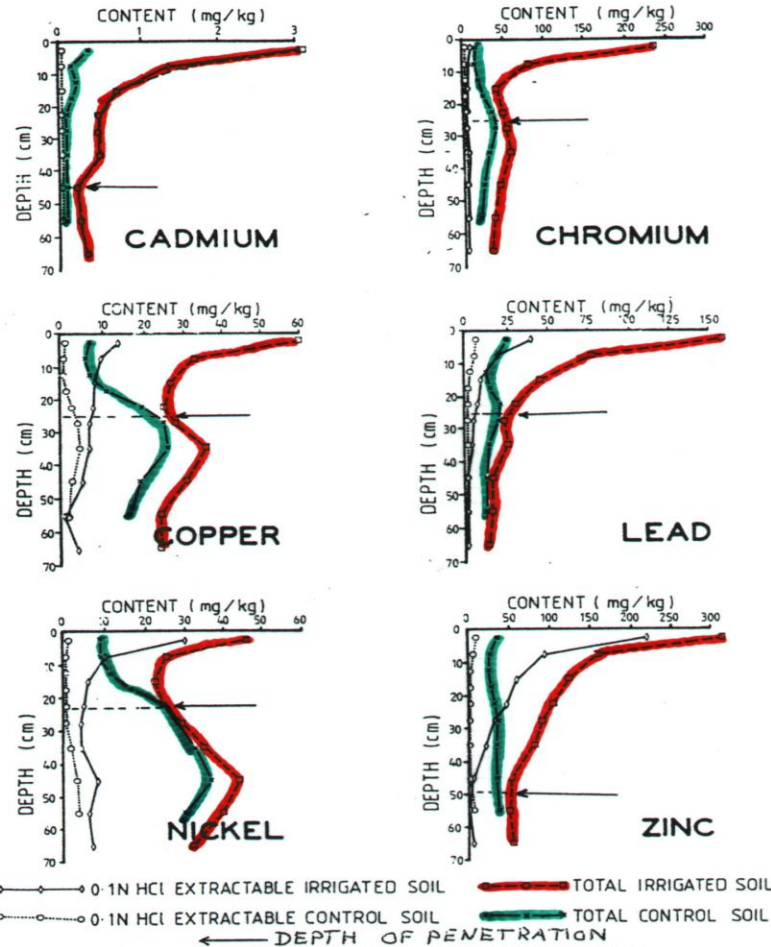
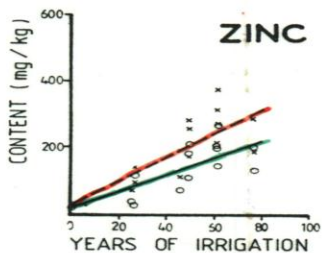
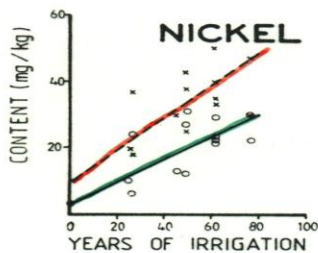
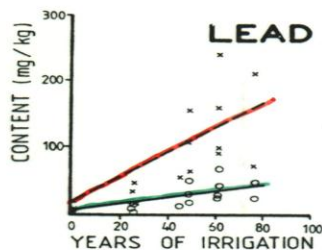
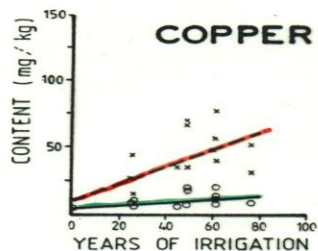
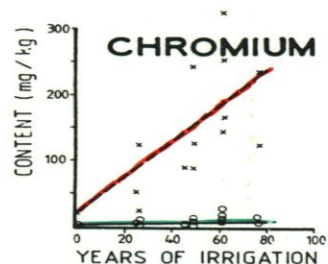
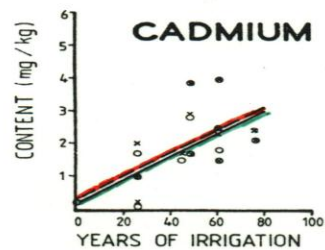


FIG. 1. THE TOTAL AND 0.1N HCL. EXTRACTABLE HEAVY METAL CONTENT OF THE SOIL PROFILE

- Note the “bulge” in the subsoil

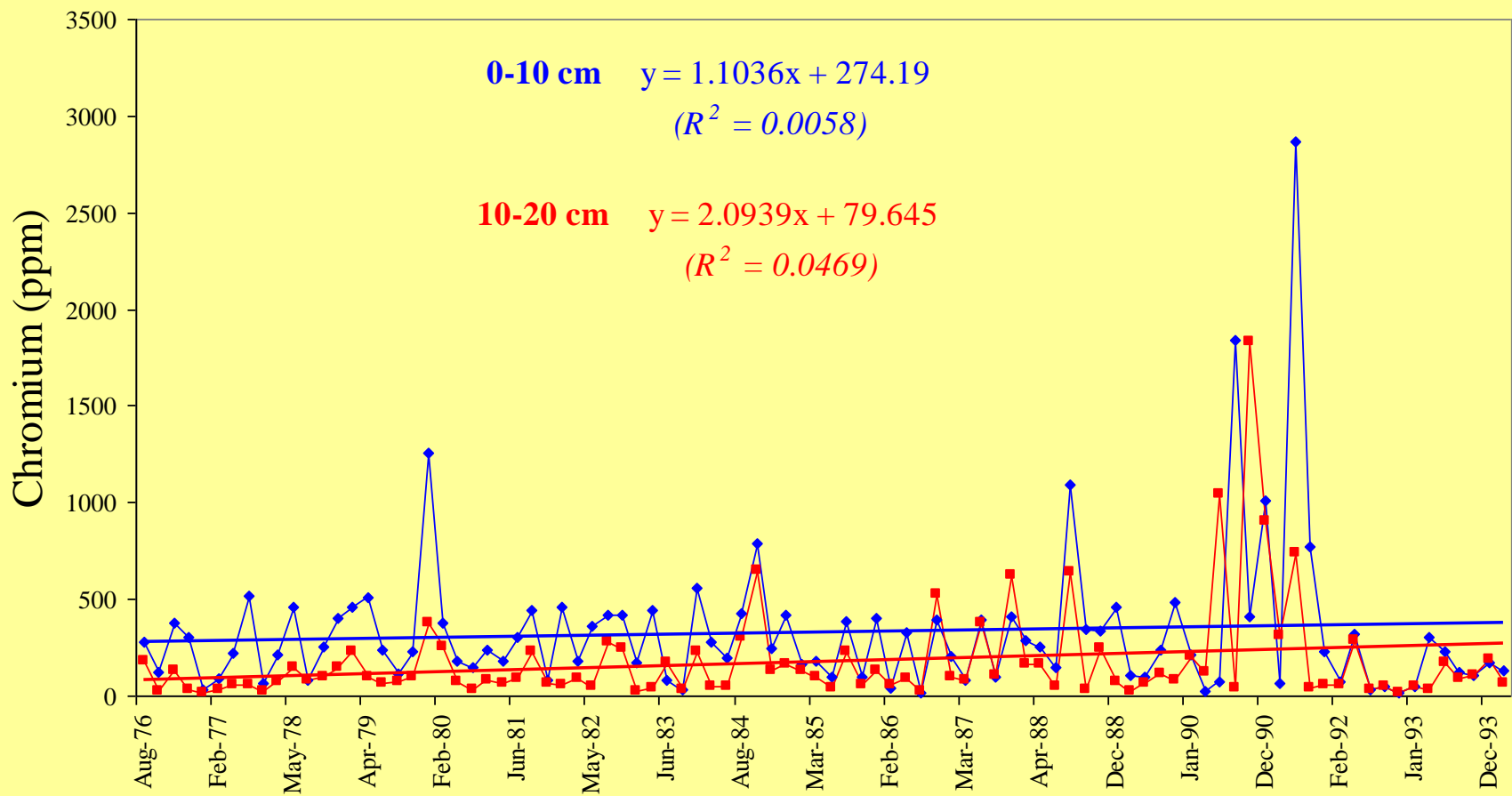


— 0.1N HCl. EXTRACTABLE (0-5cm)

— **TOTAL** (0-5cm)

FIG 2. APPARENT TRENDS BETWEEN METAL CONTENT OF SOIL AND YEARS OF IRRIGATION

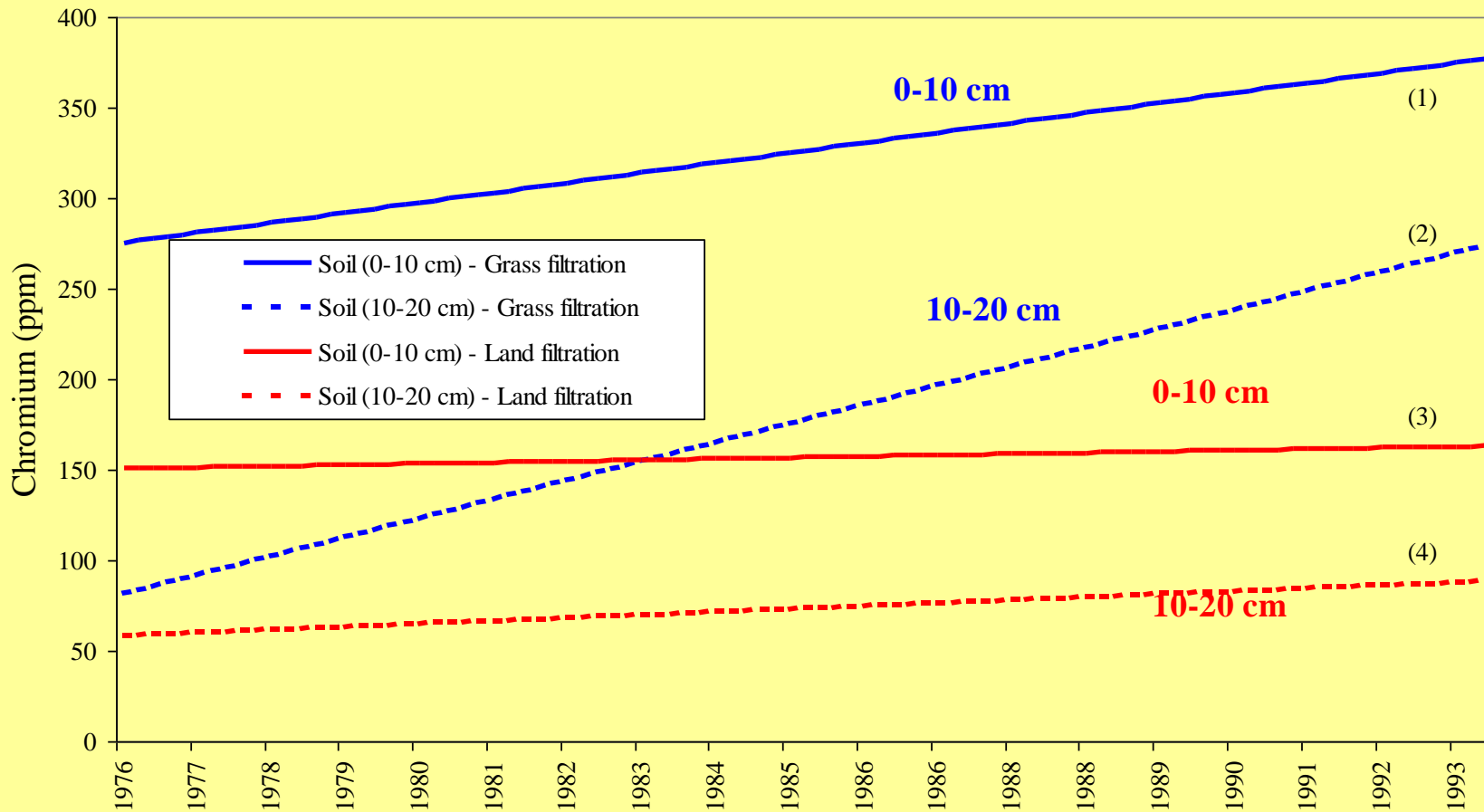
Chromium : Soil -Grass filtration



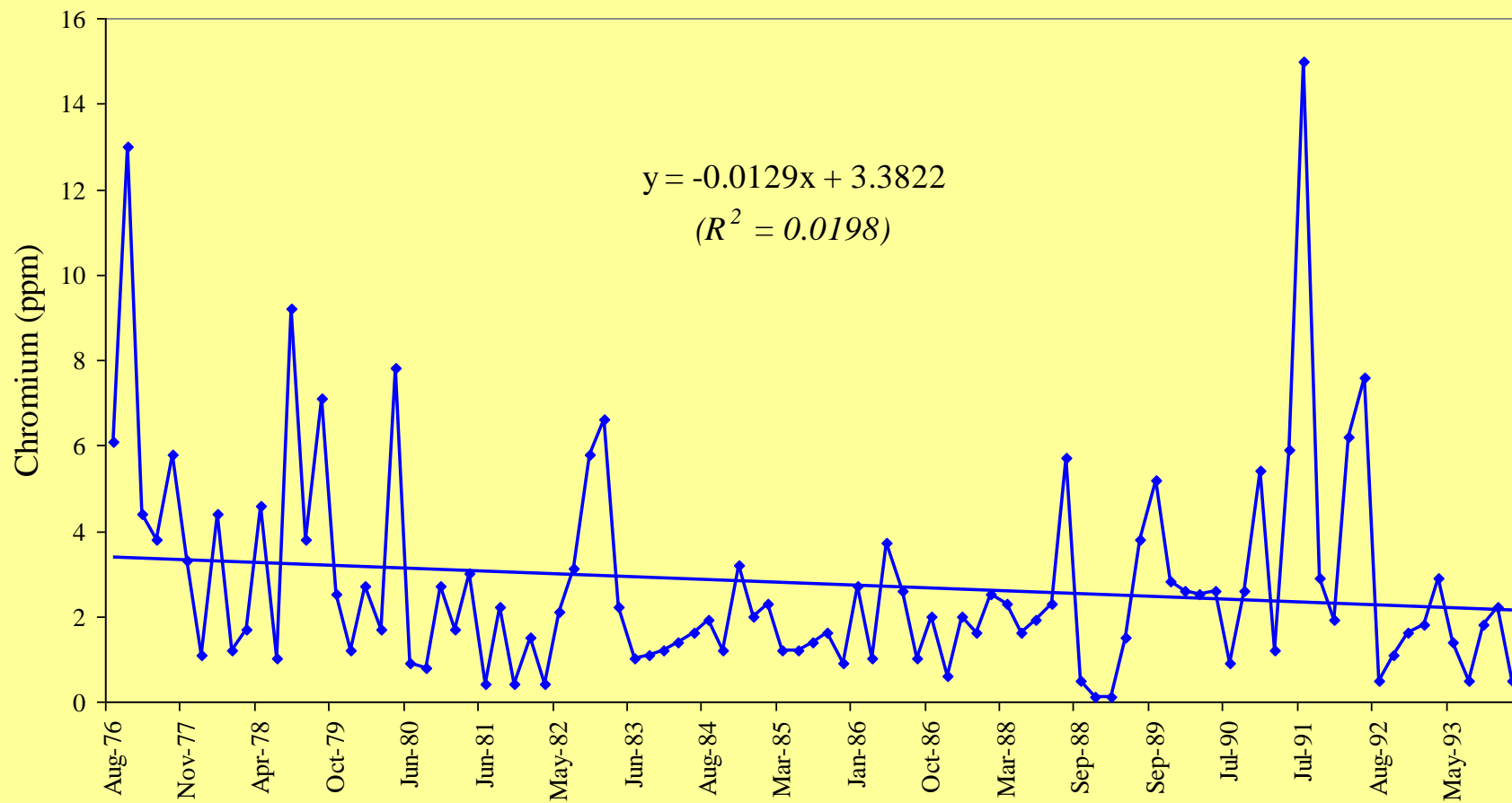


Chromium : Soil

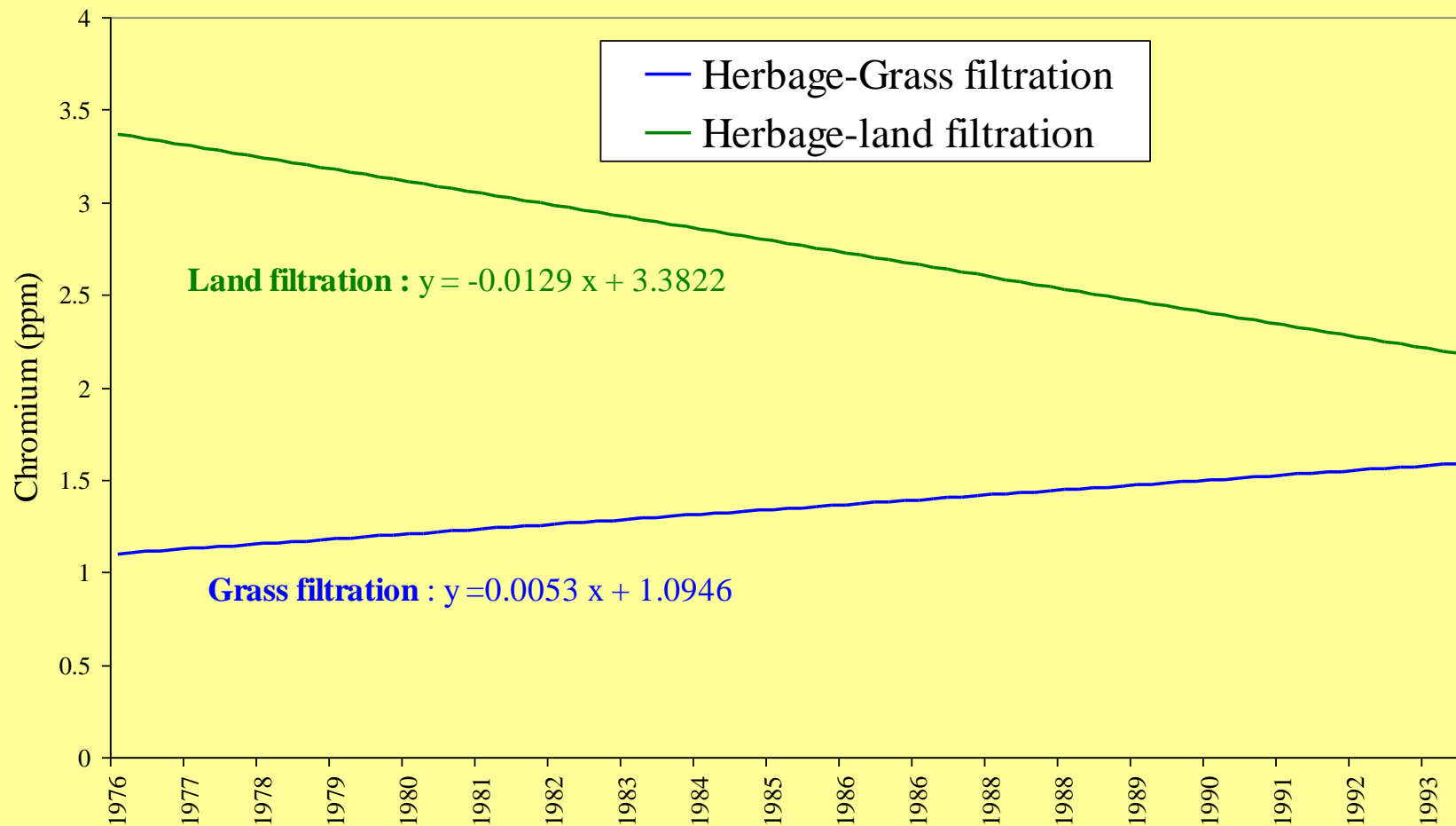
- (1) Grass filtration (0-10 cm): $y = 1.1036 x + 274.19$
- (2) Grass filtration (10-20 cm) : $y = 2.0939 x + 79.645$
- (3) Land filtration (0-10 cm): $y = 0.1351 x + 150.44$
- (4) Land filtration (10-20 cm): $y = 0.327 x + 58.483$



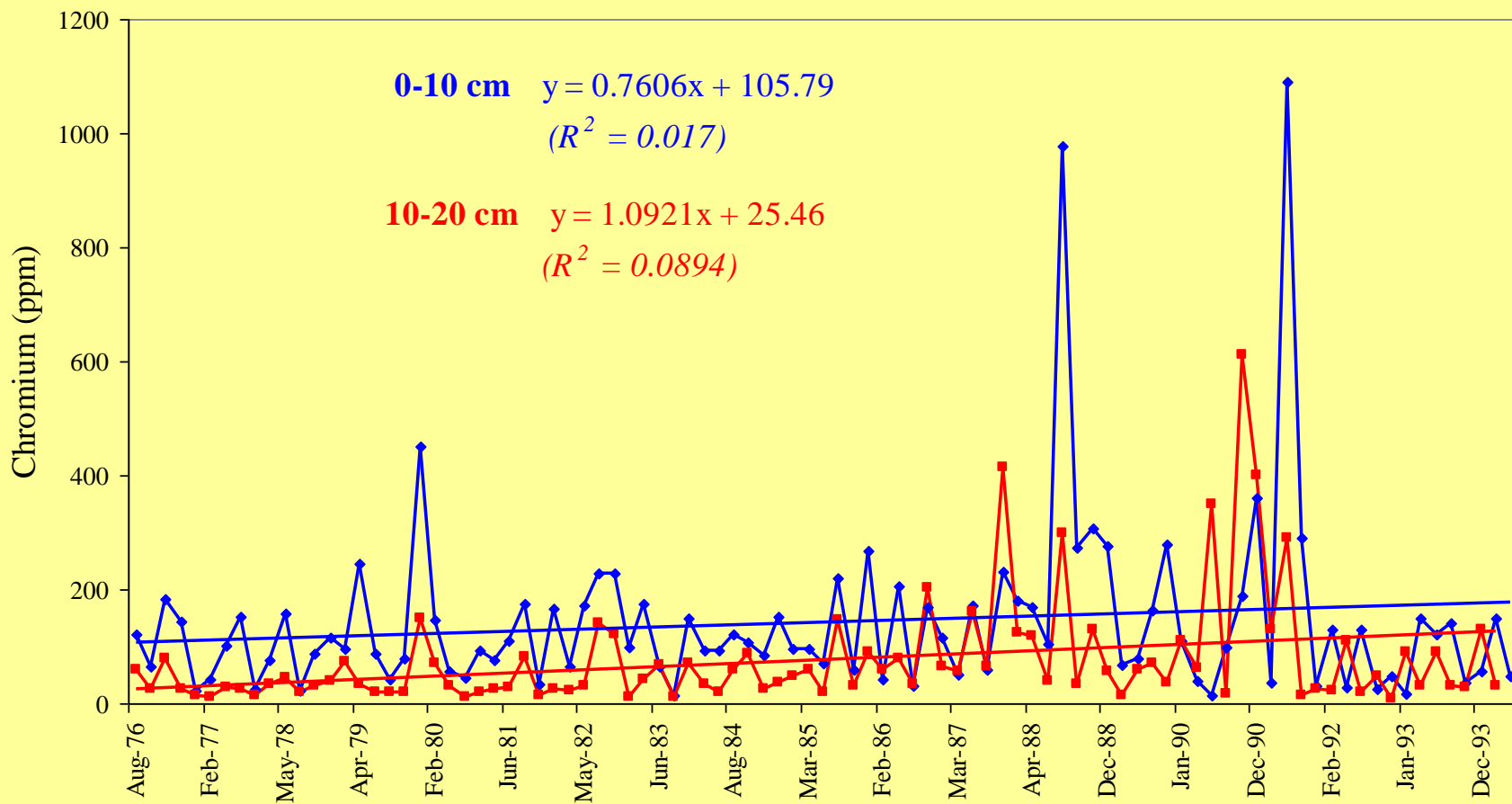
Chromium : Herbage-Land filtration



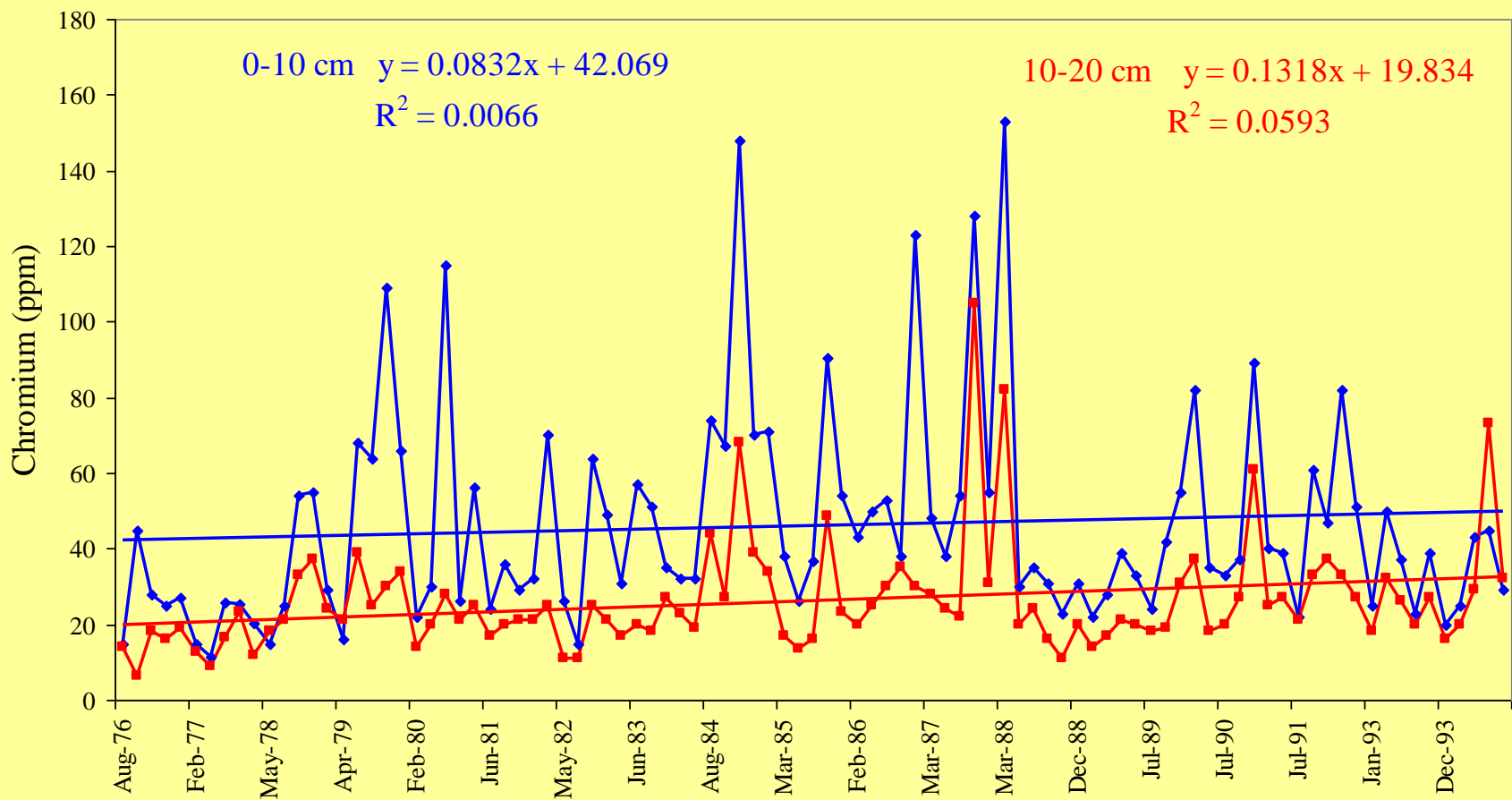
Chromium : Herbage



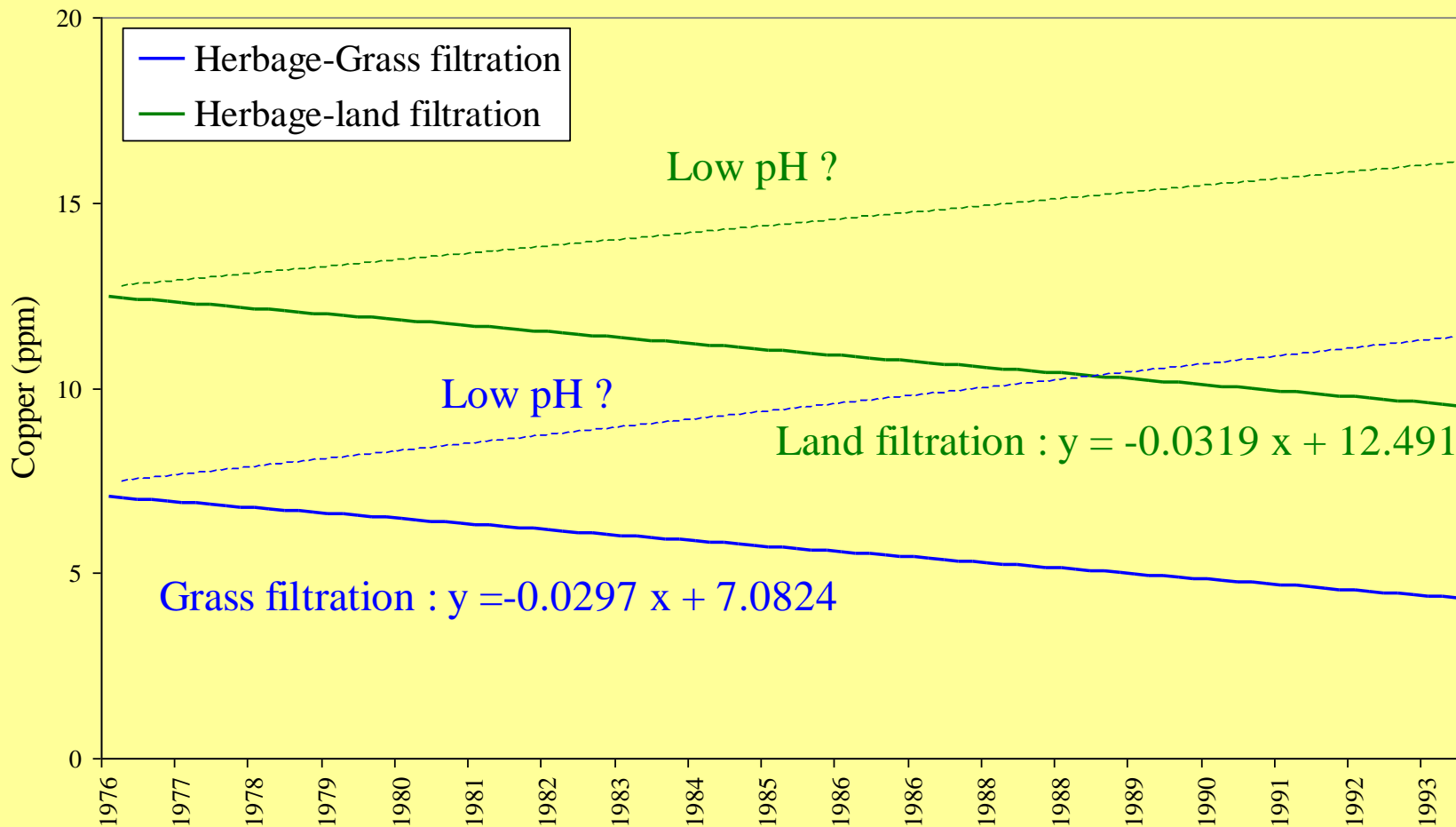
Copper : Soil -Grass filtration



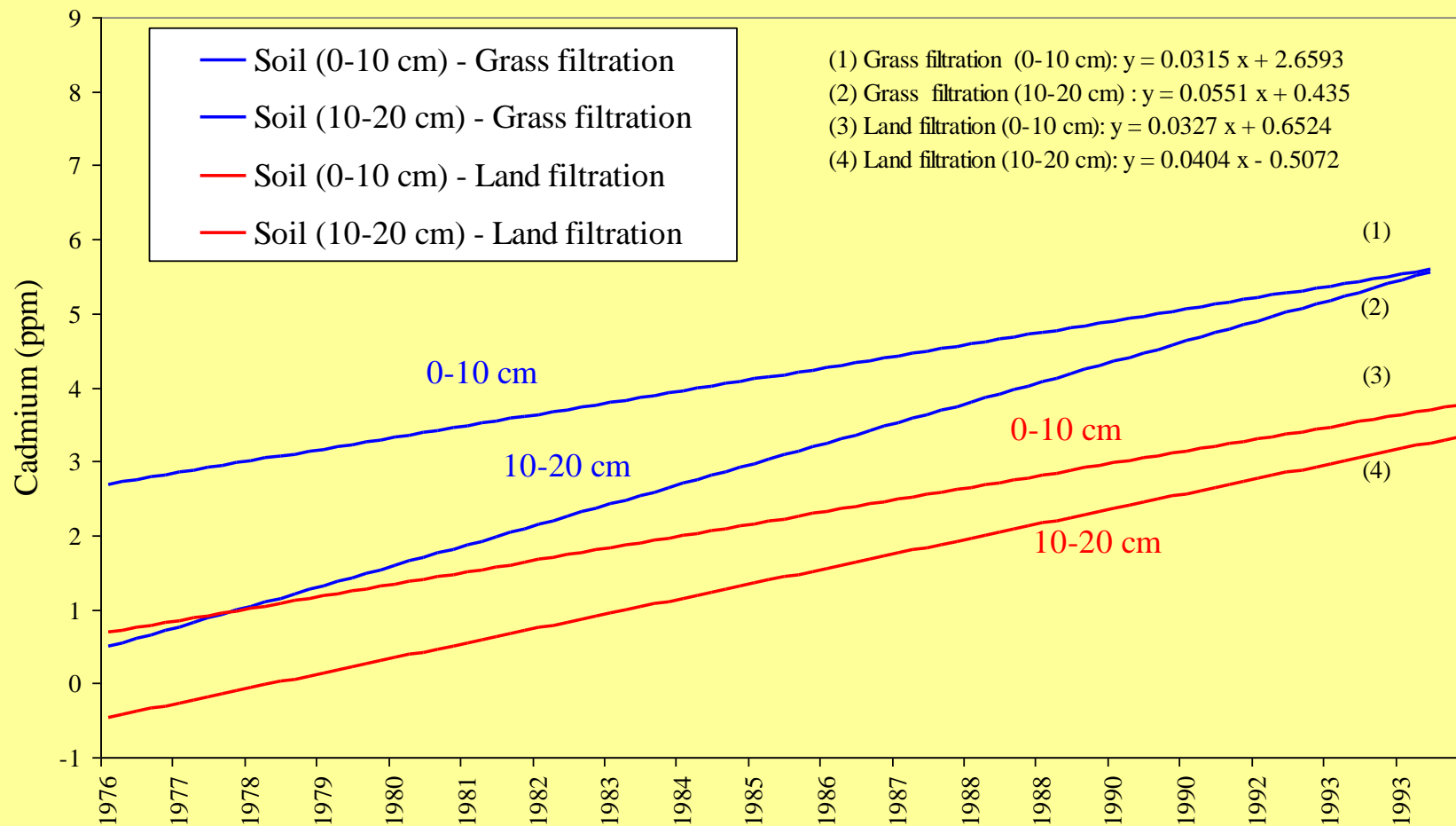
Copper : Soil-land filtration



Copper : Herbage

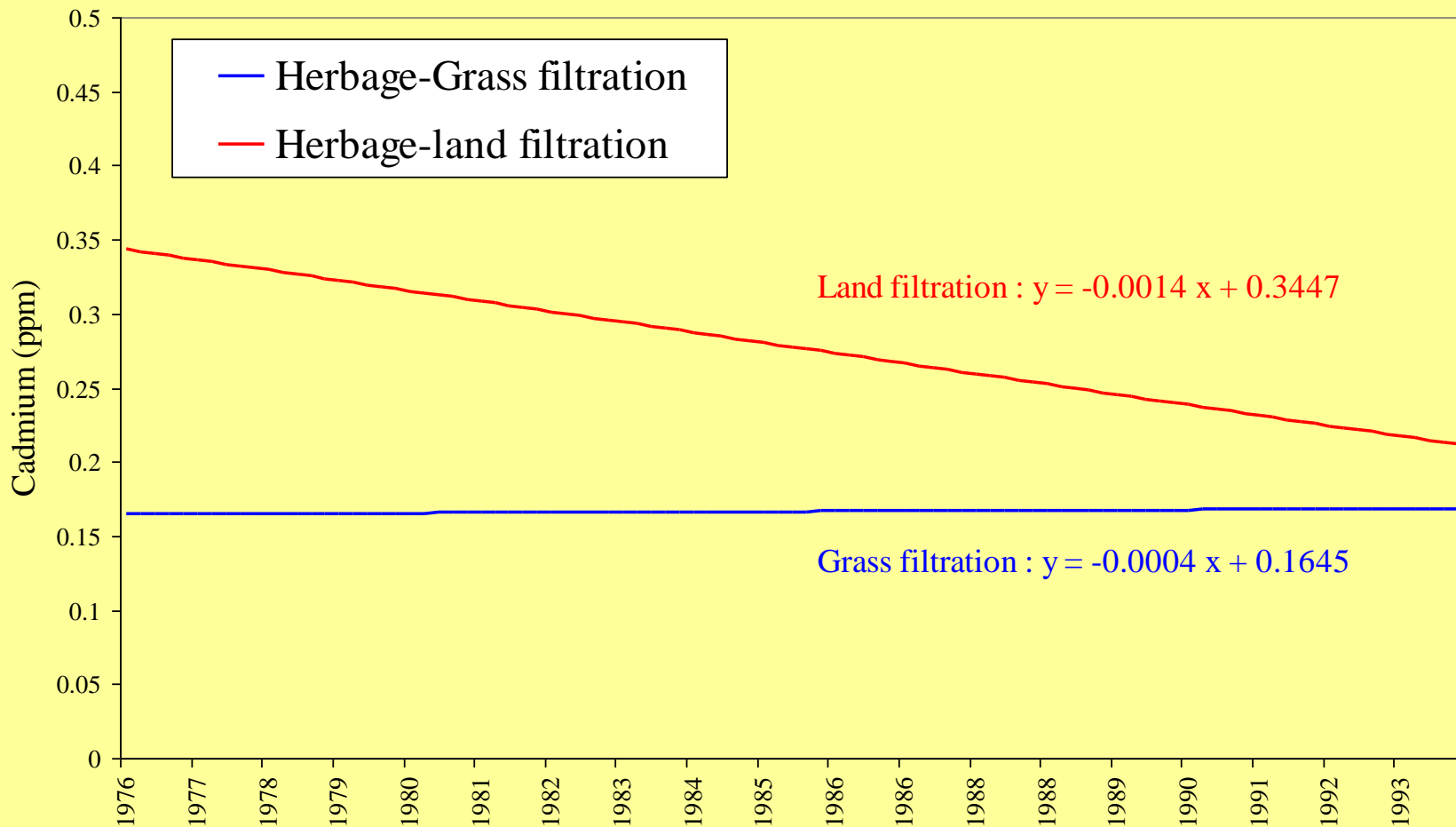


Cadmium : Soil





Cadmium : Herbage





It is important to prevent wastes and treat wastewater at the source rather than the destination to make irrigation sustainable

- Cleaner production all over again
- We cannot go on as we have in the past



Confucius (551-479 BC)

The Analects

The Master said: “Failure to cultivate moral power, failure to explore what I have learned, incapacity to stand by what I know to be right, incapacity to reform what is not good - these are my worries.”



Thank you!

*Thanks also to Dr Helen Suter who
helped to put this show together*