MANAGING IRRIGATION TO MAXIMIZE MAIZE YIELD AND MINIMIZE ENVIRONMENTAL IMPACTS FROM NITRATE LEACHING IN MUNICIPAL SLUDGE AMENDED SOILS

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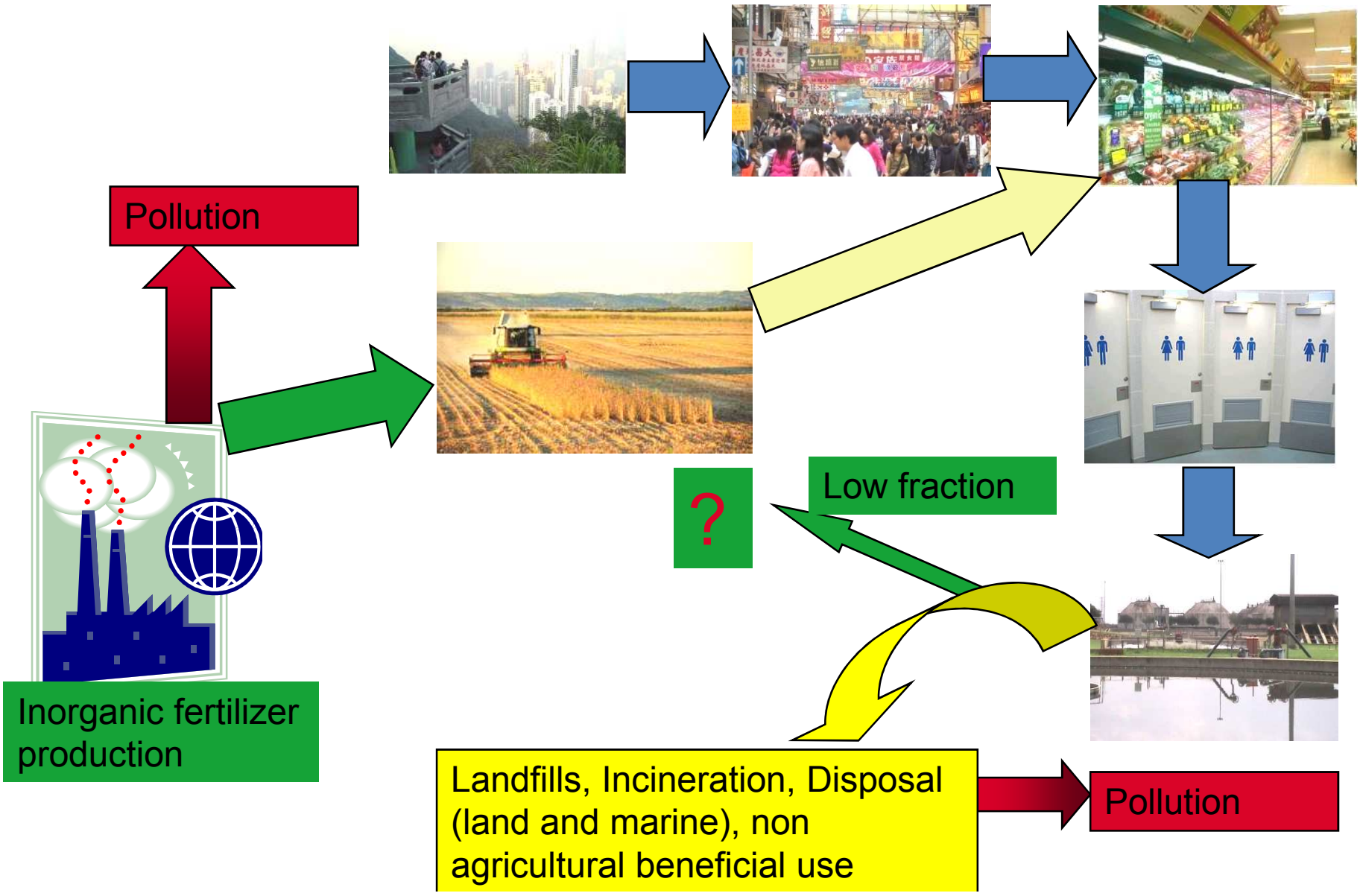
BACKGROUND


Pollution
?
Low fraction
Inorganic fertilizer production
Landfills, Incineration, Disposal (land and marine), non agricultural beneficial use
Pollution

Background

- Sludge quality varies depending on source
  - Municipal or industrial
- Therefore not all sludges are safe for agricultural use.
- Agricultural benefits – if properly used with regulation
  - Improves soil physical characteristics
    - Soil structure, water holding capacity, aeration
  - Improves soil chemical characteristics
    - Source of both macro and micro nutrients, improves CEC

Regulation for agricultural use

- Current South African sludge guidelines categorises sludges based on:
  - Microbiological – (A, B, C): based on microbial counts
  - Stability – (1, 2, 3): based on smell and vector attraction
  - Pollutant – (a, b, c): based on heavy metal concentrations

- A:1:a – applied according to crop requirement to an upper sludge loading rate of 10 t ha^{-1}

- All other classes have some restrictions

Problem statement

– There is little information,
  - on integrated water and nutrient management practices in sludge amended soils.

Hypothesis

- It was hypothesized that:
  - deficit irrigation could minimize nitrate leaching below the active root zone from sludge amended soils.

Materials and Methods

- SWB-Sci model
- Soil types considered
  - Loamy sand
    - 81% sand, 12%, 7% clay
  - Clay loam
    - 37% sand, 25% silt, 38% clay

Materials and Methods

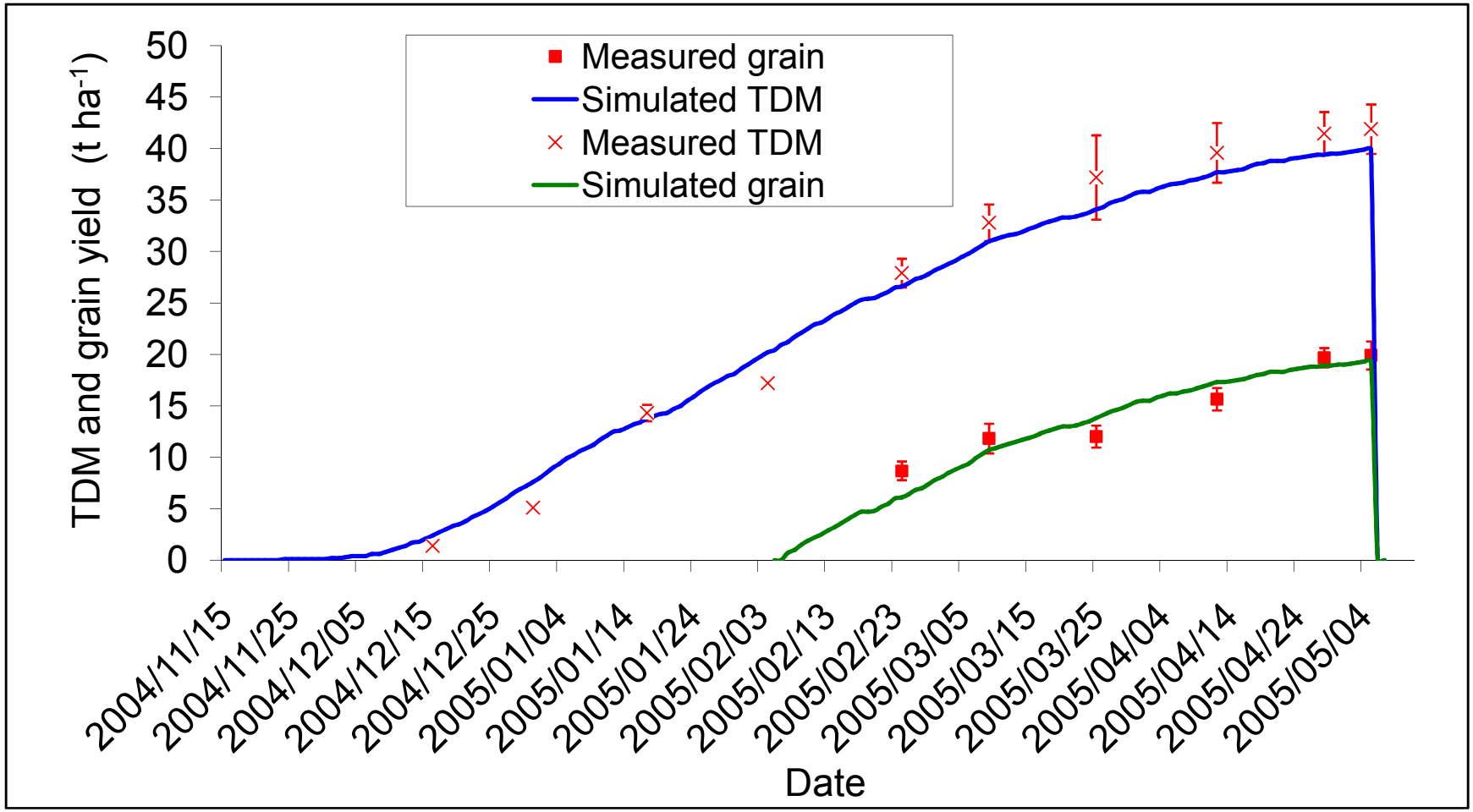
- Irrigation strategy:
  1. Fill the root zone to field capacity,
  2. Leave room for rain (10 mm, 20 mm, 20 mm, 20 mm)

- Irrigation was applied once 40% of the PAW was depleted.

RESULTS AND DISCUSSION

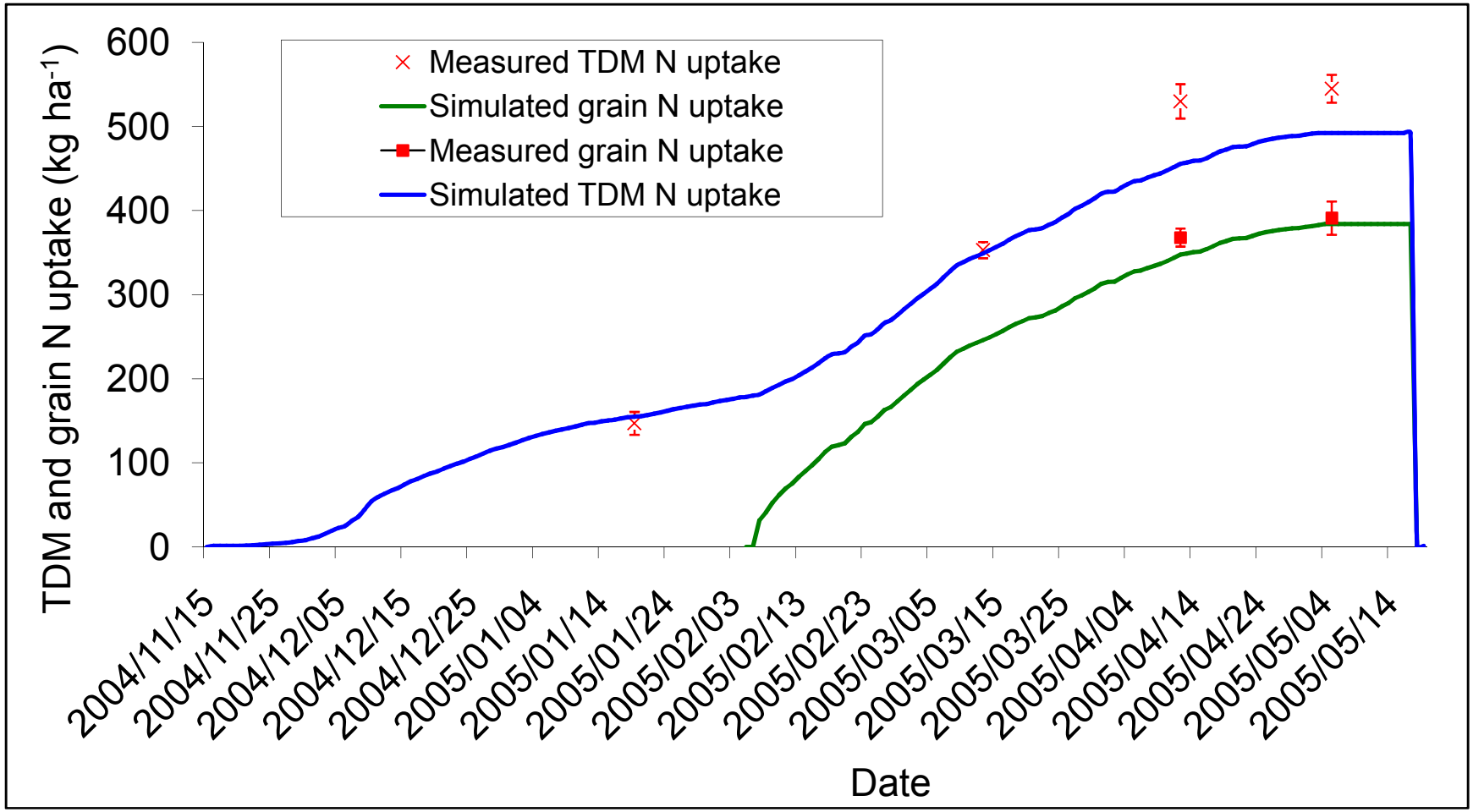
Model calibration

Measured vs simulated maize aboveground biomass (TDM) and grain yield



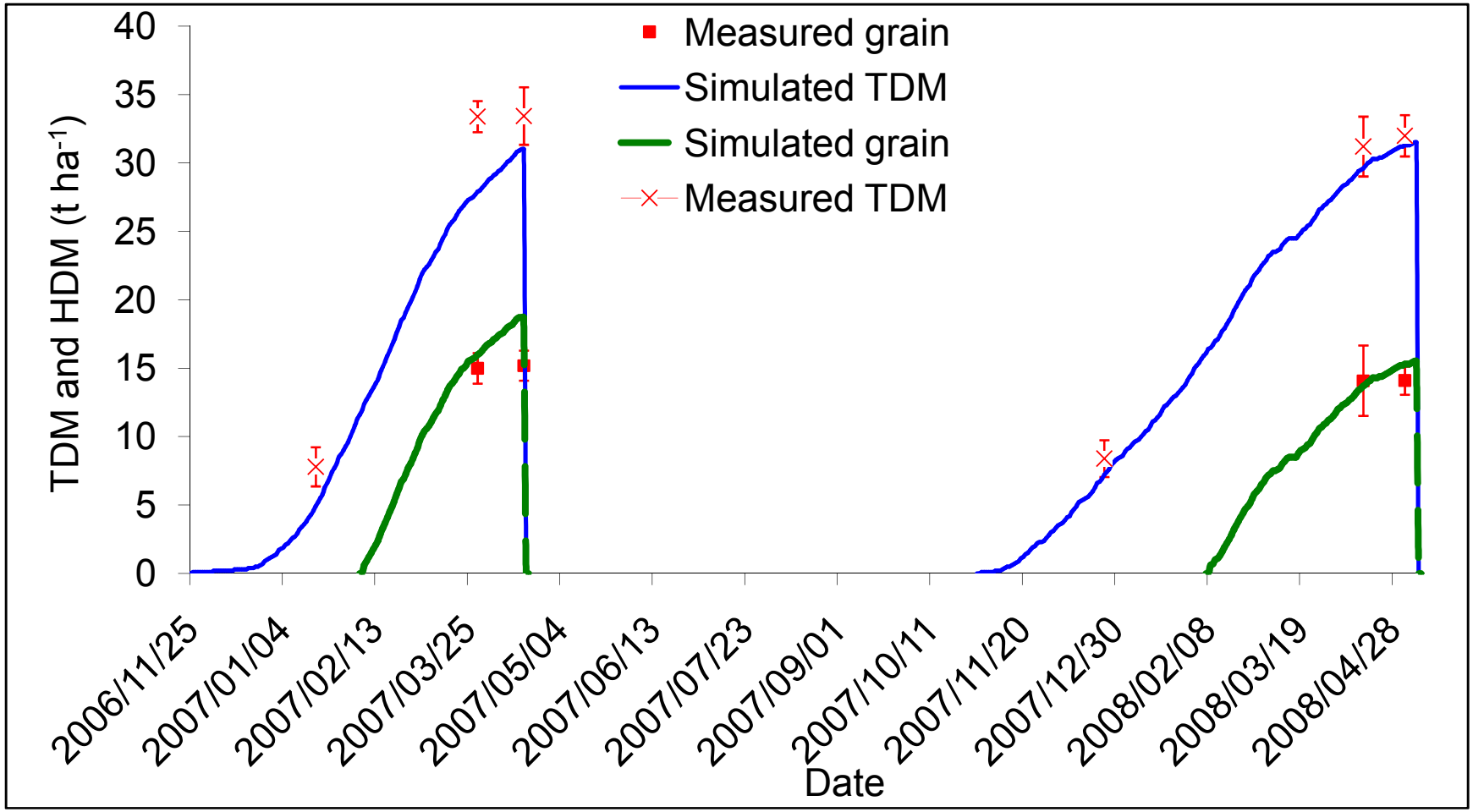
Model calibration

Measured vs. simulated maize above ground biomass (TDM) and grain N uptake



Model validation

Irrigated maize above ground biomass (TDM) and grain



Model validation

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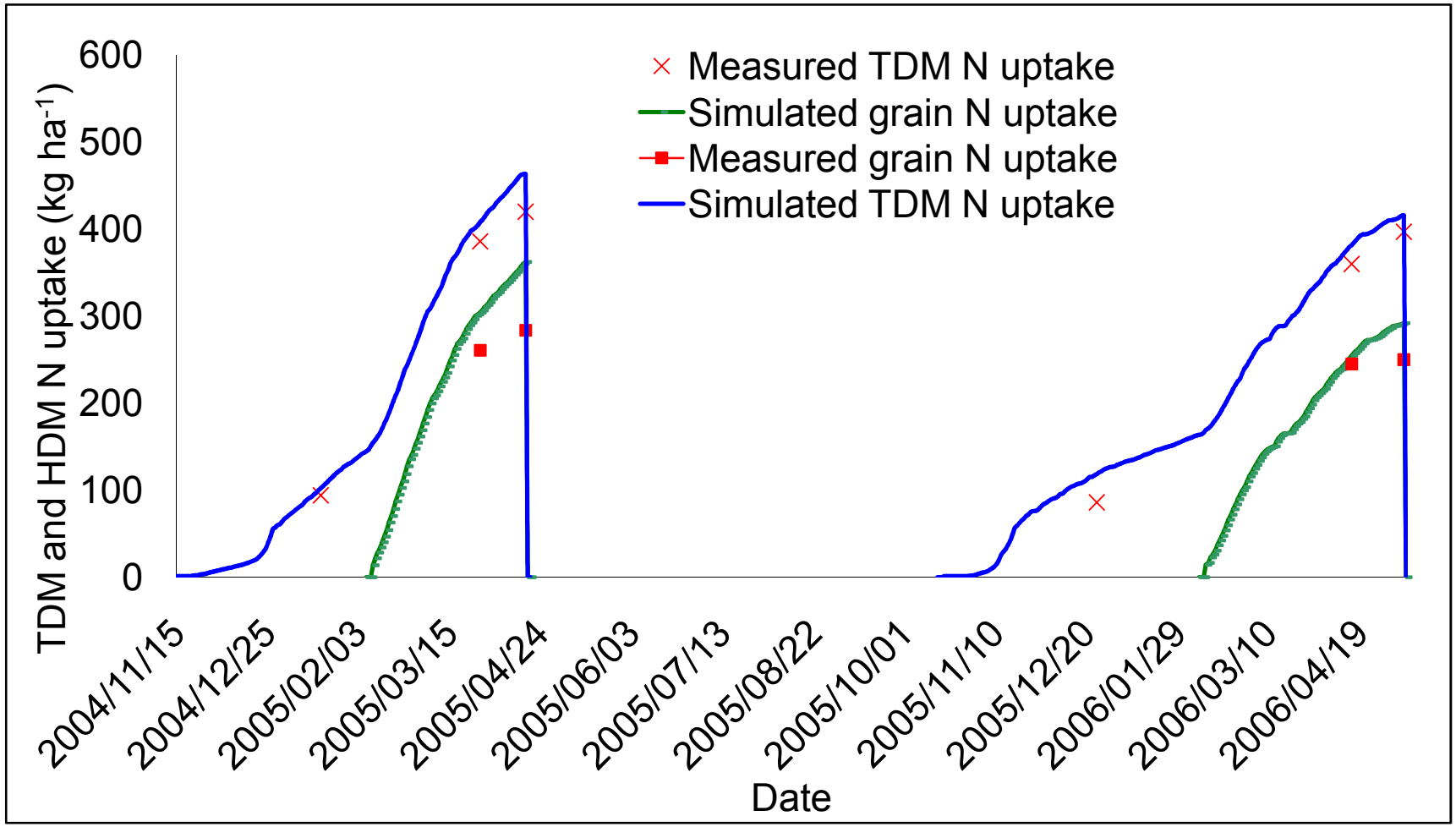
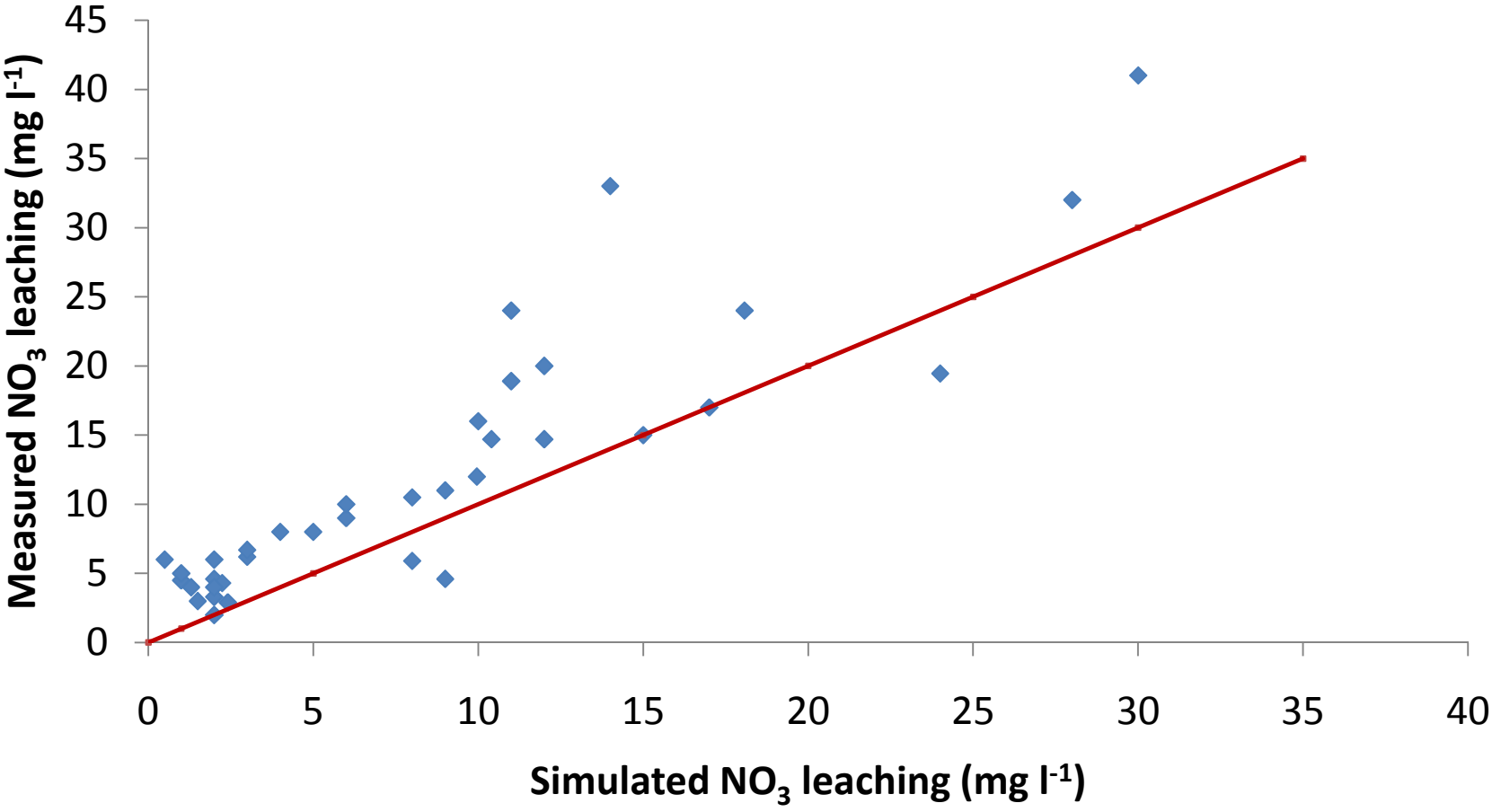


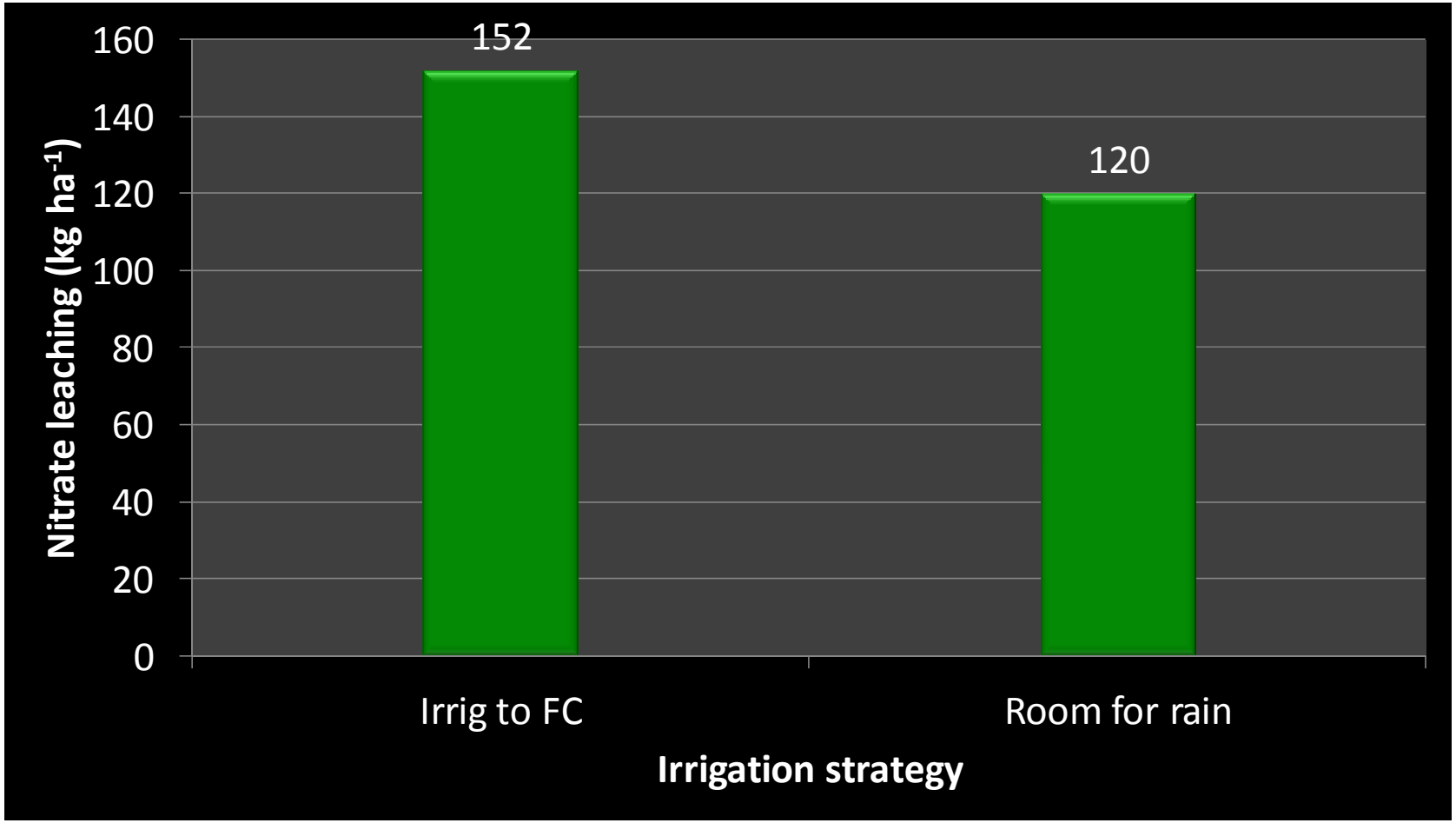
Model validation

Measured vs. Simulated nitrate leaching

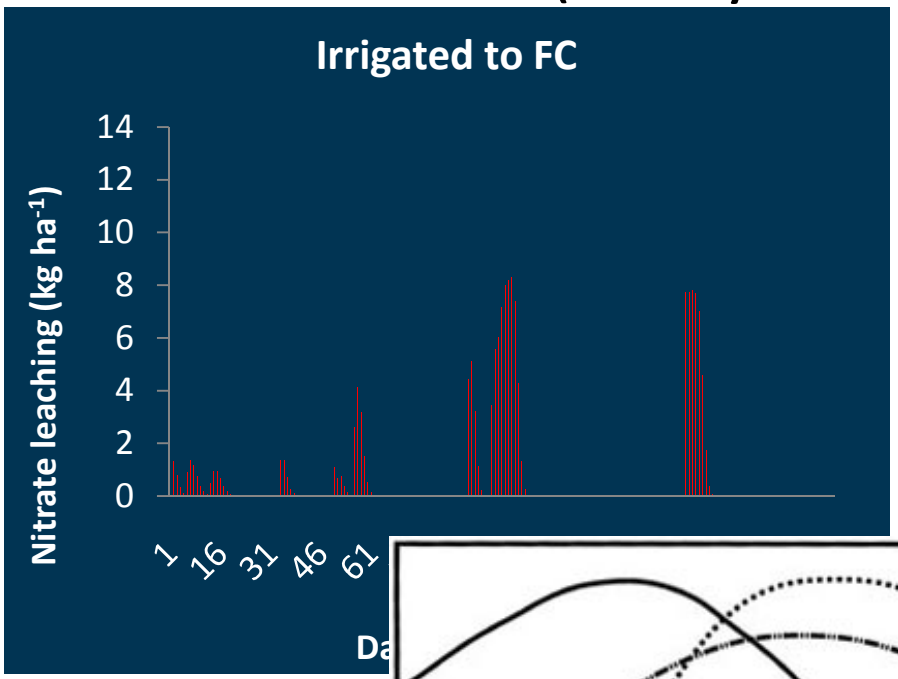


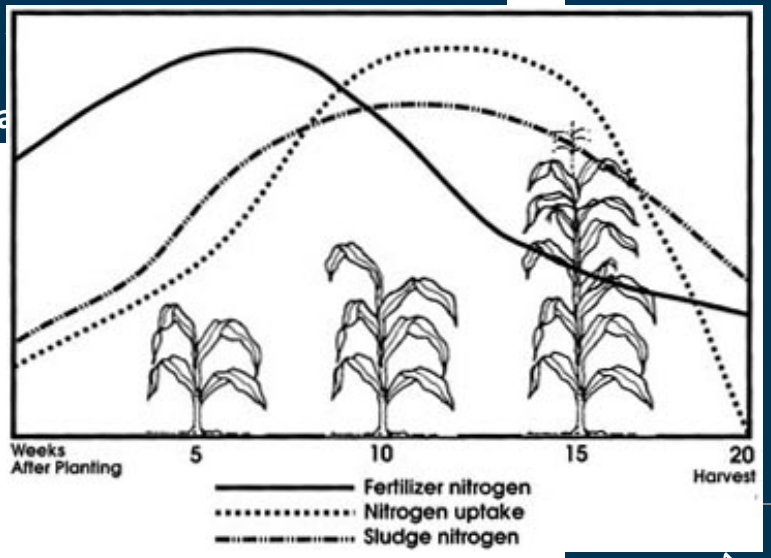
Basic scenario simulations on the effect of edaphic, irrigation management and rainfall on nitrate leaching

Nitrate leaching is influenced by irrigation strategy (irrig. to FC vs. leave room for rain)

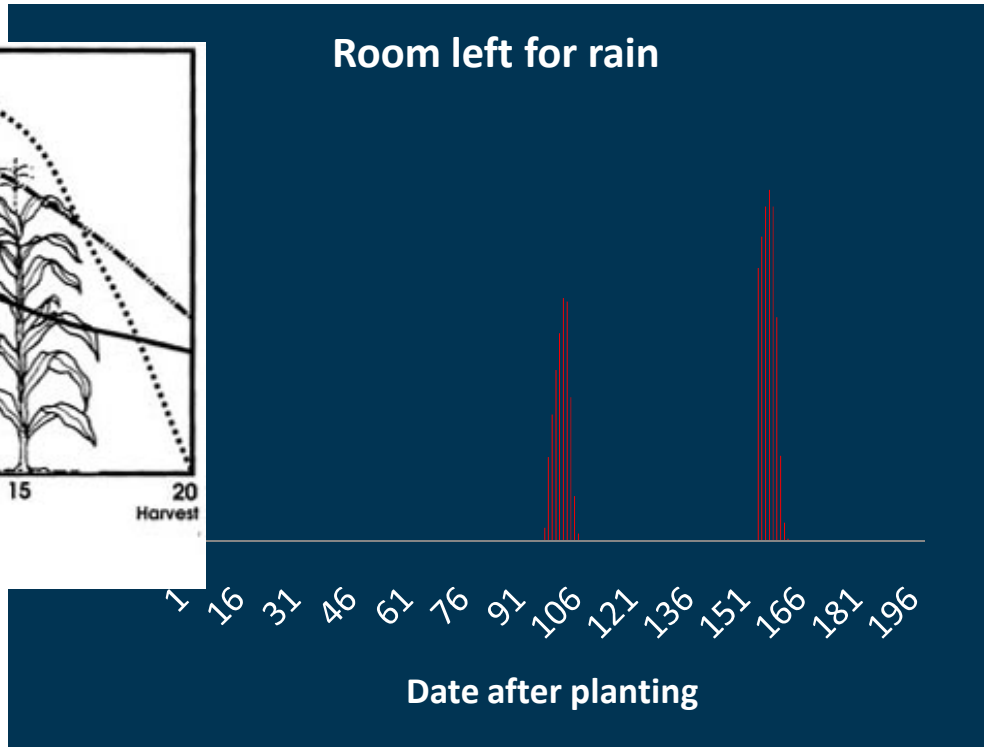


How does RR minimize nitrate leaching? (loamy sand as an example)



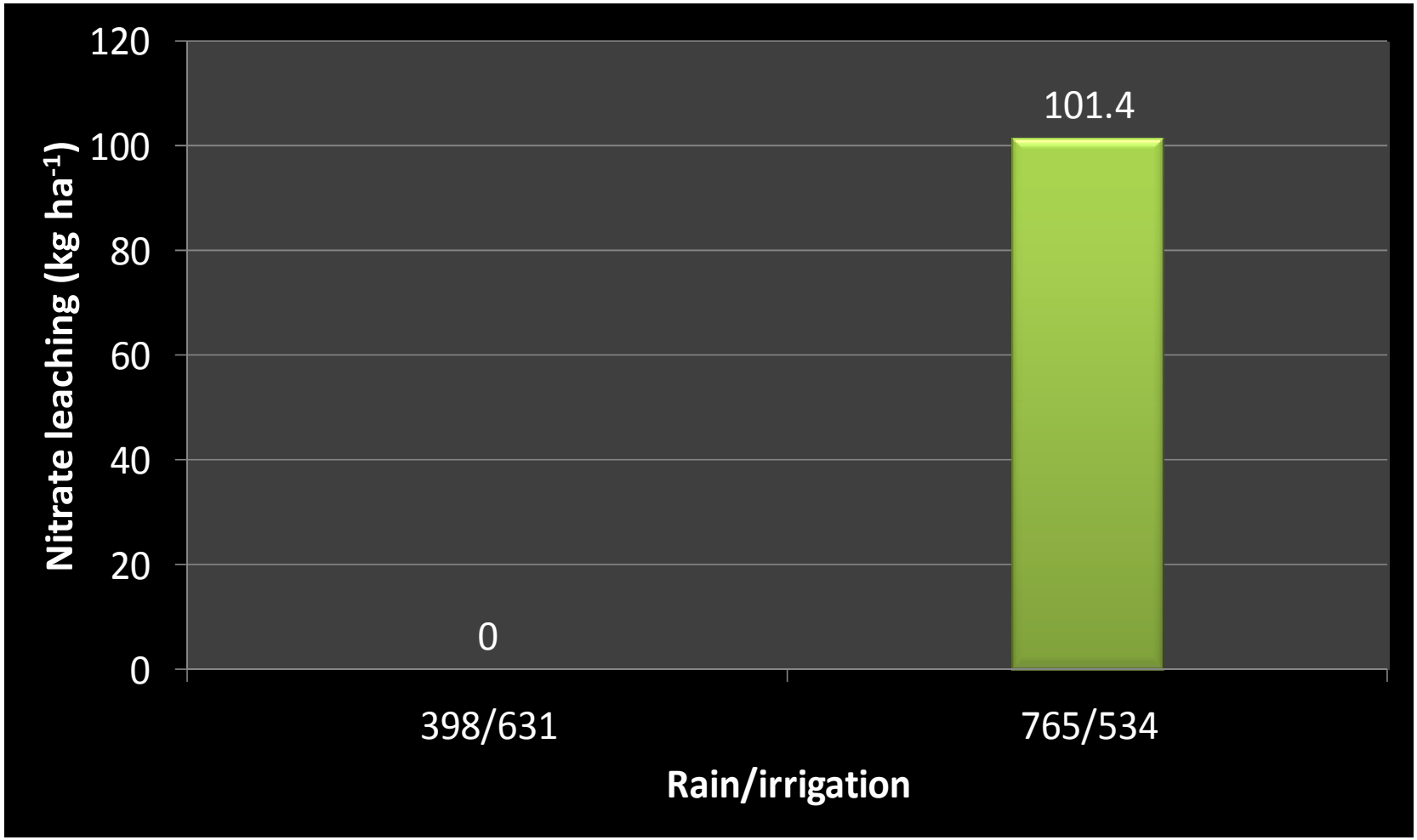


- Minimizes leaching in the beginning of the season

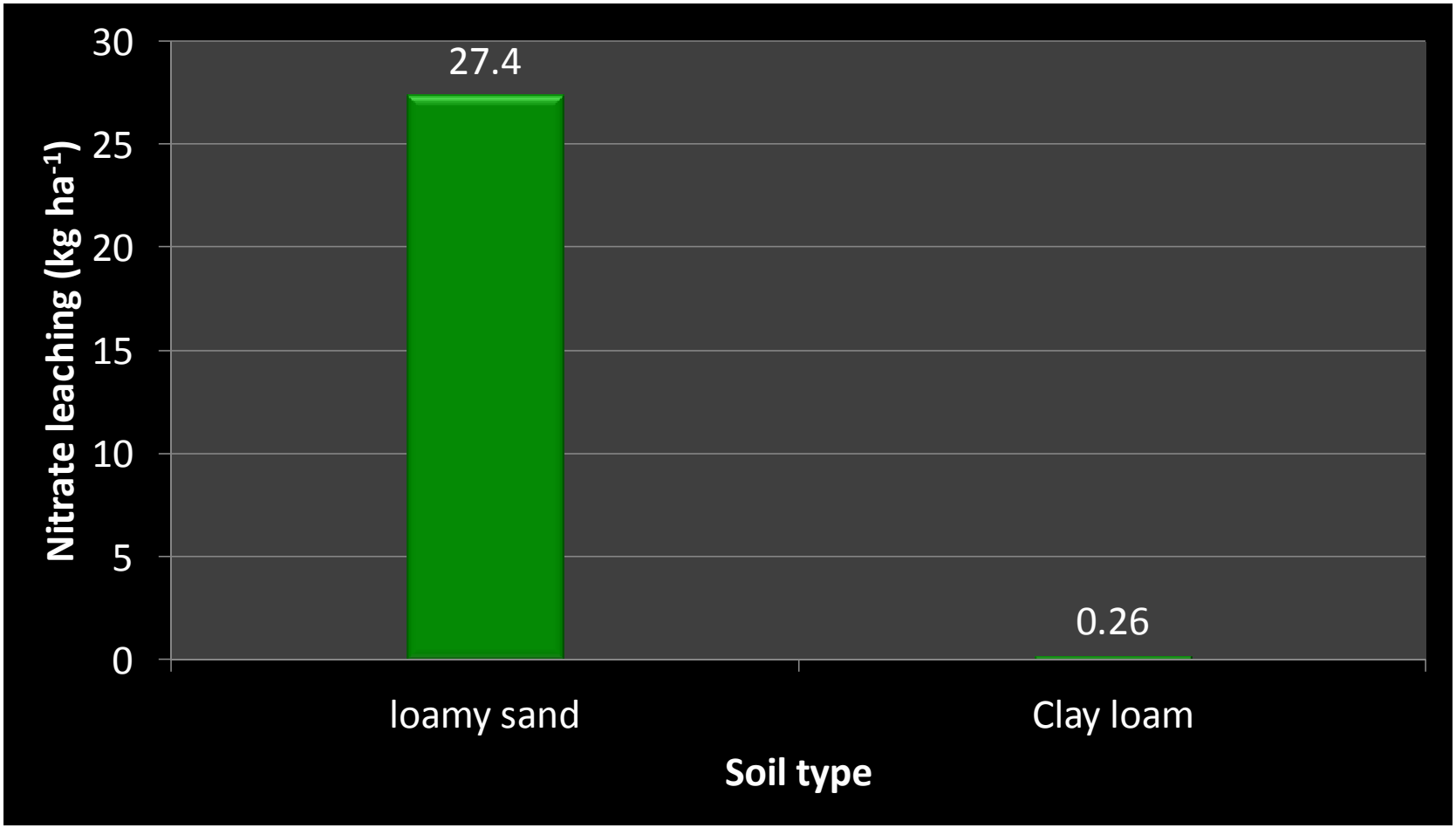


Nitrate leaching is season dependent

(similar irrigation strategies)

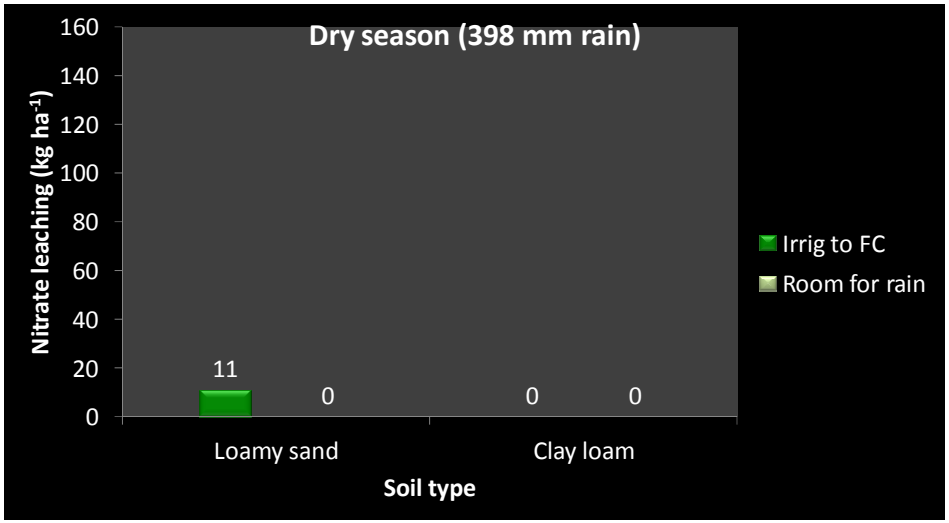


Nitrate leaching is soil dependent
(similar irrigation strategies)



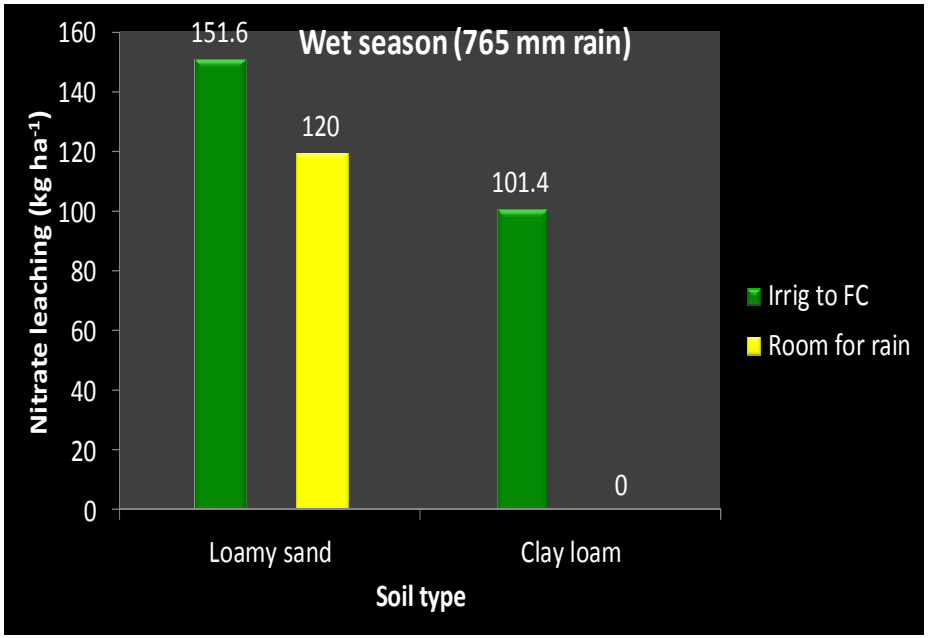
Effect of combination of factors on nitrate leaching

Effectiveness of irrigation strategy in reducing nitrate leaching is soil and season dependent

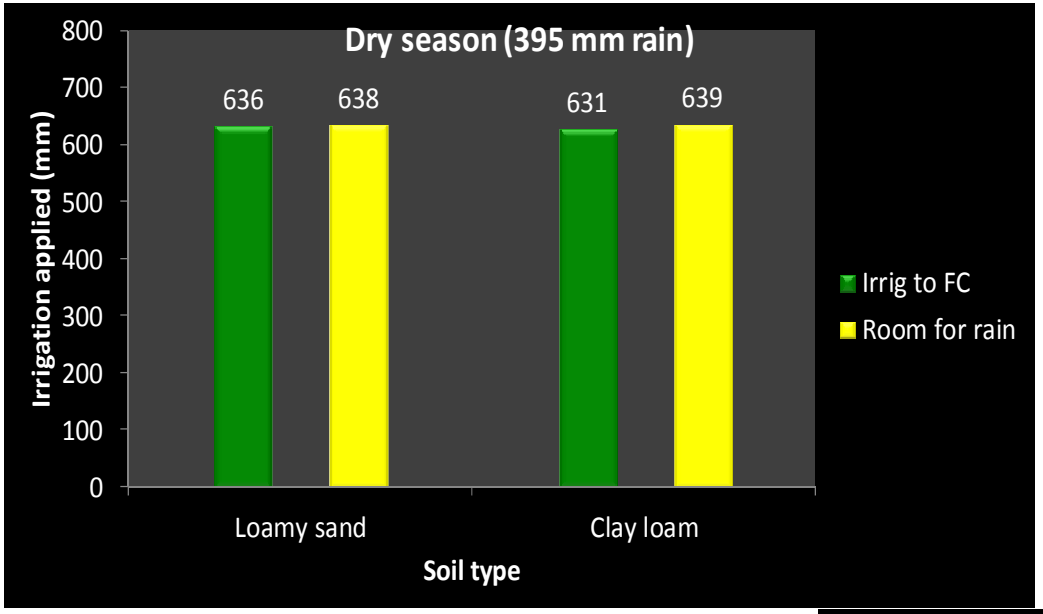


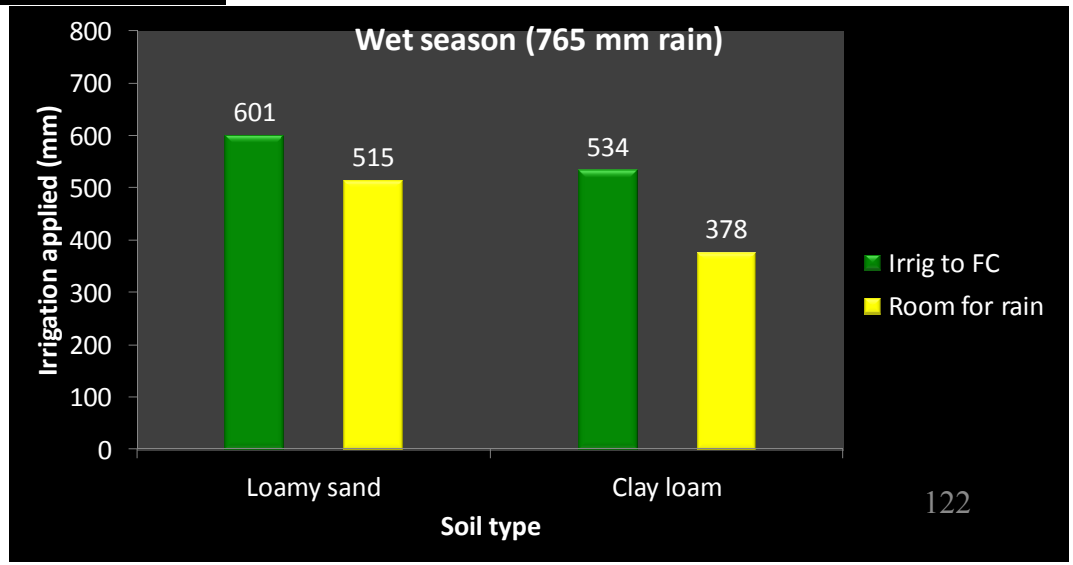
- Loamy sand vs. clay loam soil

- Dry vs. Wet season

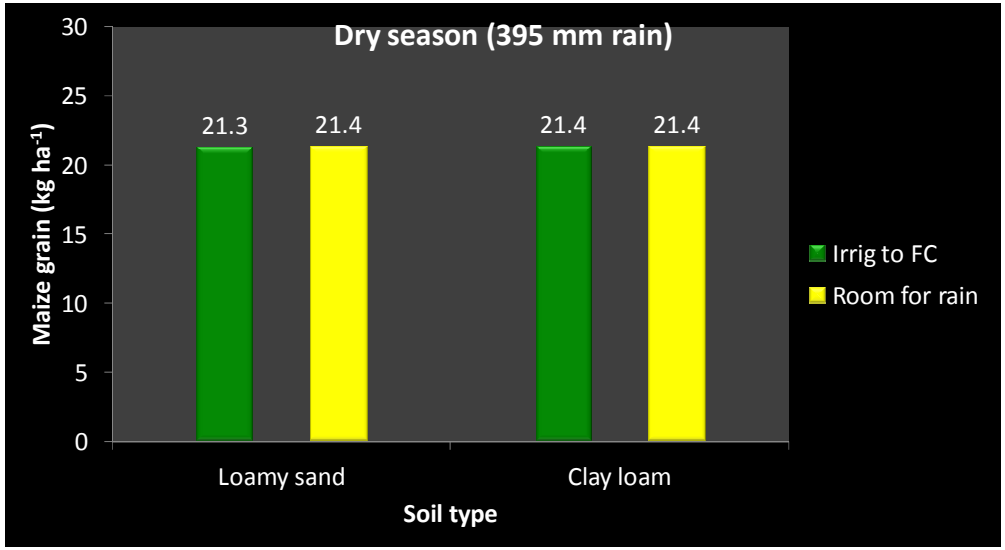


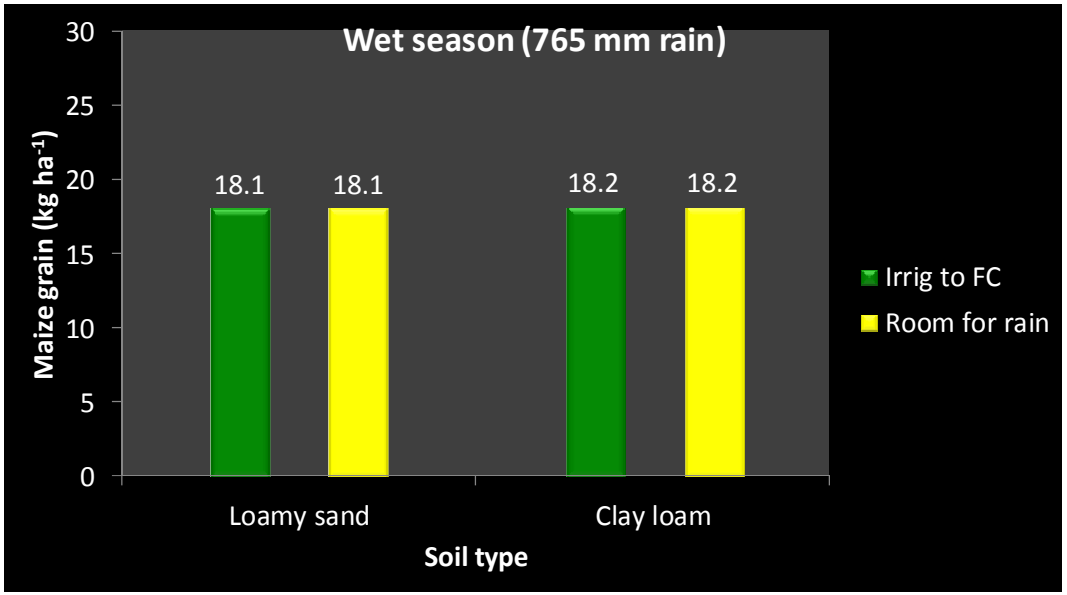
Effectiveness of irrigation strategy in saving water (loamy sand vs. Clay loam)



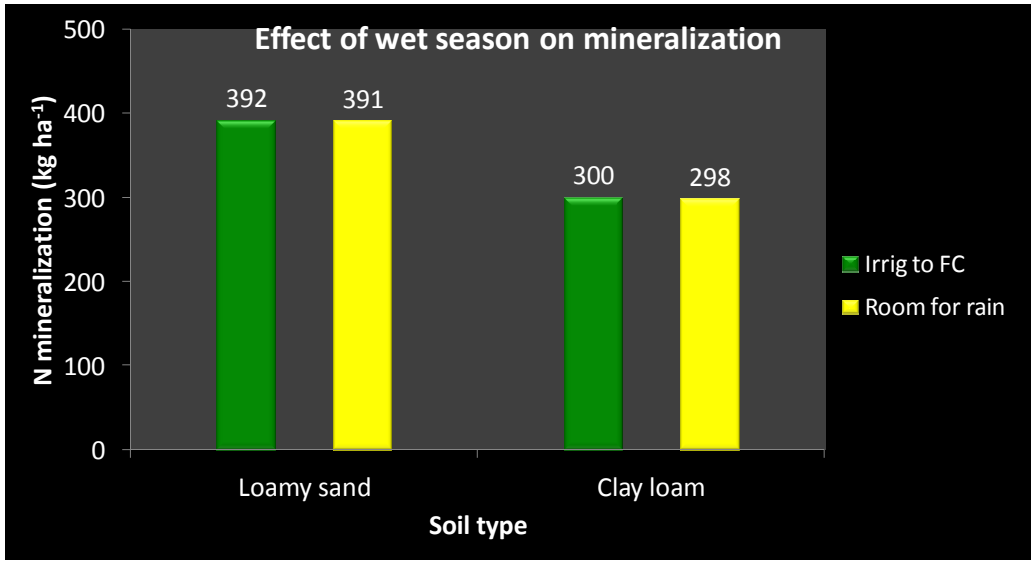


Effect of irrigation strategies on maize grain yield in contrasting soil types (loamy sand vs. Clay loam)



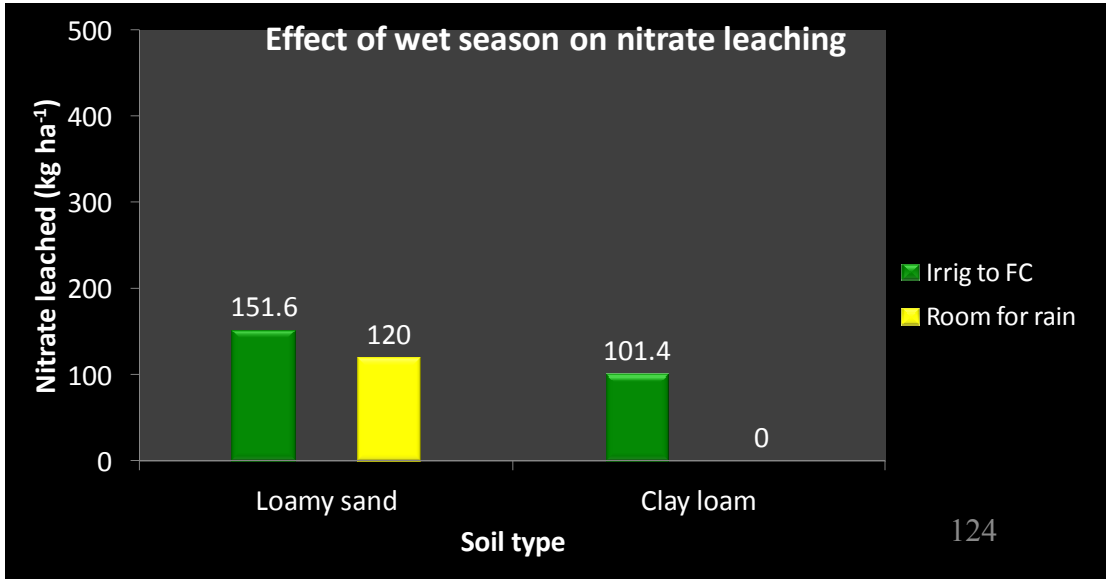


Cause for low yield during the wet season



- Lower mineralization from clay loam soils in contrast to loamy sand

- Higher leaching from sandy loam compared with clay loam soils



Conclusion

- Proper understanding of the interaction between water and N dynamics is key for maximal maize production through:
  - Saving water,
  - Enhancing mineralization, and
  - Minimizing nitrate leaching.

- Deficit irrigation showed promising results in terms of minimizing nitrate leaching and saving water for irrigation.

- Effectiveness of deficit irrigation to reduce nitrate leaching is soil and rainfall amount/distribution dependent.

Acknowledgements

Thank you