Land, water and energy use efficiencies of potato production in South Africa

JM Steyn[1], JE van der Waals[1],
AC Franke[2], AJ Haverkort[1,2]

[1]University of Pretoria
[2]Wageningen University

Universiteit van Pretoria
University of Pretoria

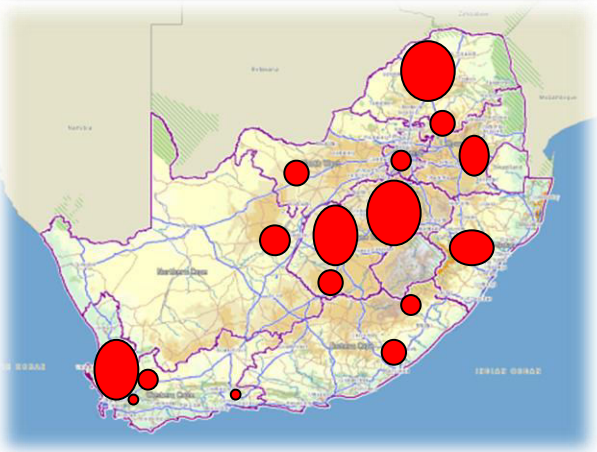
WAGENINGEN UR
For quality of life

Layout of presentation

- Introduction:
  - The SA potato industry
  - Resource use efficiencies
- Methodology
- Results
  - Land
  - Water
  - Energy (CO_2)
- What can we do about it?

Introduction

- ± 50 000 ha potatoes produced
- 16 geographical regions of SA
- Potato regions differ in
- soils, climate, production practices



Universiteit van Pretoria
University of Pretoria

WAGENINGEN UR
For quality of life

Introduction

- Production practices also differ for table, processing, seed
- These affect
  - amount of input resources used to produce potatoes
  - resource use efficiencies (footprints)

Universiteit van Pretoria
University of Pretoria

WAGENINGEN UR
For quality of life

Introduction

- Potato – requires high input levels
- Seed, fertilizers, pest control chemicals, energy
- Cost of energy has risen sharply
- High input cost >>R100 000/ha
- Product prices – almost constant
- Significant negative impact on financial sustainability

Universiteit van Pretoria
University of Pretoria

WAGENINGEN UR
For quality of life

Introduction

- High resource input levels also affect environmental sustainability
- Expressed as efficiencies or Environmental Footprints

Land use efficiency

- LUE = yield per unit area of land (t/ha)

Energy use efficiency

- Energy inputs per ton of potato
- or "Carbon footprint"
- Total amount of "greenhouse gases" produced by any activity
- Expressed in tons of CO_2 produced
- Includes energy used for 1º and 2º production

Universiteit van Pretoria
University of Pretoria

WAGENINGEN UR
For quality of life

Water use efficiency

- Yield per unit of water used (kg/ha/mm water)
- or "Water footprint"
- Total volume of water used to produce a unit of product (L/kg)
- Includes both direct and indirect water use
- Examples of some food products:
  - 80 L/ orange (150 gram)
  - 1020 L/ L orange juice

Universiteit van Pretoria
University of Pretoria

WAGENINGEN UR
For quality of life

"Water footprints"

- 4620 L / 300g steak
- 43 L / 150 g potato

- Resource use efficiencies = indicators of sustainability of production
- not determined for SA potato production before

Objectives

- To assess and benchmark potato production areas regarding their
  - use of land,
  - water,
  - energy (carbon)

Universiteit van Pretoria
University of Pretoria

WAGENINGEN UR
For quality of life

Objectives

- Identify resource intensive practices
- Recommend interventions how to address these
- Improve environmental and economic sustainability

Universiteit van Pretoria
University of Pretoria

WAGENINGEN UR
For quality of life

Methodology

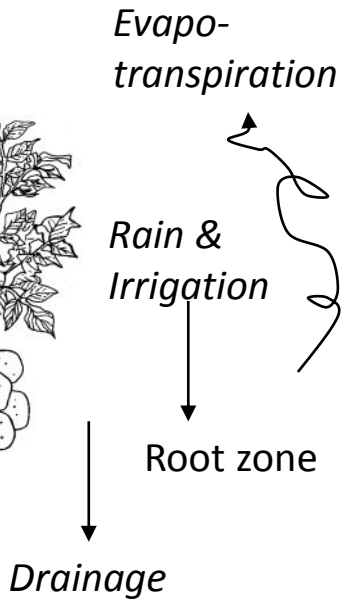
- Surveys in all 16 potato production regions
- Interviewed ≥3 farmers per production system (seed, table, processing)
- ±100 farmers interviewed = 15%
- ±100 questions – inputs, practices
- Processed per farm, region and country

Universiteit van Pretoria
University of Pretoria

WAGENINGEN UR
For quality of life

Land use efficiency

- 5 year average yields (t/ha)
- Yield gap analysis = actual yield vs. calculated potential yields
- Using LINTUL-potato growth model
  - temp, radiation, water inputs



Water use efficiency

- Irrigation need = ET - rainfall
- WU = rainfall + total amount of irrigation applied in season
- WUE = kg/ha potato mm^{-1}
- Only water used for 1° production not washing plant
- Actual water use vs. LINTUL model simulated need

Universiteit van Pretoria
University of Pretoria

WAGENINGEN UR
For quality of life

Energy use efficiency

- Used "Cool Farm Tool-Potato" (CFT-Potato) (Haverkort & Hiller, 2011)
- Decision support tool for growers / companies to calculate their CO_2 footprints
- Total kg CO_2 equivalent greenhouse gases produced / ton potatoes

Universiteit van Pretoria
University of Pretoria

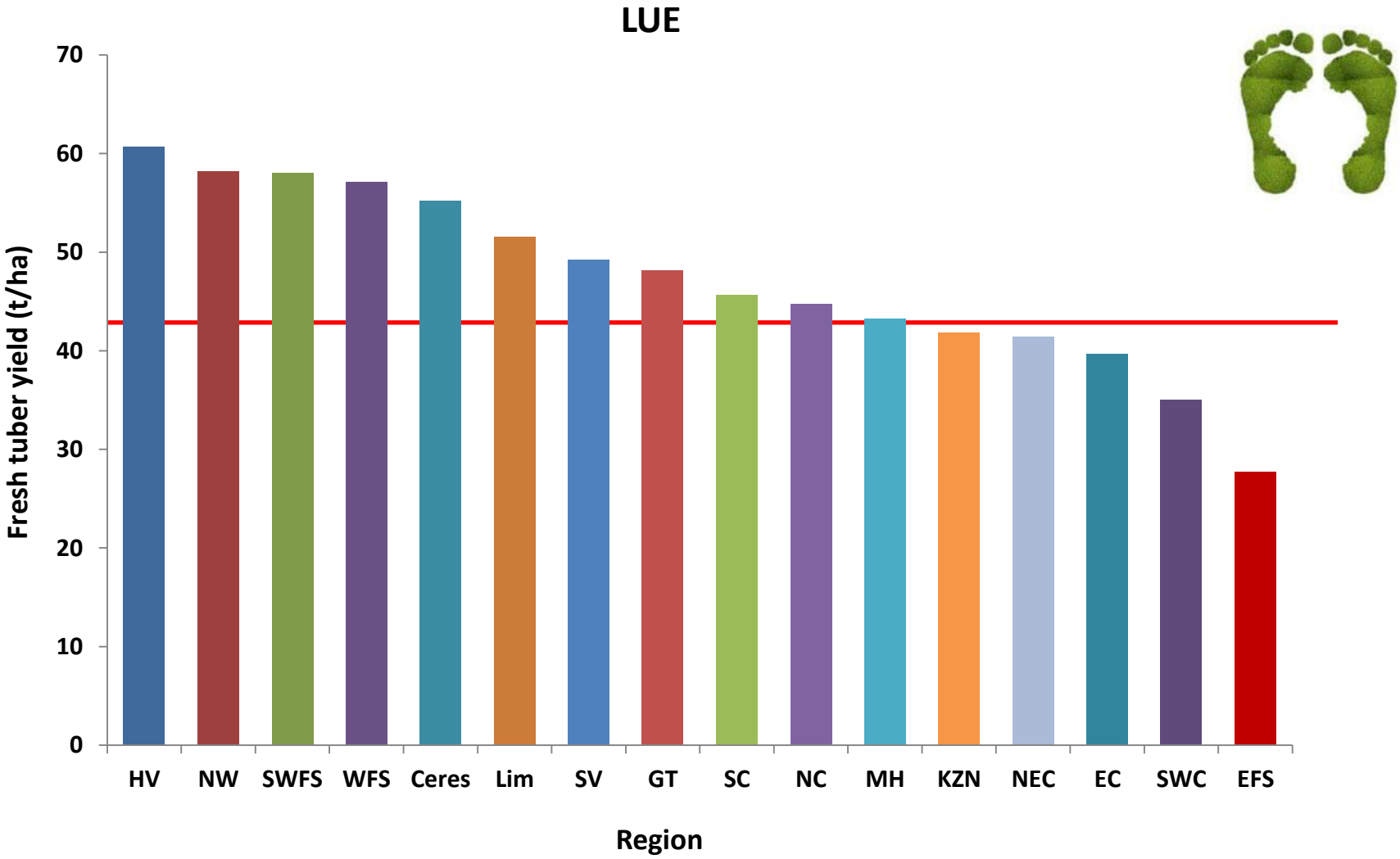
WAGENINGEN UR
For quality of life

RESULTS

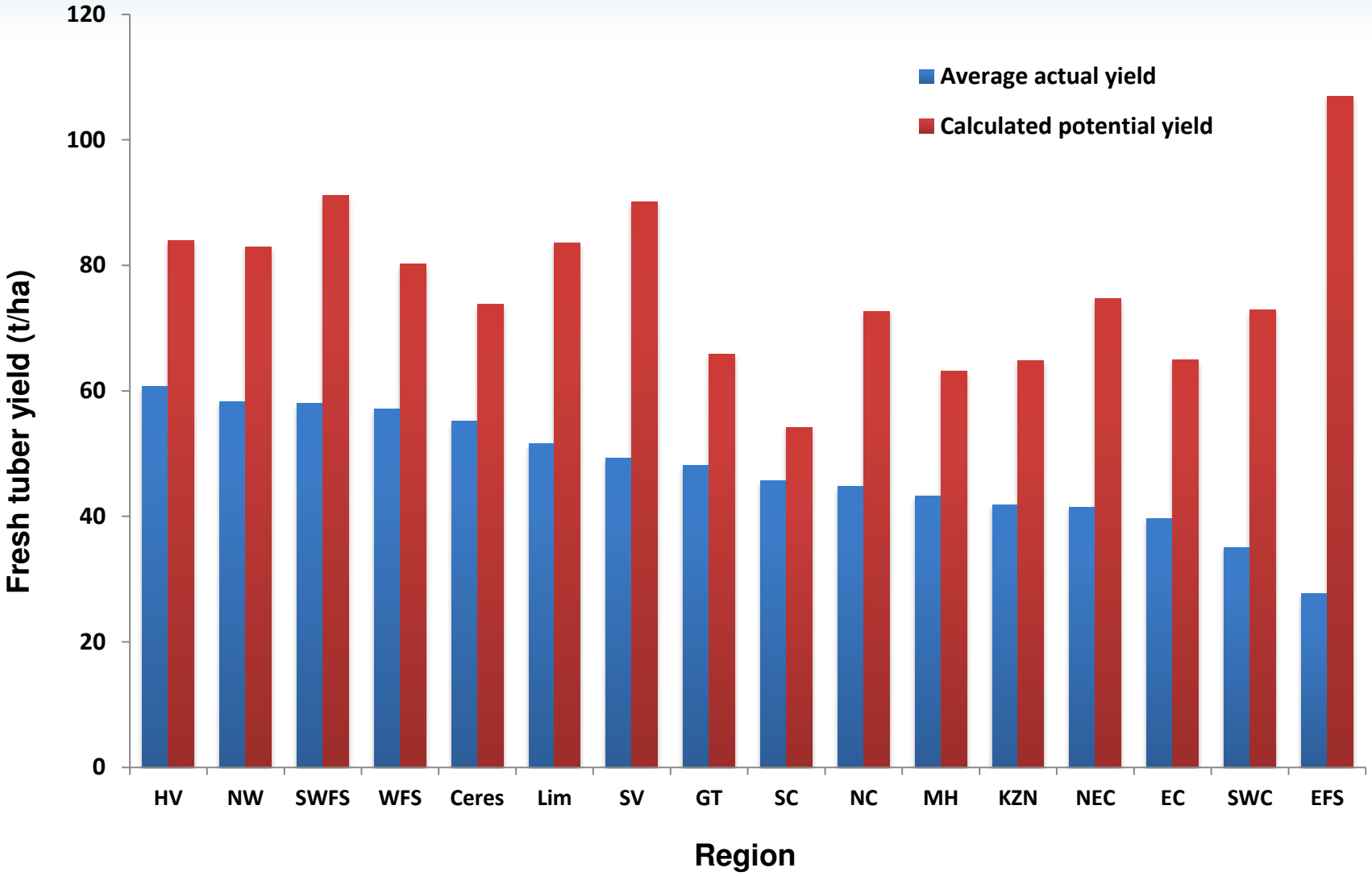
Universiteit van Pretoria
University of Pretoria

WAGENINGEN UR
For quality of life

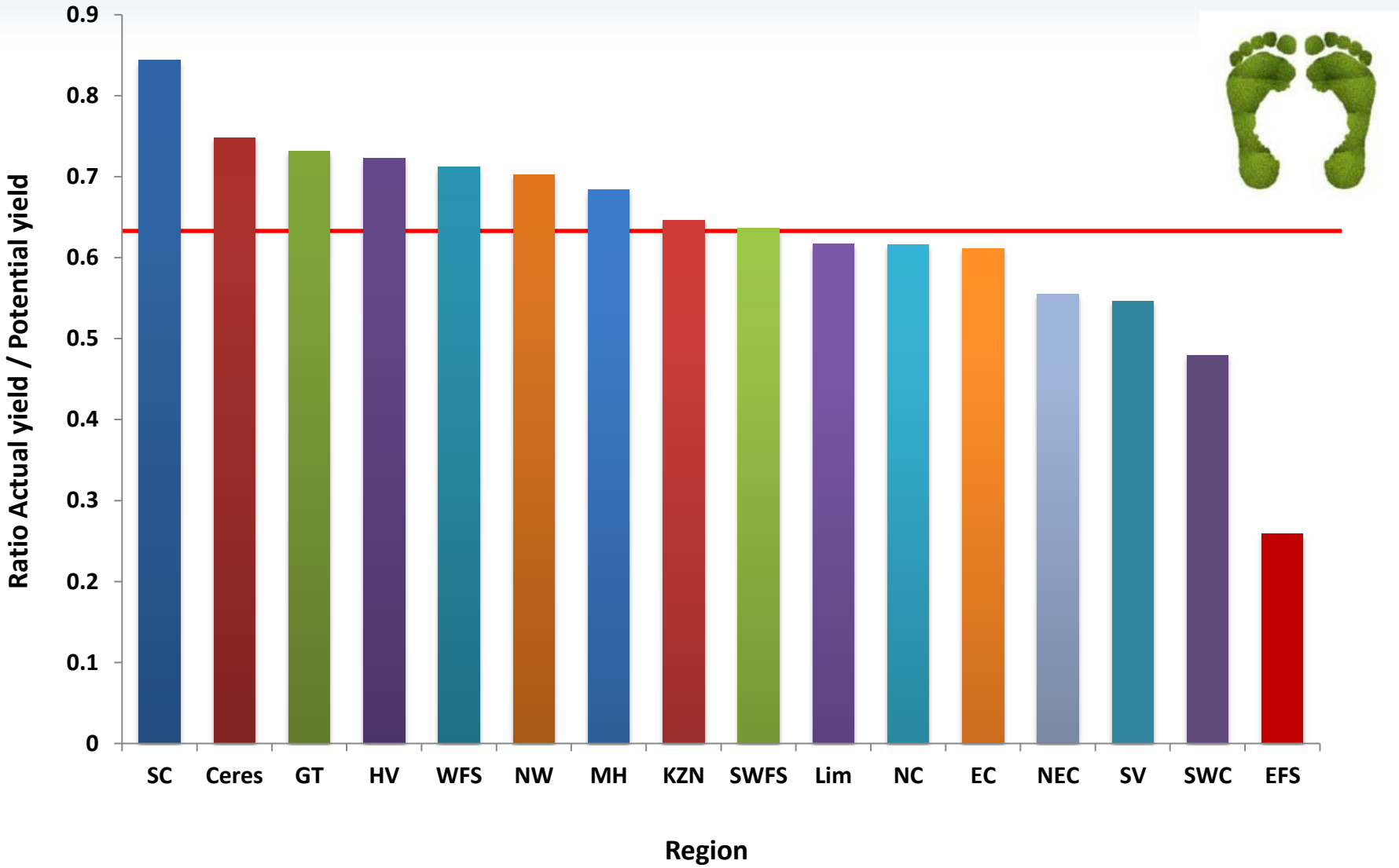
Land use efficiency



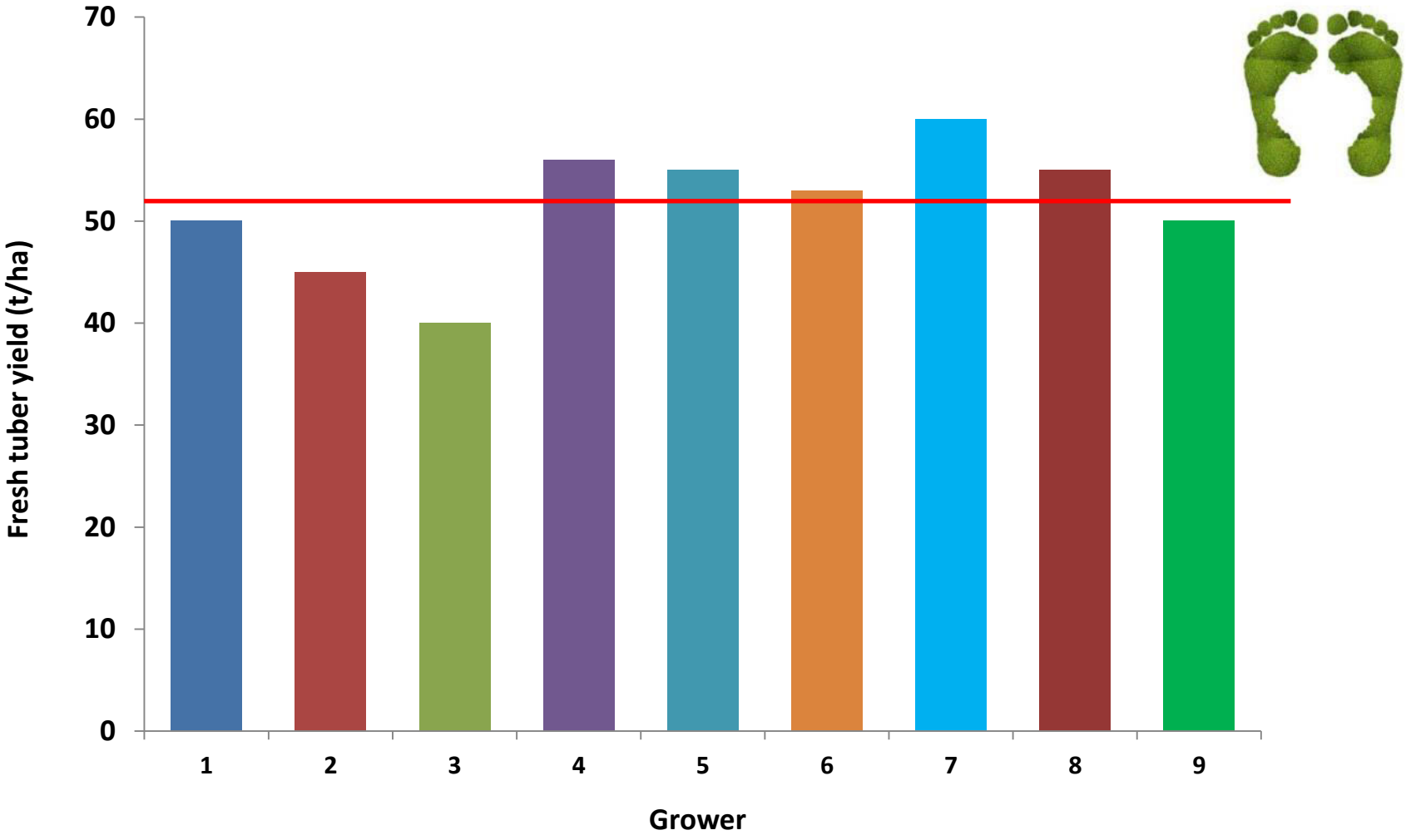
Land use efficiency



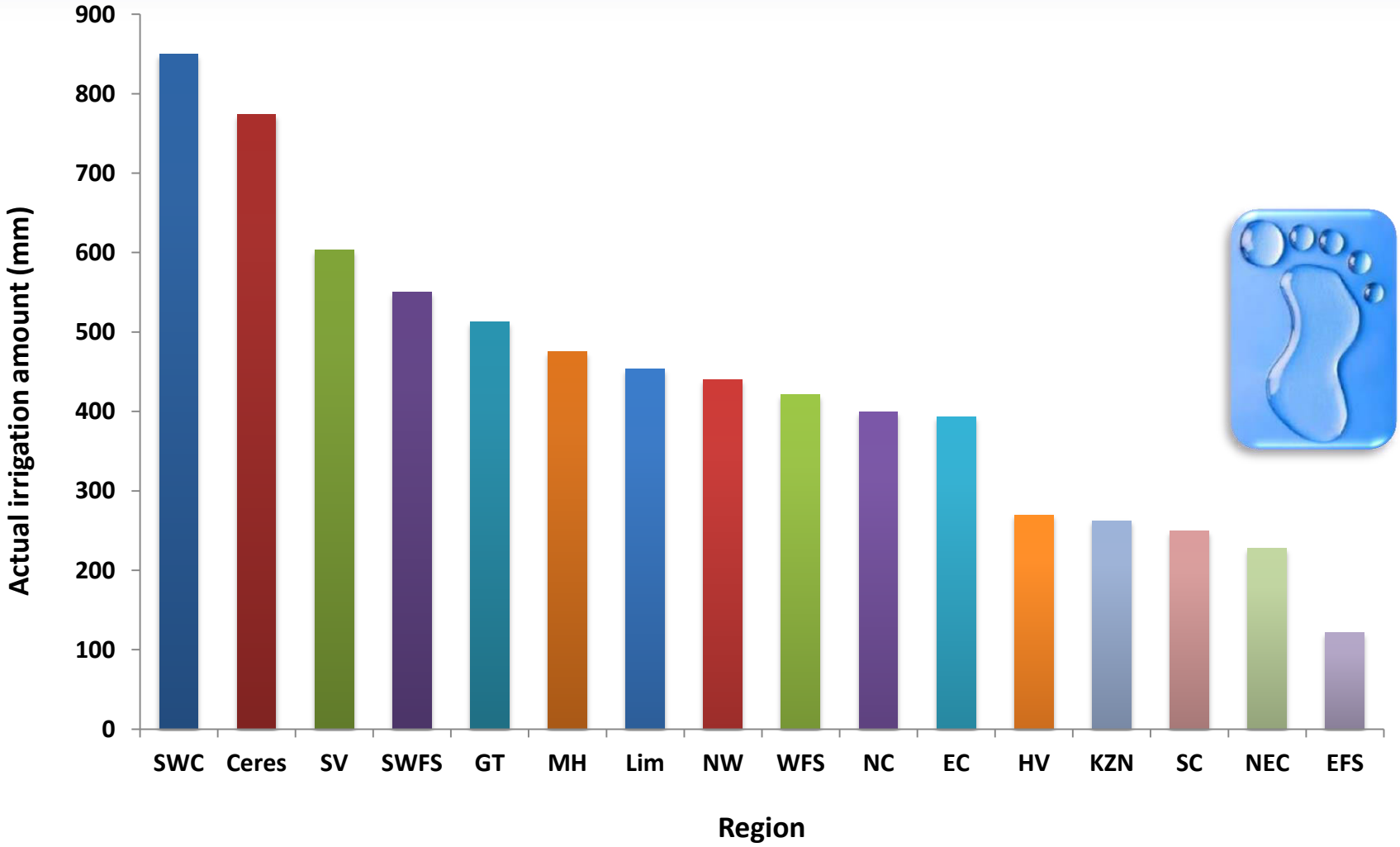
Land use efficiency



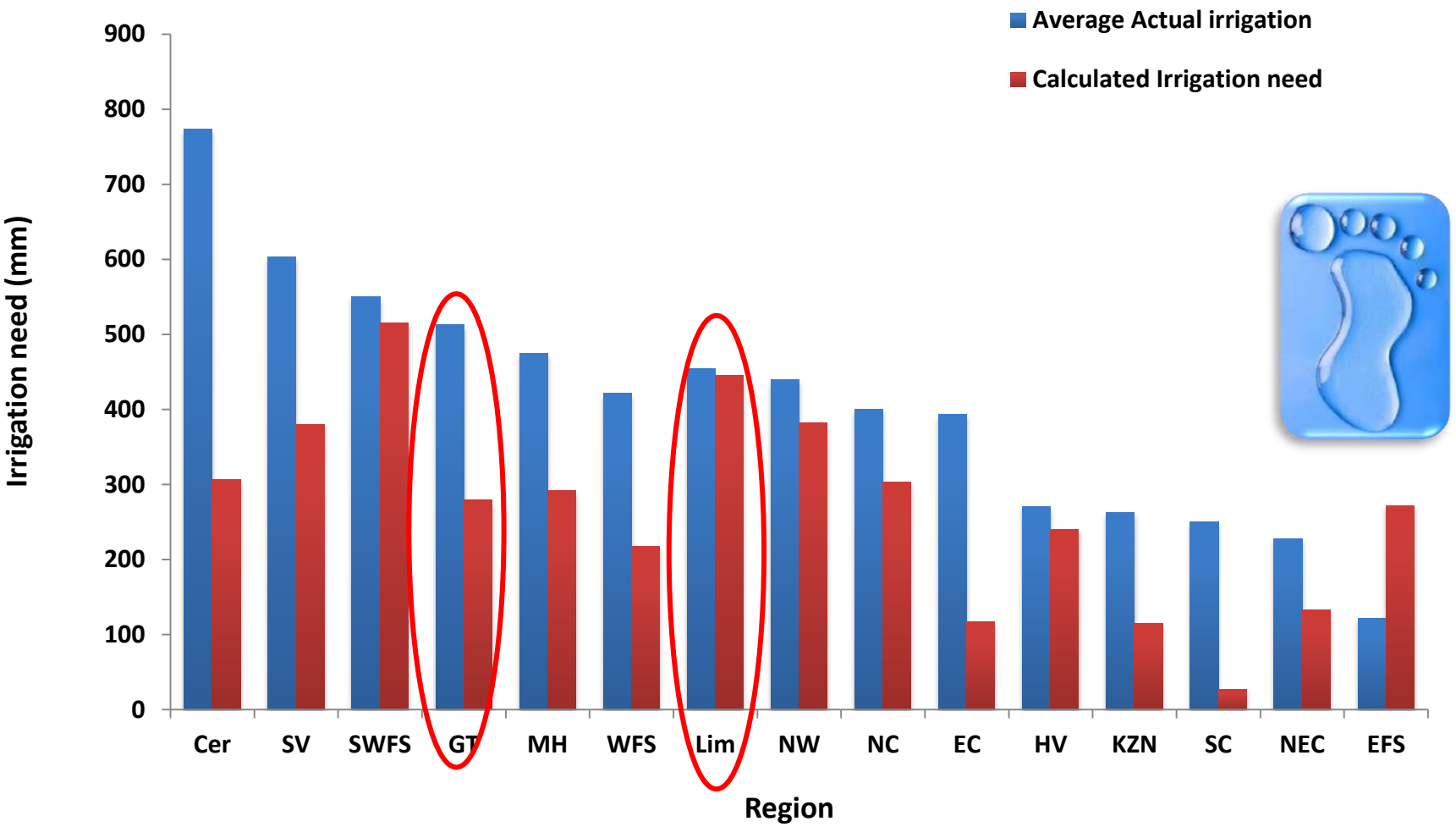
Land use efficiency



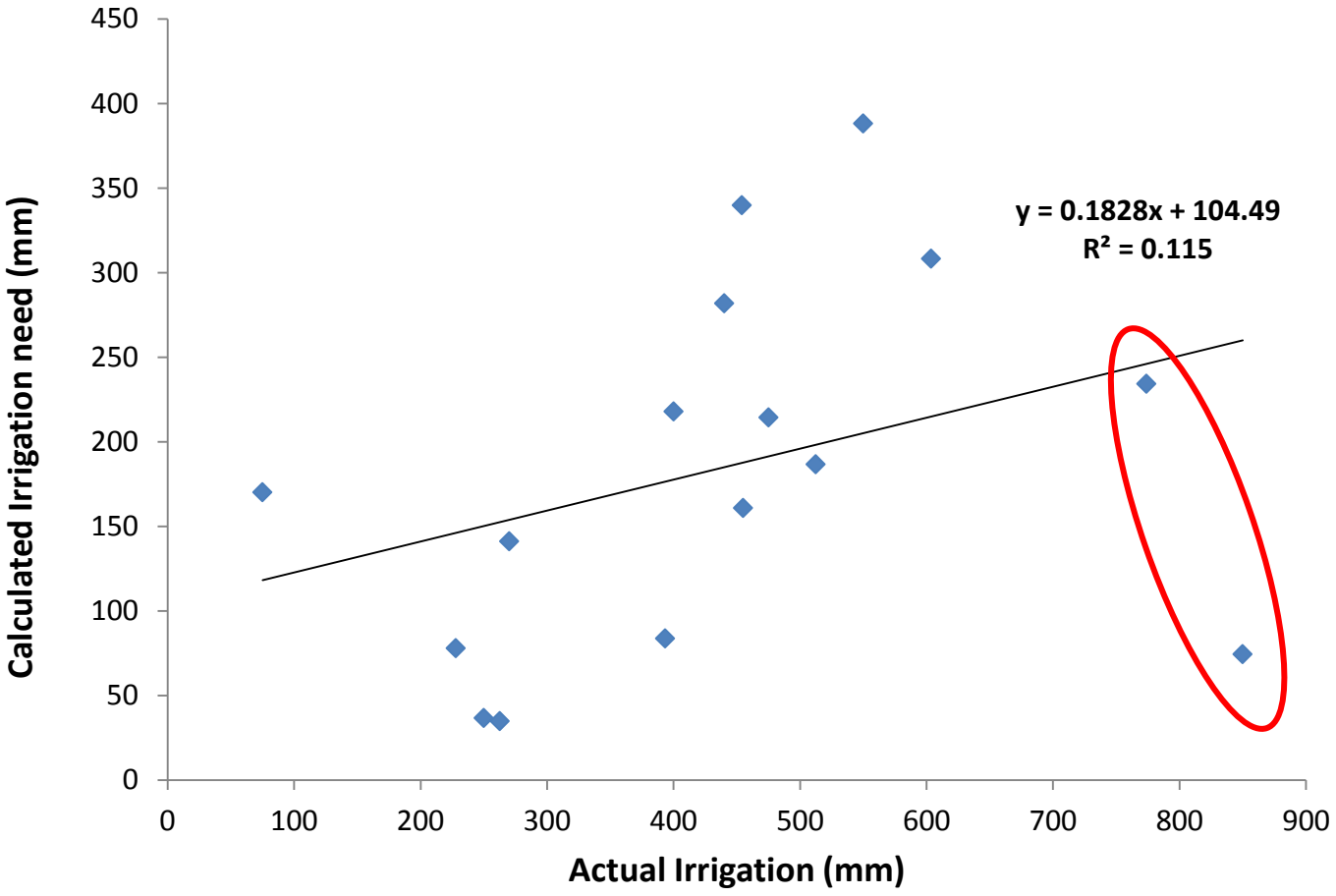
Actual Irrigation



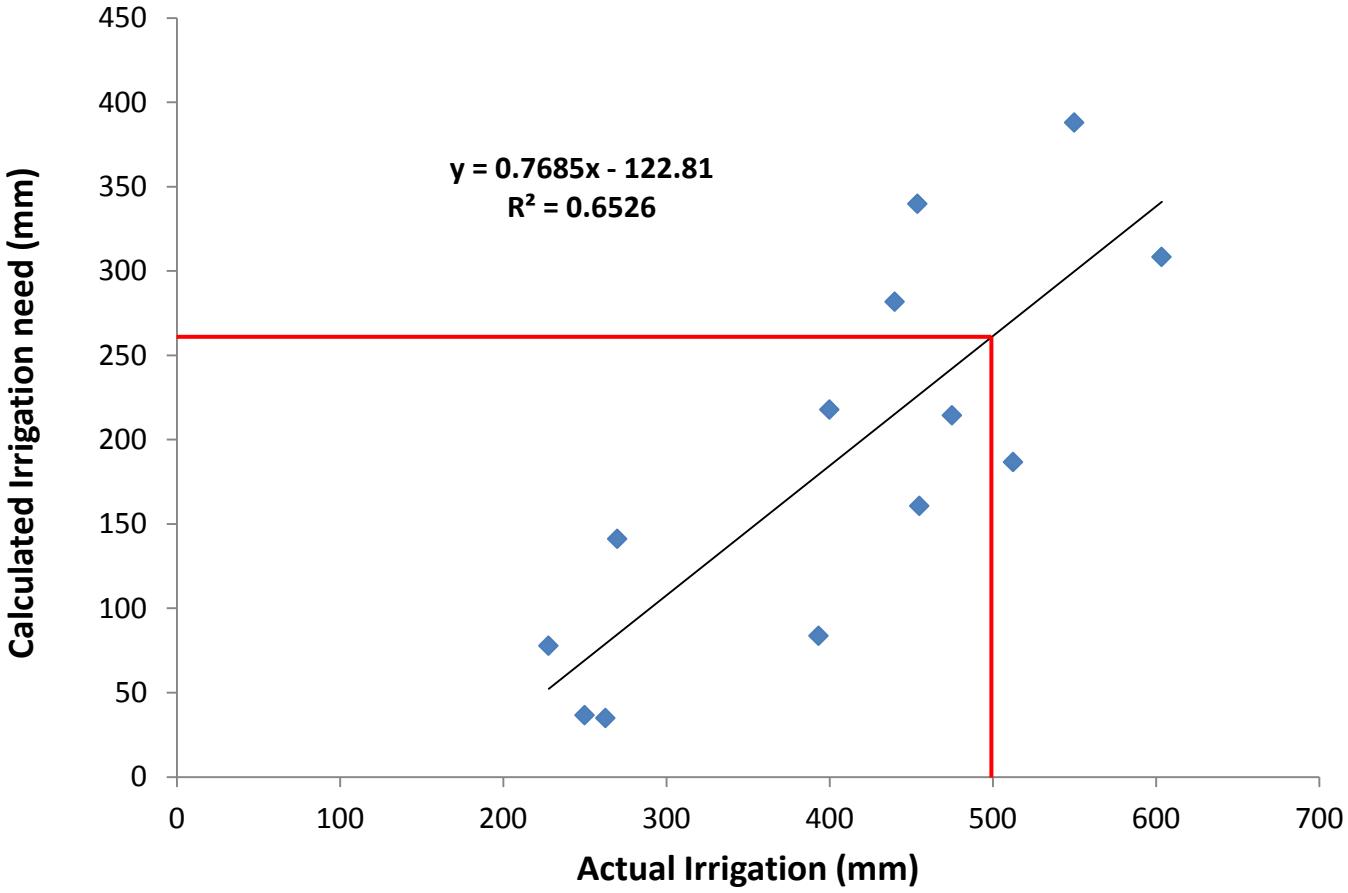
Actual Irrigation vs Irrigation need



Actual Irrigation vs Irrigation need



Actual Irrigation vs Irrigation need

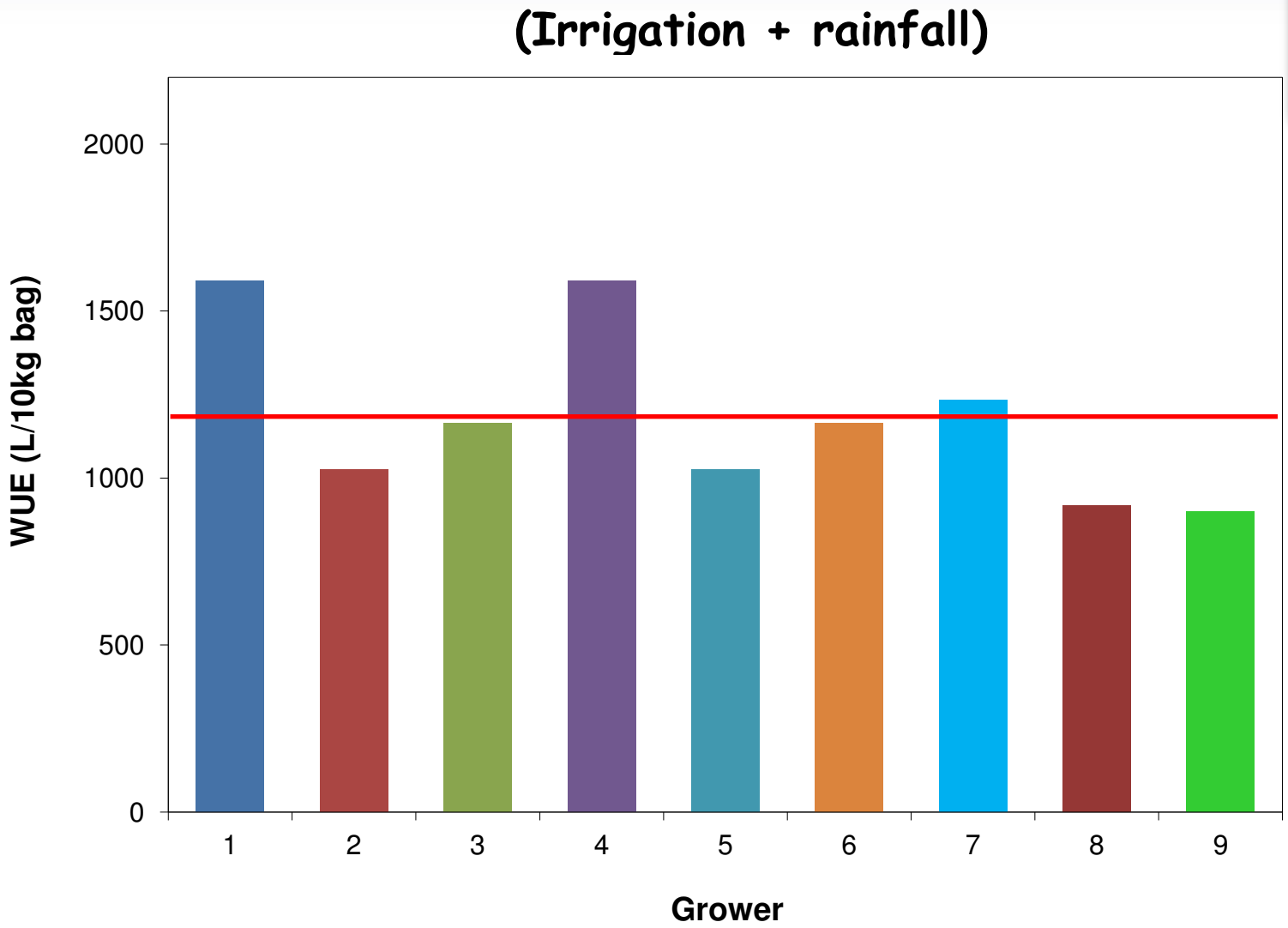


Water use efficiency

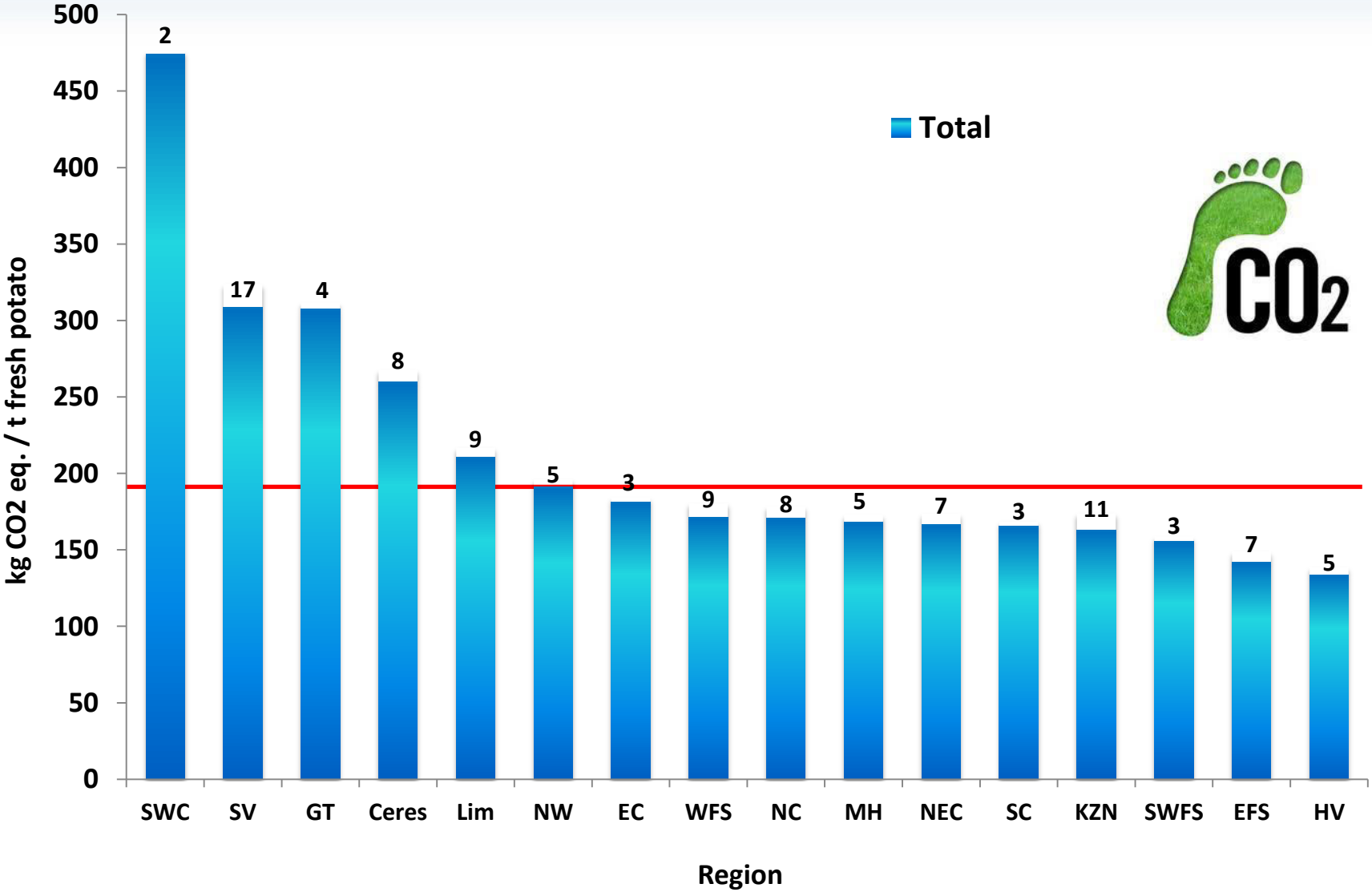
(Irrigation + rainfall)

18 L / medium tuber

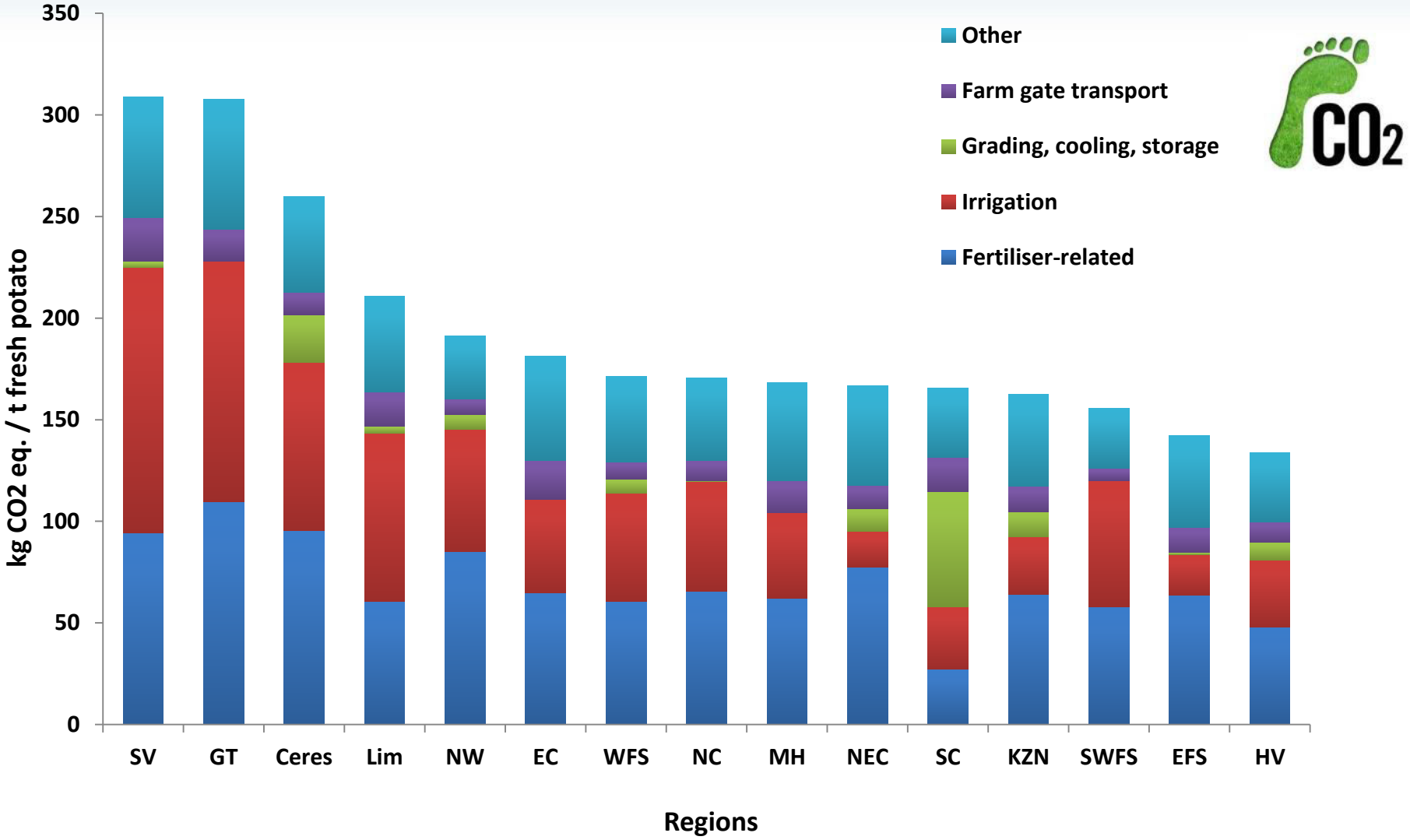
Water use efficiency



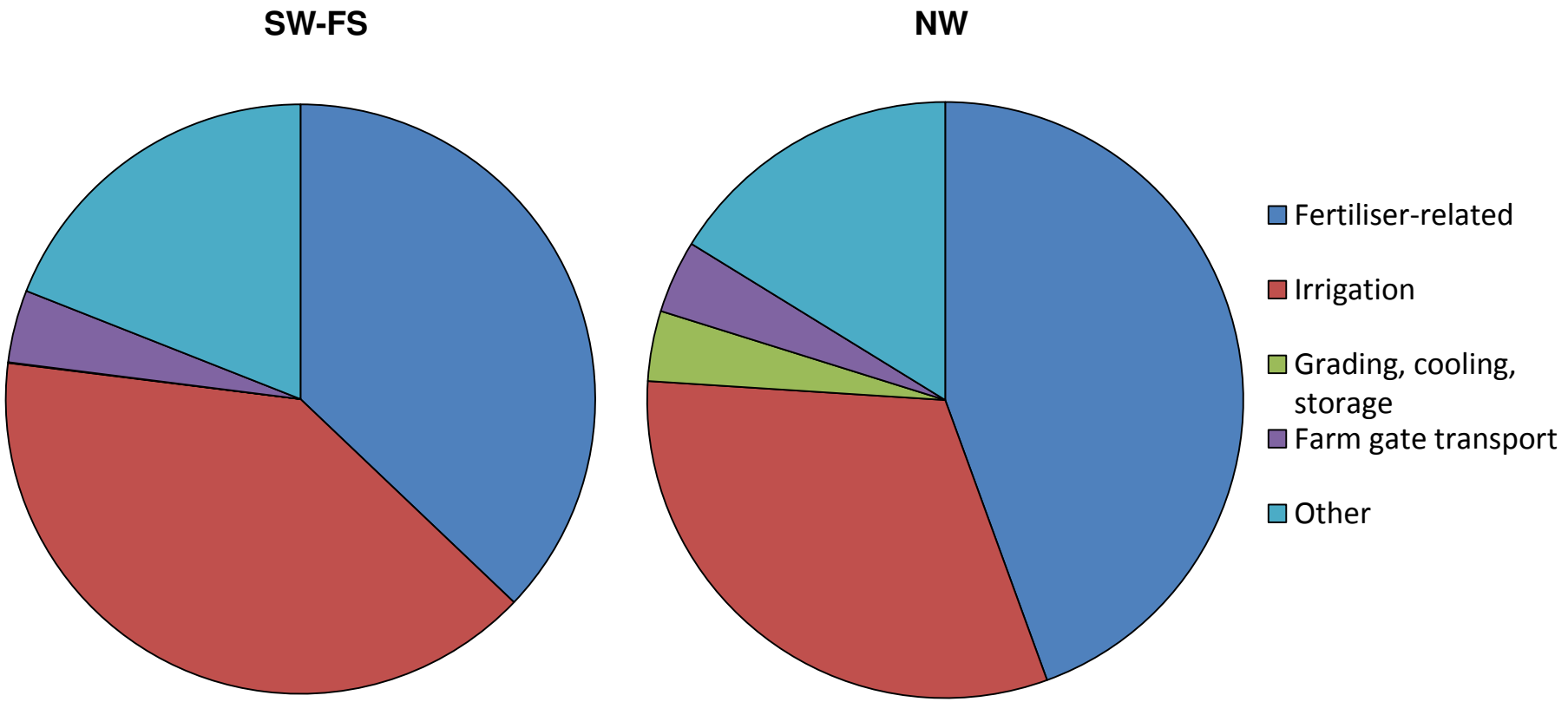
Energy use efficiency



Energy use efficiency



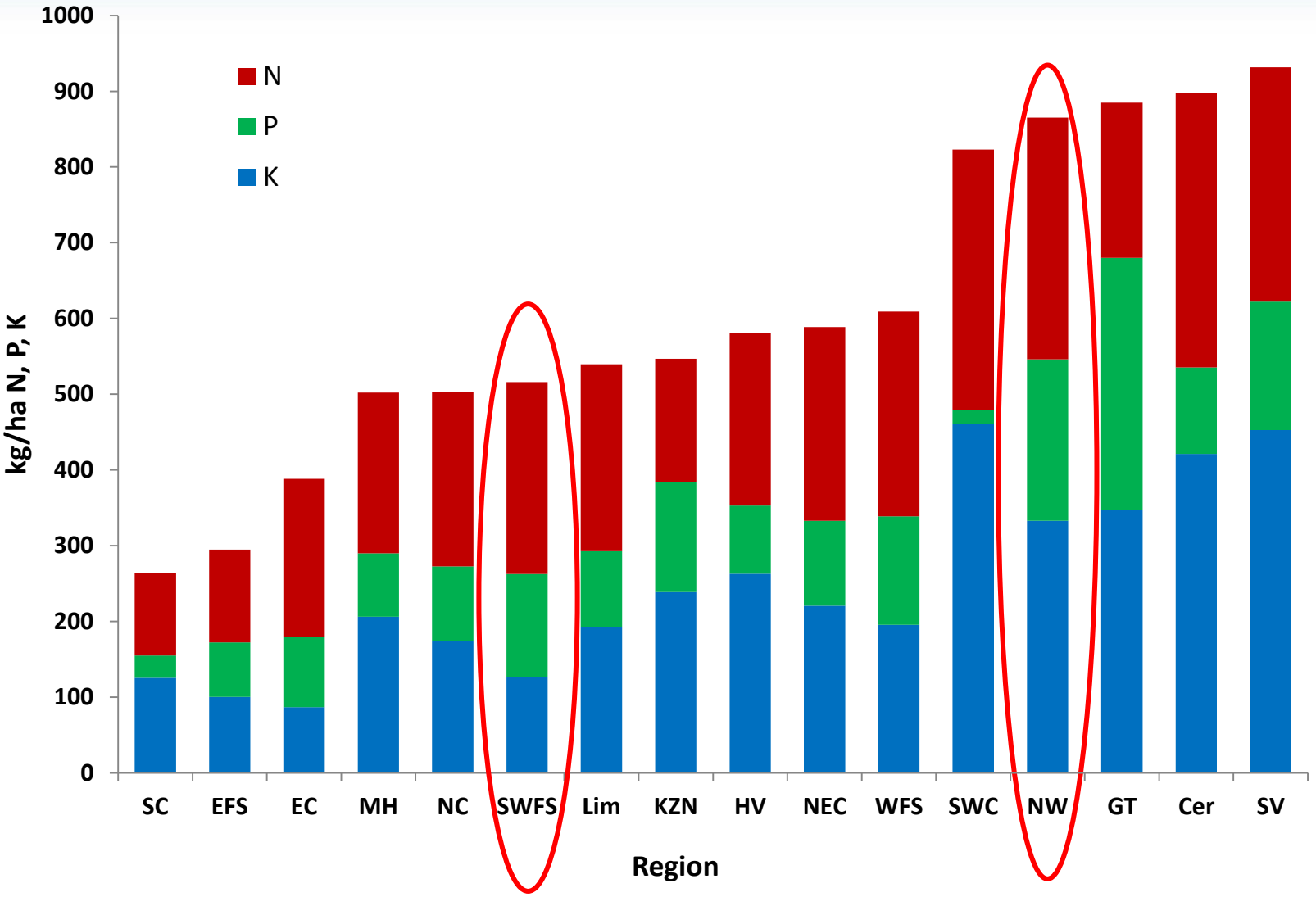
Carbon footprint



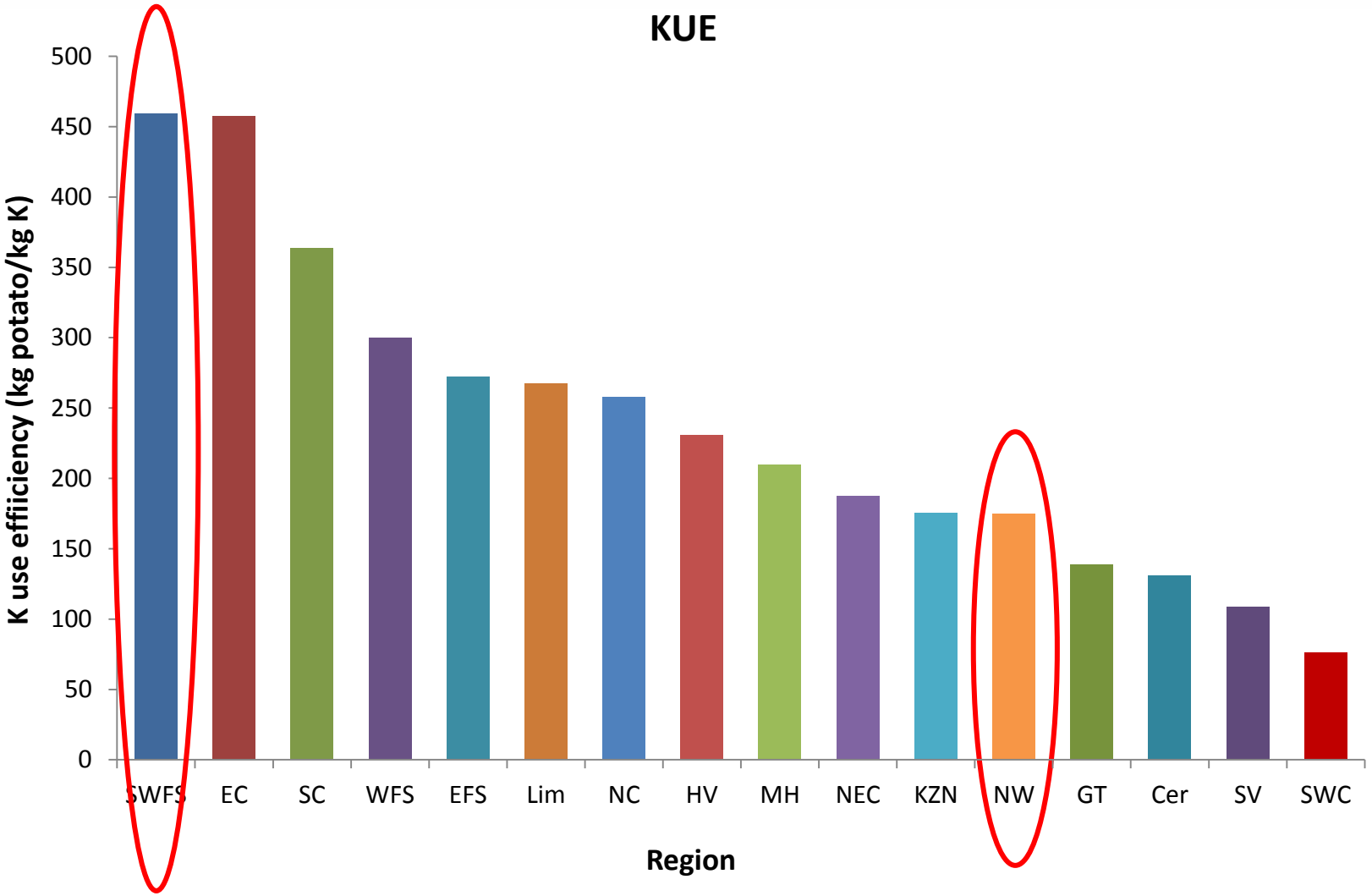
Universiteit van Pretoria
University of Pretoria

WAGENINGEN UR
For quality of life

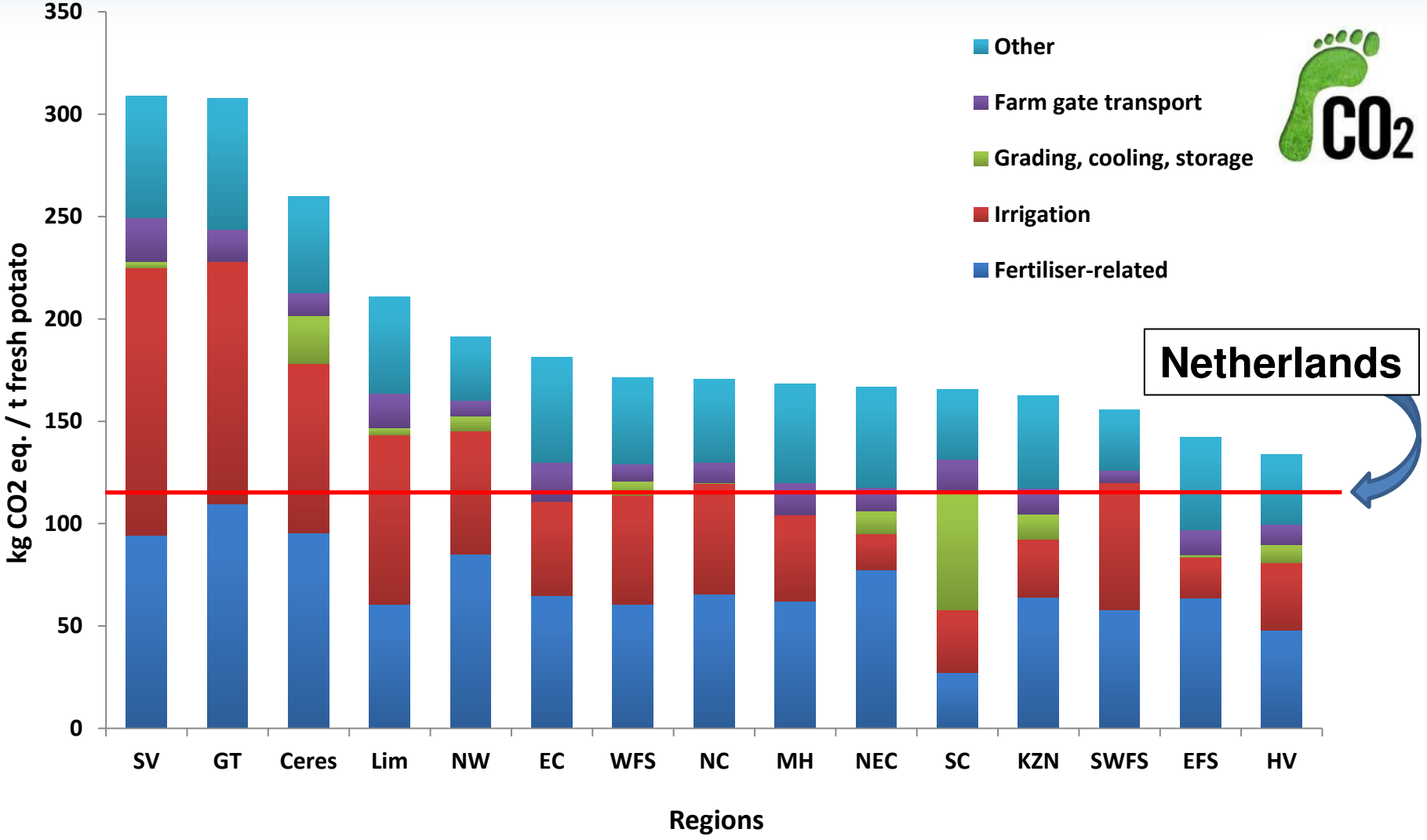
Nutrient rate/ha



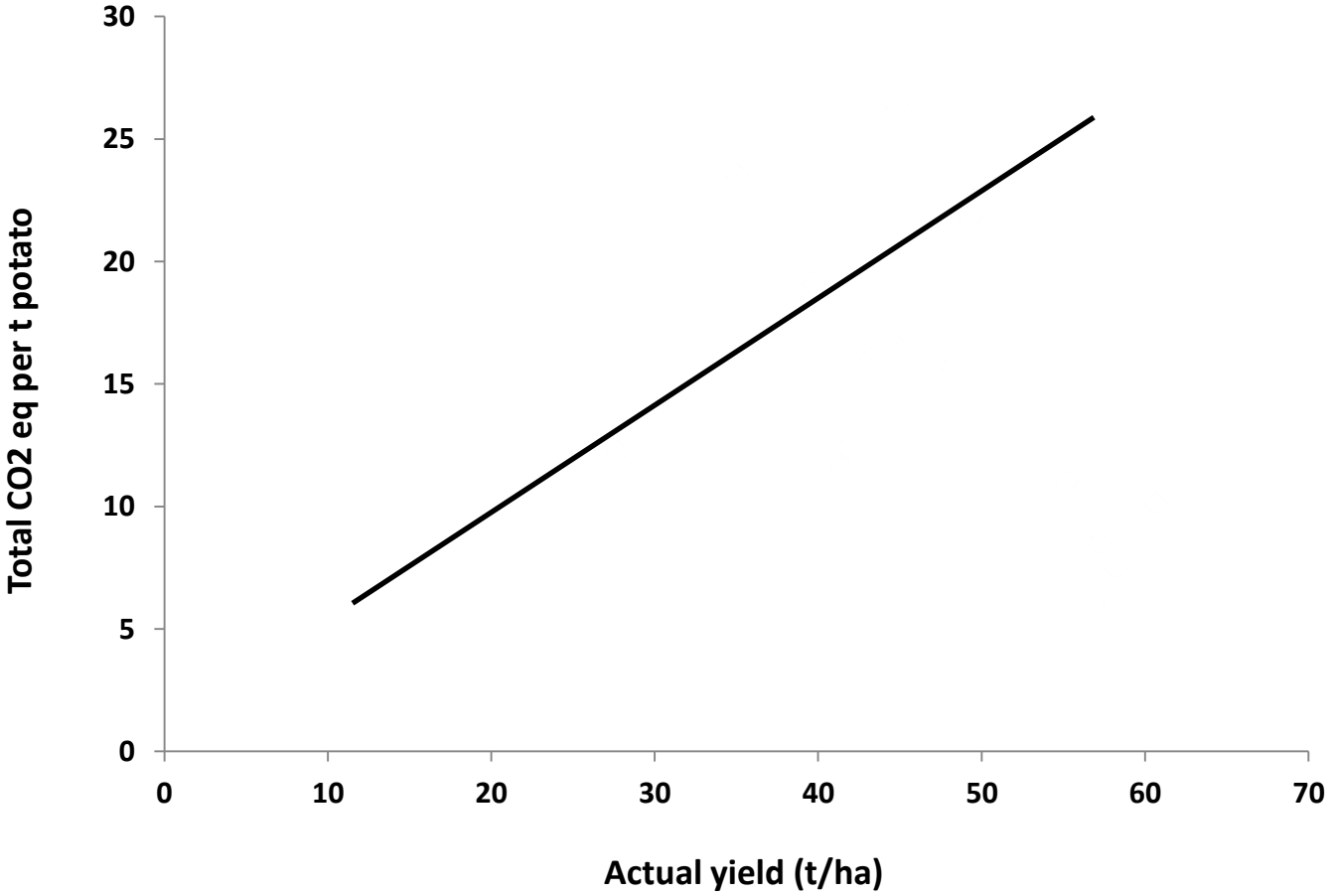
Potassium use efficiency



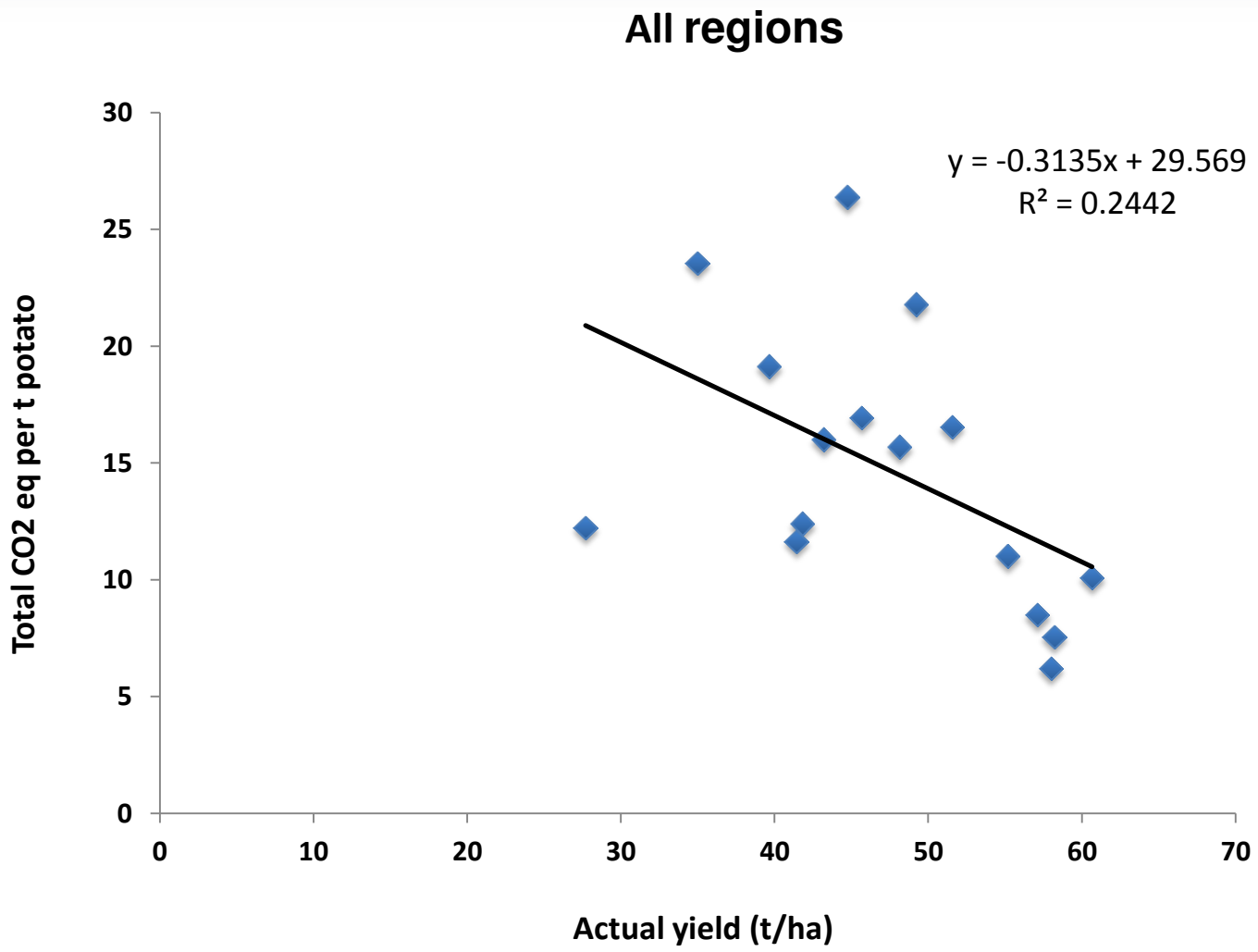
Energy use efficiency



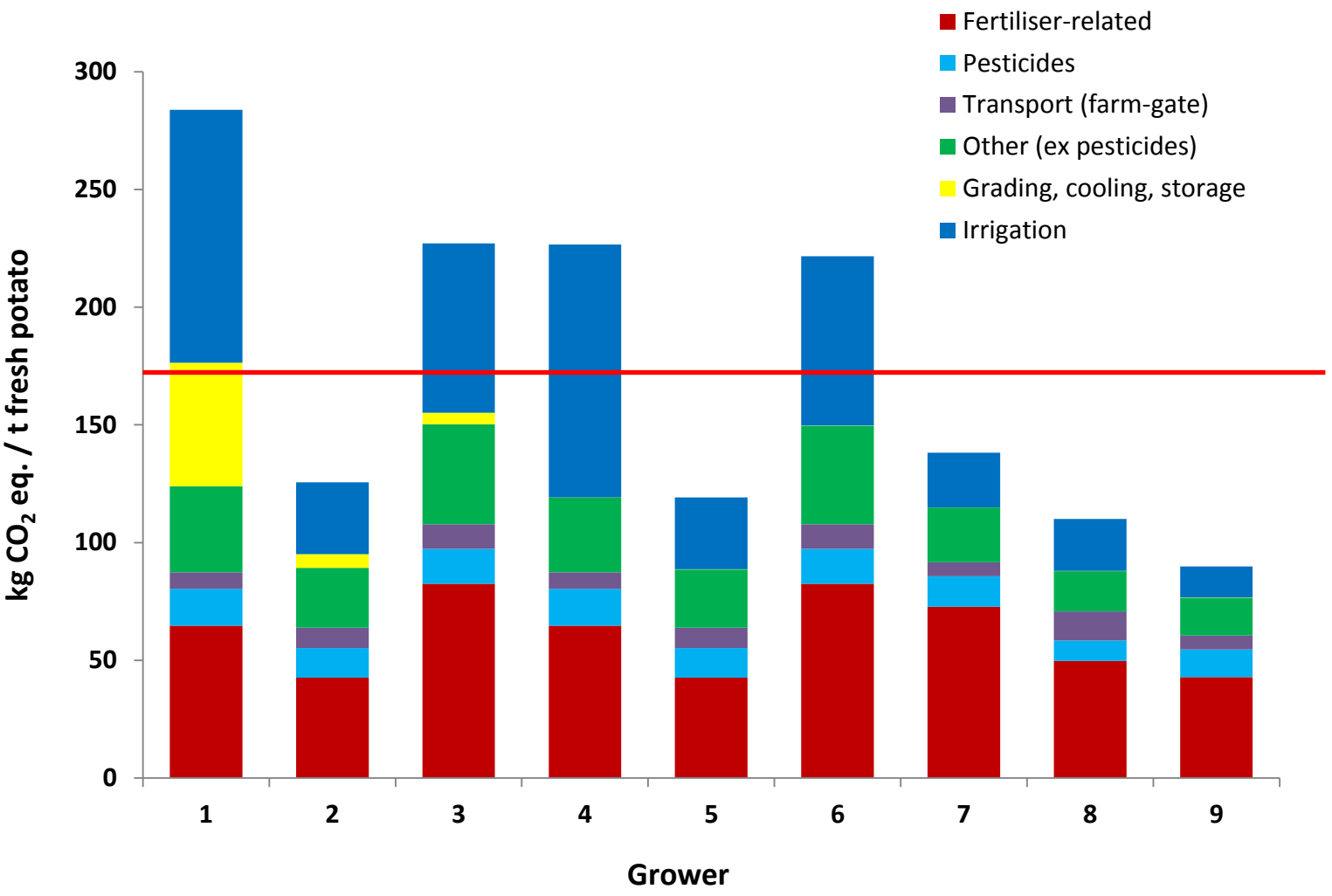
Land vs Energy use efficiency



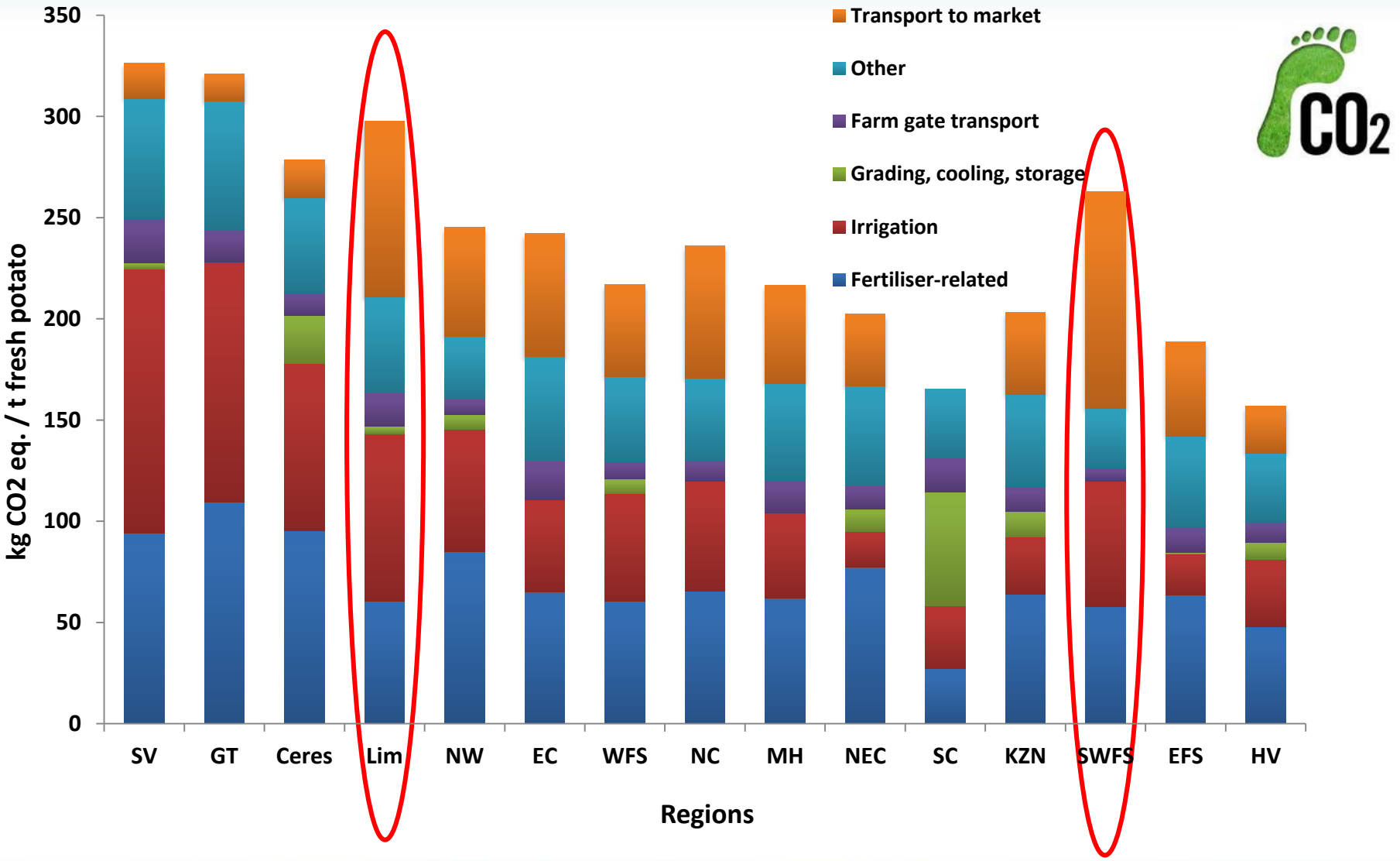
Land vs Energy use efficiency



Energy use efficiency



Energy use efficiency



Discussion and Conclusions

- Significant range in energy use efficiency (C-footprints) between regions
  - Soils, climate, practices differ
- Also between growers within a region
- Major contributors to energy use:
  - Fertilizers - 35%
  - Irrigation - 30%
  - Transport - 6.5%
    (20% incl. to market)

Universiteit van Pretoria
University of Pretoria

WAGENINGEN UR
For quality of life

Discussion and Conclusions

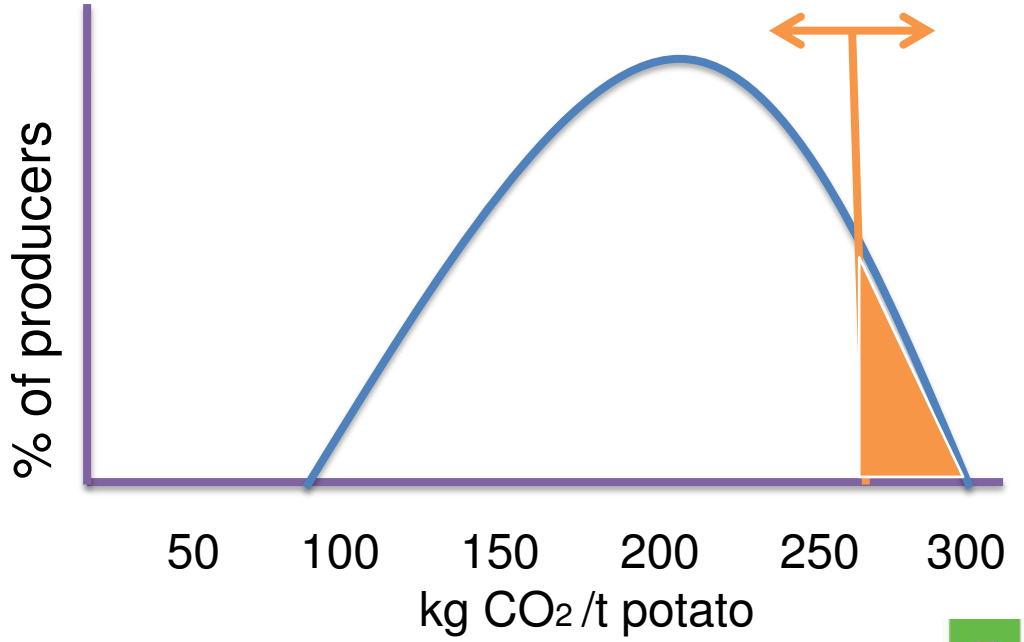
- Nutrient levels vary substantially
- Low efficiencies for some growers & regions
- LUE – country average 43 t/ha = 63% of potential
- WUE – average of 80 kg/ha/mm
- Vast differences between & within regions
- Opportunity for improvement

Universiteit van Pretoria
University of Pretoria

WAGENINGEN UR
For quality of life

Discussion and Conclusions

- Where to from here?
- What can be done about it?
- Set norms and move the curve



Universiteit van Pretoria
University of Pretoria

WAGENINGEN UR
For quality of life

Discussion and Conclusions

- Identify most inefficient practices – per region / individual growers
- Interact with growers - feedback sessions
- Explore options to improve efficiencies by altering practices / field operations
  - e.g. lower application levels of chemicals or fertilizers
  - use decision support systems, e.g. irrigation scheduling tools / fertilizer recommendations
- Improve environmental & financial sustainability

Acknowledgements

- Potato growers in different regions
- Potatoes South Africa
- University of Pretoria
- Netherlands Embassy
- THRIP

Universiteit van Pretoria
University of Pretoria

potatoes
SOUTH AFRICA
pure potato passion

WAGENINGEN UR
For quality of life