Pullman, Washington, USA
12-14 August, 2013
International Quinoa Research Symposium

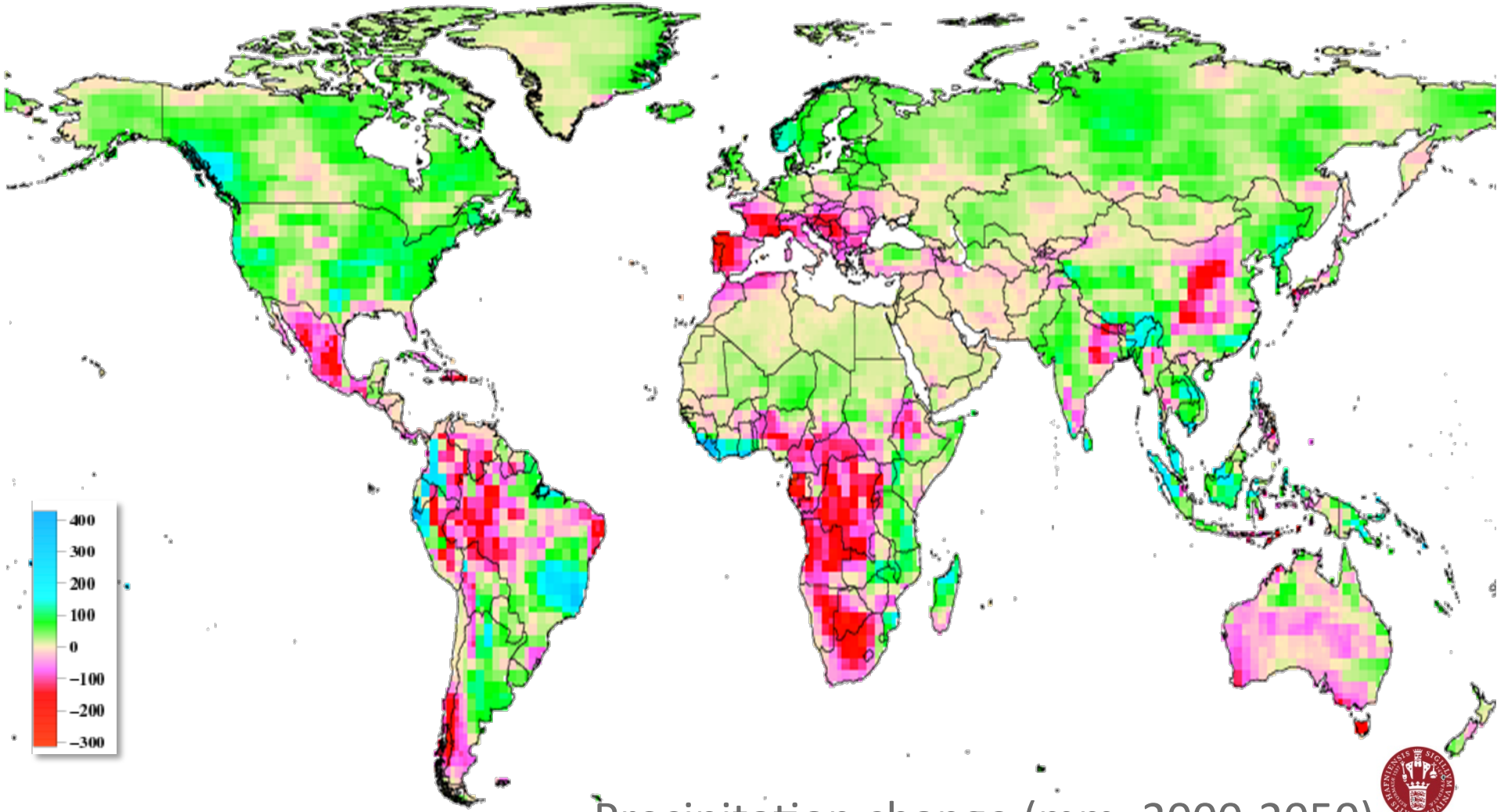
What is the Global Potential of Quinoa?

Sven-Erik Jacobsen

Content

- Intro
- Possible solutions
  - Production systems
    - New technology
    - New genetic material
- New genetic material
- Quinua
- Breeding
  Photoperiod
  Stresses
- Cultivation
  Promotion
- Conclusión

Climate is likely to change for the worse in many developing countries



Precipitation change (mm, 2000-2050)

CSIRO, A2, AR4

Possible solutions for climate proof cropping systems

- Improved cropping systems
- New technologies
- New genetic material

SWUP-MED

New genetic material

Stress tolerant varieties

Drought tolerant and other abiotic stress traits should be identified in breeding programmes using advanced physiological and biochemical screening tools

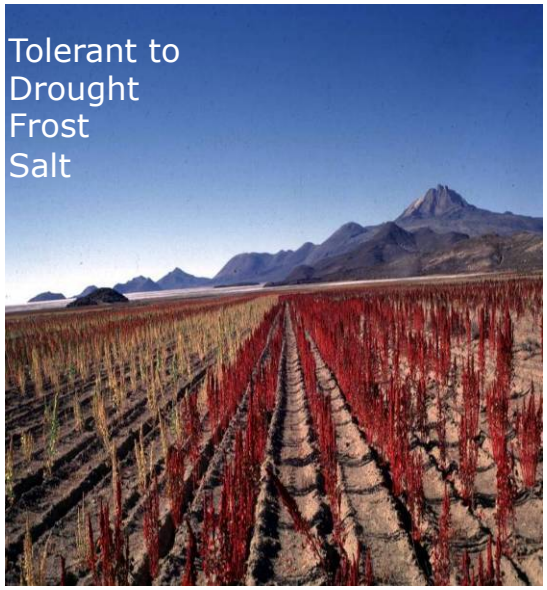
New crops

Quinoa

Nutritional value

High protein quality
High protein content (12-20%)
High vitamin content (A, B2, E)
High mineral content (Ca, Mg, Fe, Zn)

Cultivation



Tolerant to
Drought
Frost
Salt

Market

Market

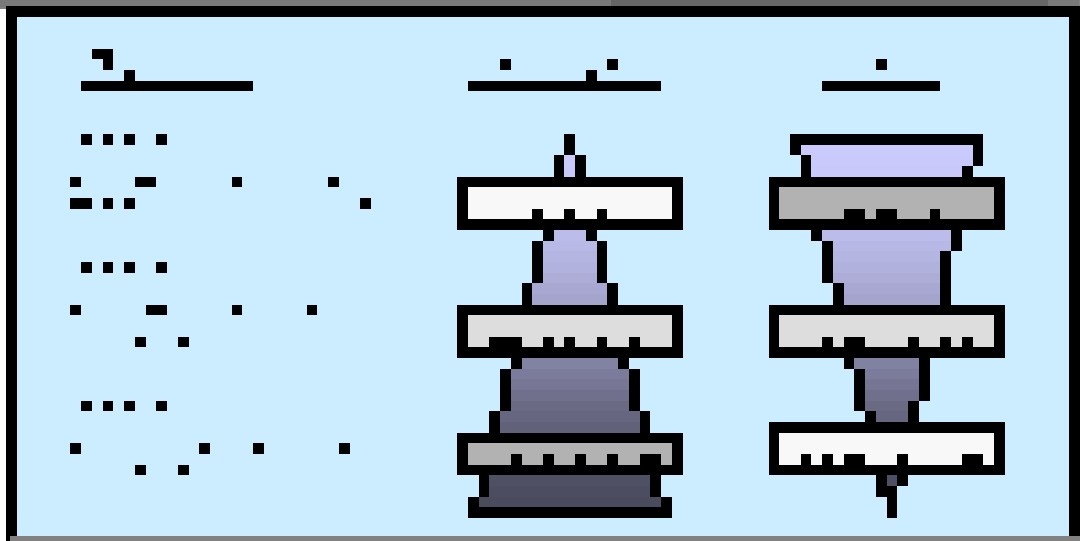
Family

Local market

International market

- Organic produce
  - First quality
  - Stable, constant production
  - Primary products / Processed products

Organization
Lack of confidence
Confederation



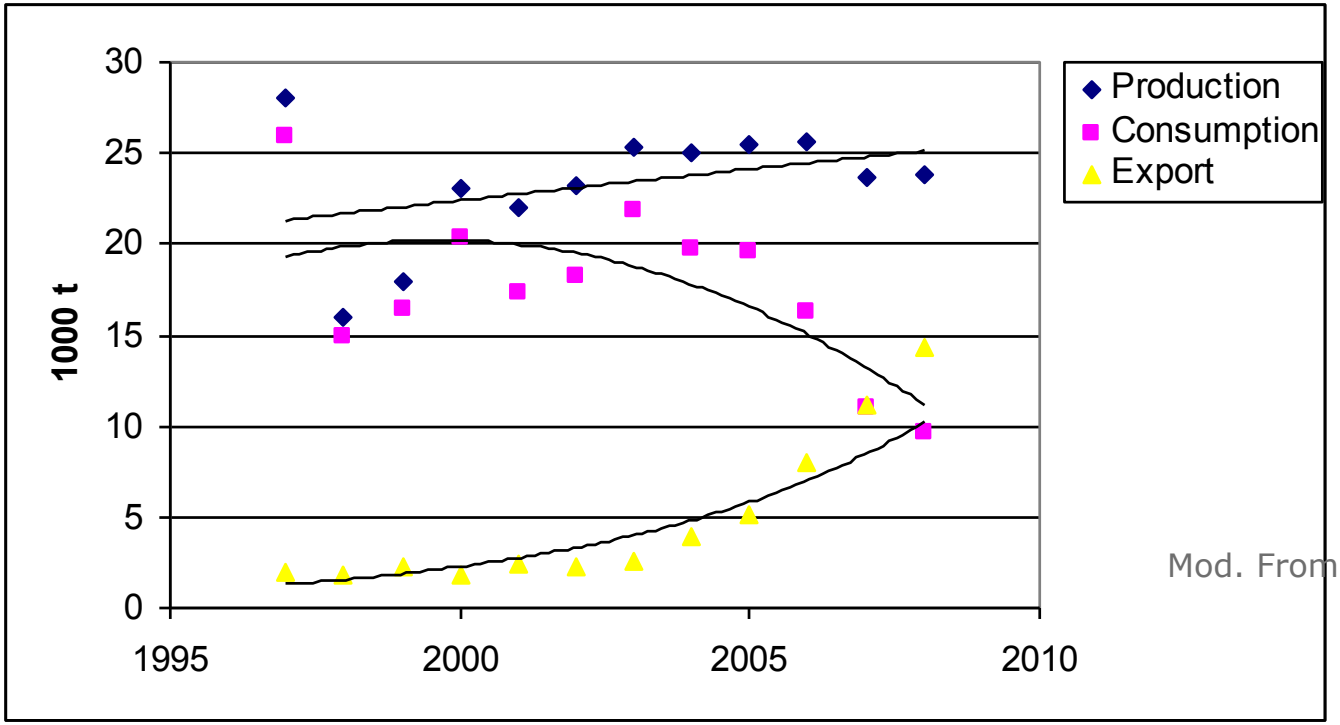
Participatory Market Chain Approach (PMCA) (Bernet et al., 2005)

Dissemination

Field day

Workshops

Quinoa: Production, consumption, export, Bolivia



Mod. From MDRyT, 2009

How can we benefit from the situation?

Production

Market

Consumption

IV International Quinoa Conference, Ecuador





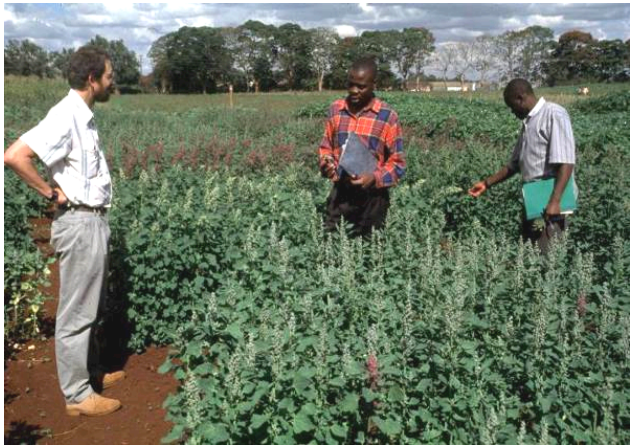

How can we supply quinoa for future **consumption**?

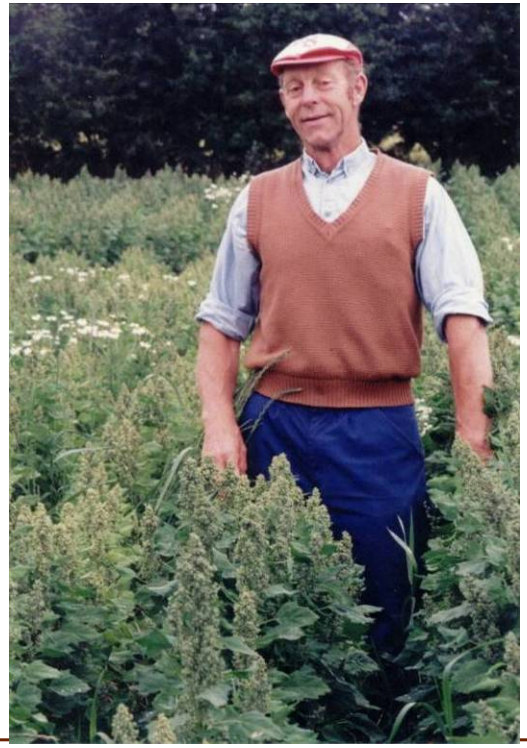
Bolivia and Peru

Andes

How can we supply quinoa for future **market** demand?

Production of quinoa Real in Bolivia
Bolivia and Peru
Andes
Global production





Breeding

Breeding objectives are:

- Climate proof varieties
- Tolerance to abiotic and biotic stresses
- Quality
- Photoperiod

Adaptation to:

- Climate change
- Stresses
- Photoperiod

Genetic diversity

3000 accessions
Gene banks
Conservation in situ
Diversity in morfological, physiological and biochemical parameters

Ecotypes of quinua:

- Altiplano (>3600 masl)
- Salar (3600 masl)
- Valleys (2500-3600 masl)
- Subtropical (<2500 masl)
- Sea level (0-500)

Characters of interest

- Morphology
  - Plant short-long
  - Branched-single stem
  - Amaranthiforme-glomerulate
  - Open-closed
  - Plant and seed colour
  - Seed size
- Physiology
  - Tolerance to abiotic stresses
  - Early maturity
- Agronomy
  - Tolerance to biotic stresses
  - Adapted to mechanization
- Biochemistry
  - Saponin
  - Protein
  - Protein composition
  - Nutritional value
  - Processed products

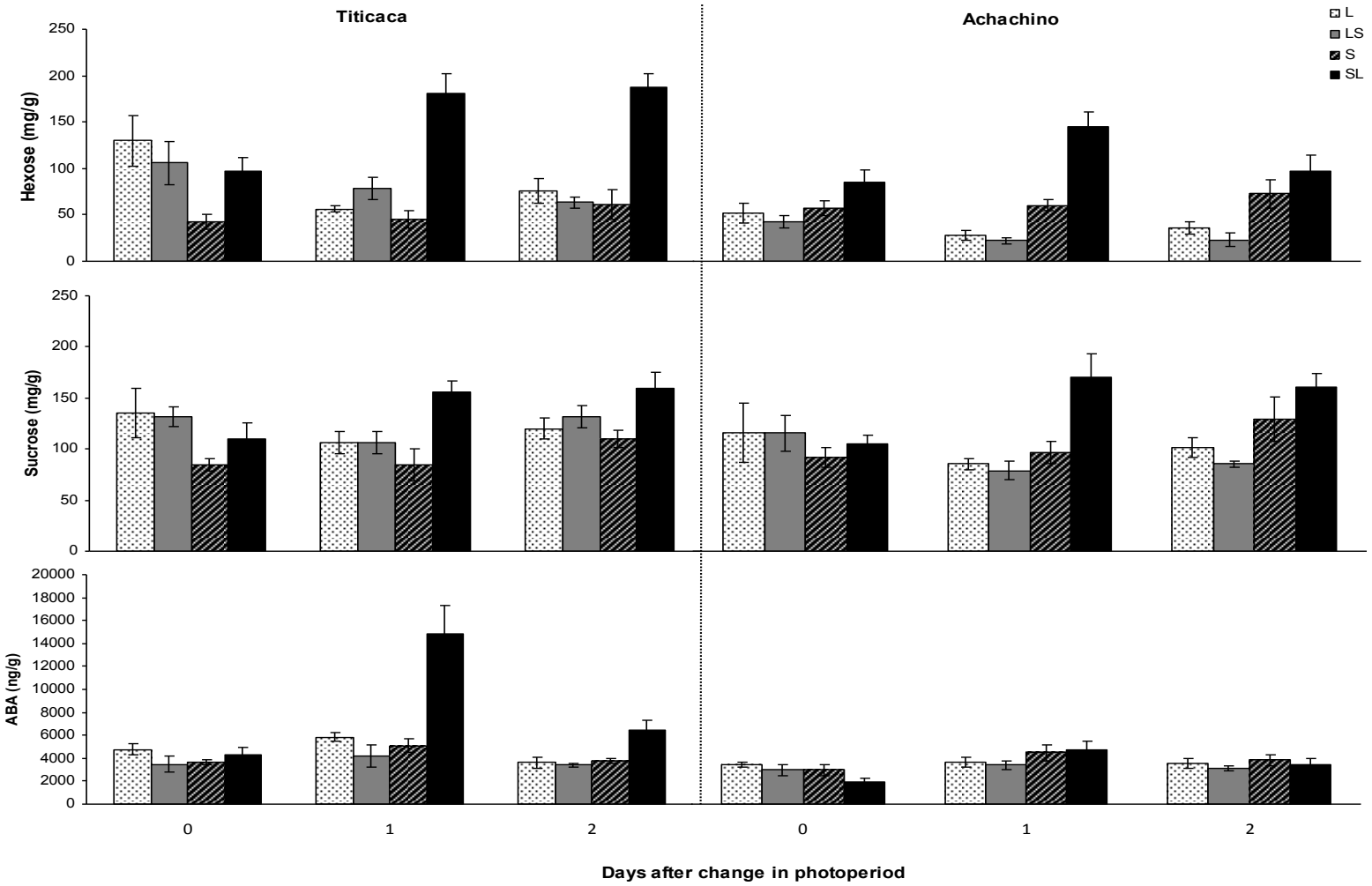
Model plant

Yield

Photoperiod

(a)
Titicaca and Achachino, short to long photoperiod (SL), continuous short period (S)

(b) 49 days after sowing
Yellowing of the lower leaves of the SL plants developed after the shift in photoperiod



Soluble sugar and ABA content of the top-most, fully expanded, leaves collected on the day of shifting photoperiod

Anthesis

Vital stage of the plant

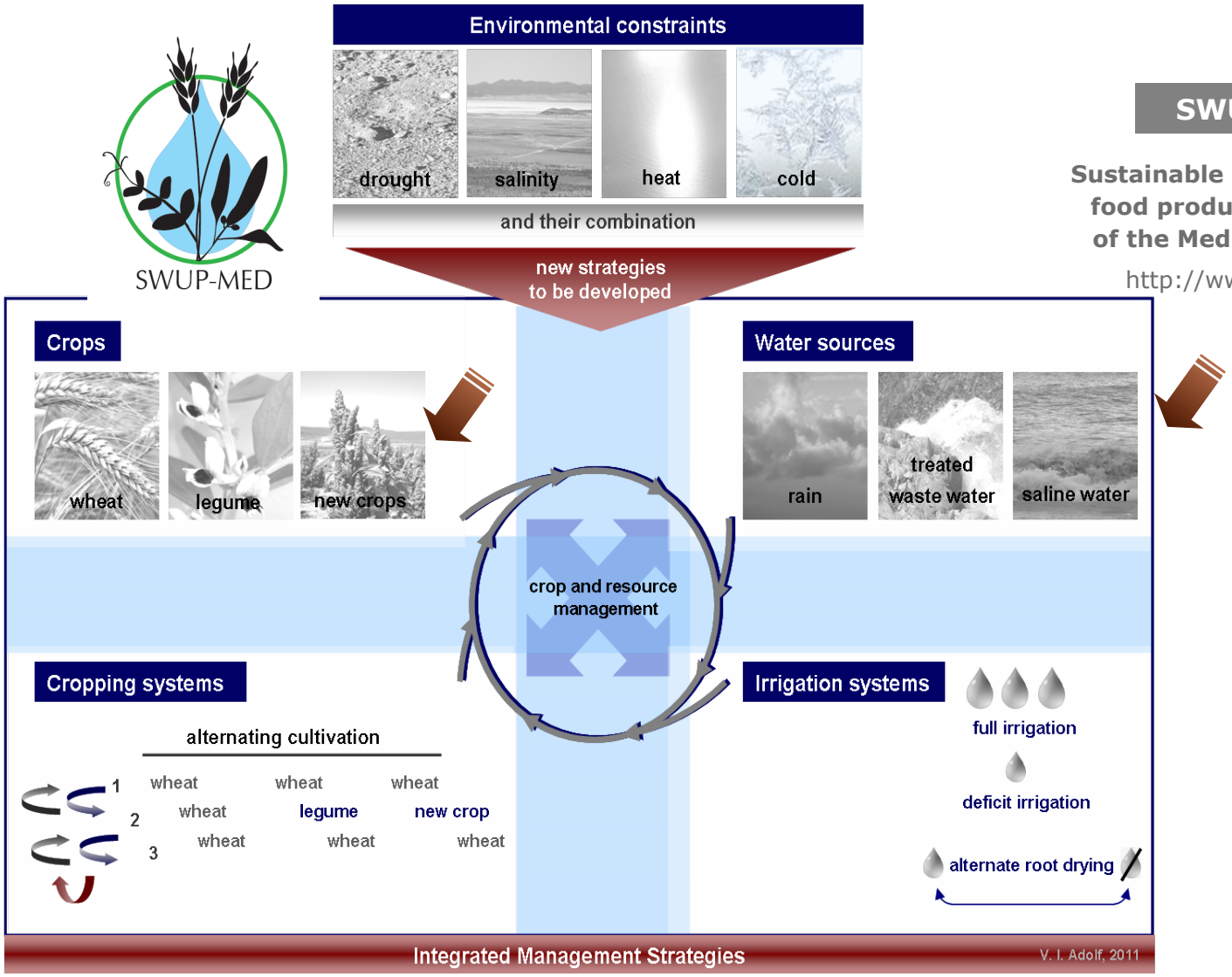
Transition from vegetative to reproductive growth

Objective of breeding:

Manipulate the phenology (esp. anthesis) according to geographical region

Adaptation aimed at photoperiod and temperature

Stresses



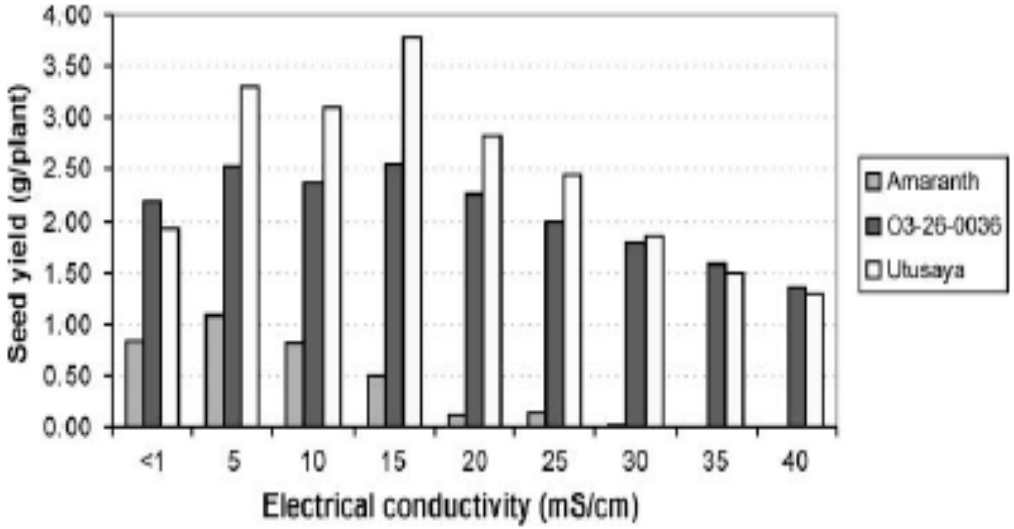
SWUP-MED

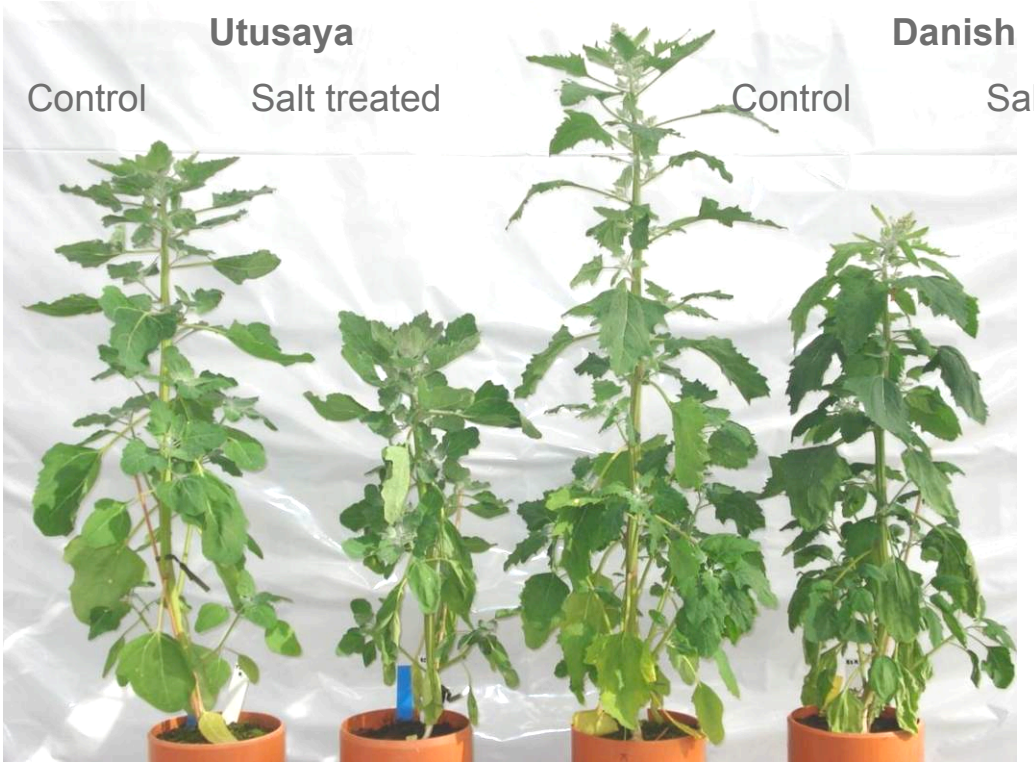
Sustainable water use securing food production in dry areas of the Mediterranean region

http://www.swup-med.dk/

Salinity

Yield

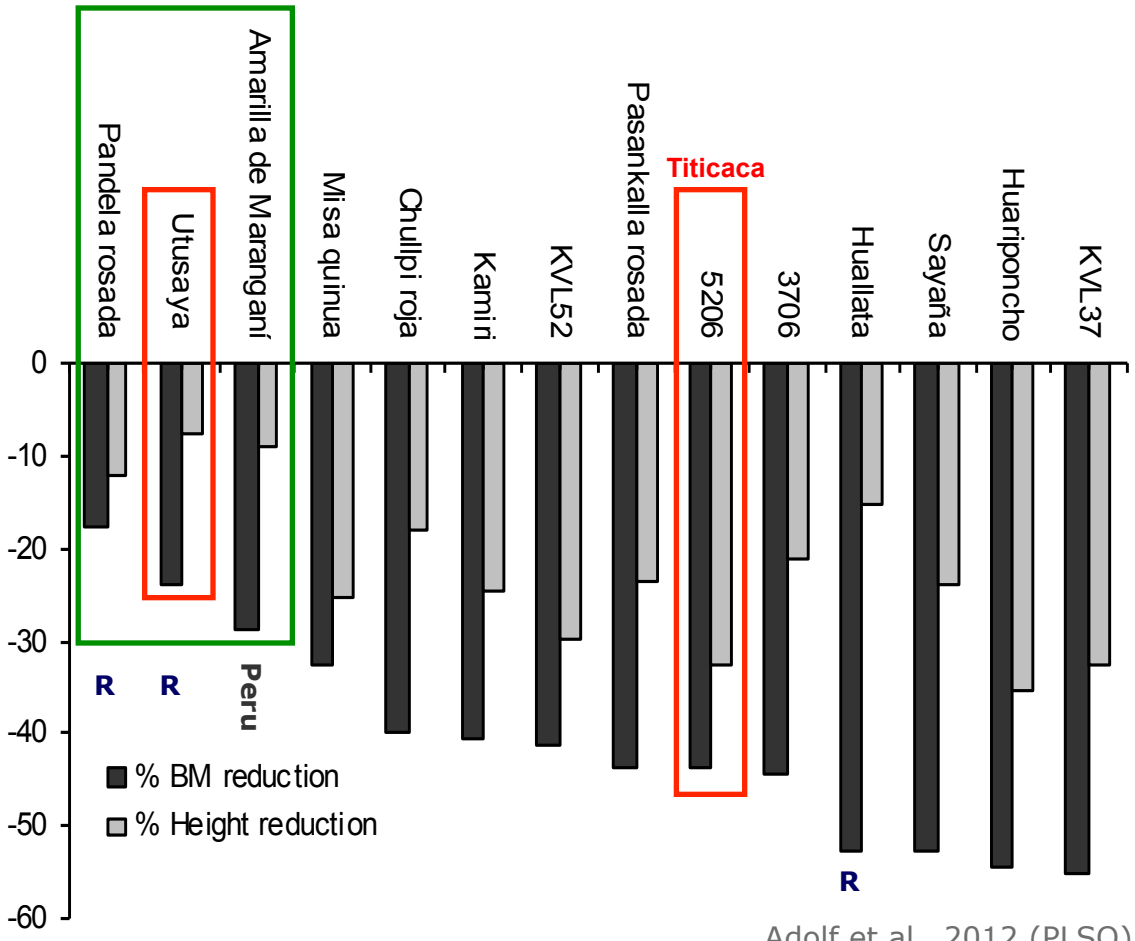




Inter-specific variation

Percent fresh weight biomass and height reduction in 14 quinoa varieties

Intraspecies differences



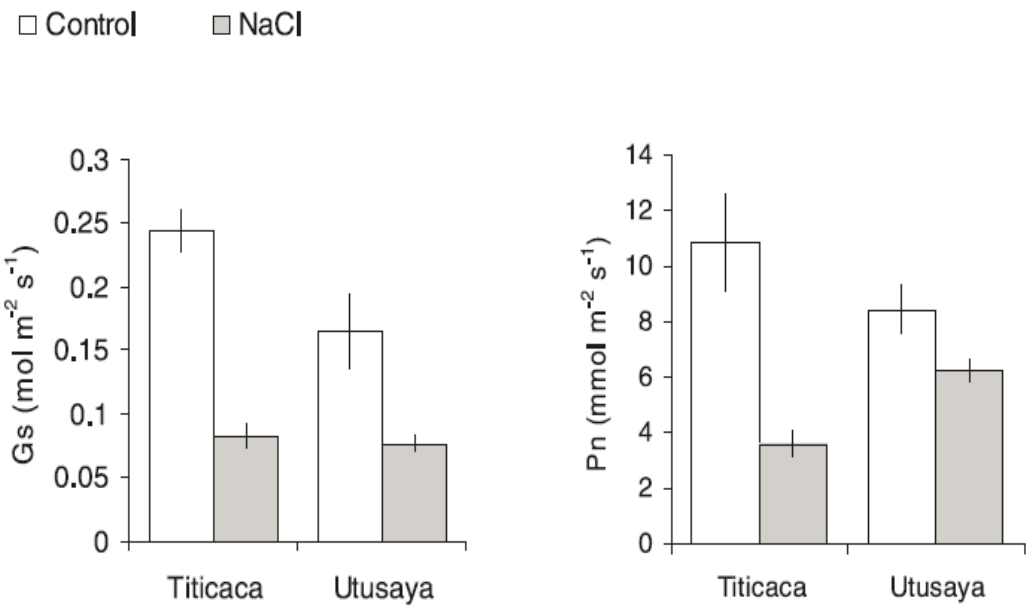
R = Real type

Adolf et al., 2012 (PLSO)

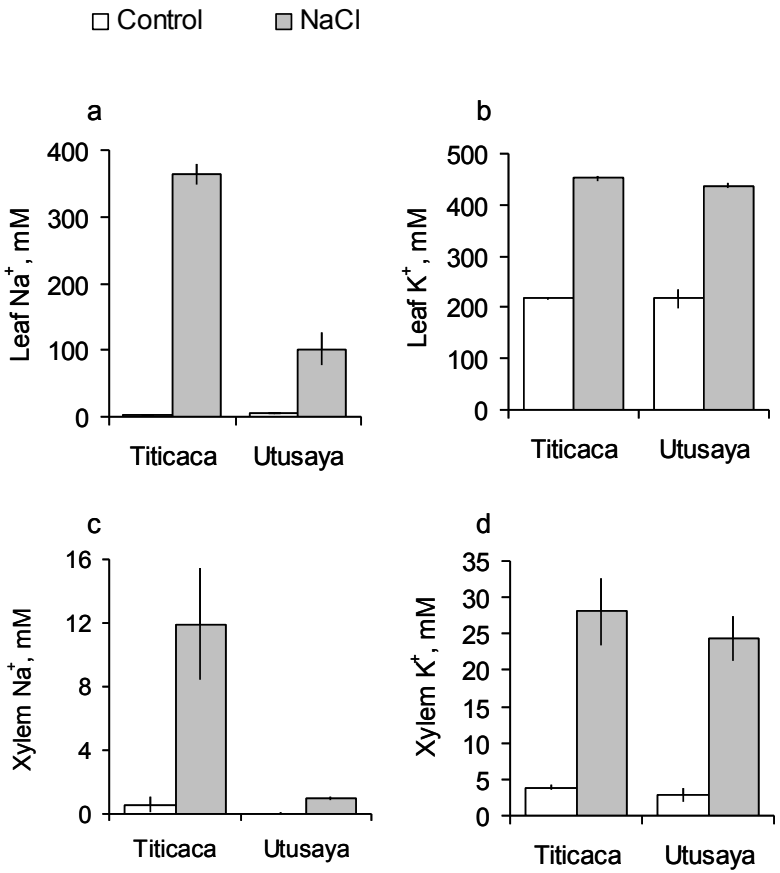
Mechanisms

Intraspecies differences

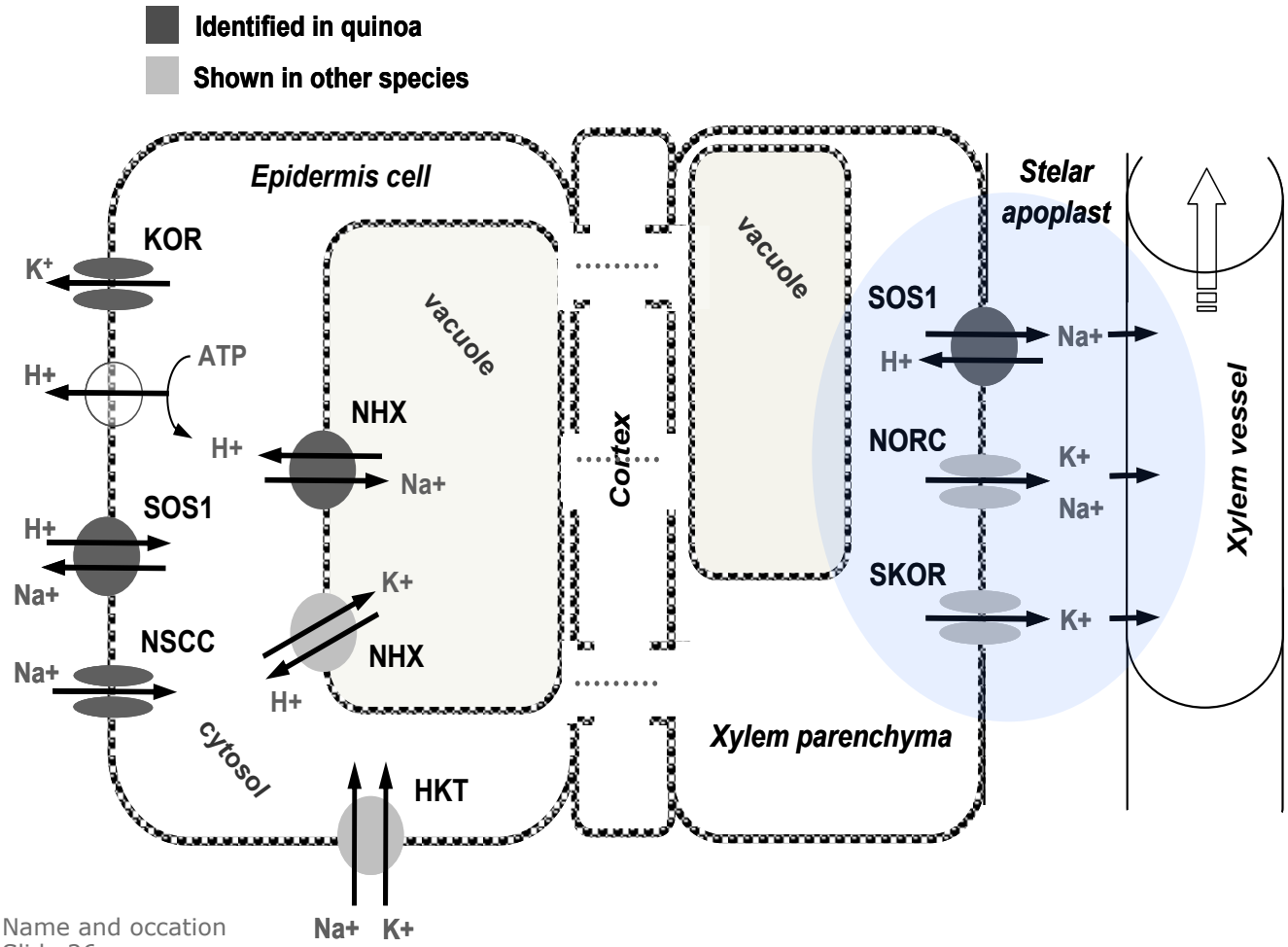
Utusaya vs. *Titcaca*: Stomatal conductance & Photosynthesis



Na and K


Control
NaCl
a
Leaf Na+, mM
400
300
200
100
0
Titicaca
Utusaya
b
Leaf K+, mM
500
400
300
200
100
0
Titicaca
Utusaya
c
Xylem Na+, mM
16
12
8
4
0
Titicaca
Utusaya
d
Xylem K+, mM
35
30
25
20
15
10
5
0
Titicaca
Utusaya

Transporters and channels

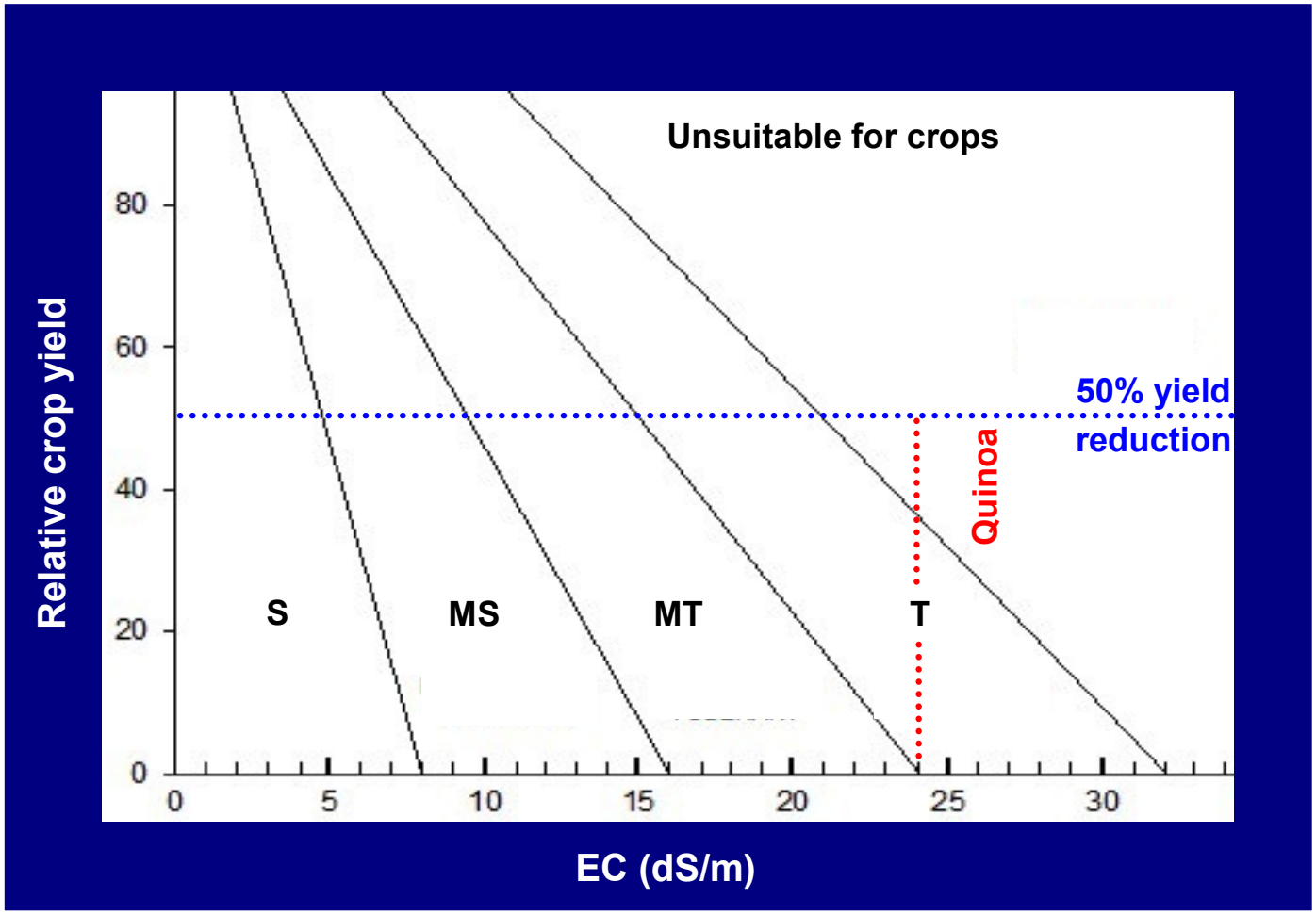


Adolf et al. (2012)

Salt tolerance mechanisms

- Exclusion of Na from leaf
- Mantain low level of Na in cytosol
  - Active pumping of Na to the vacuole, against the electrochemical gradiente
  - Prevent diffusion of Na to cytosol
- Better K retention
  - Osmotic role
  - Avoid protein catabolism
  - Avoid PCD
- Mantain K/Na in cytosol
- High level of H+ pumping to maintain membrane potential
- More SOS1
- Reduced stomatal density

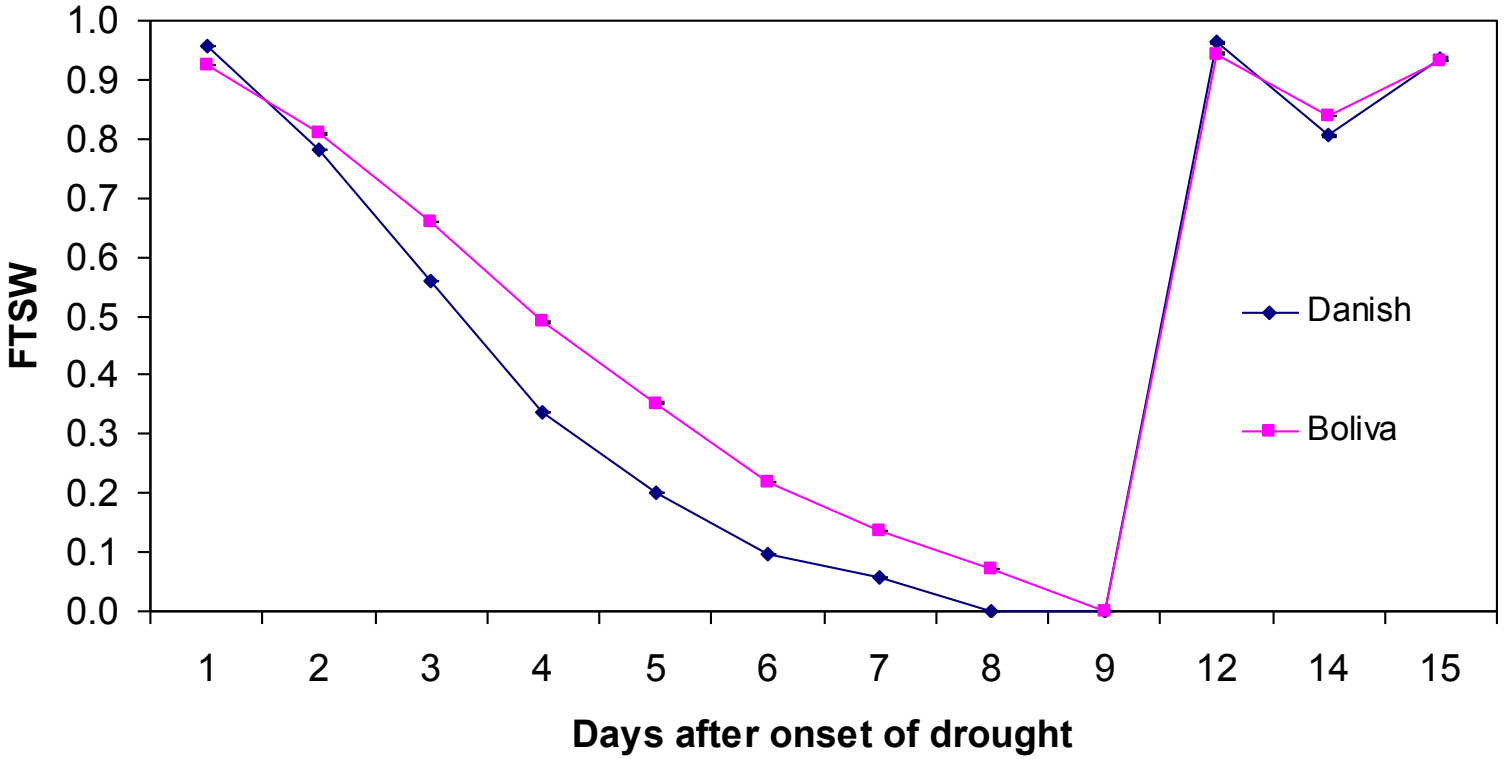
Salt tolerance



Razzaghi et al., 2012

Drought

Available water



FTSW: the fraction of transpirable soil water

FTSW=(WTn-WTf)/TTSW

WTn: *pot weight on given date*

WTf: pot weight when transpiration rate of the stressed pants decreased to 10% of control plants

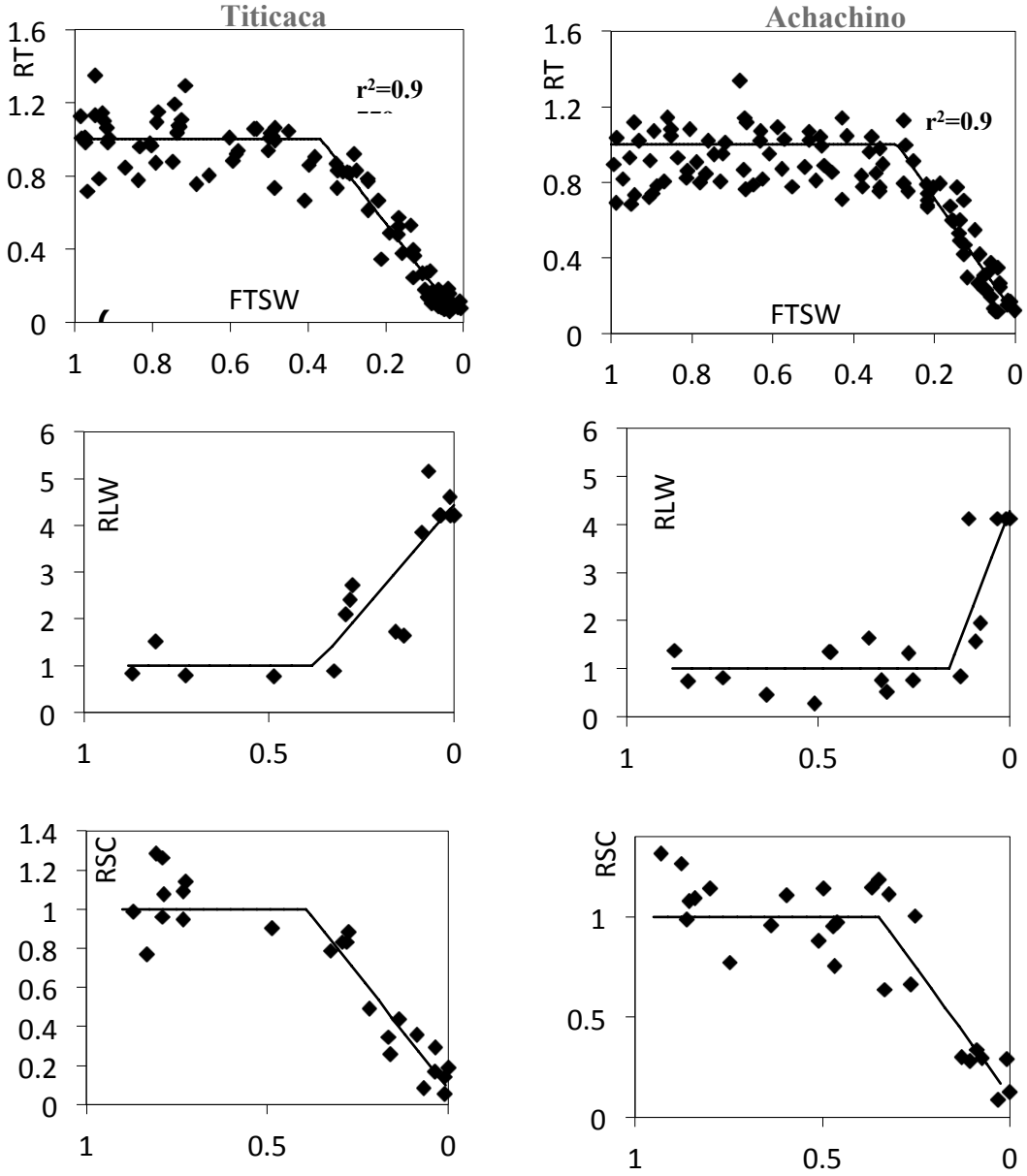
TTSW: Total transpirable soil water

Drought tolerance

BS BC DS DC

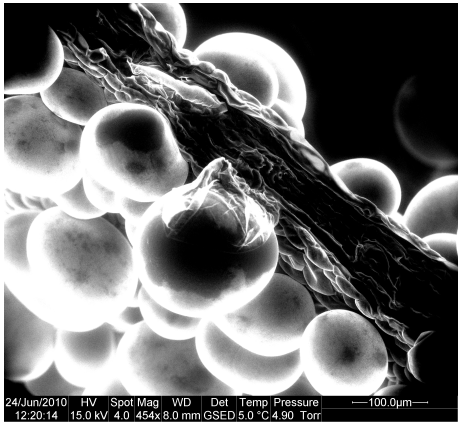
B: Boliviana
D: Danes
C: Control
S: Sequía

Linear plateau model



Drought tolerance mechanisms

Plasticity
Small, thick-walled cells adapted to maintain turgor under drought
Low osmotic potential
Dense root system
Reduction in leaf area from leaf loss
Vesicles



Cultivation - Denmark

Sowing

Emergence

Weeding

Left: Sowing machine
Right: Hoeing, sowing of green manure crop

Slurry: position with GPS just under seeds

May

Mildew

Late May

10d

Beginning June

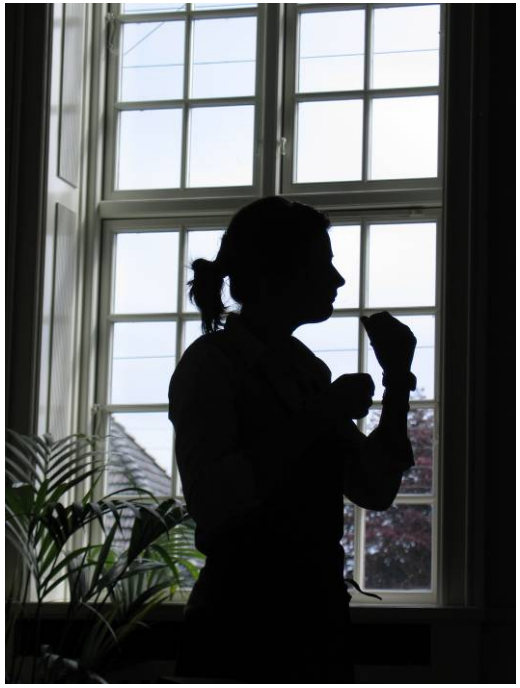
July

August-September Harvest

I Festival Gastronómico Turístico de la Quinua en Puno

Promotion

The Great Quinoa Day



New products







Products Pullman

Products Denmark

Knabstrup

Saison

Development of high quality and high status products for the consumers:

Vegetarians, women, coeliacs, elderly, gourmets
and all who like tasty and healthy food

TRENDS OF TIME:

Ecology
Vegetarian products
Health
BMI
Slow food
Fast food
Fair trade

The role of quinoa

- Adaptation
  - Genetic diversity
- Nutritional value
  - Complete food
- Tolerant to adverse, abiotic stresses
  - Drought, salt, cold
- Global market
  - World interest

- A significant role!