WATER USE, DROUGHT TOLERANCE AND NUTRITIONAL VALUE OF INDIGENOUS CROPS: AN OVERVIEW

Modi A.T., Beletse Y. & Oelosfe A.

31 August 2011

Another project sponsored by www.wrc.org.za

INTRODUCTION

South Africa faces serious challenges

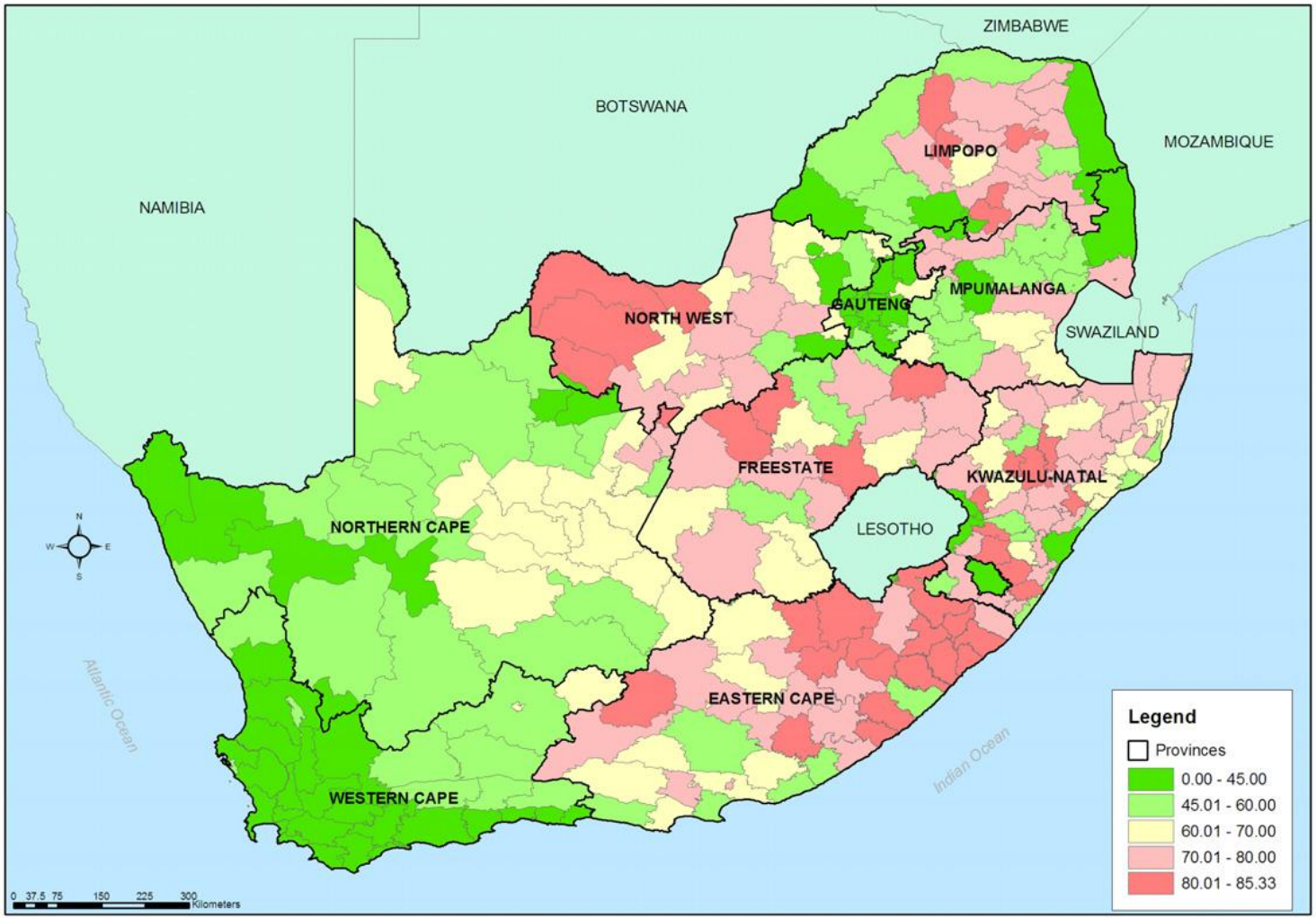
- **Paramount in the context of sustainable livelihoods are:**

- **Water scarcity** for agriculture
- Vulnerable soils (e.g. low carbon content)

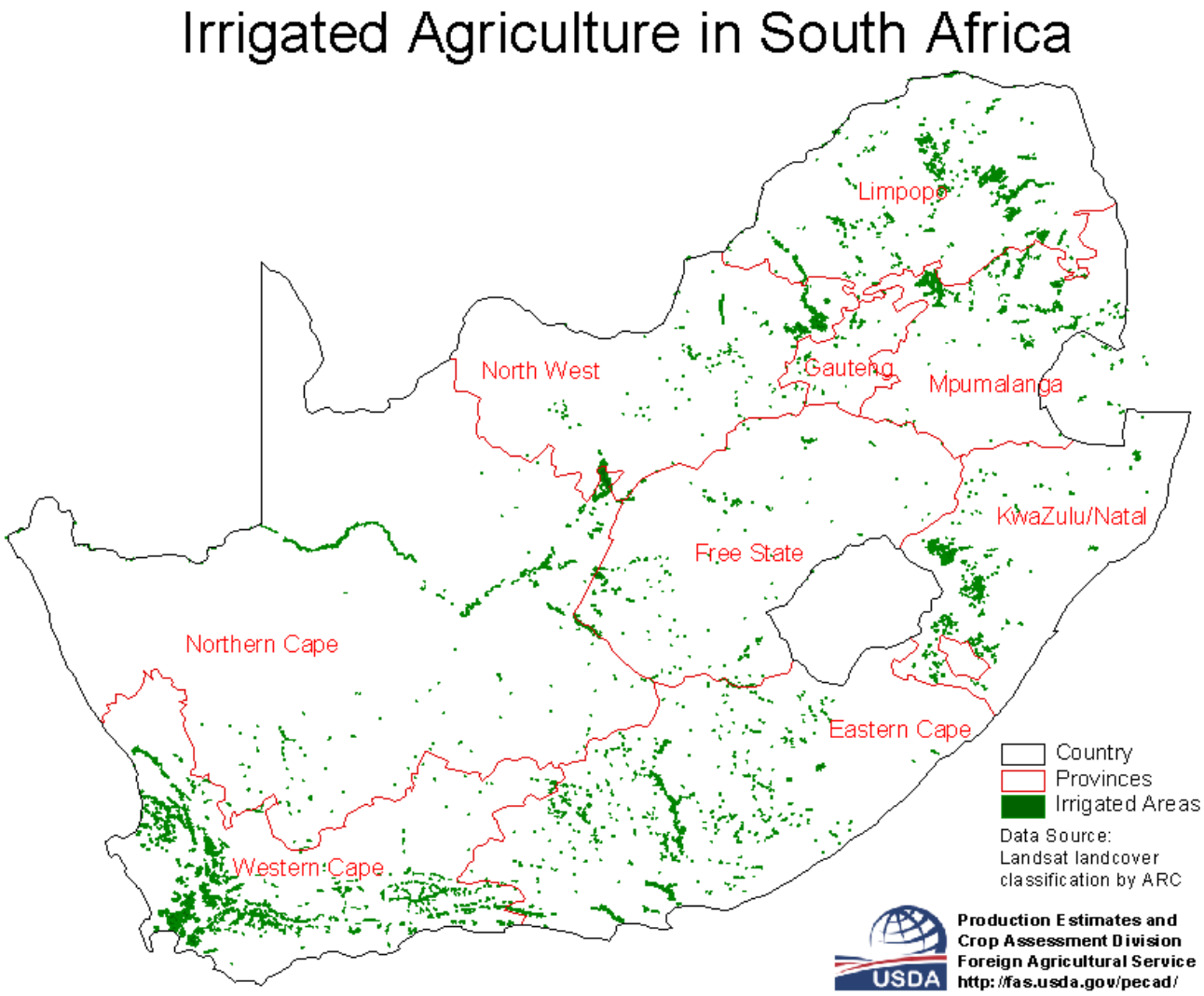
- Climate change (exacerbated by wrong human choices)
  - Population growth (exacerbated by wrong human choices)
    - Food insecurity (especially hidden hunger)

FOOD INSECURITY "HOT SPOTS" IN SOUTH AFRICA:

Legend: % food insecure households (Stats SA, 2006)



SOUTH AFRICA IS SPARSELY IRRIGATED DUE TO SCANTY RAINFALL



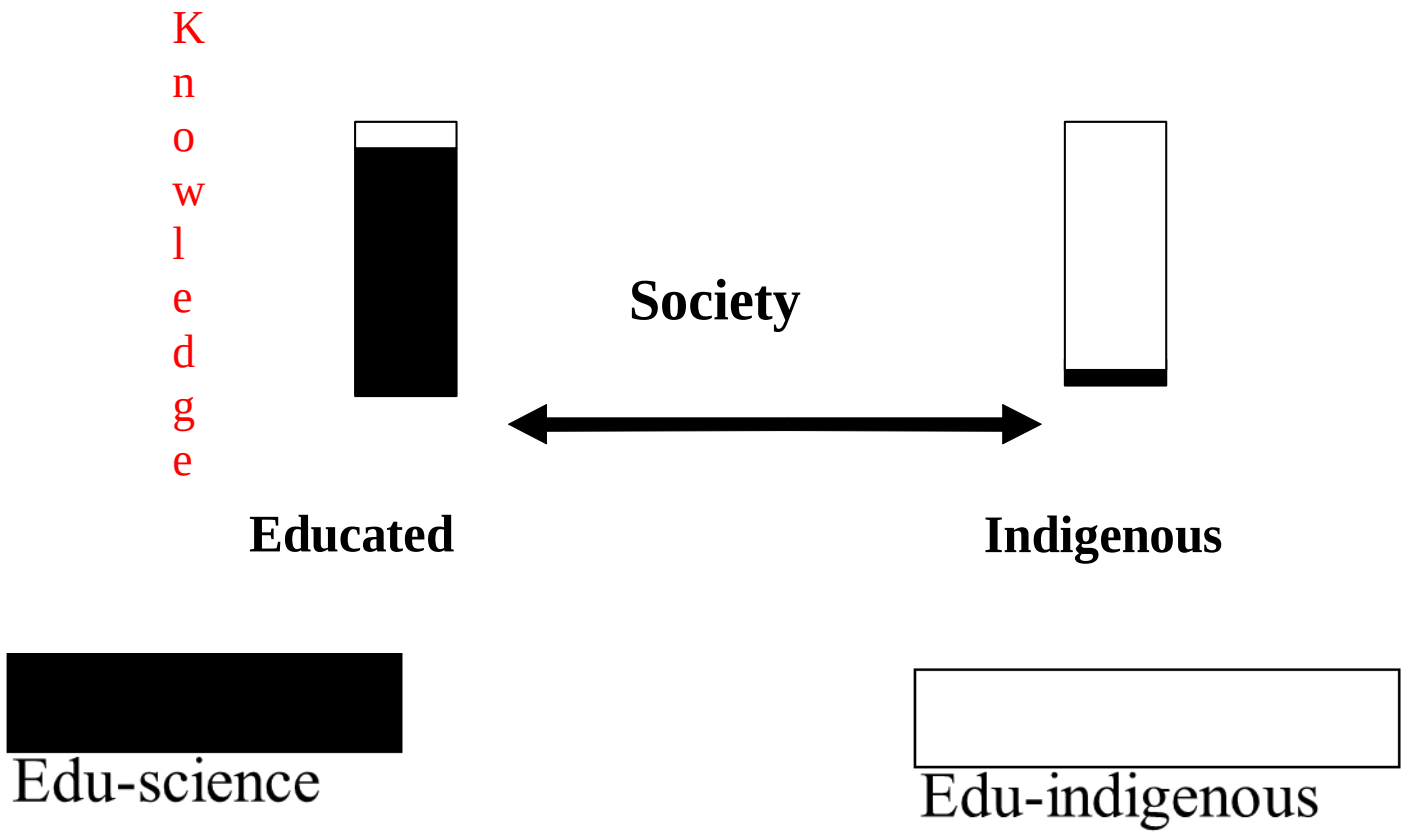
Another project sponsored by www.wrc.org.za

THE IGNORED AFRICAN GIFT: INDIGENOUS KNOWLEDGE

A knowledge system that has originated locally and naturally about

- Physical **environment,**
- Biological folk **taxonomies and**
- **Experimentation**

INDIGENOUS KNOWLEDGE IS EXPERT KNOWLEDGE



INDIGENOUS CROPS AND FOOD RESOURCE DIVERSITY

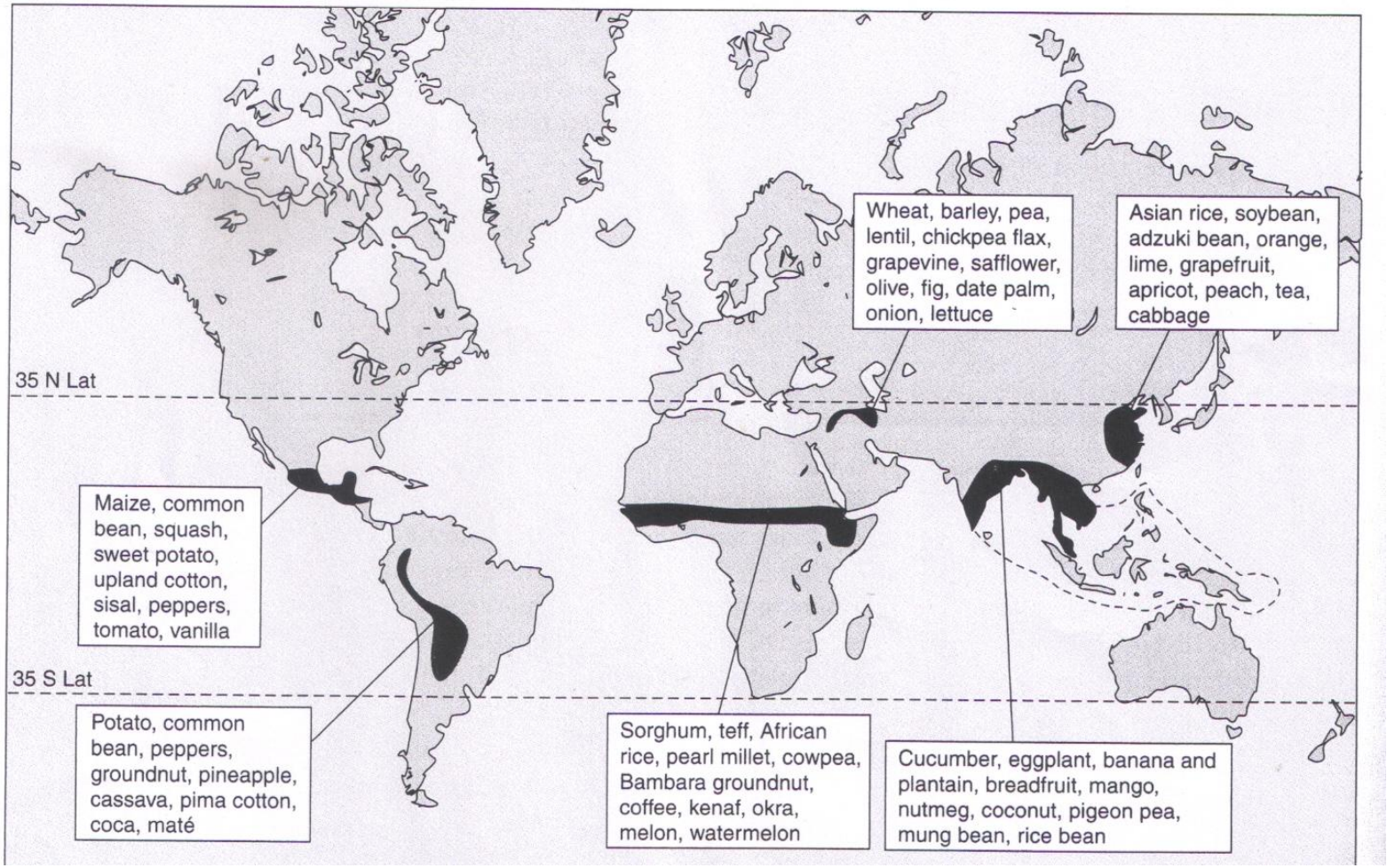
Plants used by African hunter-gatherers

Grass seeds	ca. 60 spp.
Legumes	ca. 50 spp.
Roots and tubers	ca. 90 spp.
Oil seeds	ca. 60 spp.
Fruits and nuts	> 500 spp.
Vegetables and spices	> 600 spp.
Total	**> 1410 spp**.

Source: List of Foods Used in Africa (Jardin, 1967)

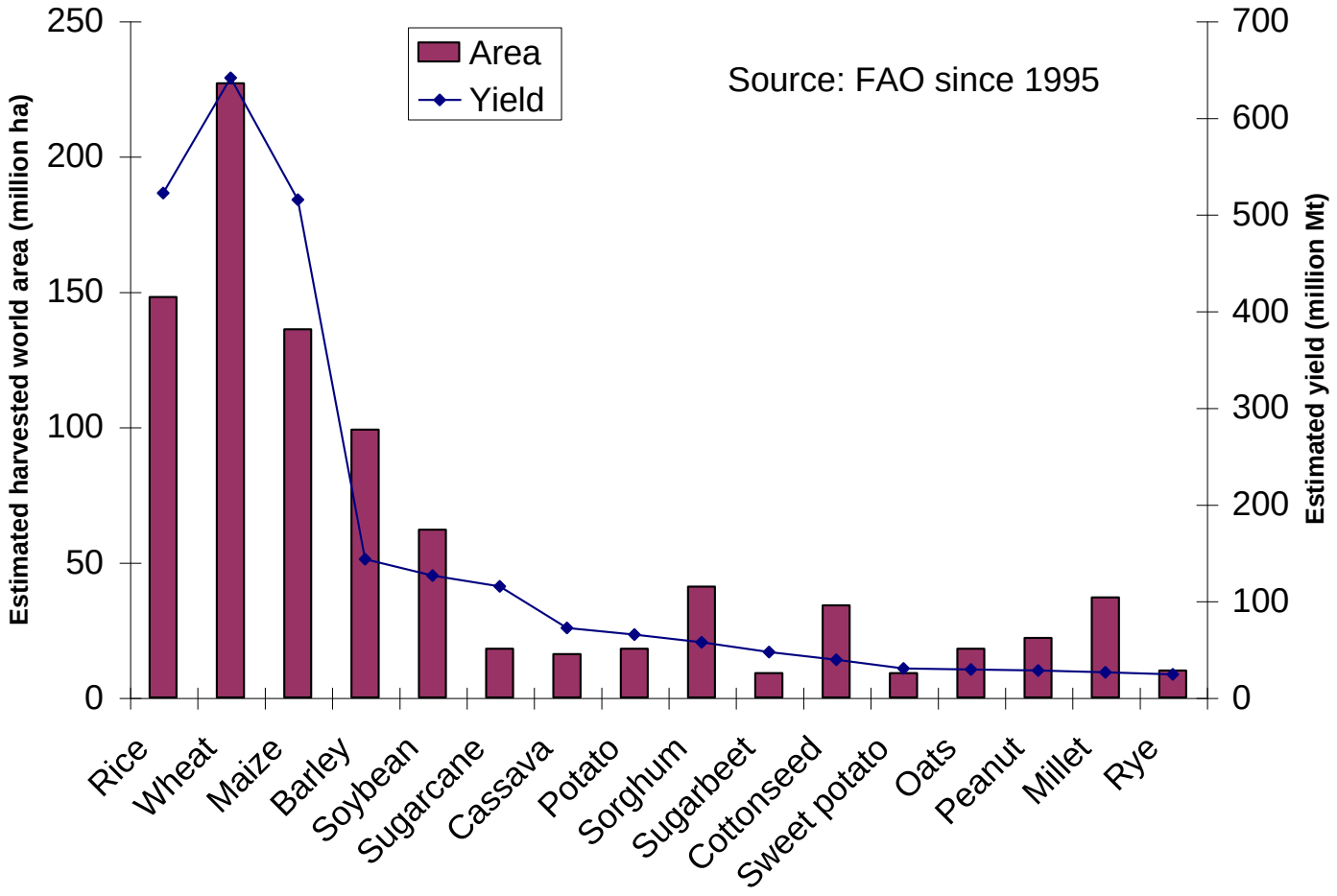
MAJOR CENTRES OF CROP ORIGIN POINT TO LOCATIONS OF EARLY TECHNOLOGICAL ADVANCEMENTS

Sadly, this is where poverty is generally worse today!



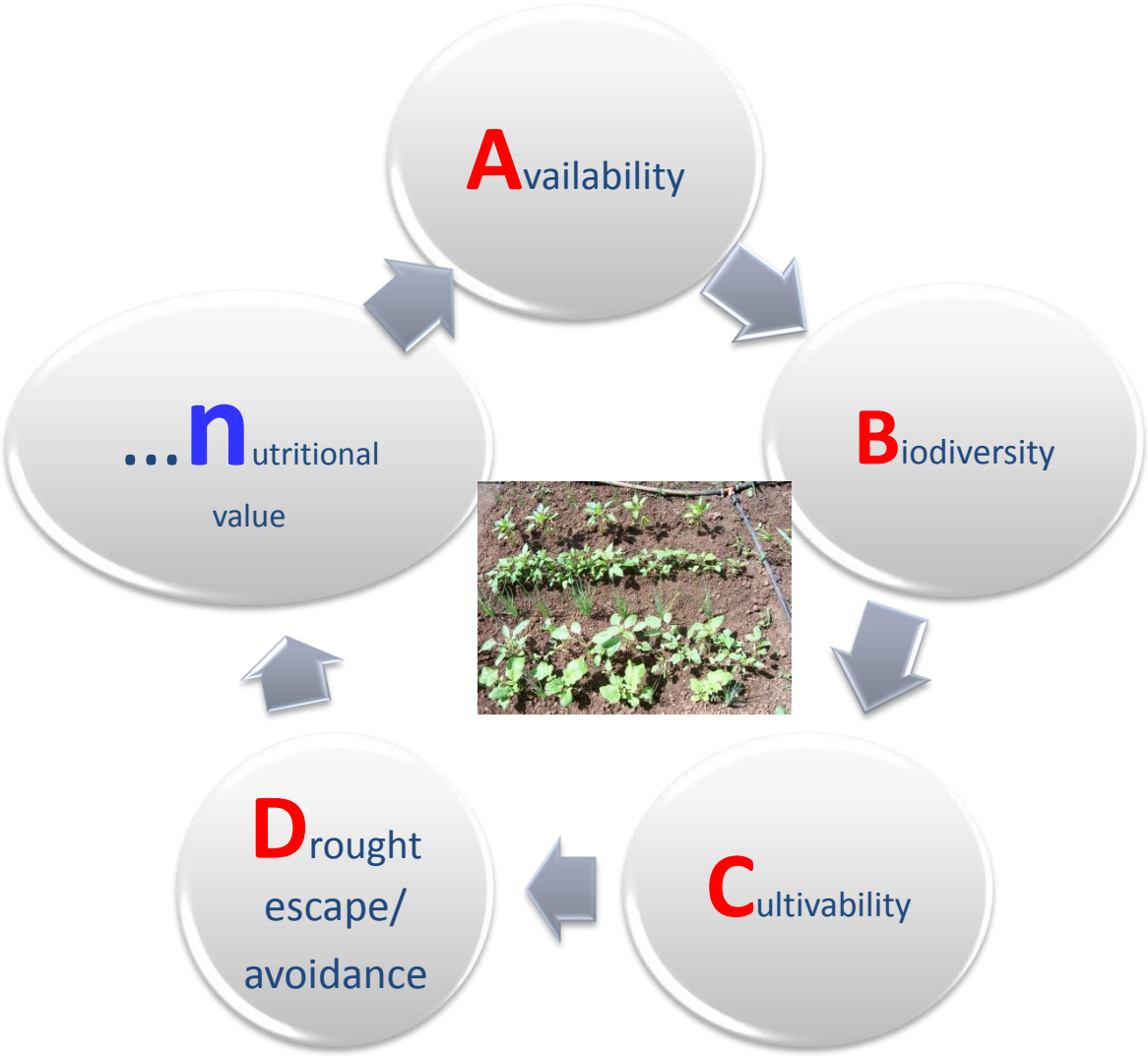
Another project sponsored by www.wrc.org.za

INDIGENOUS CROPS AND FOOD RESOURCE DIVERSITY

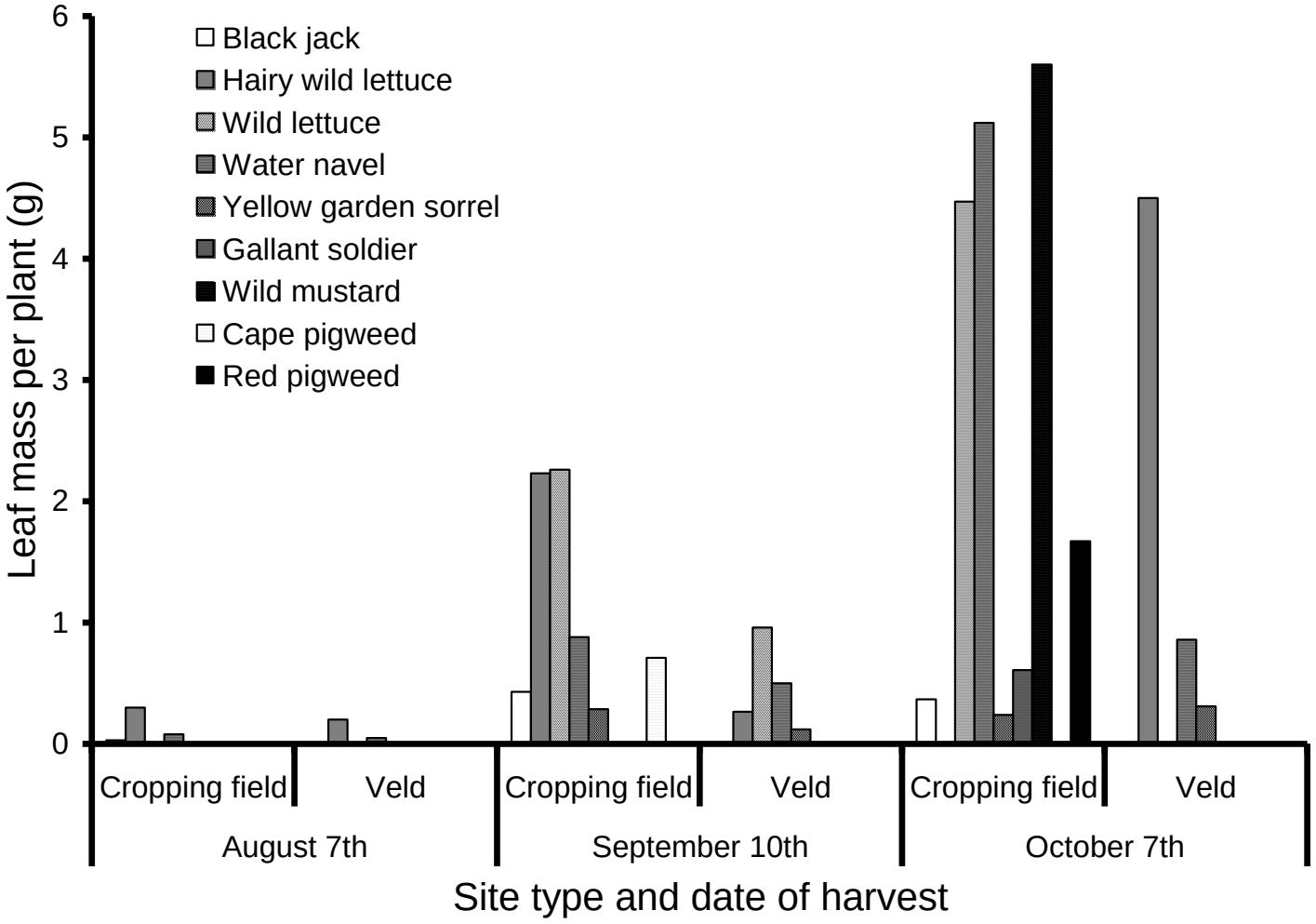


Another project sponsored by www.wrc.org.za

INDIGENOUS, INDIGENISED AND TRADITIONAL CROPS HAVE POSITIVE CHARACTERISTICS

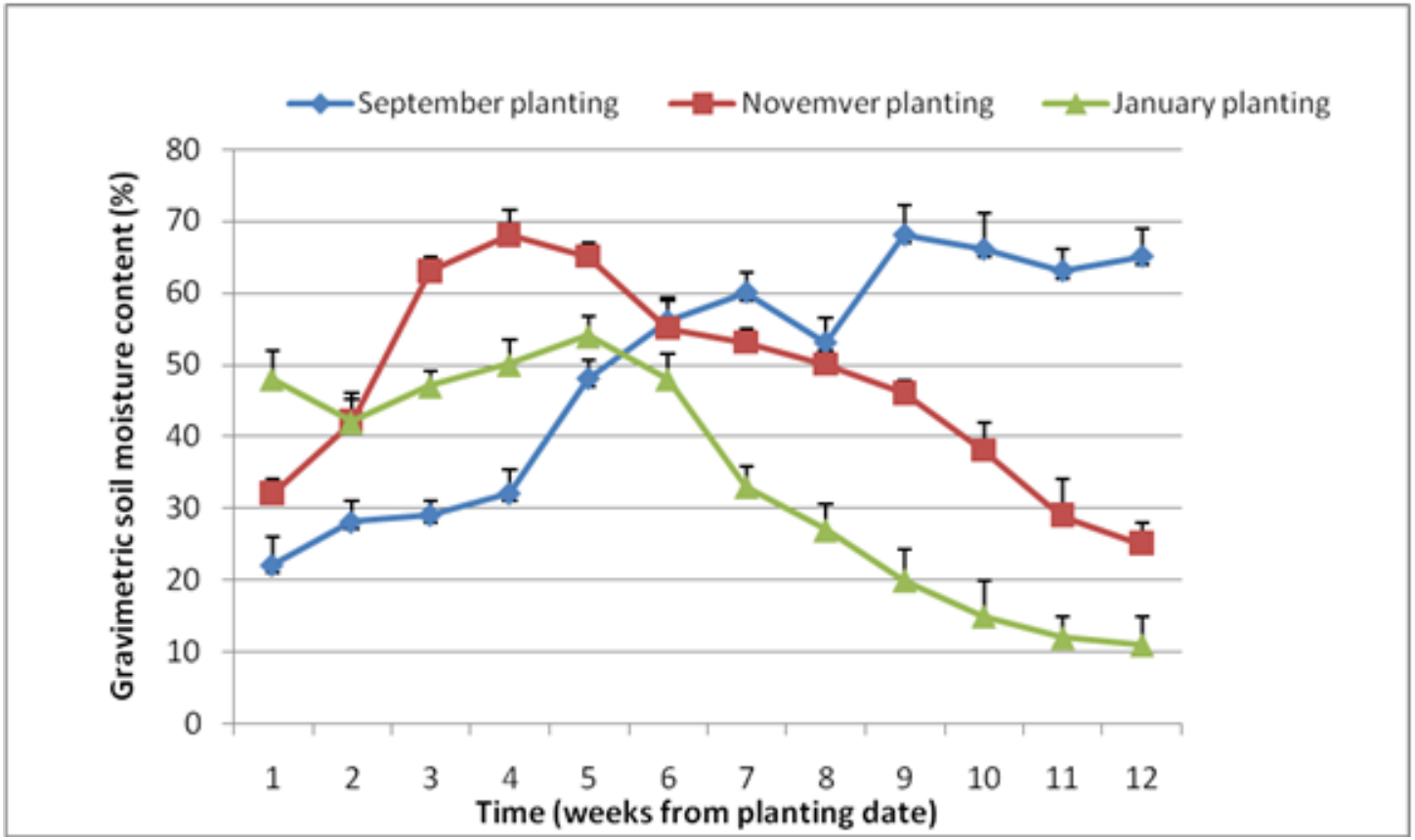


AVAILABILITY SUGGESTS BIODIVERSITY AND POTENTIAL TO WITHSTAND DROUGHT - GROWING EVEN OUTSIDE THE RAINY SEASON



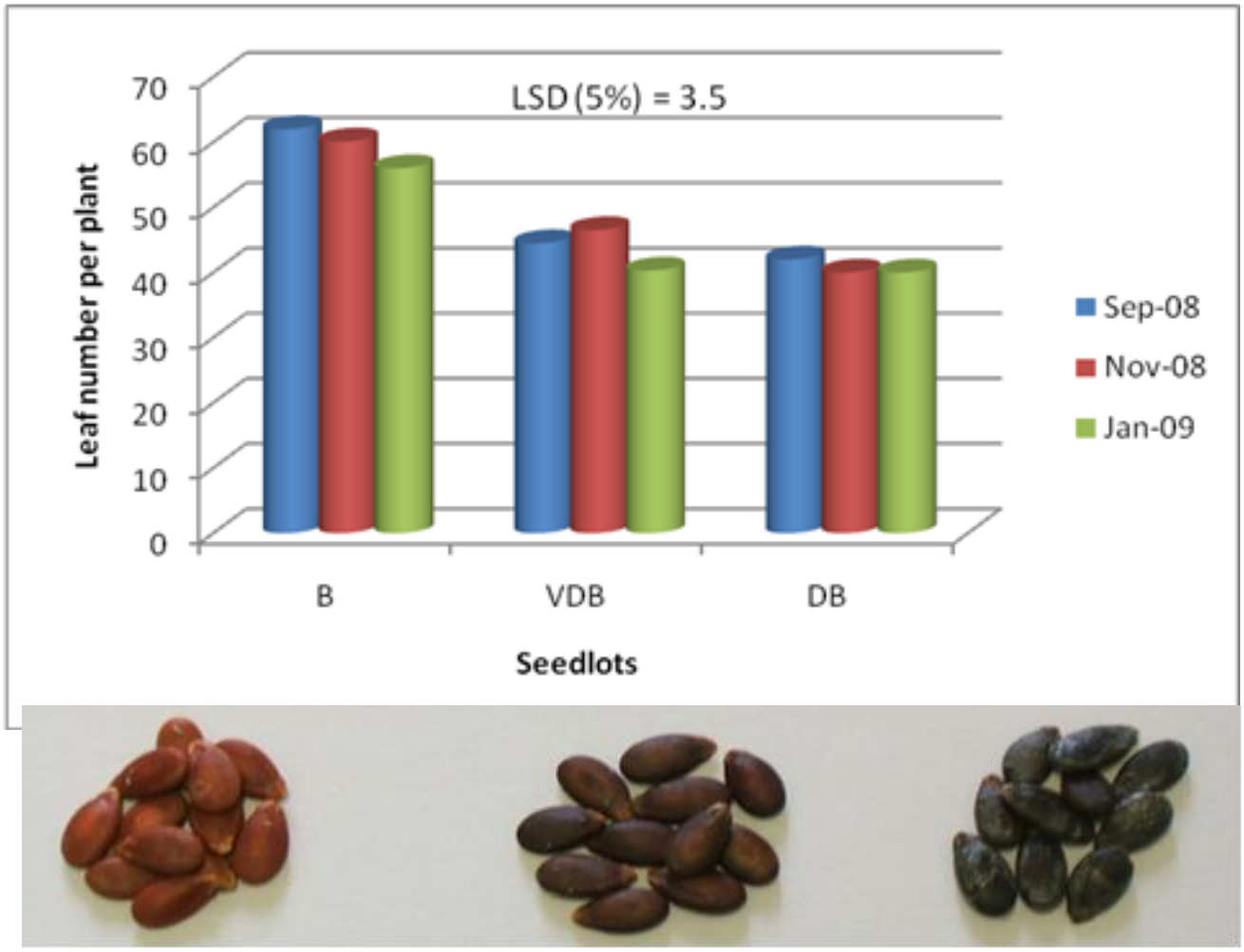
Another project sponsored by www.wrc.org.za

CHANGES IN SOIL WATER CONTENT DURING THE FIRST 12 WEEKS OF WILD WATERMELON GROWTH – IMPLICATIONS FOR CULTIVABILITY

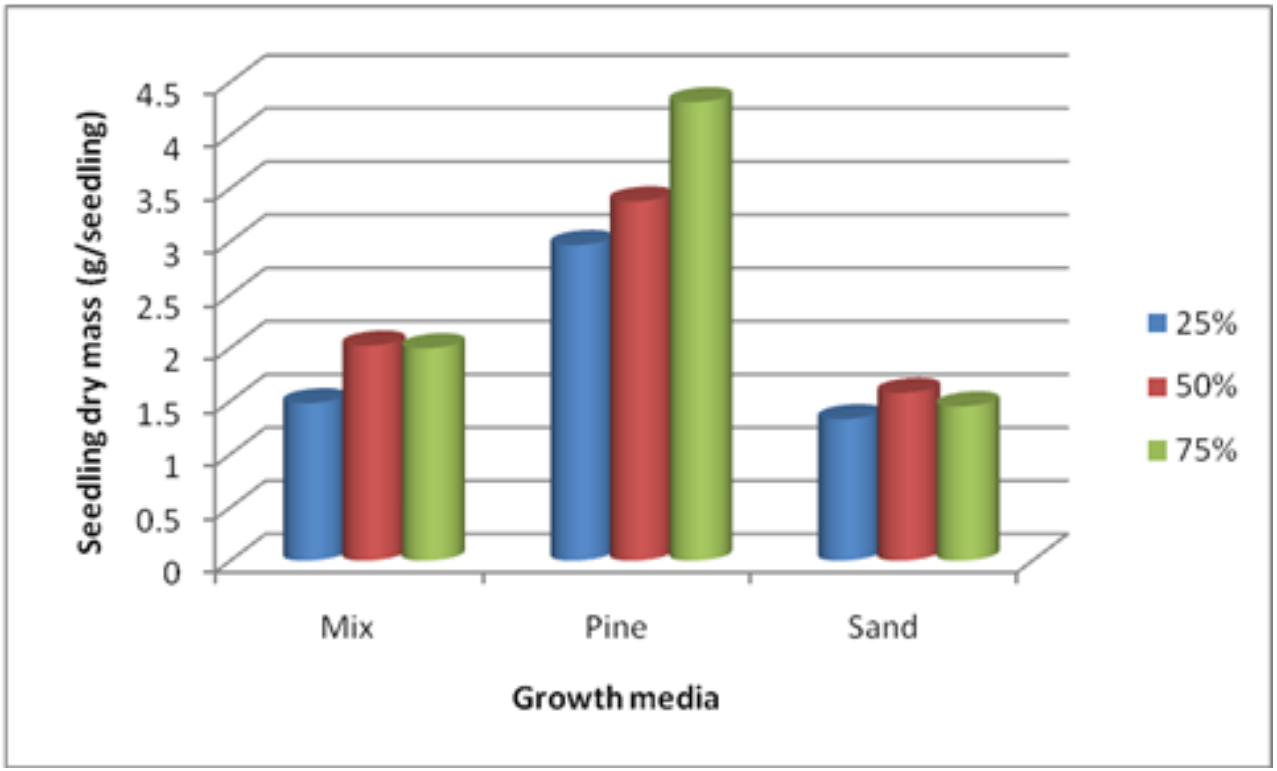


Another project sponsored by www.wrc.org.za

CROP GROWTH IN RESPONSE TO PLANTING DATE

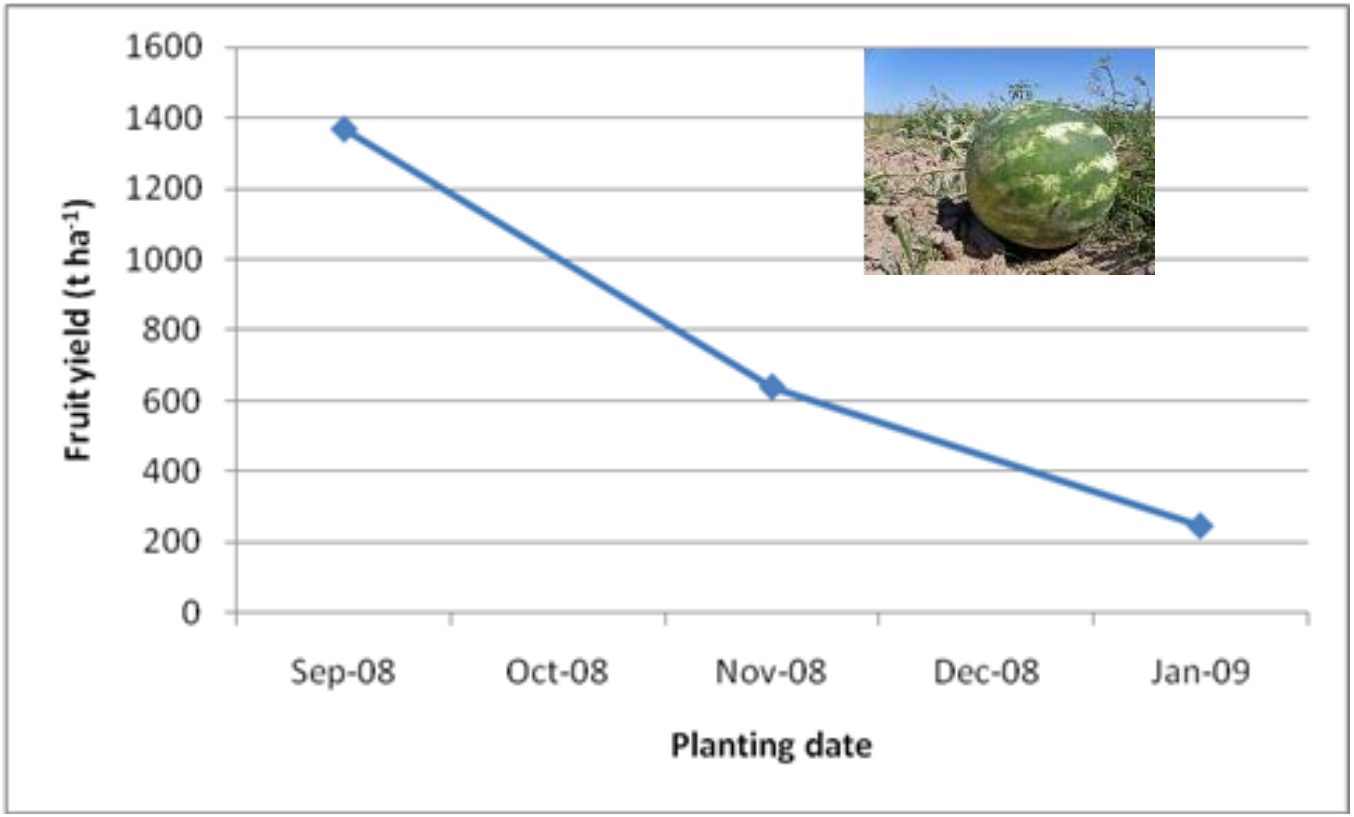


CROP GROWTH ENVIRONMENT DETERMINES DROUGHT ESCAPE



Another project sponsored by www.wrc.org.za

CROP YIELD IN RESPONSE TO PLANTING DATE



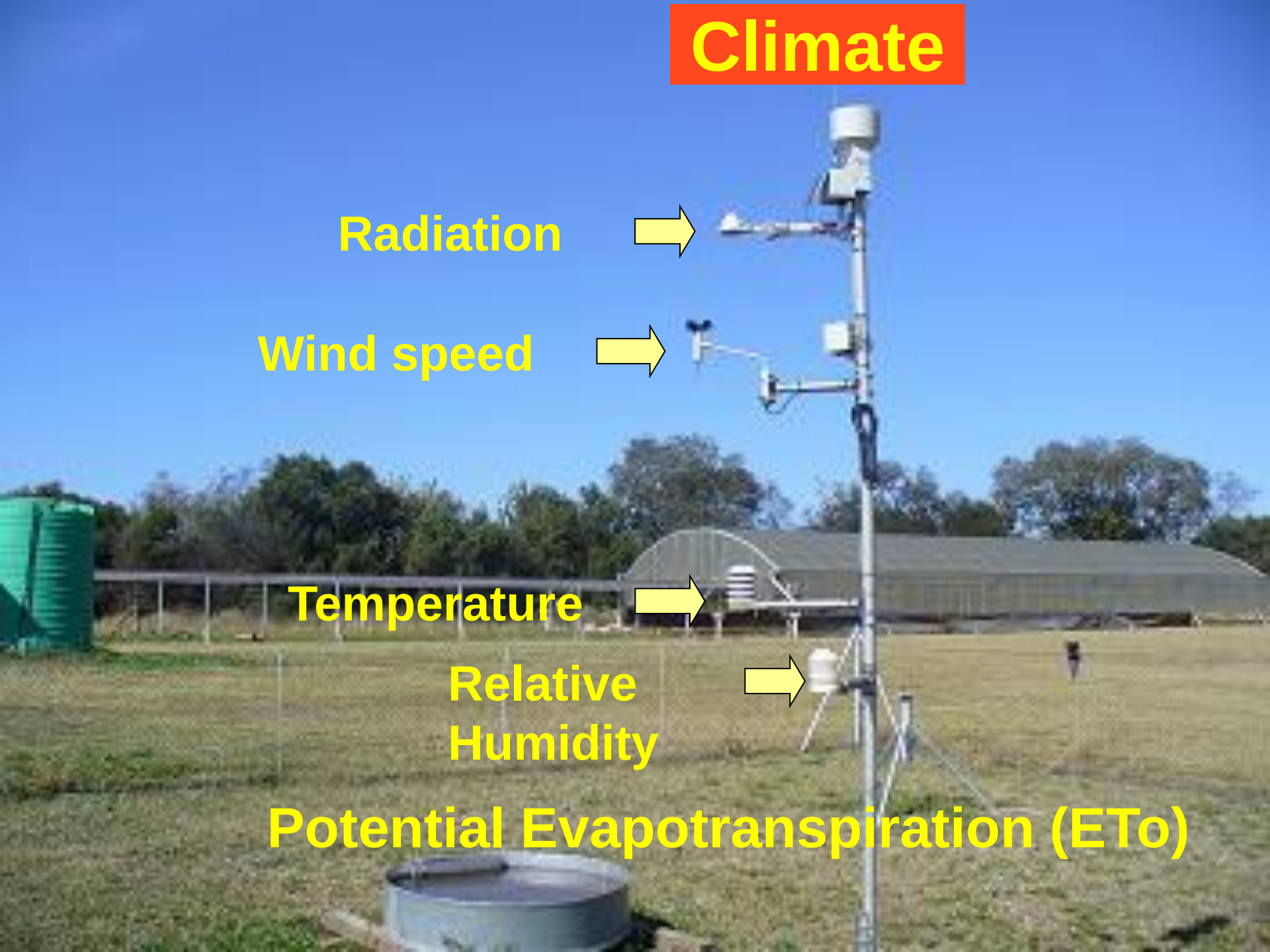
CROP WATER REQUIREMENT SUGGESTS CULTIVABILITY

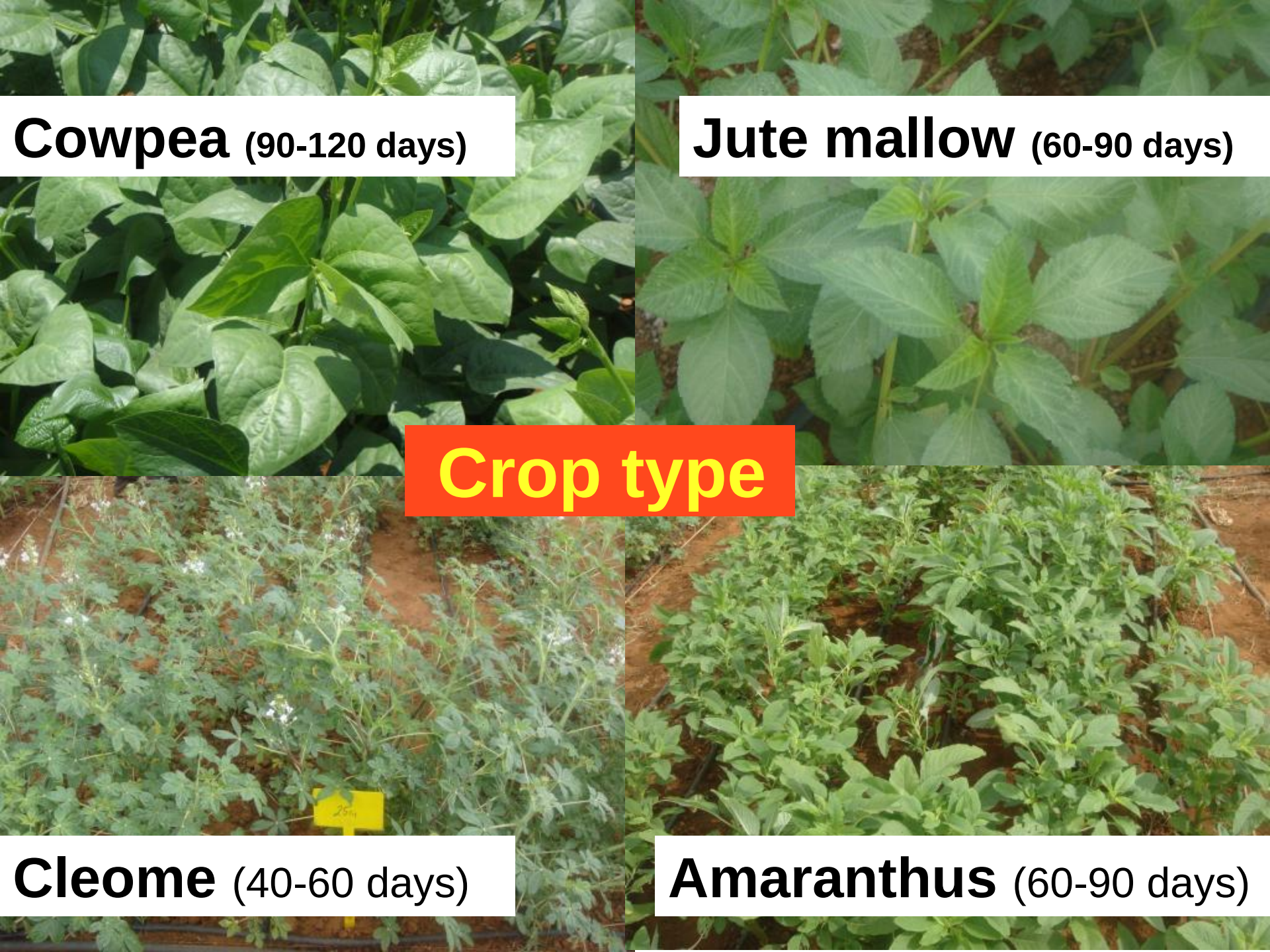
Crop water need in a given period of normal growth under field conditions is influenced by:

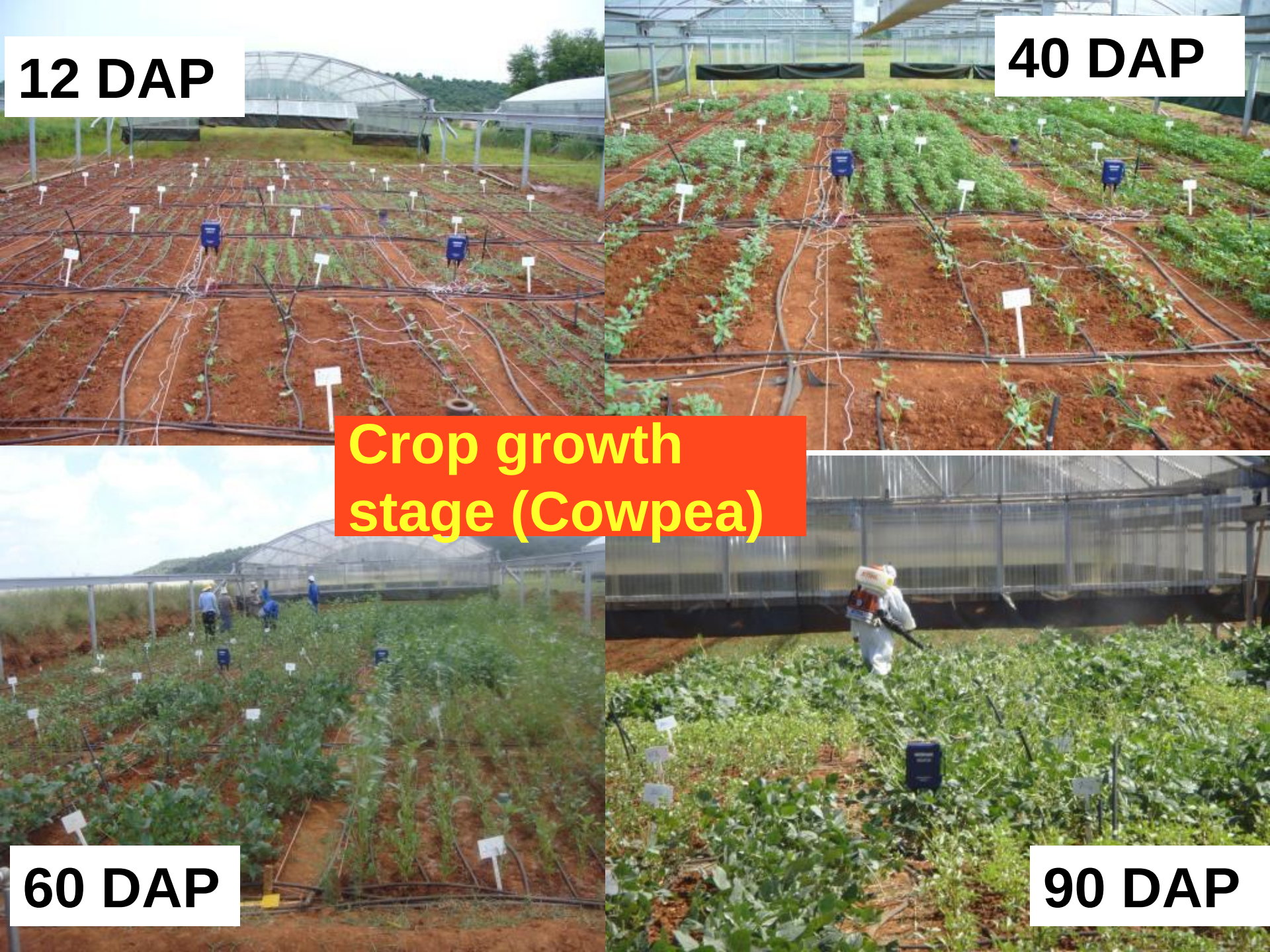
1. Climate
2. Crop type
3. Crop growth stage






Climate
Radiation
Wind speed
Temperature
Relative Humidity
Potential Evapotranspiration (ETo)


Cowpea (90-120 days)
Jute mallow (60-90 days)
Crop type
Cleome (40-60 days)
Amaranthus (60-90 days)


12 DAP
40 DAP
Crop growth stage (Cowpea)
60 DAP
90 DAP

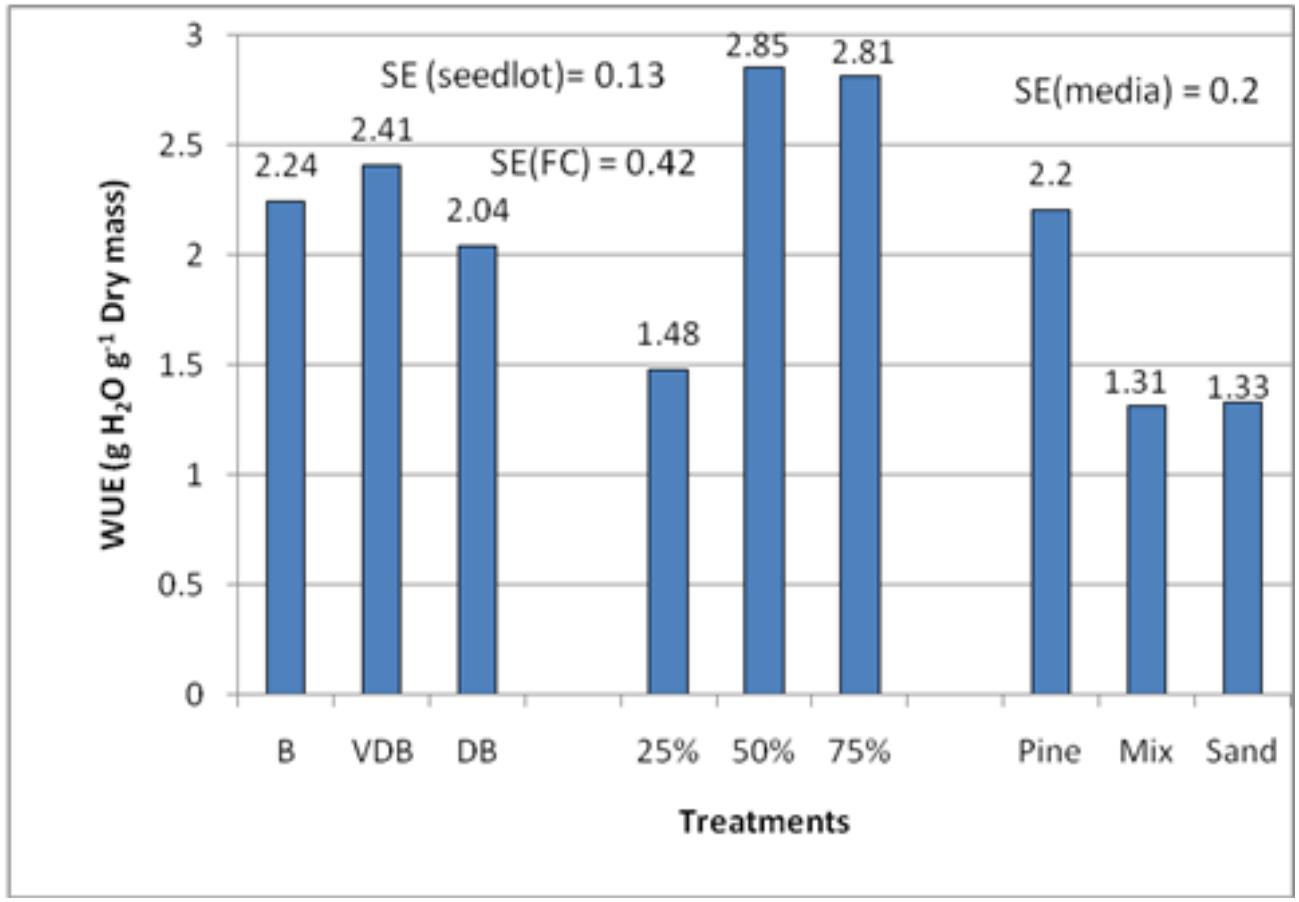
WATER PRODUCTIVITY SUGGESTS CULTIVABILITY AND POTENTIAL DROUGHT ESCAPE

$$\text{Water Productivity} = \frac{\text{Biomass produced (kg)}}{\text{Water transpired (m}^3\text{)}}$$



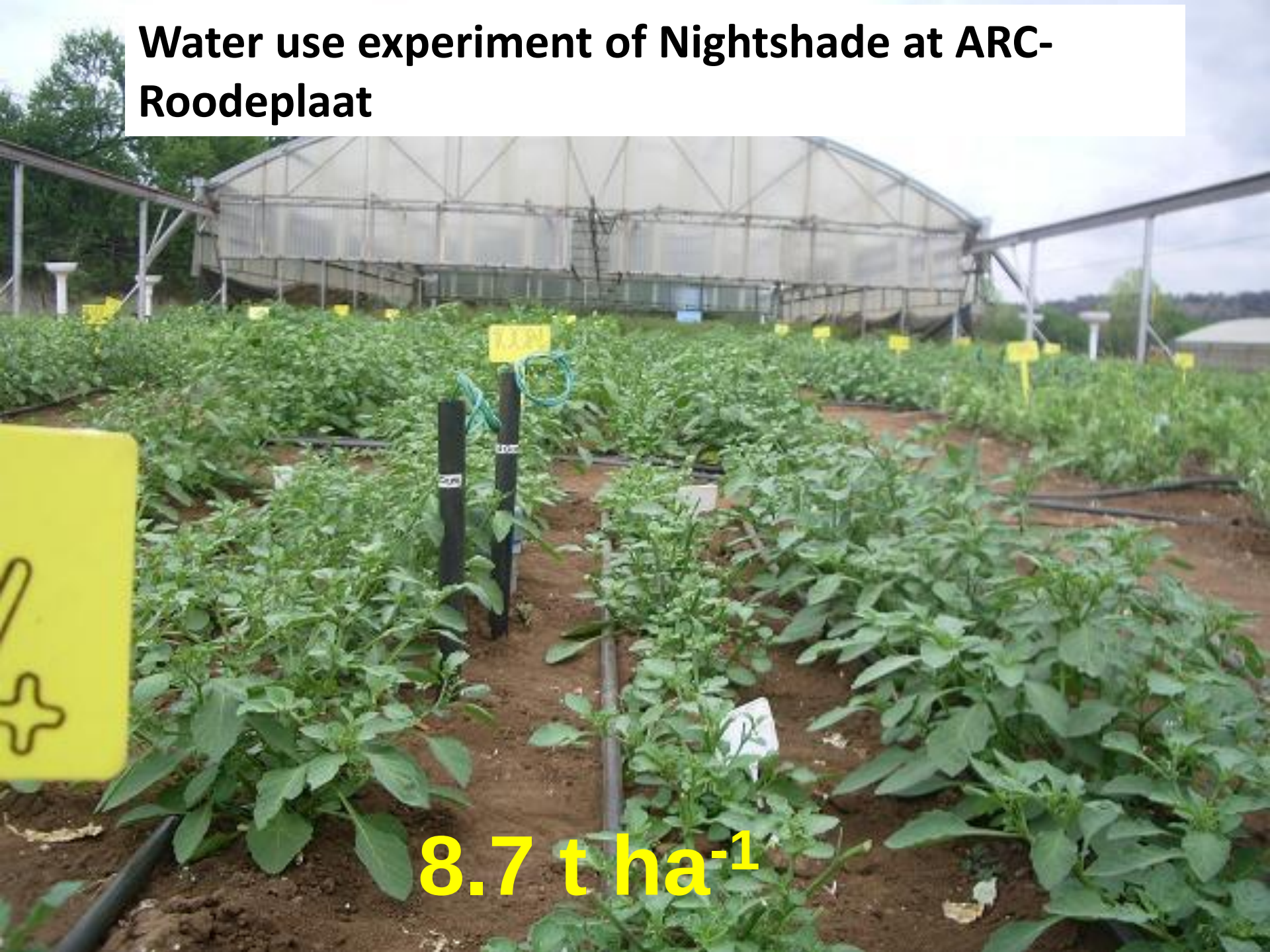


WATER USE EFFICIENCY IS INFLUENCED BY ENVIRONMENT IN WATERMELON



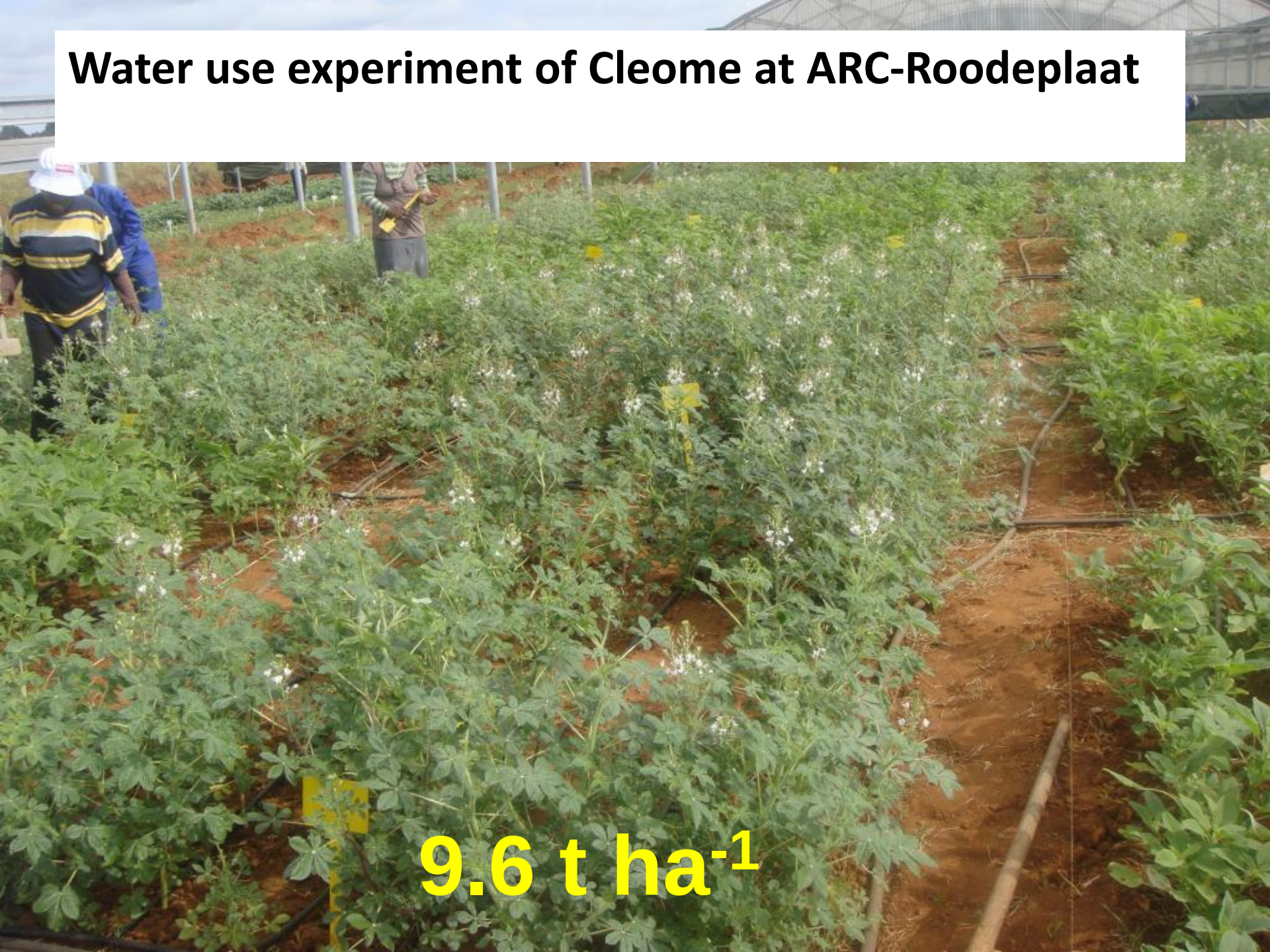
Water use experiment of Mustard at ARC-Roodeplaat

Water use experiment of Nightshade at ARC-Roodeplaat

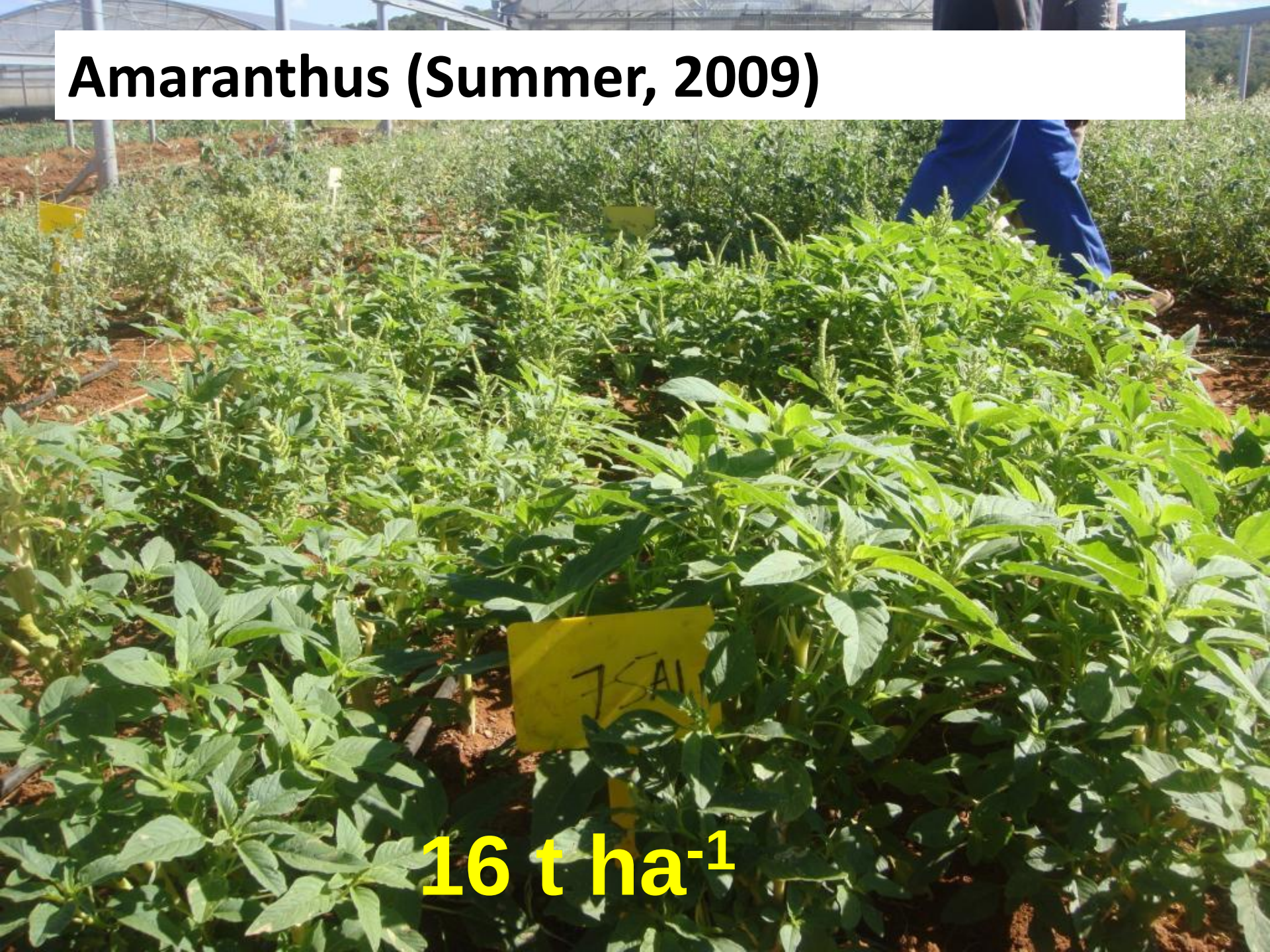


Water use experiment of Corchorus at ARC-Roodeplaat

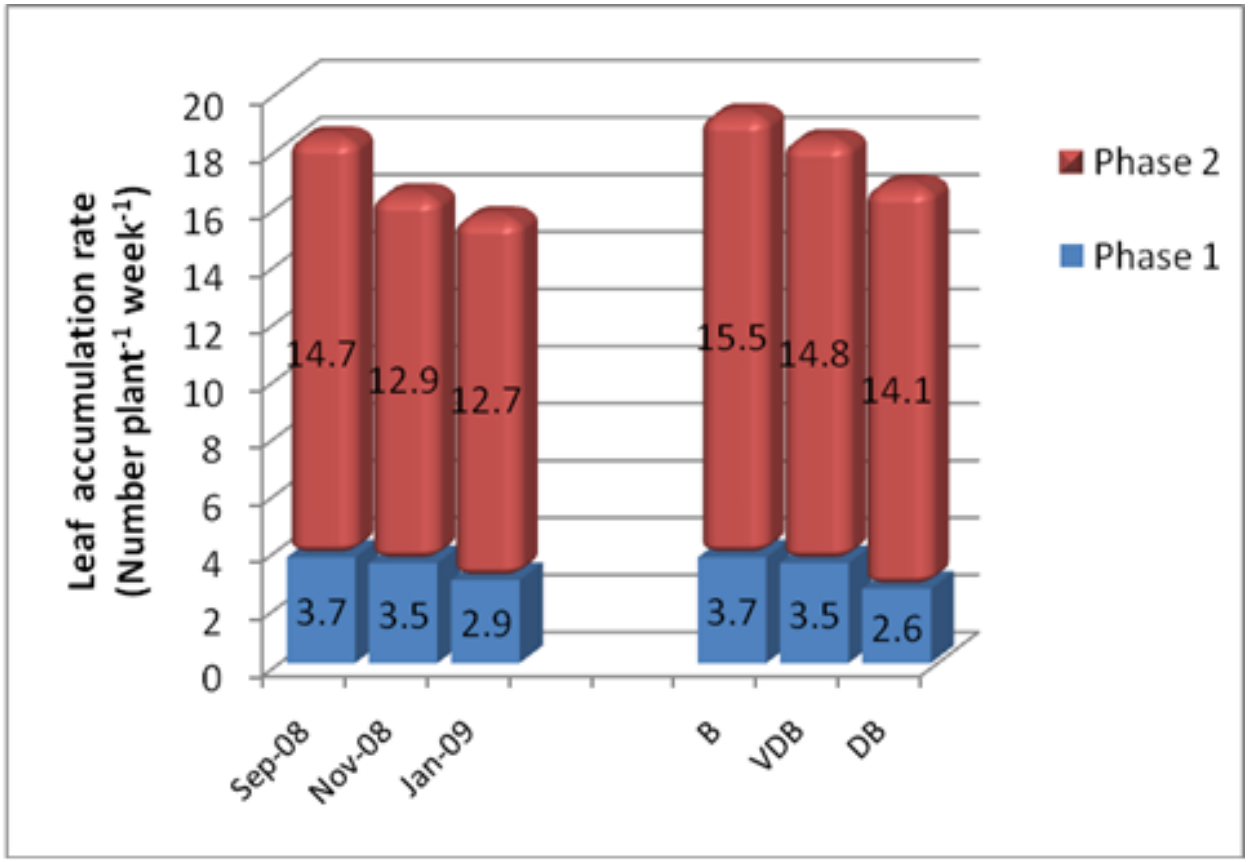
Water use experiment of Cleome at ARC-Roodeplaat



Amaranthus (Summer, 2009)



CROP GROWTH STAGE DETERMINES CROP RESPONSE TO WATER AVAILABILITY



Another project sponsored by www.wrc.org.za

CROP WATER REQUIREMENT IS LINKED TO STAGE OF DEVELOPMENT

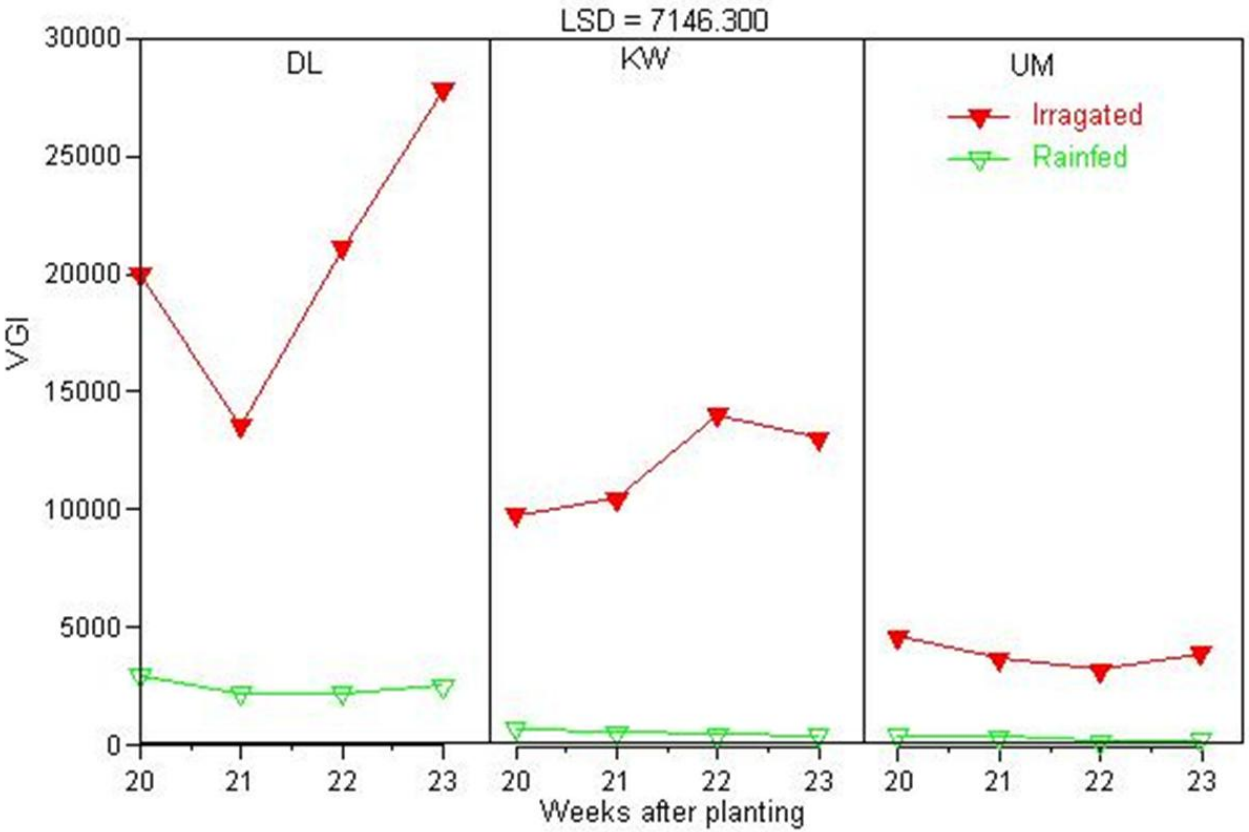
Crop coefficient (Kc) estimates for different growth stages

(Crop water requirement = Kc * ETo)

Leafy vegetables	Initial growth stage		Development growth stage		Middle growth stage		Late growth stage	
	(days)	Kc	(days)	Kc	(days)	Kc	(days)	Kc
Chinese cabbage (*Brassica rapa subsp. Chinensis*)	25	0.83	20	0.98	20	1.00	15	1.00
Nightshade (*Solanum retroflexum*)	20	0.78	40	0.53	35	0.91	30	1.00

VEGETATIVE GROWTH INDEX (VGI) IS A GOOD INDICATOR OF PRODUCTION POTENTIAL IN TARO

VGI considers leaf area, plant height as well as suckers and stolons; and is positively correlated to corm yield

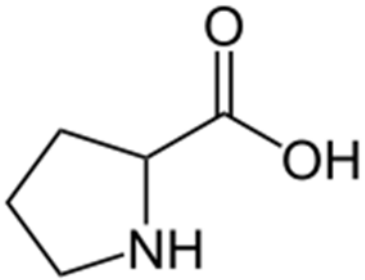


Another project sponsored by www.wrc.org.za

DROUGHT AVOIDANCE IS AN IMPORTANT SURVIVAL STRATEGY

Proline (Pr)

Proline is biosynthetically derived from the amino acid L-glutamate and its immediate precursor is the amino acid [(S)-1-pyrroline-5-carboxylate](#) (P5C).



DROUGHT AVOIDANCE IS AN IMPORTANT SURVIVAL STRATEGY

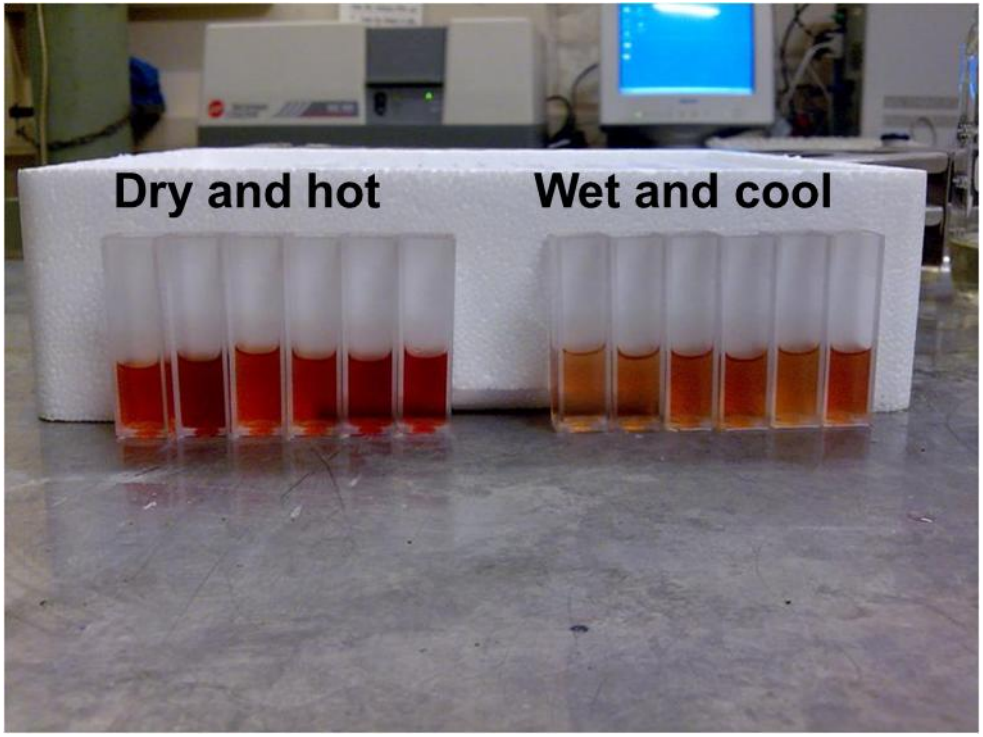
Physiological roles of proline:

- A compatible solute serving to protect folded protein structures against denaturation;
- Stabilises cell membranes by interacting with phospholipids;
- Functions as a hydroxyl radical scavenger;
- Functions in osmotic adjustment
- Serves as a nitrogen source

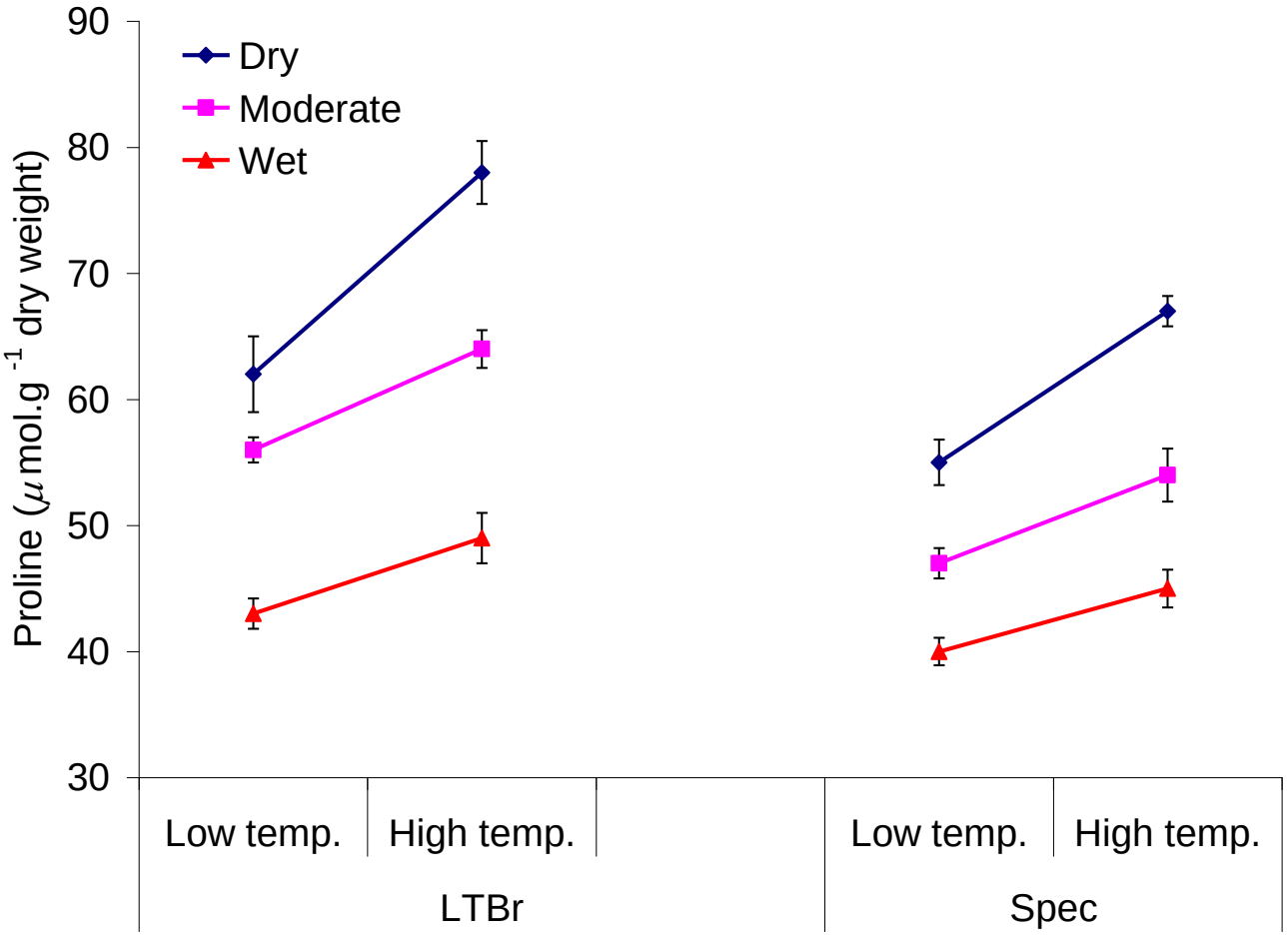




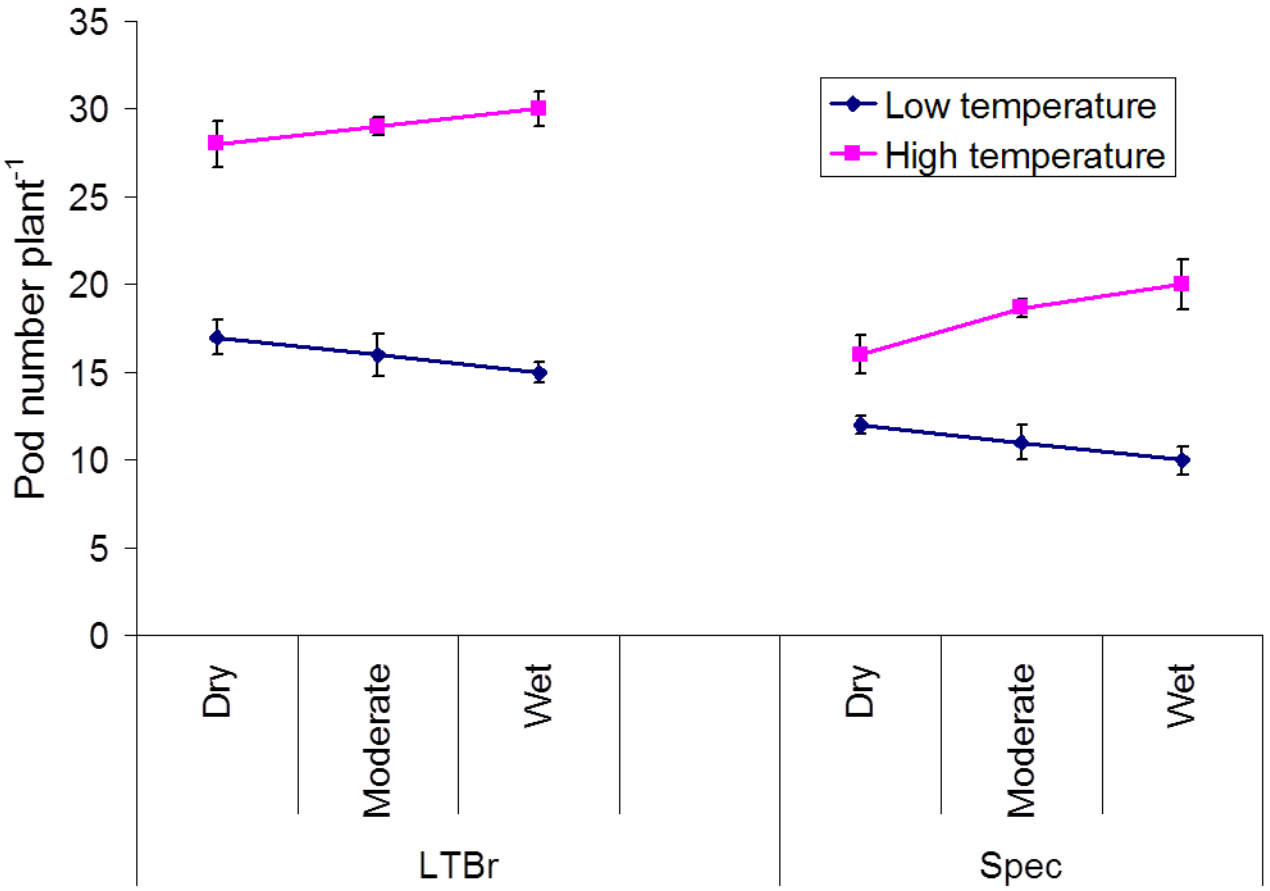
PROLINE ACCUMULATION IS A GOOD INDICATOR OF WATER STRESS



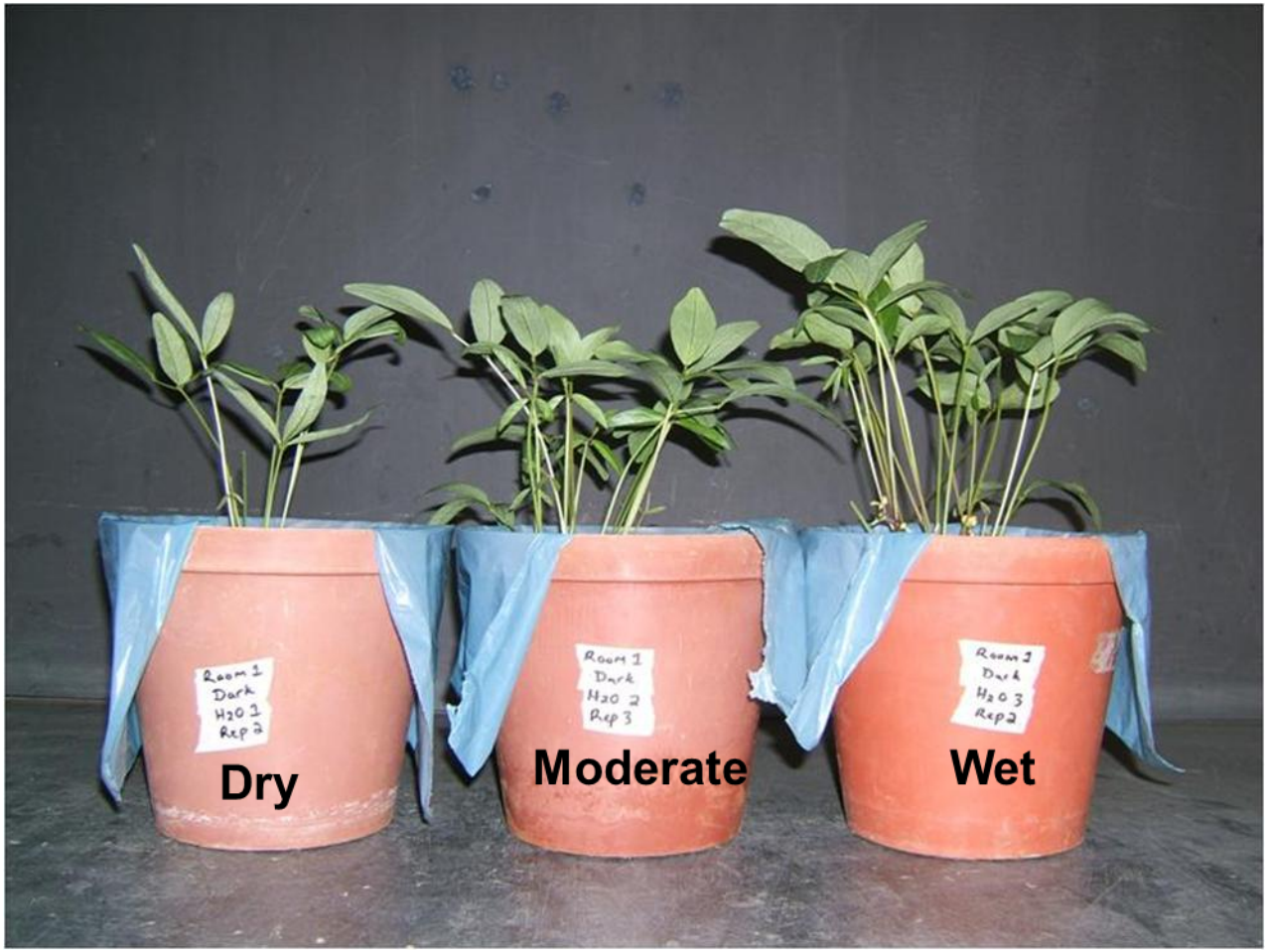
PROLINE ACCUMULATION IS A GOOD INDICATOR OF WATER STRESS



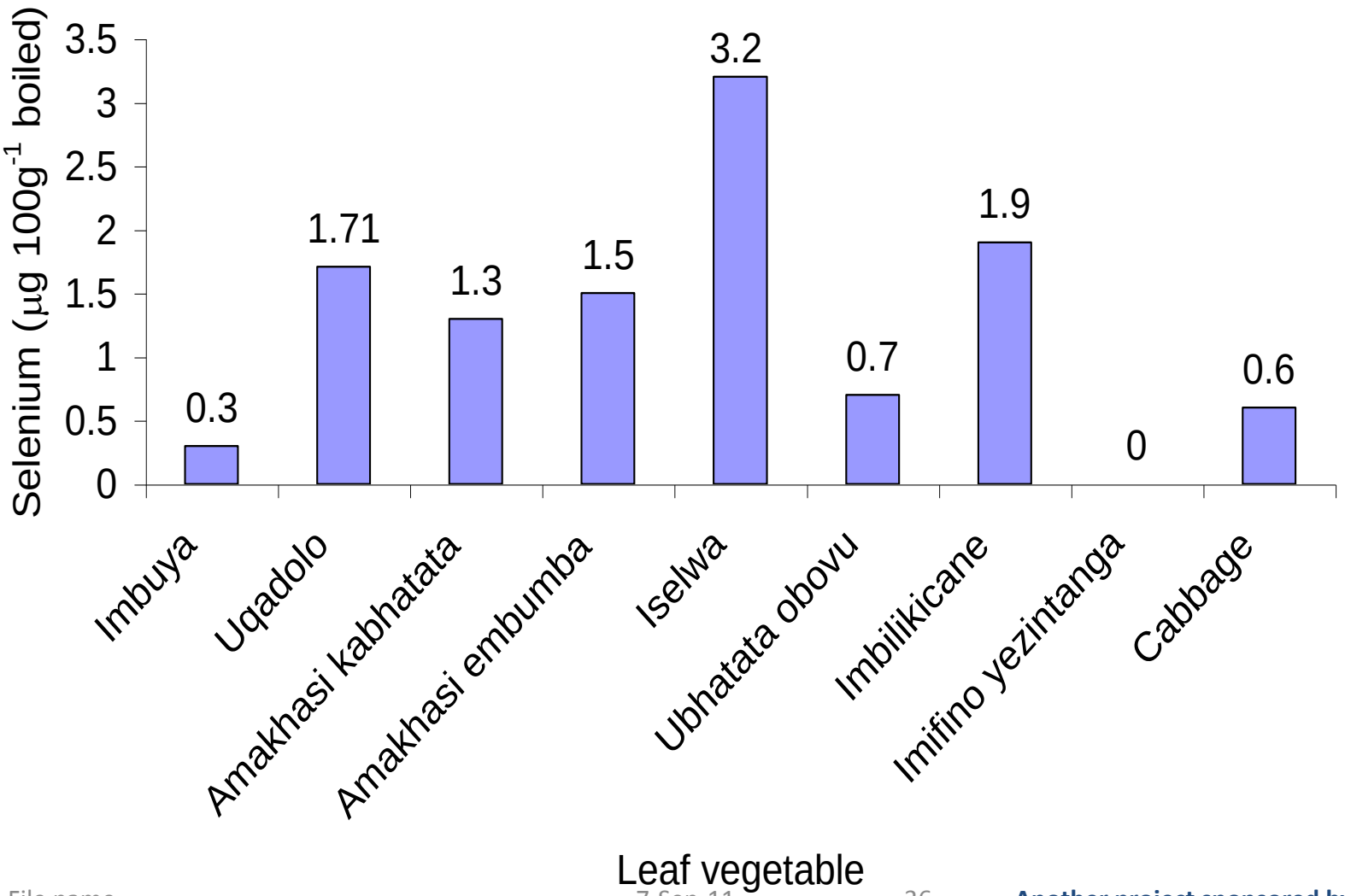
SIGNIFICANCE OF GENOTYPE X TEMPERATURE X WATER INTERACTION



RESILIENCE TO DROUGHT EFFECT IS KEY

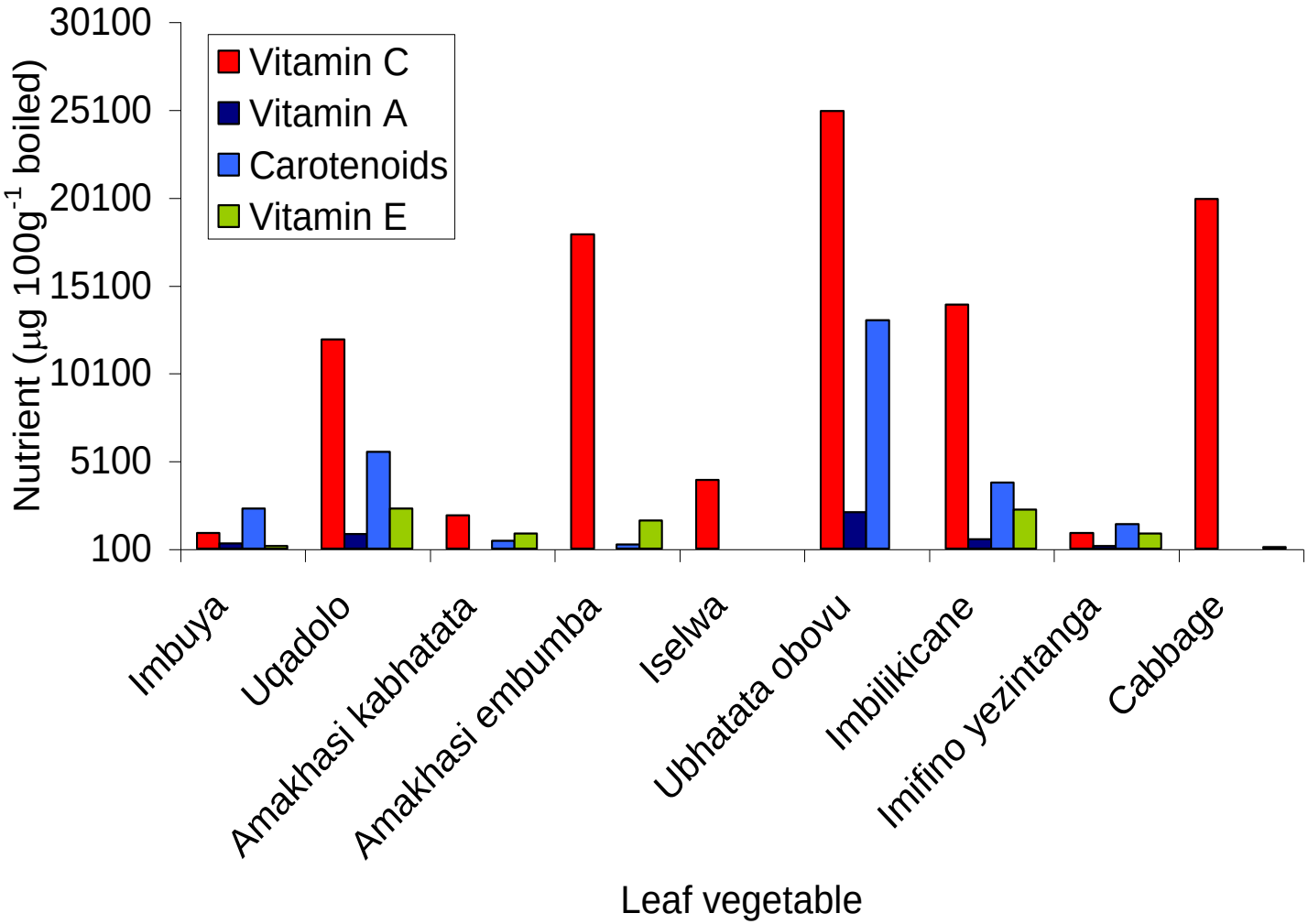


NUTRITIONAL VALUE CAN ALLEVIATE "HIDDEN HUNGER"



Another project sponsored by www.wrc.org.za

Nutritional value can alleviate hidden hunger



Another project sponsored by www.wrc.org.za

CONCLUSION

- Wild indigenous crops are an important source of germplasm for food crop improvement to respond to water scarcity in South Africa.
- Water use efficiency of indigenous and indigenised crops relies on avoiding desiccation, so that neither cell/tissue activity nor survival is threatened and ability to maintain physiological activity at low water contents.