Production of Underutilised Crops under Climate Change Scenarios in Semi-arid Southern Africa

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Introduction

Climate change influences crop production,

- ➢ need to explore alternative combination of crops for semi-arid regions of southern Africa.

Underutilised crops introduced

- To enhance crop productivity and nutritive value of smallholder's diets,
- To promote crop diversification and
- To decrease water use.

Potential evaluated using historic & future climate change scenarios in a crop-climate modelling exercise.

South African major staple foods

But crop failure 3 out of 10 years

=> Need alternative crops

Method

- AquaCrop modelling of
- two crops,
- both hardy & drought resistant,
- a cereal = Pearl millet
- a legume = Bambara groundnut
- in a semi-arid region of southern Africa

Climate change predictions for Bloemfontein, Central Free State

- Bloemfontein, in Free State Province of South Africa
- a semi-arid region at altitude of 1353m on lat. 29.1ºS & long. 26.3ºE.
- summer frost-free period is October – March, & winter May – August.
- Downscaled future climate data for Bloemfontein airport weather station simulating 2 scenarios namely SREScenarios A2 & B1 vs baseline (1991-2010)
- For 2 GCMs namely CSIRO mk3.5 and MPI ECHAM 5

Using average maximum & minimum temperatures and total rainfall downloaded from climate information portal of the University of Cape Town - Climate Systems Analysis Group http://cip.csag.uct.ac.za/webclient/introduction

	Temperature (°C)							
	Maximum				Minimum			
Scenario	A2		B1		A2		B1	
Season	CSIRO	MPI	CSIRO	MPI	CSIRO	MPI	CSIRO	MPI
DJF	0.7	0.8	0.3	0.1	1.1	0.5	0.6	0.0
MAM	3.6	2.5	3.1	1.8	4.8	2.9	4.4	2.2
JJA	4.6	4.3	4.3	3.3	6.2	5.4	5.9	4.2
SON	1.7	3.1	1.4	2.3	3.1	3.4	2.8	2.5
Annual	2.6	2.7	2.3	1.9	3.8	3.0	3.4	2.2

AquaCrop Model Runs

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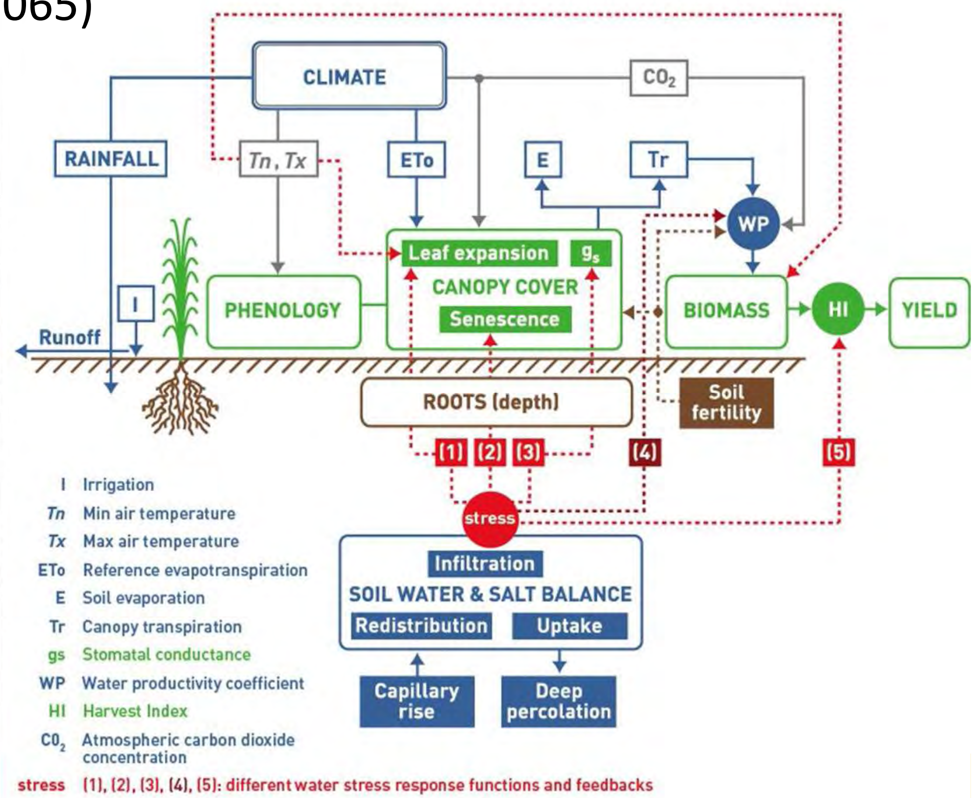
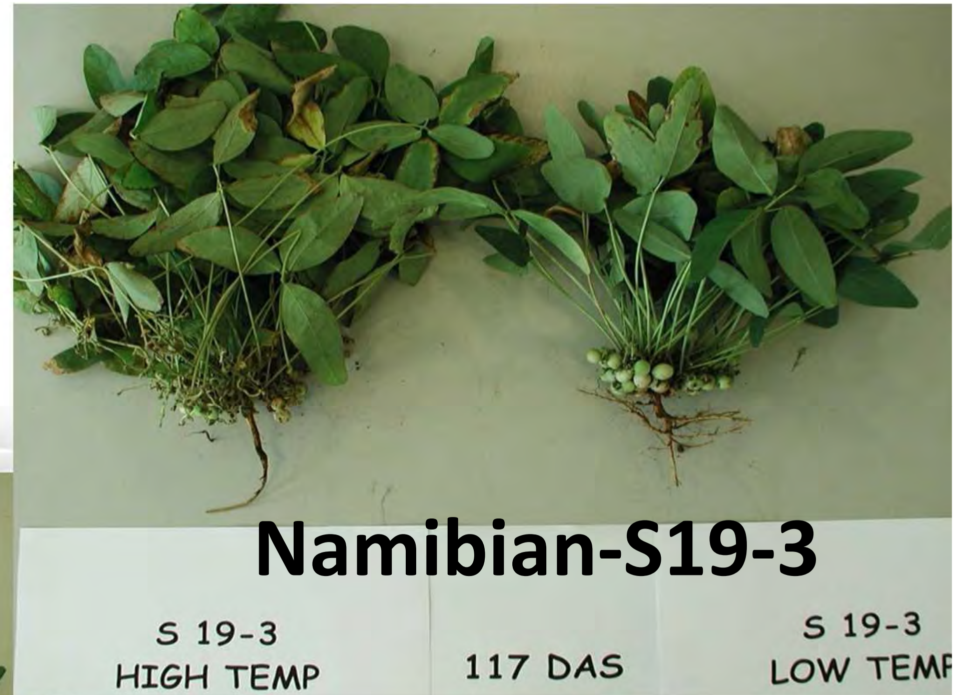
- Crop productivity & yield variability was simulated using AquaCrop
- for Bloemfontein, FS
- using recommended planting dates a/c onset of rainfall criteria (25 mm in 5 d)
- **For 2 climate time slices:**
  - historical climate data (1991-2010) (Baseline)
  - projected future climate data (2046-2065)
- **For the two crops (x2)**
  - Pearl Millet - 2 varieties
  - Bambara Groundnut - 2 landraces
- **For 2 management conditions**
  - rainfed
  - irrigated
- **Output were**
  - total above ground biomass,
  - seed yield
  - seasonal water use.

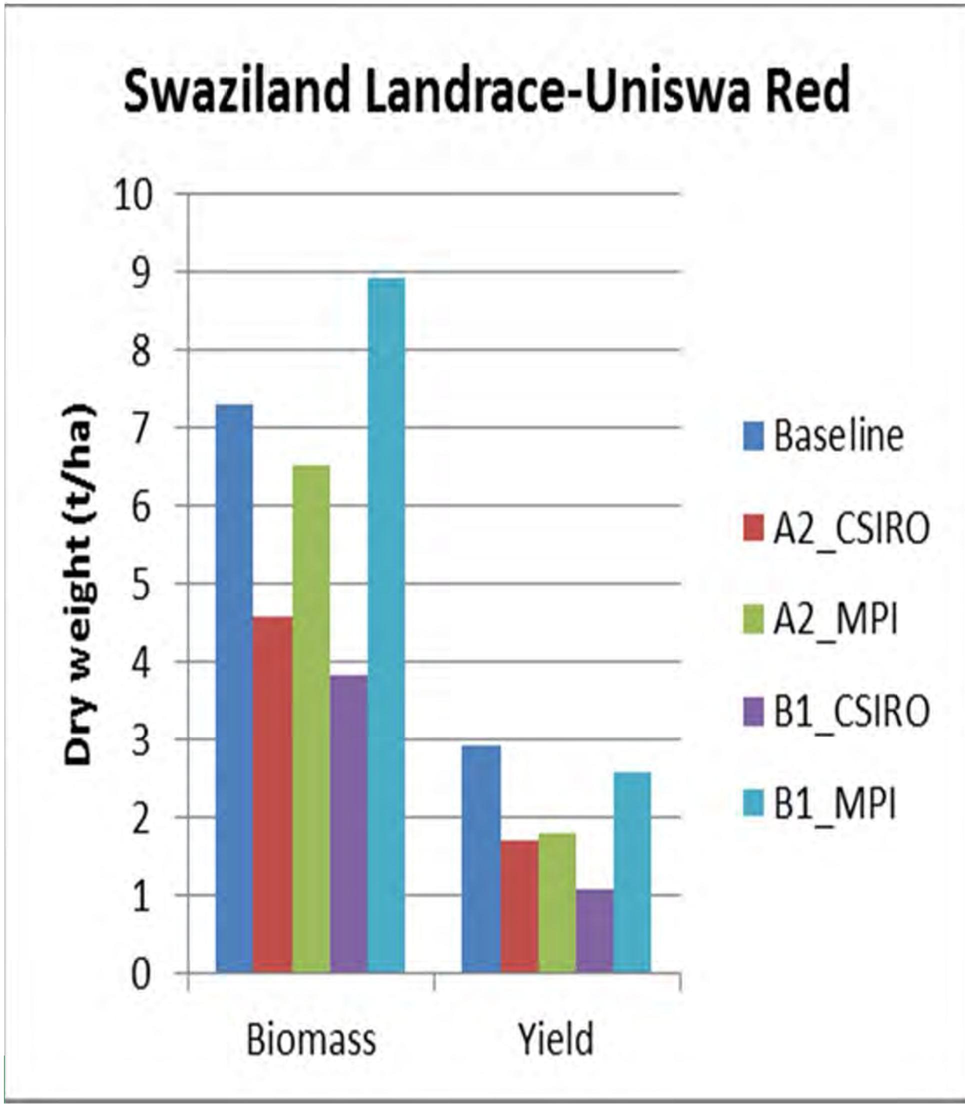


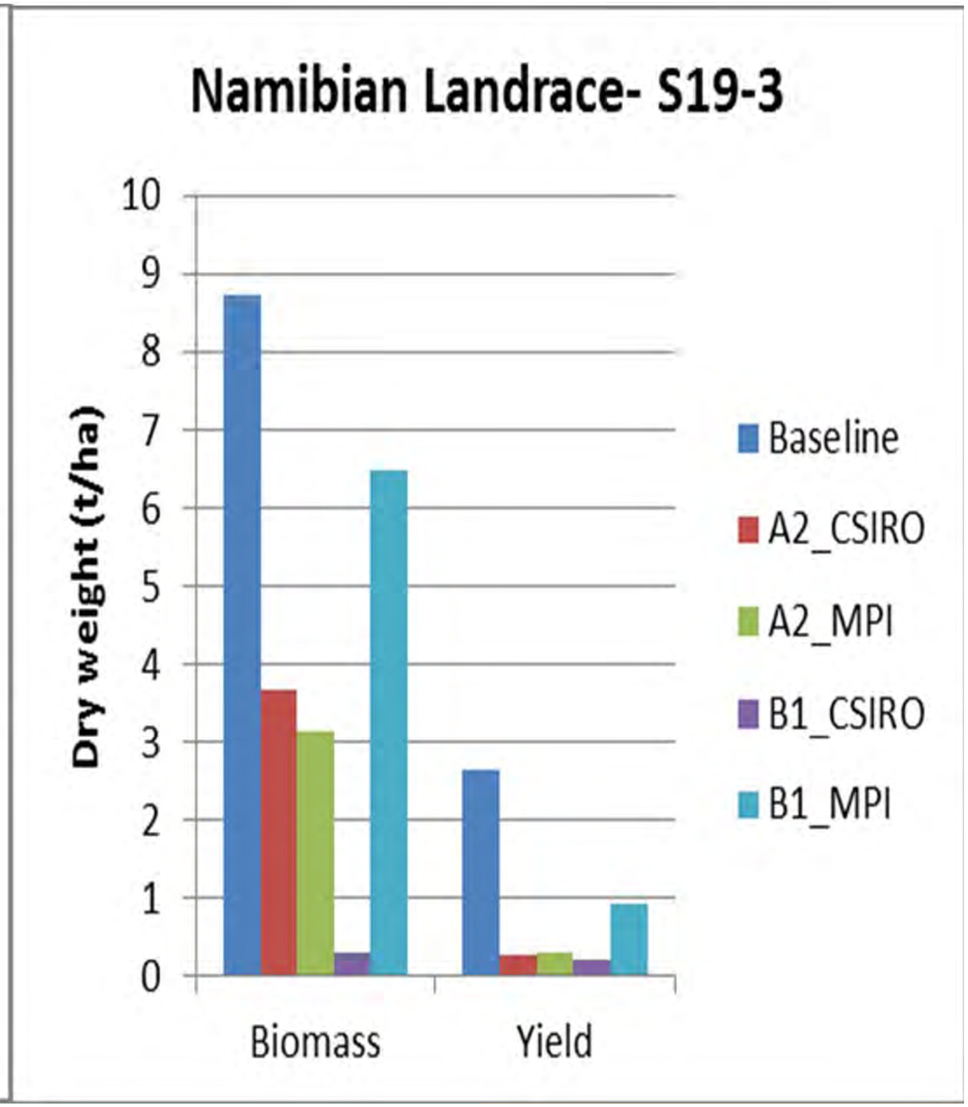
Bambara groundnuts

Known Temperature Effect



Effect of Climate change on Bambara groundnut landraces originating from Swaziland-UniswaRed & Namibian-S19-3 under 2 scenarios (A2 & B1) with 2 GCMs (MPI ECHAM 5 & CSIRO mk3.5)



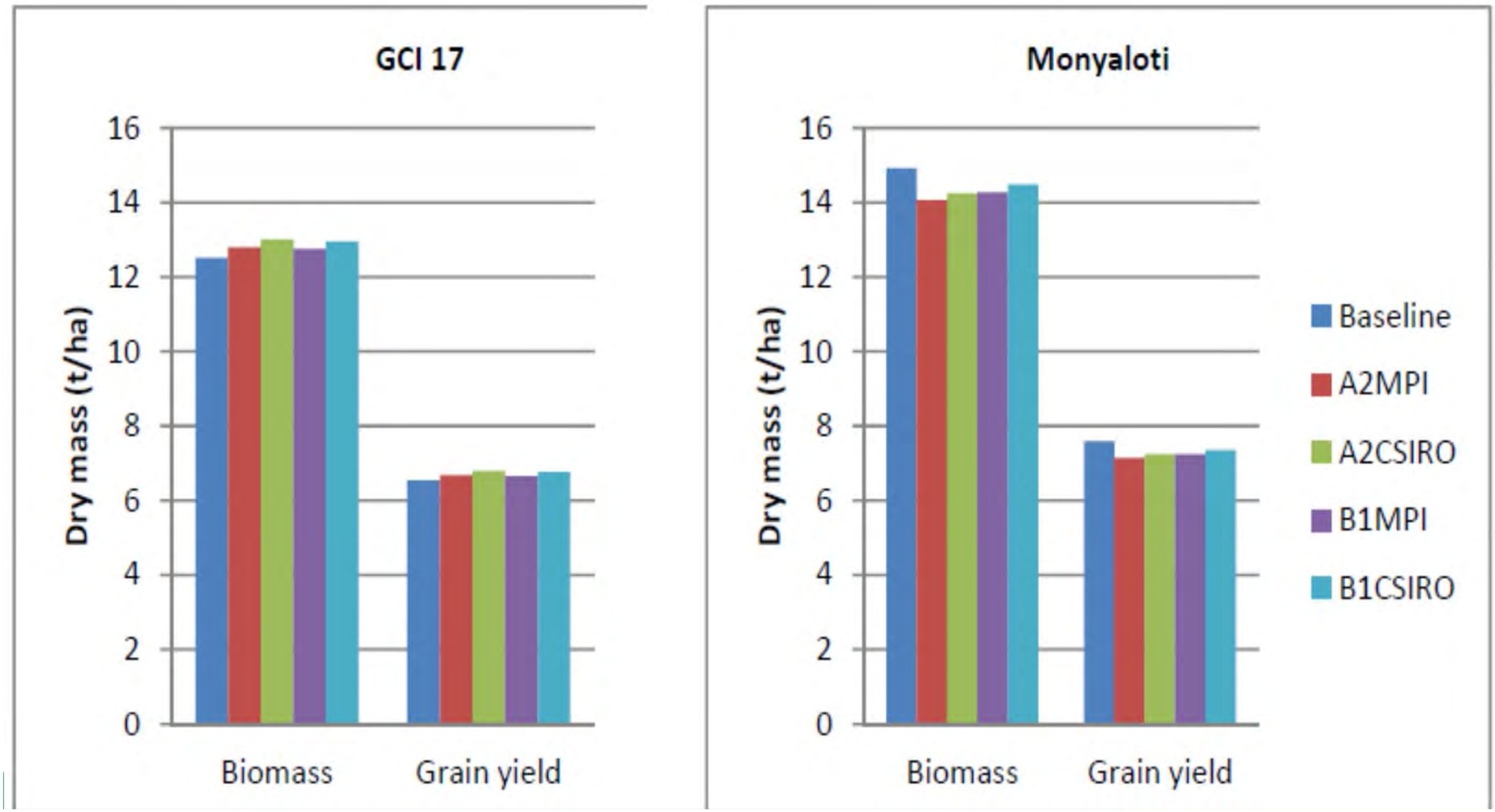


Pearl Millet

Effect of climate change on pearl millet

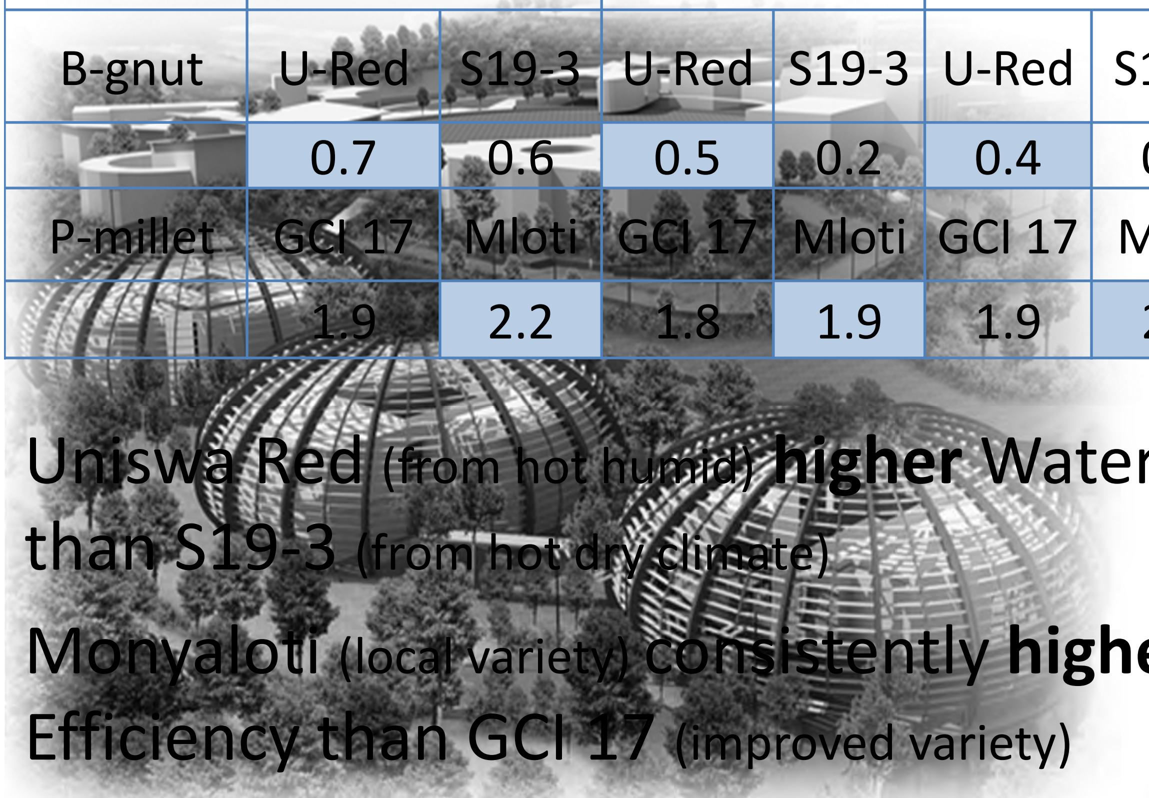
2 lines (improved variety = GCI17 & local variety = Monyaloti)

under 2 scenarios (A2 & B1) with 2 GCMs (MPI ECHAM 5 & CSIRO mk3.5)



Water Use of both under two scenarios (A2 & B1) with 2 GCMs (MPI ECHAM 5 & CSIRO mk3.5)

	Water Use (Kg/m3)									
Scenario	baseline		A2				B1			
GCM	historic		CSIRO		MPI		CSIRO		MPI	
B-gnut	U-Red	S19-3	U-Red	S19-3	U-Red	S19-3	U-Red	S19-3	U-Red	S19-3
	0.7	0.6	0.5	0.2	0.4	0.2	0.3	0.1	0.5	0.3
P-millet	GCI 17	Mloti	GCI 17	Mloti	GCI 17	Mloti	GCI 17	Mloti	GCI 17	Mloti
	1.9	2.2	1.8	1.9	1.9	2.0	1.9	2.0	1.9	2.0

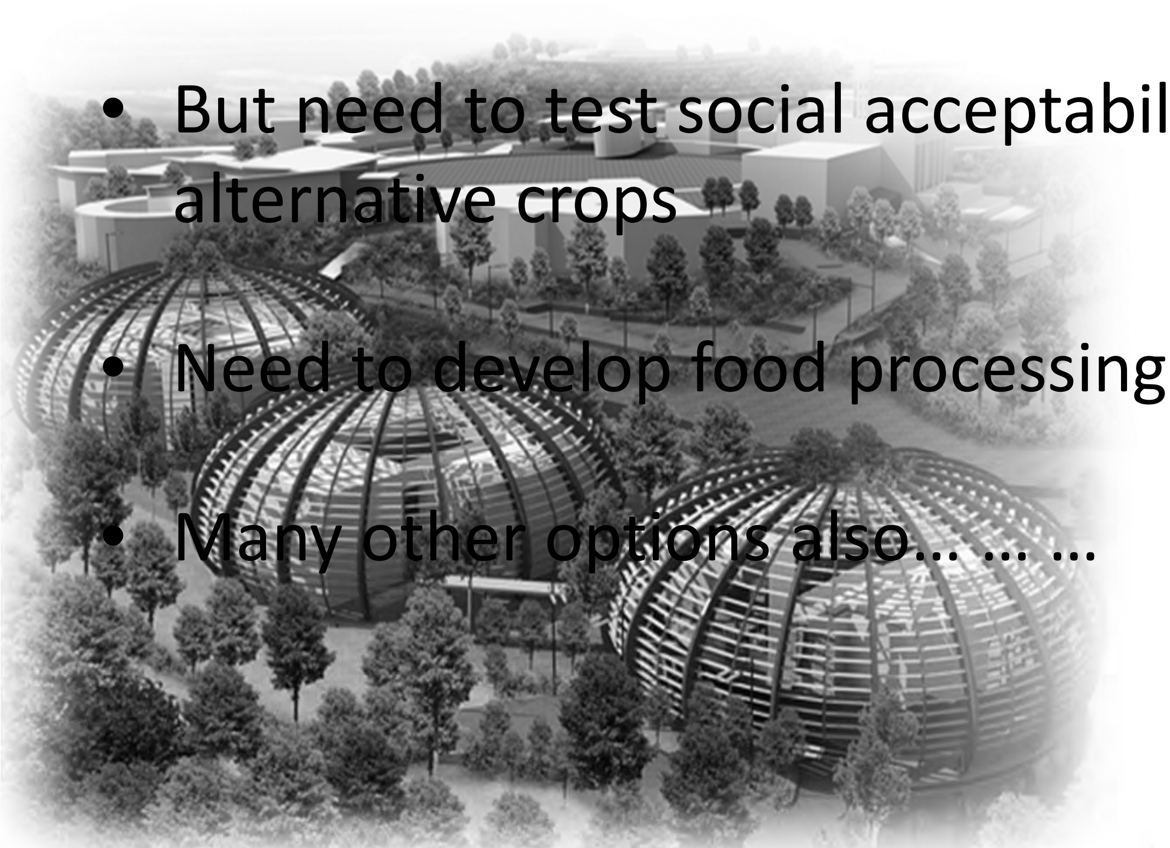


Uniswa Red (from hot humid) **higher** Water Use Efficiency than S19-3 (from hot dry climate)

Monyaloti (local variety) consistently **higher** Water Use Efficiency than GCI 17 (improved variety)

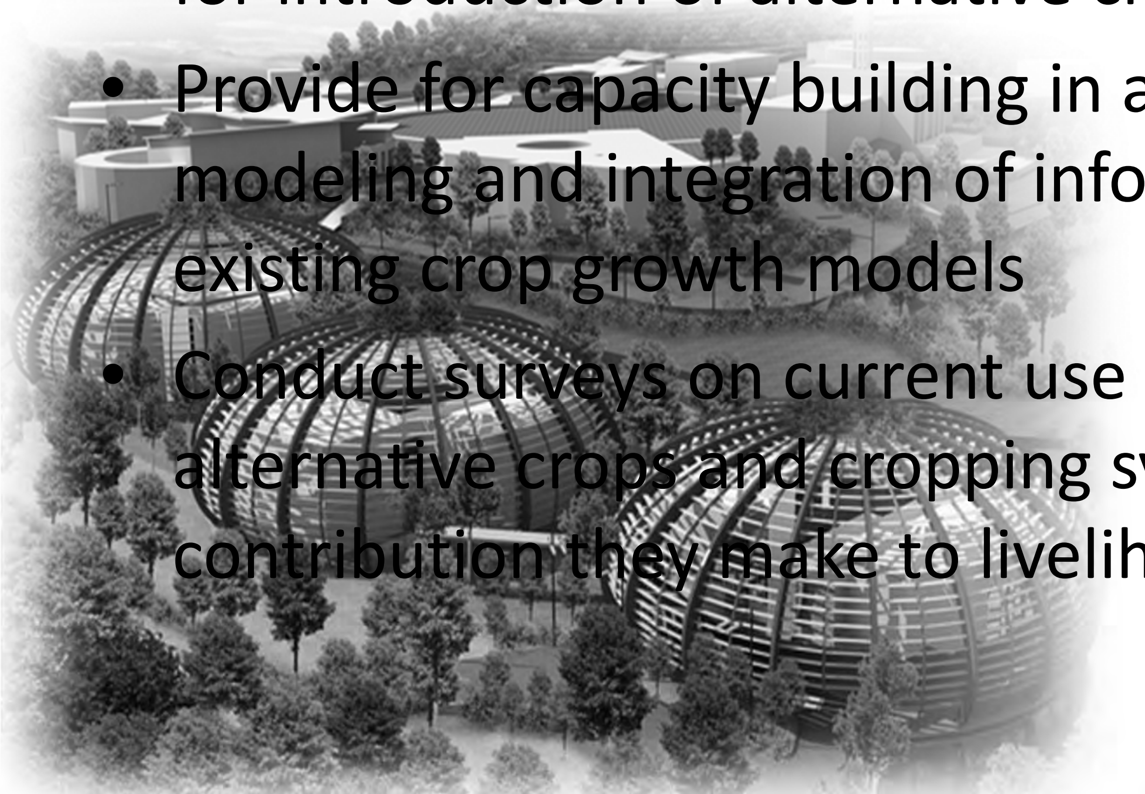
Conclusions

- Crop model able to assess suitability of alternative crops for future climate
- But need to test social acceptability of alternative crops
- Need to develop food processing & products
- Many other options also… … …



Policy Notes

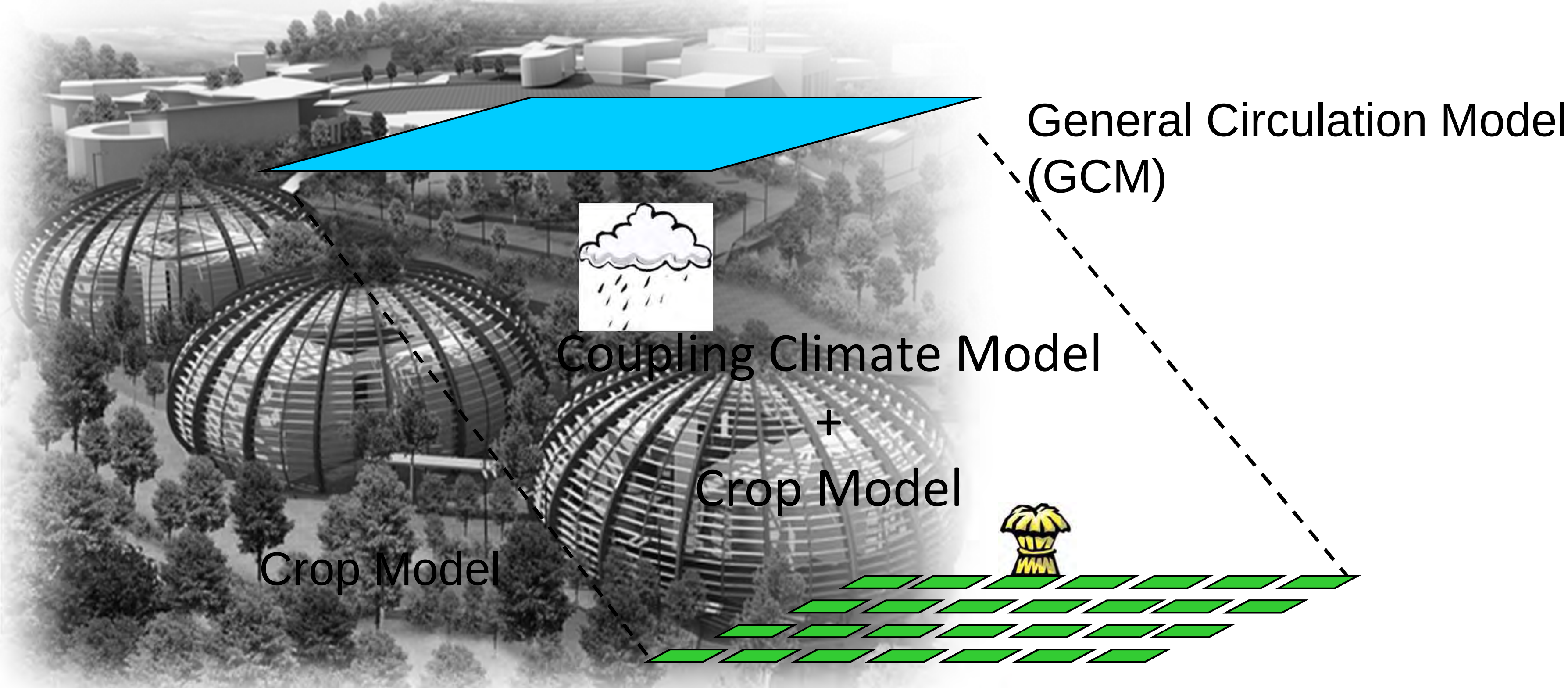
- Promote use of locally calibrated crop models for developing climate change adaptation strategies for introduction of alternative crops
- Provide for capacity building in areas of climate modeling and integration of information into existing crop growth models
- Conduct surveys on current use level of alternative crops and cropping systems and the contribution they make to livelihoods



CropBASE

Crop-Climate model challenges

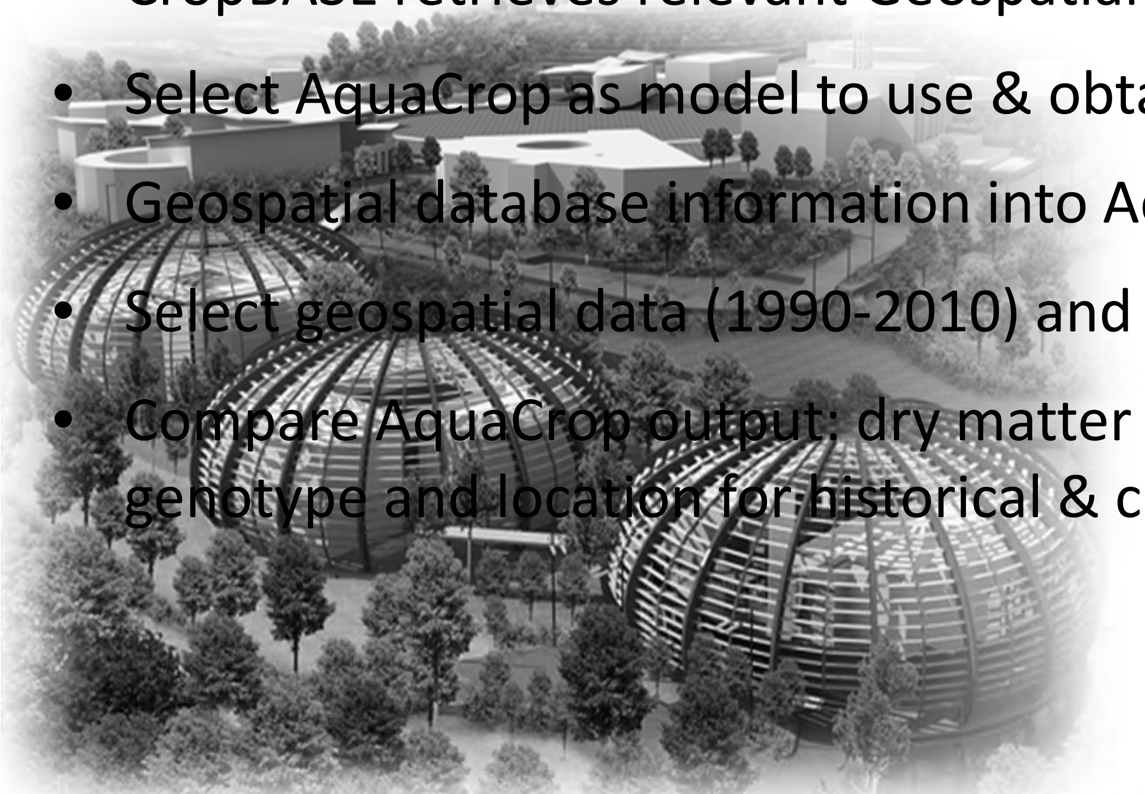
- To simulate crop productivity at country to global scales under variable climates
- To capture crop-climate interactions for underutilised crops and trait identification across geographical boundaries



CropBASE Crop-Climate Model Example

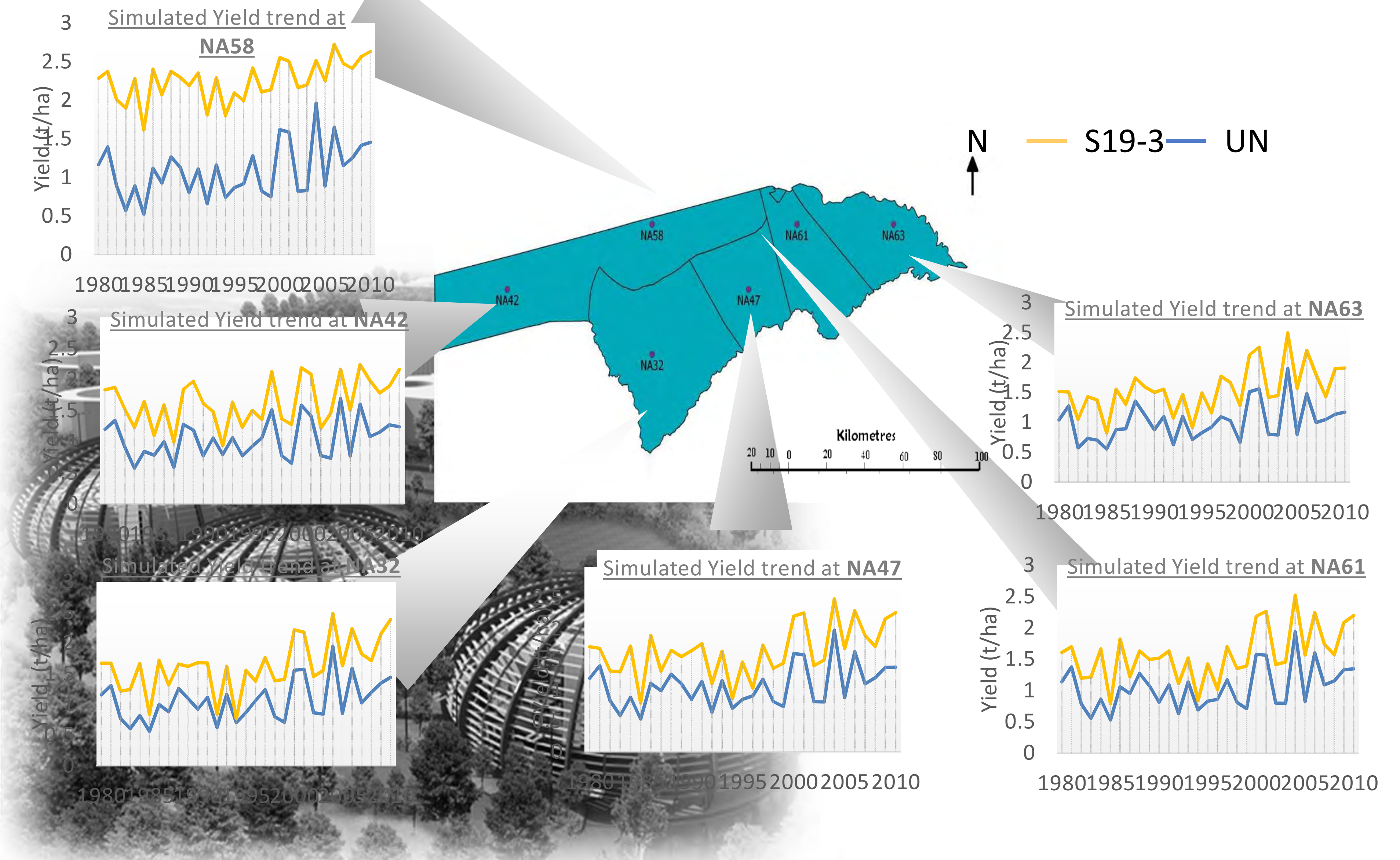
Current Approach

- Select crops and genotypes (e.g. bambara groundnut and pearl millet)
- Select locations (e.g. districts in Southern Africa)
- CropBASE retrieves relevant Geospatial input data
- Select AquaCrop as model to use & obtain calibration information
- Geospatial database information into AquaCrop format
- Select geospatial data (1990-2010) and climate data from GCMs
- Compare AquaCrop output: dry matter & yield for 20-years for each genotype and location for historical & climate change scenario.



CropBASE Crop-Climate Model Example

Namibia: Bambara groundnut landraces yield predictions

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