
**Tropical Plant Production and Agricultural Systems Modelling (TROPAGS)**

Georg-August-Universität Göttingen, Department of Crop Science,
Grisebachstr. 6, Göttingen

# CONTENT

- Mission
- Team
- Teaching
- Research

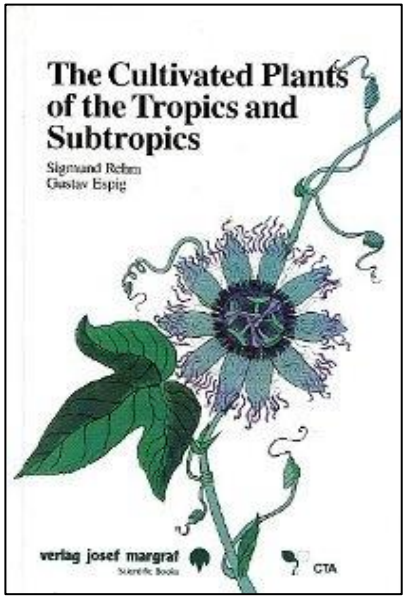
# MISSION

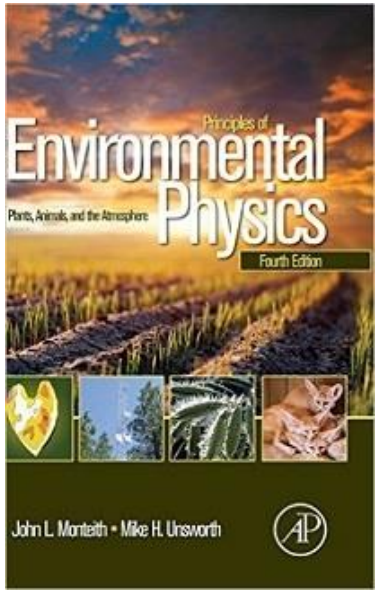
**Our goal is to conduct research and research-oriented training to further the understanding of the functioning of major tropical plant production systems in a changing environment.**

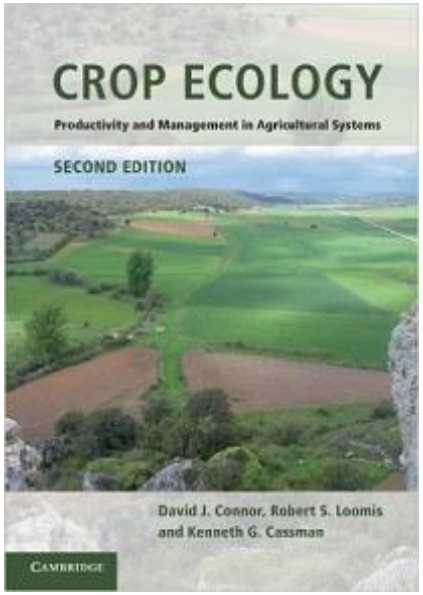
# TEAM

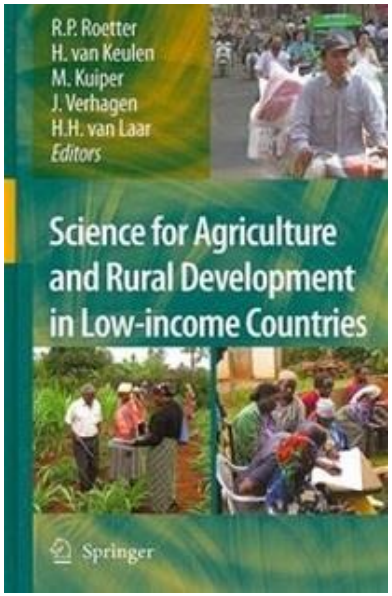
# TEACHING

- Management of Tropical Plant Production Systems
- Einführung in tropische und internationale Agrar-wissenschaft
- Tropical Agroecosystem Functions



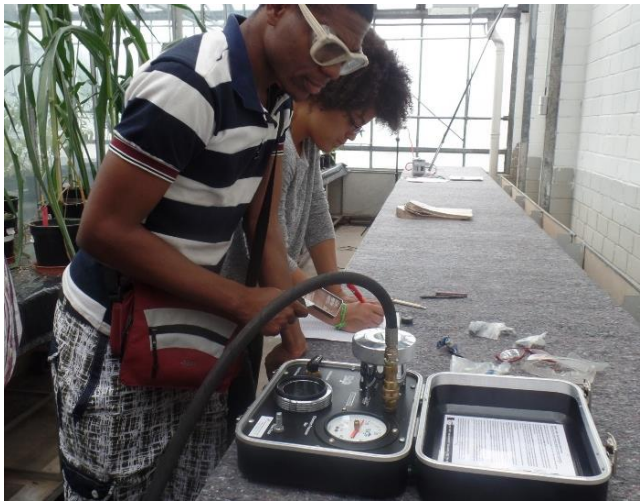



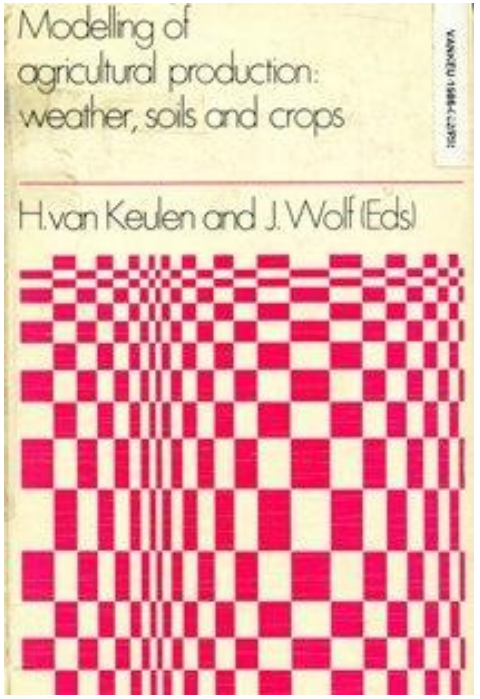



# TEACHING

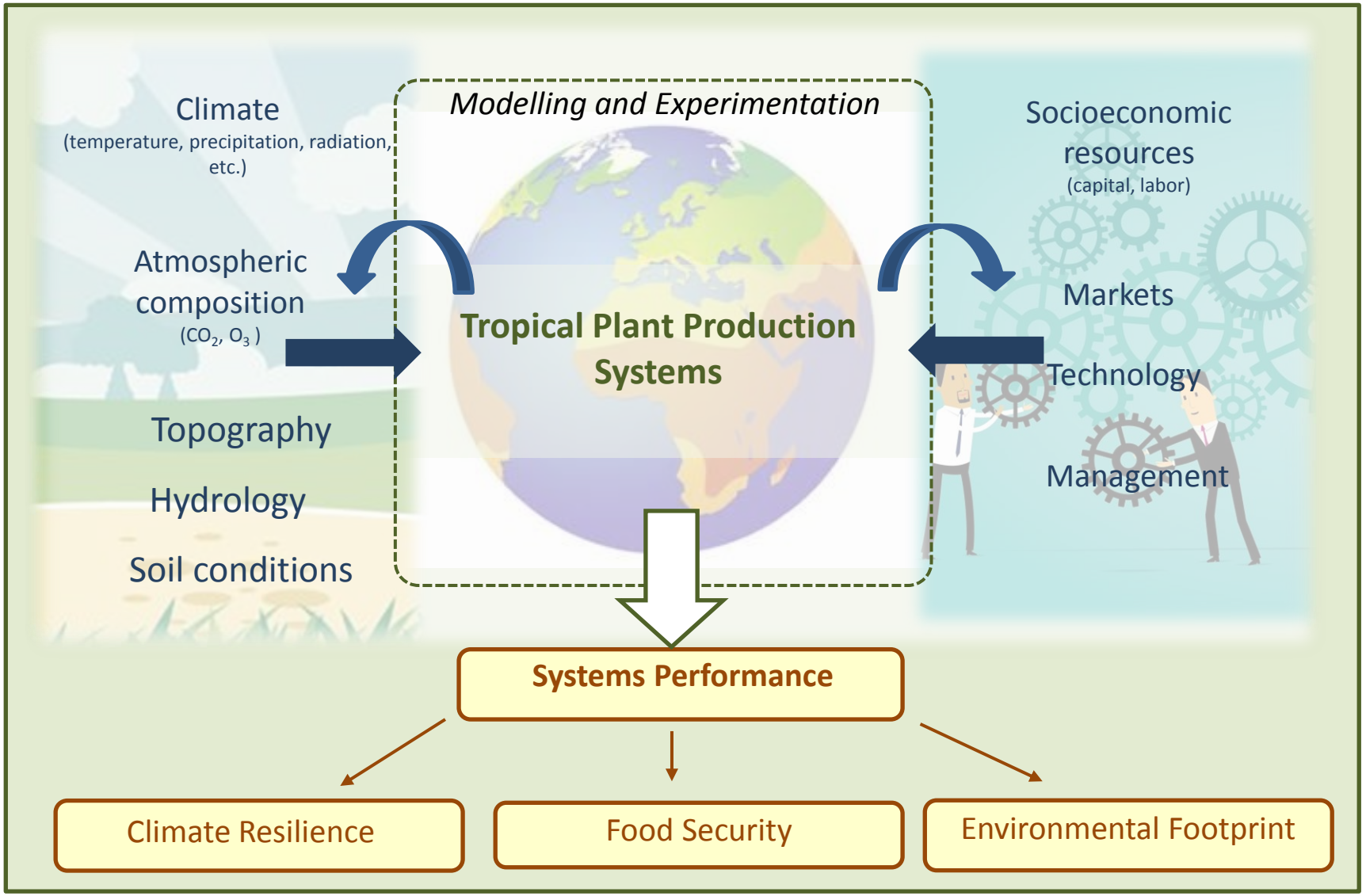
- Experimental Techniques in Tropical Agronomy
- Crop Modelling for Risk Management



Measurment of water potential and scarification experiment, summer term 2016 *©Photos: E.K-D.,2016*



# RESEARCH – ANALYTICAL FRAMEWORK



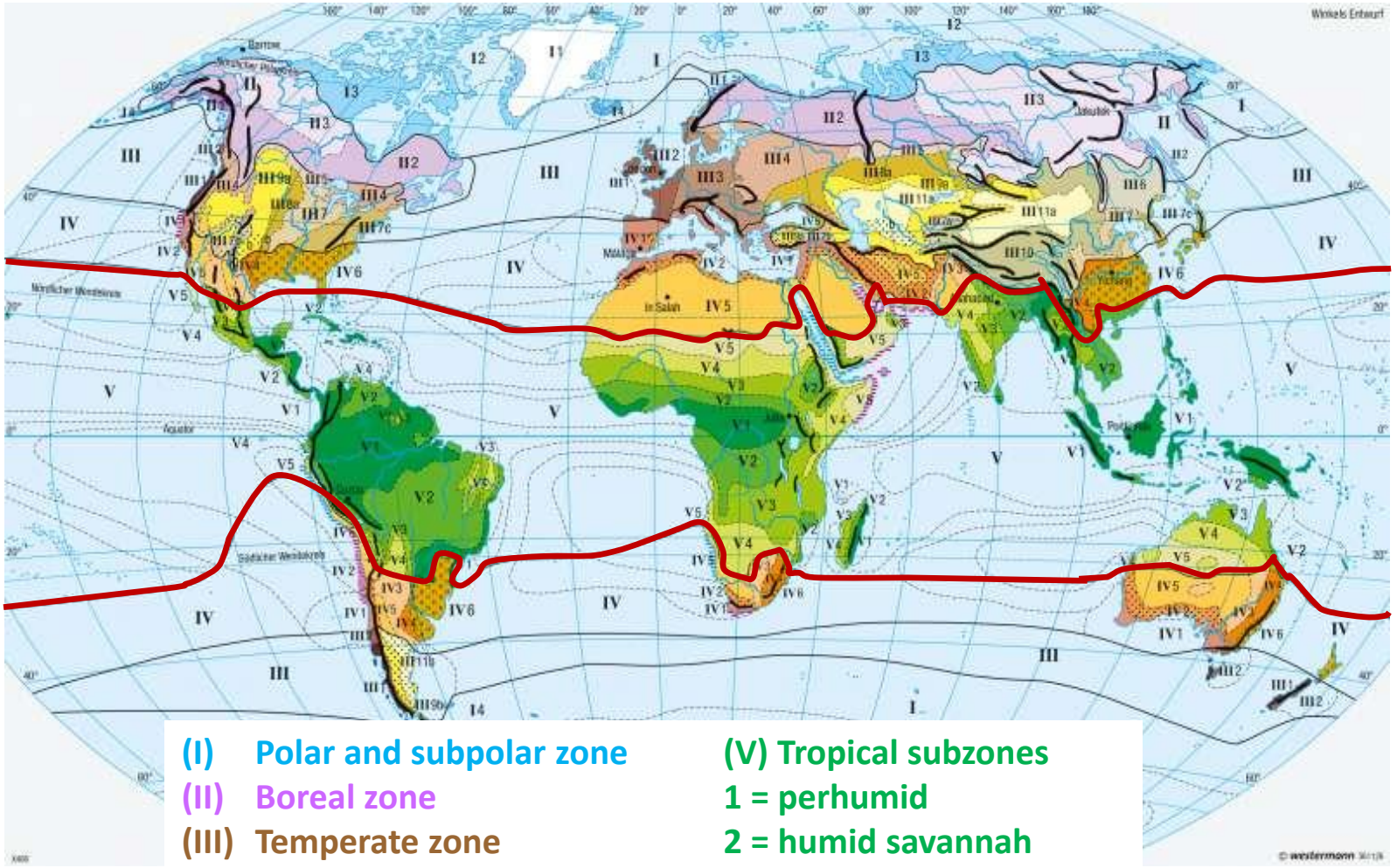
# RESEARCH FOCI

- Assessment of **climate** induced **risks** on **crop production** and **food security**
- Design of climate adaptation and mitigation options
- **Utilizing genetic diversity** and crop **ideotyping** to support breeding

# RESEARCH FOCI

- **Design and development** of agroecosytem models and modelling platforms
- Crop **model development** and **improvement**
- **Integrated analysis** of agricultural systems and food security from farm up to global scales

# TROLL – PFAFFEN CLIMATE CLASSIFICATION ACCORDING TO THERMAL AND HYGRIC SEASON



(I) Polar and subpolar zone
(II) Boreal zone
(III) Temperate zone
(IV) Subtropical zone
(V) Tropical zone

(V) Tropical subzones
1 = perhumid
2 = humid savannah
3 = dry savannah
4 = thornbush savannah
5 = semi-desert, desert

*Source: Diercke, 2008*


Maize
© M.Marver
Sorghum
© Pioneer.com
Wheat
© Getreide-forum.de
Coffee
© thinkstock-k1371542
Cowpea
© pictokon.org
Pearl millet
© W.Nel
Maize
© M.Marver
Sorghum
© Pioneer.com
Cocao
© I.Abd.
Cocoa
© I.Abd.
Oil palm
© I.Abd.
Rice
© S.Porembski.
Groundnut
© Icrisat.org
Cowpea
© pictokon.org
Wheat
© Getreide-forum.de
Maize
© M.Marver
googlemaps

# OUR PARTNERS

# TROPAGS WEBPAGE

Tropical Plant Production and Agricultural Systems Modelling

Team Research Publications Teaching Projects & Partners News & Positions Contact

Current page: Homepage Aa+ Aa- Search | Deutsch

Head:
Prof. Dr. Reimund P. Rötter

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**Mission**

Our goal is to conduct research and research-oriented training to further the understanding of the functioning of major tropical plant production systems in a changing environment. Environmental changes comprise the big challenges agricultural systems are increasingly facing in the future in the different regions in the tropics and sub-tropics: water scarcity, soil nutrient depletion, soil loss, more severe adverse weather events, enhanced ozone concentrations and climate change. Last, but not least, in collaboration with other disciplines we conduct quantitative research on the various dimensions of food security at different scales.

*Read more about research and teaching...*

**Key publications:**

→technological innovations

Hoffmann, M.P., et al. (2016). *Journal of Agronomy and Crop Science* n/a-n/a.
DOI:10.1111/jac.12159

Kassie, B.T., et al. (2014). *Field Crops Research* 160, 41-53
DOI:10.1016/j.fcr.2014.02.010

→climate risks

Asseng, S., et al. (2015). *Nature Climate Change* 5, 143-147.
DOI:10.1038/nclimate2470

Rötter, R.P., et al. (2013). *Ecol Evol* 3, 4197-4214.
DOI:10.1002/ece3.782

- https://www.uni-goettingen.de/de/106511.html
- Google: Uni Göttingen TROPAGS

# PROJECTS WITH PhD-STUDENTS

Bundesministerium für
wirtschaftliche Zusammenarbeit
und Entwicklung

**Coffee & Cocoa -** Trade-offs and synergies in climate change adaptation and mitigation in coffee and cocoa systems

IMPAC³

**IMPAC³** - Novel genotypes for mixed cropping allow for IMProved sustainable land use ACross arable land, grassland and woodland

# ALEJANDRA SARMIENTO SOLER

Alejandra
Sarmiento Soler
Bogota, Kolumbien

## Research Topic:

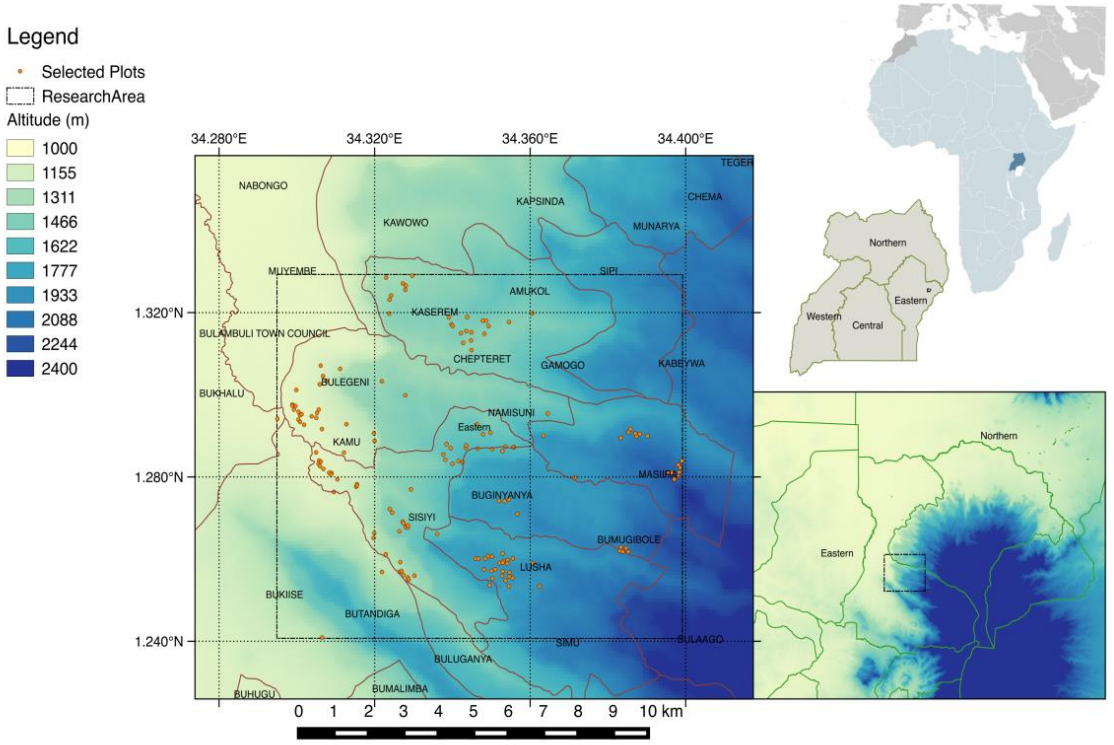
Trade-offs and synergies in climate change adaptation and mitigation in coffee and cocoa systems


Bundesministerium für
wirtschaftliche Zusammenarbeit
und Entwicklung

# OBJECTIVES

Identifying opportunities for climate adaptation and increased resilience of coffee cultivation systems through:

- Quantification of water budgets
- Determination of coffee performance under a climate and shade gradient
- Identification of yield limiting factors




Source A. Sarmiento Soler based on SRTM (Jarvis, et al. (2008), Hole-filled SRTM for the globe Version 4 (http://srtm.csi.cgiar.org))

Sapflow measurements on *Cordia africana* – Mt. Elgon, Uganda


Hydrological measurements on *Cordia africana* and Banana – Mt. Elgon, Uganda

# ISSAKA ABDULAI

Issaka Abdulai
Boaso-Bechem,
Ghana

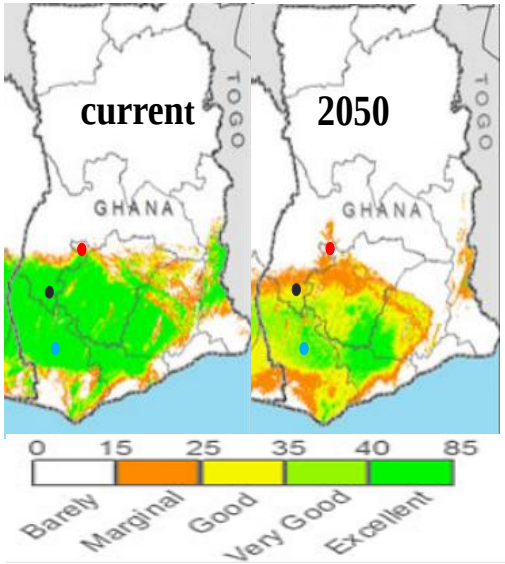
## Research Topic:

Productivity, water use and resilience to climate change of cocoa cultivation systems in Ghana


Bundesministerium für
wirtschaftliche Zusammenarbeit
und Entwicklung

# OBJECTIVES

- Characterization of cocoa production systems along climate suitability transect
- Cocoa production, yield gap, plant productivity along climate gradient
- Microclimate and water use in cocoa cultivation systems




Climate suitability map
*(Läderach, Climatic Change, 2013)*

Production system

Yield gap

*©Photos: I.Abd., 2012*

Precipitation and soil water measurements – Asnakragua, Ghana

Transportation to research location – Asnakragua, Ghana

*©Photo: I.Abd., 2014*

# WILLIAM NELSON

William Nelson
London, England

**Research Topic:**

Resource (water, light, nutrients) use efficiency in cereal-legume intercropping systems

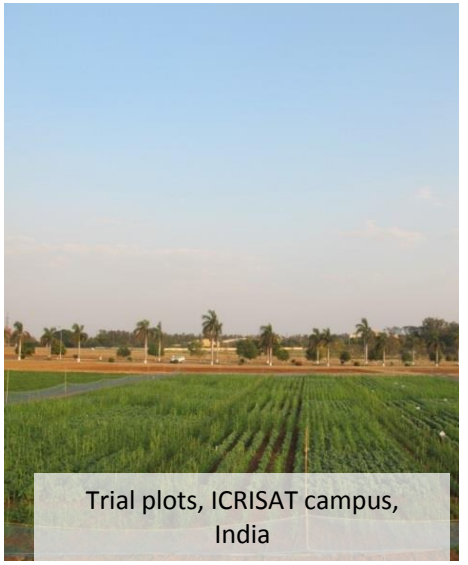
IMPAC3

# OBJECTIVES

- **Can irrigation enhance production** under extreme conditions - how much water is needed?
- **Can intercropping help adaptation** to climate extremes in achieving reasonable yields?
- **Can planting density improve performance?**

Low density cowpea/pearl millet intercropping

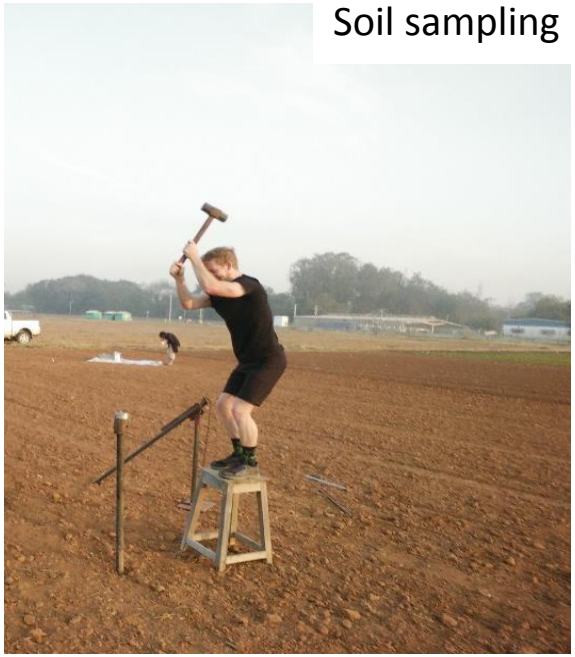
Stem height measurement



Trial plots, ICRISAT campus, India

Crop upper limit tent

Soil sampling



Thinning

Data collection

Field trial – Hyderabad, India

Crop upper limit tent

Soil sampling

Weeding

Data collection

# Field Trial – Experimental Station Reinshof

Cowpea-pearl millet intercropping

Soil sampling

Millet pest

Data collection

# Field trial – Niger

# RATUNKU GABRIEL LEKALAKALA

Gabriel Lekalaka
Mokopane,
Limpopo, Südafrika

## Research Topic:

Finding opportunities for managing climate risk in highly resource constrained crop based smallholder farming system of the Limpopo basin

# OBJECTIVES

Determining potential strategies for attaining resilience and adaptation in smallholder farming system to climate variability and change

- How do **climate-smart practices** perform at field research scale, and up-scaled across different soils, climates and locations?
- Are prevailing farmers management practices **climate proof**?
- What are likely responses to **climate adaptation** measures, concerning low productivity and climate-related risk, under future climate conditions?

# RESEARCH PROJECTS AND COOPERATIONS

AgMIP

Limpopo Living Landscapes

UNIVERSITY OF HELSINKI

SUSTAg

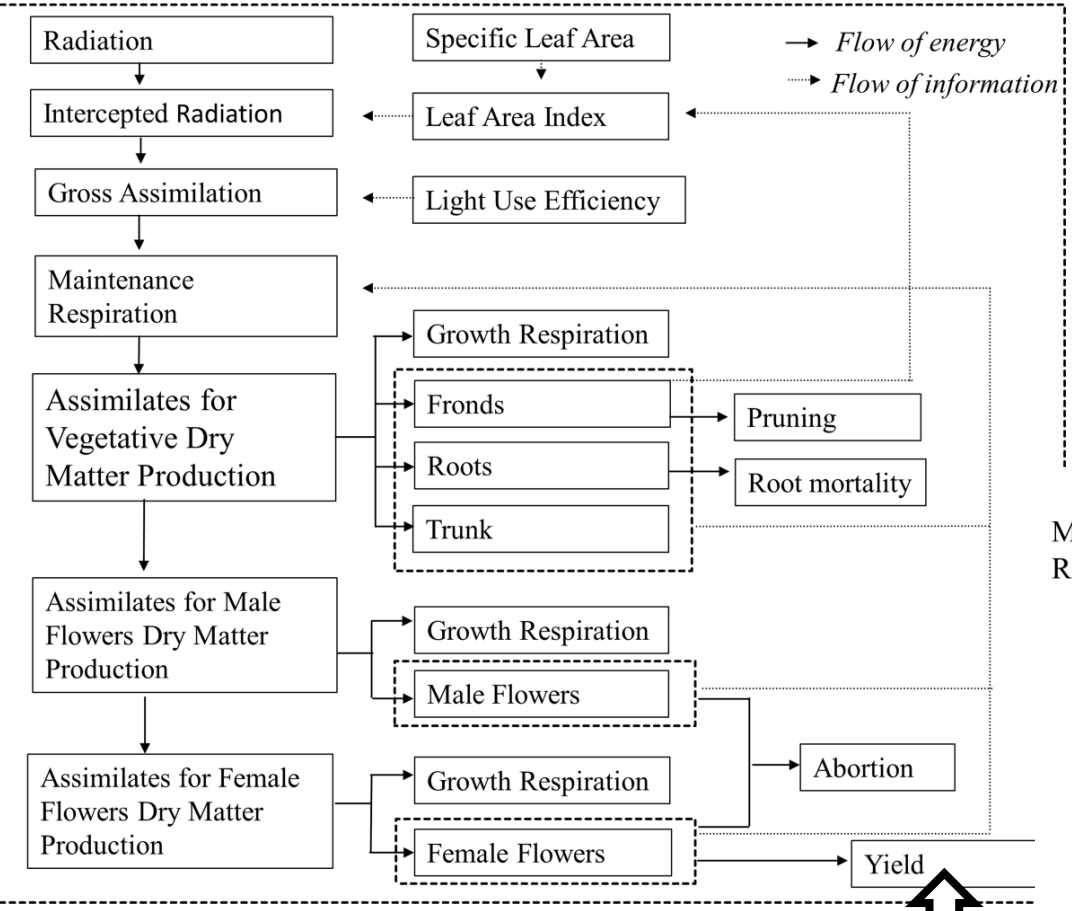
MACSUR

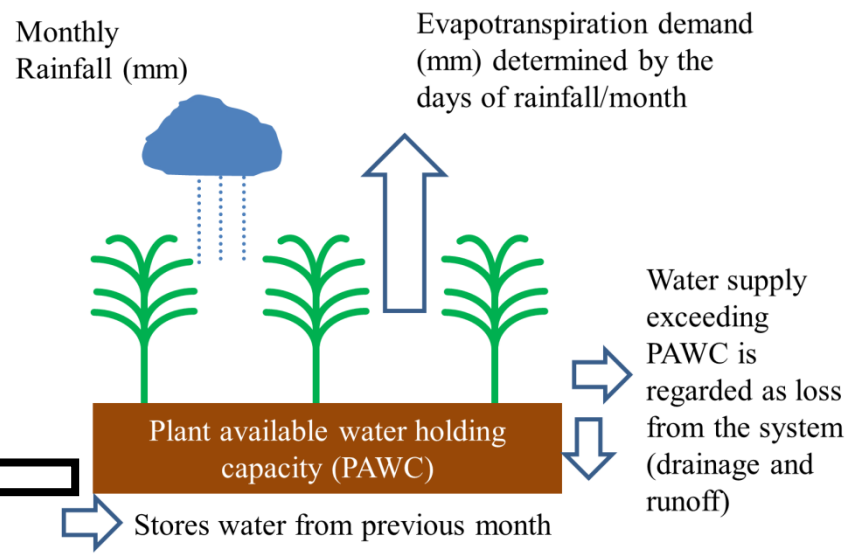
IMPAC³

Bundesministerium für
wirtschaftliche Zusammenarbeit
und Entwicklung

IPNI

# PALMSIM - A PLANT GROWTH MODEL




**Hoffmann, MP.,** et al. 2014. Simulating potential growth and yield of oil palm (Elaeis guineensis) with PALMSIM: Model description, evaluation and application. Agric. Syst. 131, 1–10. doi:10.1016/j.agsy.2014.07.006

# SPACES – LIMPOPO LIVING LANDSCAPES


*Source: M.Hoff; data from www.gadm.org*

*©Photo: M.Hoffm, 2016*

Bundesministerium für Bildung und Forschung

University of Limpopo

University of Venda
Creating Future Leaders

Limpopo Living Landscapes

# SPACES – LIMPOPO LIVING LANDSCAPES

3. Annual Meeting , August 2016 – Hoedspruit, South Africa

*©Photo: E.Fi., 2016*

Field survey – Limpopo, South Africa

# SUMMARY OF

# ONGOING RESEARCH ACTIVITIES

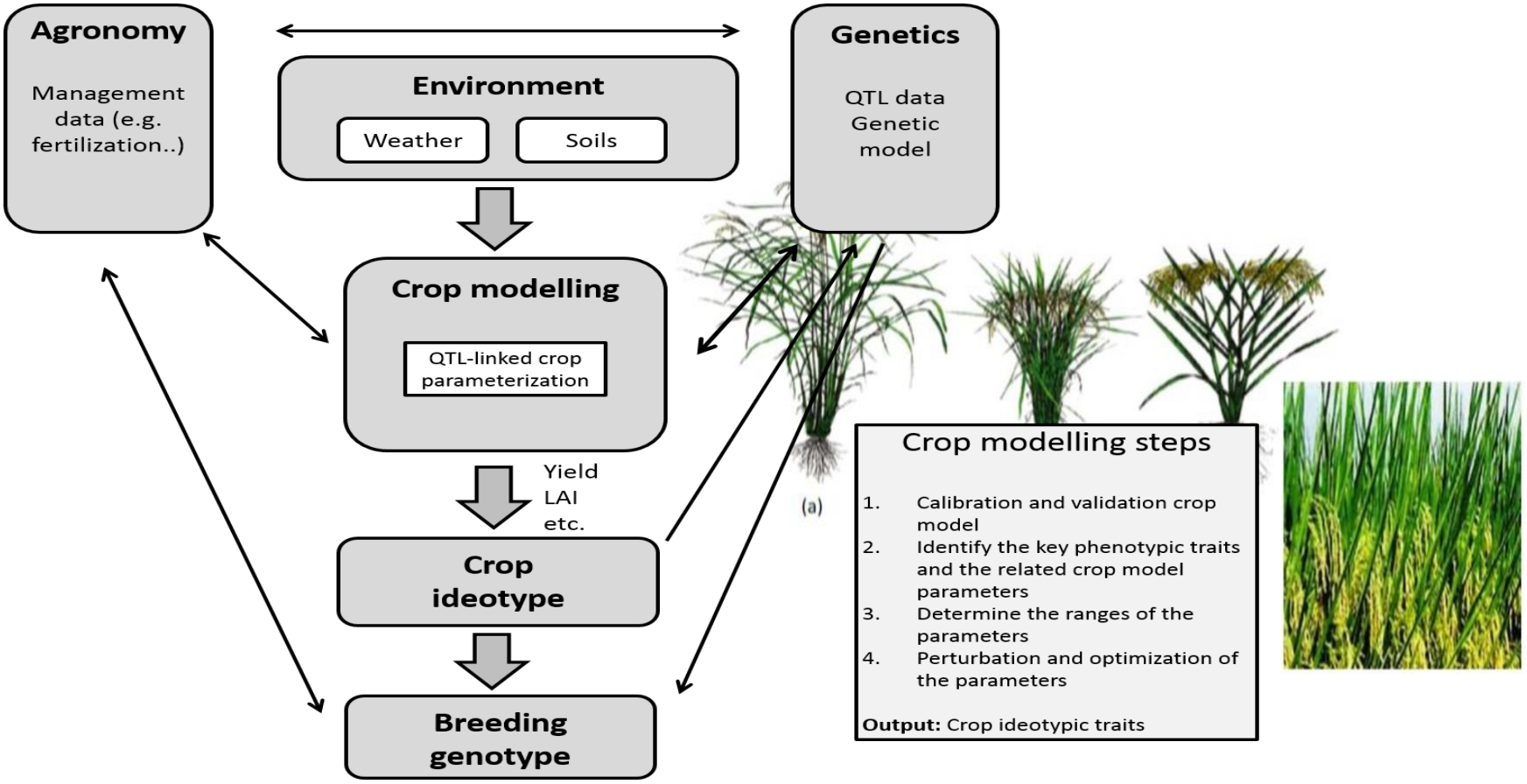
# AT TROPAGS

# ONGOING RESEARCH PROJECTS

- BMZ Coffee & Cocoa (Uganda, Ghana)
- IMPAC$^3$ (India, Germany)
- IPNI Cooperation (Indonesia/Southeast Asia)
- MACSUR (Europe)
- SUSTAg (Europe)
- AgMIP (Global)
- SPACES-LLL (South Africa)

# METHODOLOGY DEVELOPMENT AND APPLICATION

## Model aided ideotyping of climate resilient crop cultivars

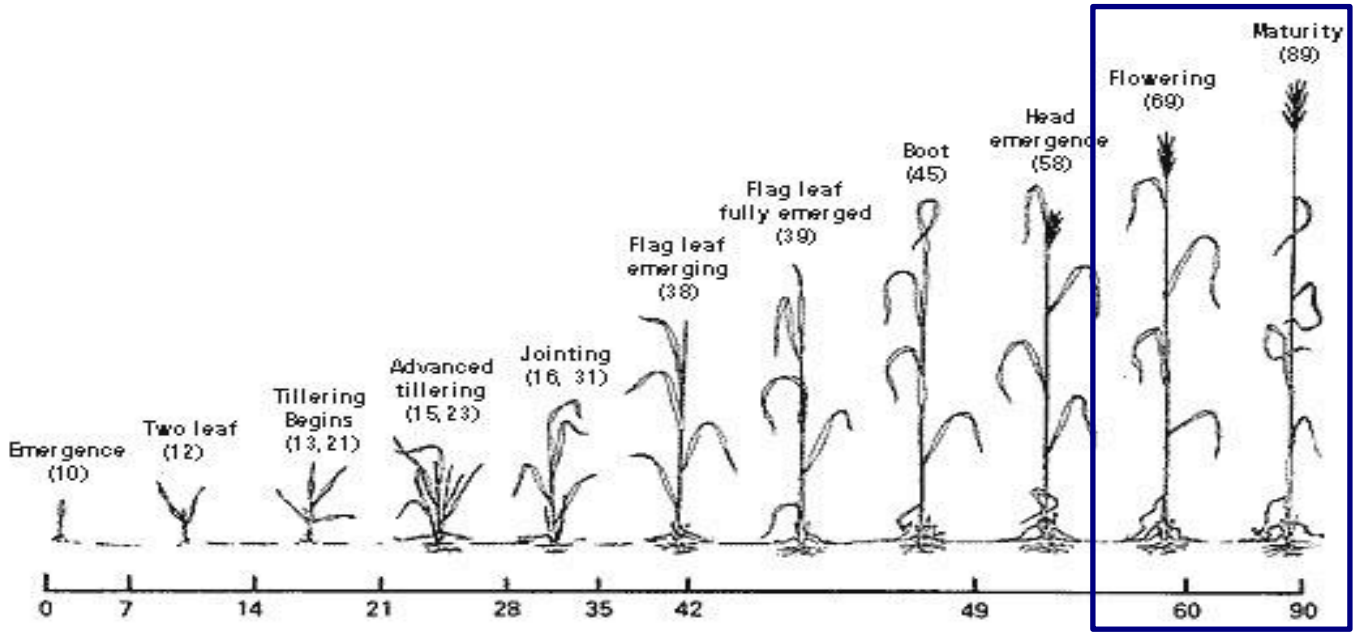



*Souce:* ***Rötter RP.,****et al. 2015 (JEXBOT)*

# MACSUR/AGMIP

## Experimentation to improve models for better quantification of extreme weather effects

*©Photos: E.Fi., B.Bo, 2016*



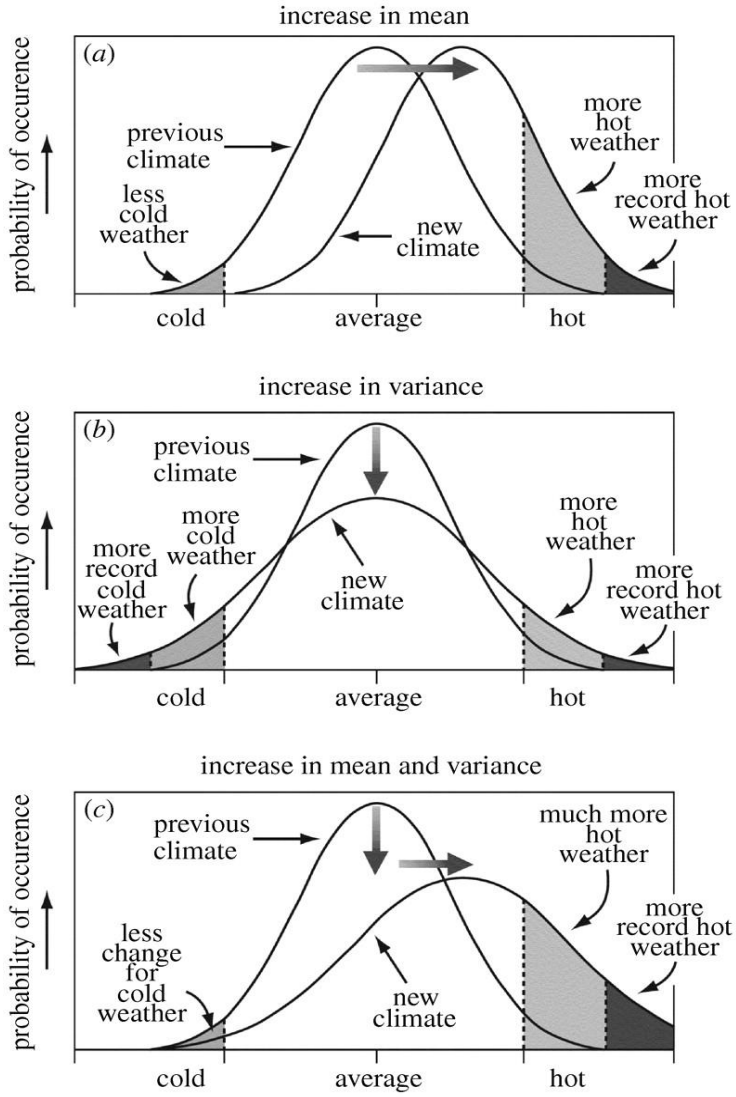

## Why wheat experiments?

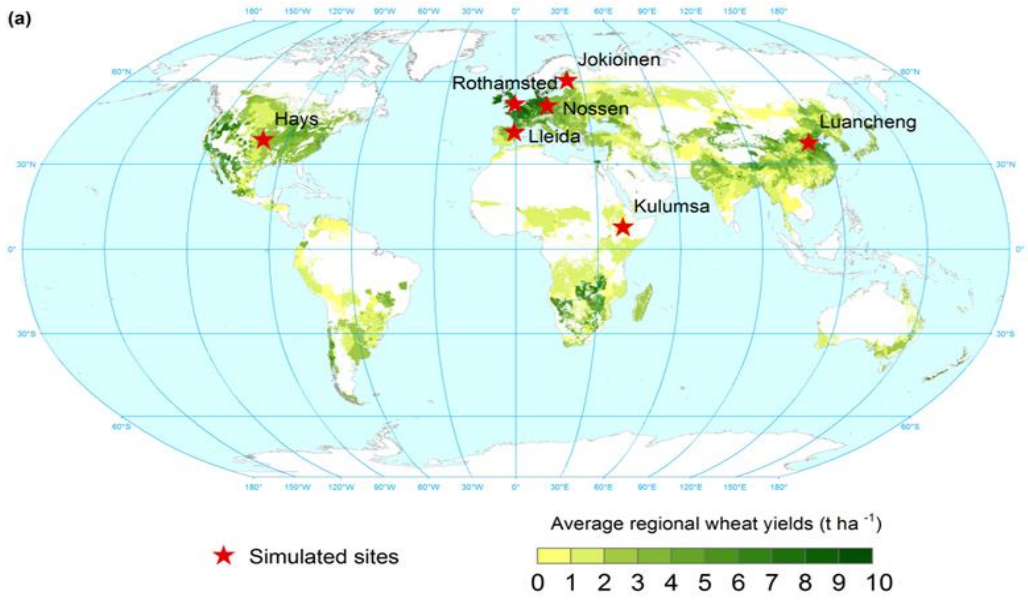
- one of the most important cereals in Europe and worldwide
- particularly sensitive to high temperatures during reproduction phase (flowering & grain filling)

## Why heat and drought stress?

- increased occurence of days with temperatures ≥ 35 °C during the most sensitive development stage (reproduction phase) due to climate change
- possible effects on yield

# EFFECTS OF CLIMATE CHANGE (MEANS AND VARIABILITY), $CO_2$ AND CULTIVATION PRACTICES ON CEREAL PRODUCTION

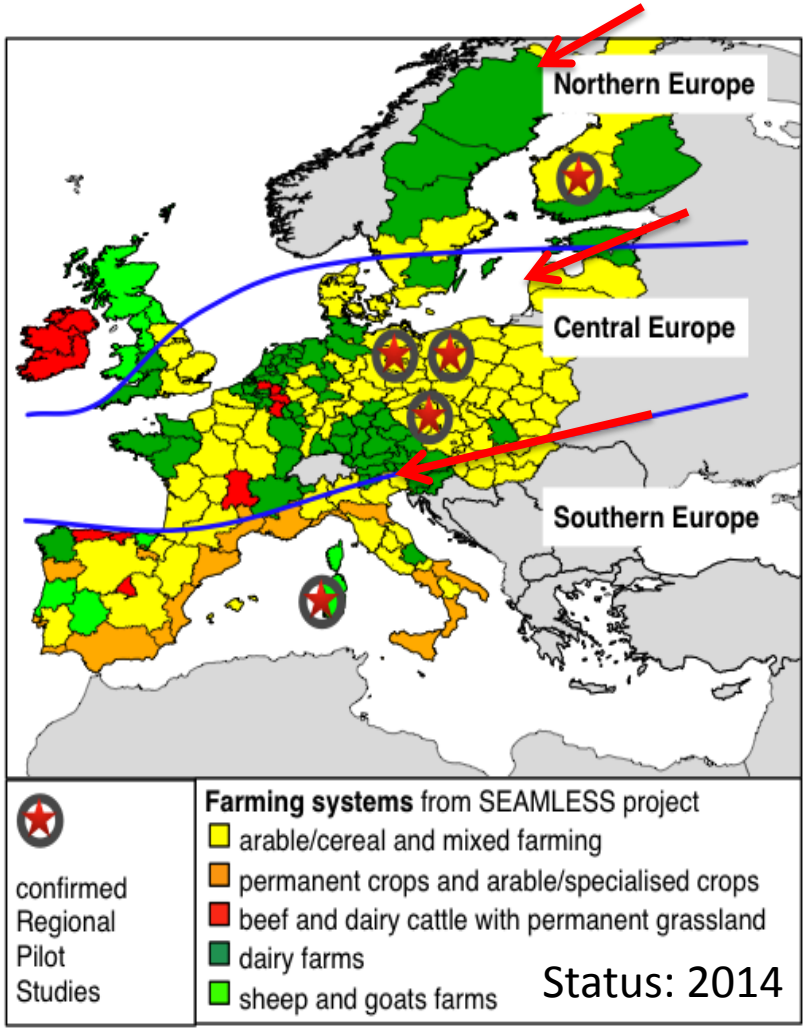



**Top:** New AgMIP-MACSUR Study, YGV: How does inter-annual variability of attainable yield affect the magnitude of yield gaps? *(Source: **Hoffmann, MP.,** et al, subm. to AgSystems)*

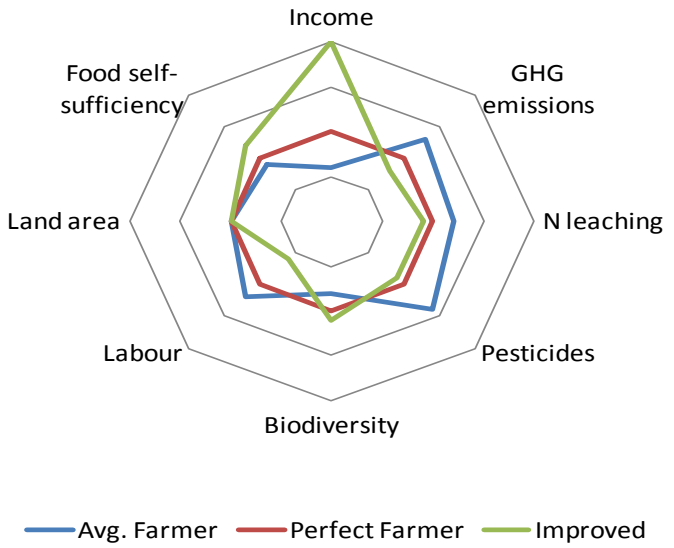
**Left:** Schematic representation showing the effects of extreme temperatures
*(Source: Porter & Semenov, 2005 adopted from IPCC 2001)*

# INTEGRIERTE REGIONALE STUDIEN ZUR KLIMAANPASSUNG




*Source: www.macsur.eu*

Vielfältige Bewertungsansätze von **Anpassungsmöglichkeiten** - eine Richtung ist die Aufstufung von mildernden Anpassungsoptionen von der Betriebsebene über regionale/nationale zu supranationalen Skalen - auch unter Berücksichtigung anderer Nachhaltigkeitsziele (siehe zB. www.mtt.fi/modags/)




Mehrere Zielführungen im Rahmen alternativer Management- / Ag-Technologien *Source: www.macsur.eu*

# GREATER PRODUCTION DAMAGE FROM MORE RECENT DROUGHTS – EL NINO 2015/16 IN SA

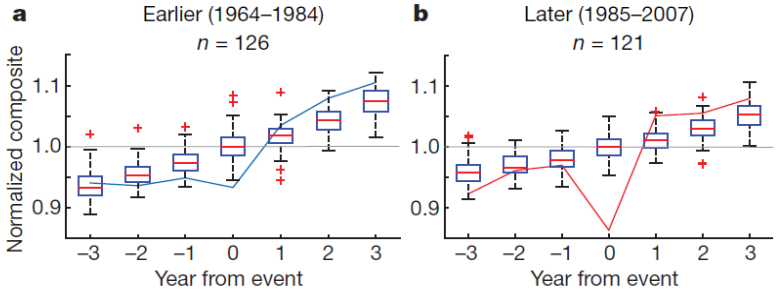
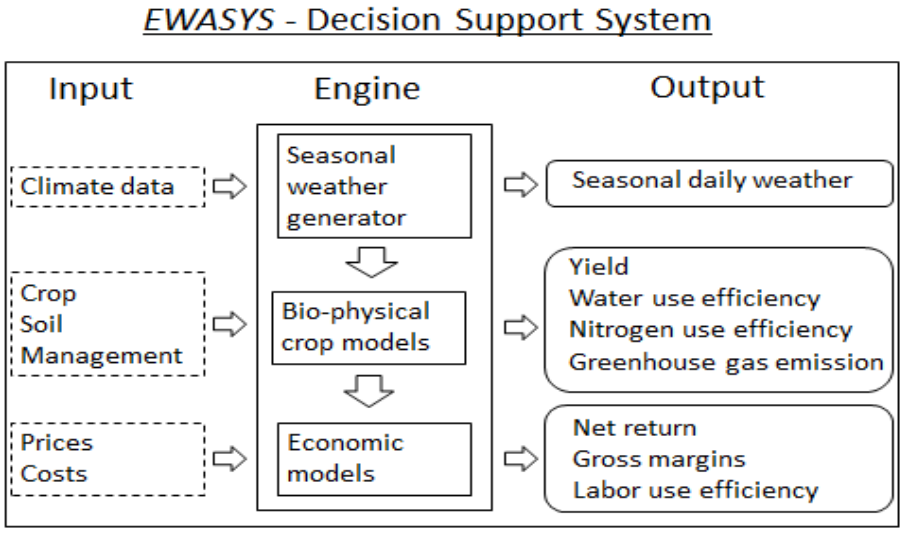
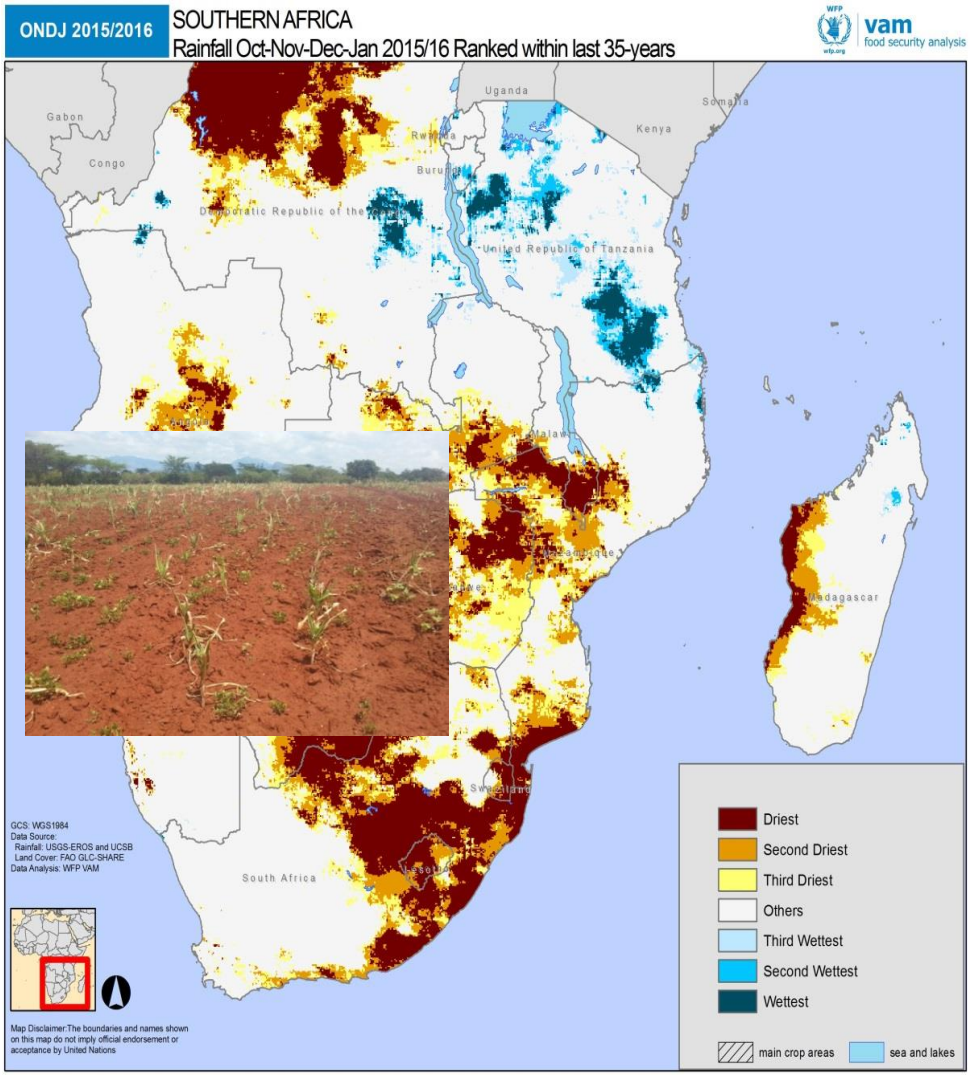



**Figure 5 | A temporal analysis of the influence of drought.** **a**, **b**, Production composites for earlier (1964–1984, $n = 126$) (**a**) and later (1985–2007, $n = 121$) (**b**) droughts, with boxplots of 100 respective control composites. In later instances, mean drought-year production losses were greater (13.7%) than in earlier instances (6.7%; $P = 0.008$, Kruskal–Wallis test). *(Source: Lesk et al. 2016, Nature)*




*(Source: **Rötter RP., Hoffmann MP.,** et al 2016 submitted)*



# PLANNED RESEARCH TOPICS
# TROPAGS 2017/18

- **Topic 1:** Climate risks and impact of extremes on crop production
- **Topic 2:** Climate change adaptation and mitigation options
- **Topic 3:** Utilizing genetic diversity and crop ideotyping to support breeding
- **Topic 4:** Smallholder food crop systems (cereals, legumes)
- **Topic 5:** Tropical perennial systems (cocoa, coffee, oil palm)
- **Topic 6:** Design and development of new crop model components and modelling frameworks
- **Topic 7:** Crop model improvement, evaluation and uncertainty analysis
- **Topic 8:** Integrated assessment and modelling (IAM) of agrifood systems

# RESEARCH PROJECTS ON TOPIC …

- **1+7: MACSUR /AgMIP** — Experimentation on heat and drought stress & publication of various special issues, e.g. „Crop impacts of climatic extremes“ ; assessment of uncertainties in impact modelling
- **1+2: ClimBar** — Model aided ideotyping of climate resilient barley cultivars
- **3: IMPAC3 follow-up** — Modelling genetic diversity and ecosystem services of intercropping
- **4: SPACES-LLL** — Completion and conductance of Master – and PhD – thesis on soil cultivation and soil carbon; food security; integration of results from subprojects; **ENAFRICA** – Sustainable management of smallholder cassava production systems Ghana
- **6: SPACES-LLL follow-ups** — Development of data platform CropM for large scale yield estimation; Early warning system for droughts and evaluation system for adaptation measures
- **8: LUSci** — Land Use Science – participation/design UGOE research cluster

Teff cultivation– Ziway, Ethiopia

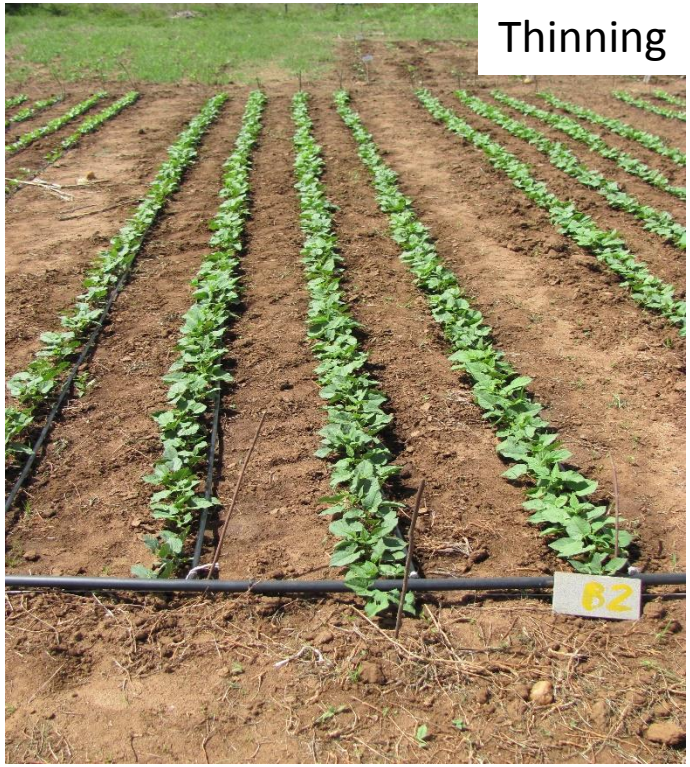
Teff threshing – Ziway, Ethiopia

Coffee farm – Mt. Elgon, Uganda

Low-input systems in semi-arid eastern Kenya

Sowing

Soil profile



Thinning

Weeding

Field trial with grain legumes – Machakos Kenya

Low-Input maize system – Limpopo, South Africa

22nd April 2015

6th June 2015

28th July 2015

19th August 2015

Cocao – Ghana

Cocoa harvest and extraction of cocoa beans for fermentation – Akumadan, Ghana

Cowpea in field trial –Hyderabad, India

Cowpea/pearl millet intercropping, field trial – Hyderabad India

Pearl millet field trial; scaring away birds with drums – Hyderabad, India

IRRI, Rice trial plots – Los Banos, Philippines

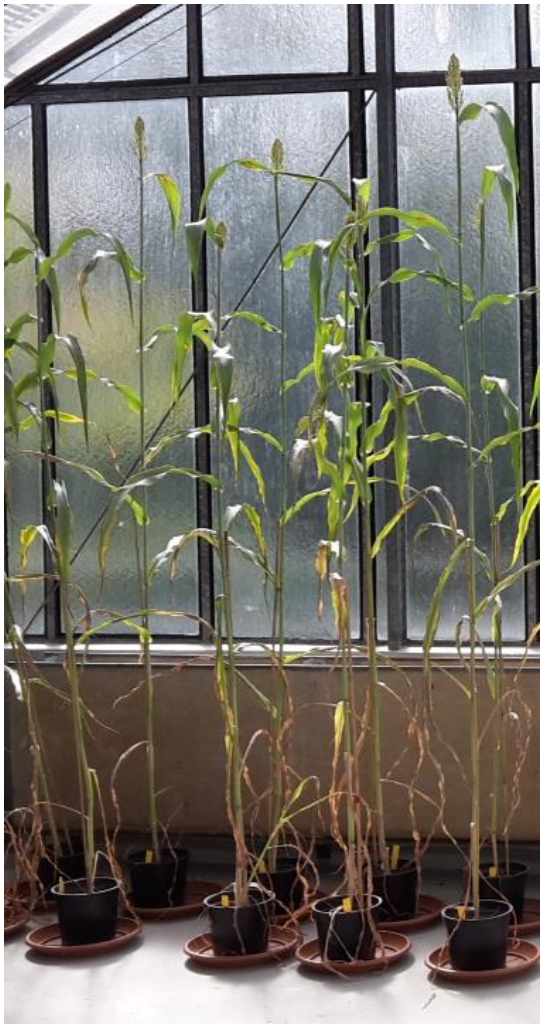
*©Photo: RPR, 2002*

Heat stress trial with sorghum – Greenhouse /DNPW Uni Göttingen



Heat stress trial with sorghum – Greenhouse /DNPW Uni Göttingen

Photosysnthesis measurements



Plants during drought stress

Leaf area measurement

Drought stress trial with sorghum – Greenhouse /DNPW Uni Göttingen

Dr. Esther Fichtler

Dr. Munir Hoffmann

William Nelson

Adriane Pape

Tom Österreicher

Prof. Dr. Reimund Rötter

Birgitt Bode

Issaka Abdulai

Alejandra Sarmiento Soler

Moira Mühlbauer

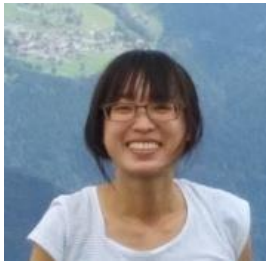
PD Dr. Martin Worbes

Ratunku Gabriel Lekalaka

Thomas Bringhenti

Dr. Ronald Kühne

Karina Schell



Dr. Hsiao-Hang Tao

Mercy Appiah

**https://www.uni-goettingen.de/de/106511.html**