Tropical Plant Production and Agricultural Systems Modelling (TROPAGS)

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

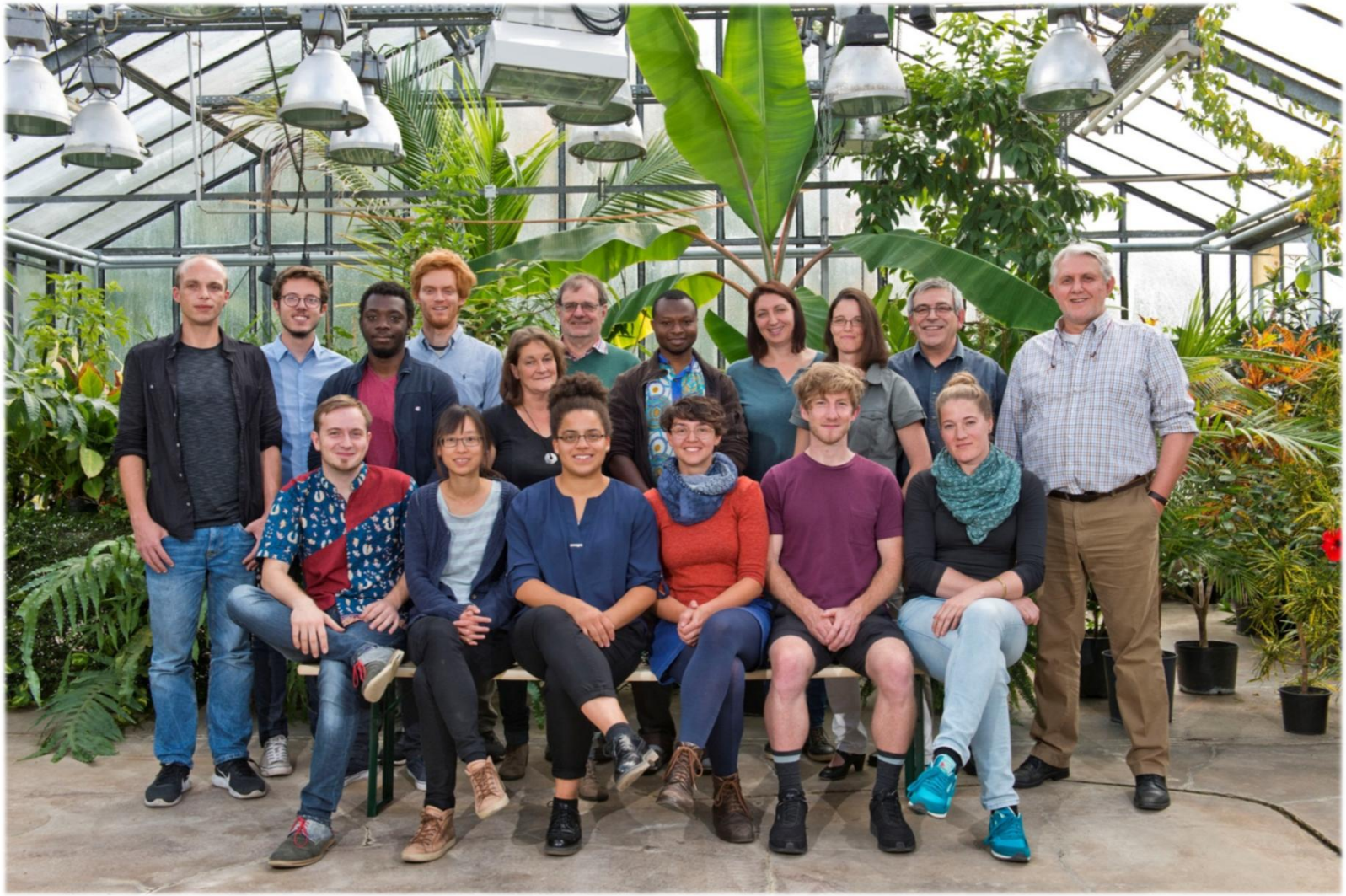
CONTENT

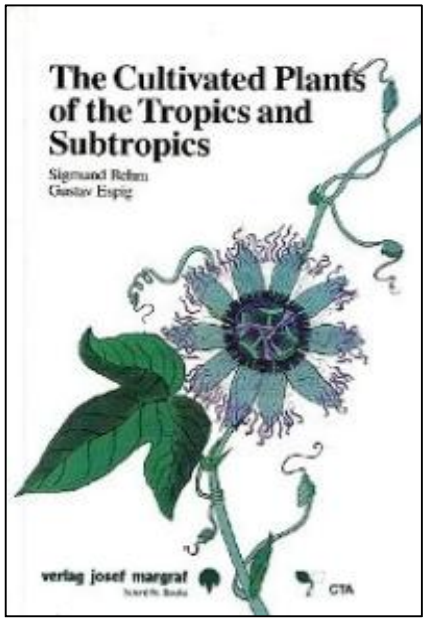
- Mission
- Team
- Teaching
- Research

MISSION

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

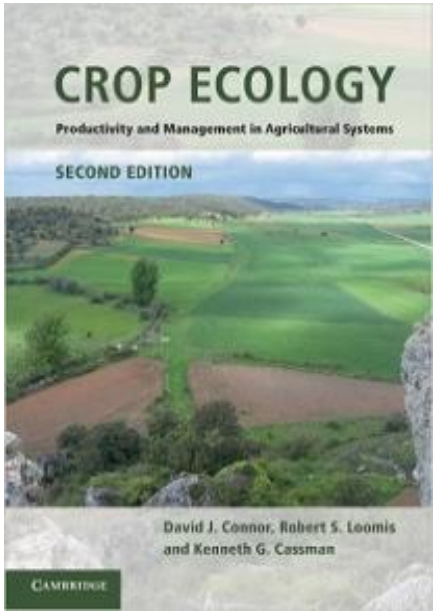
TEAM

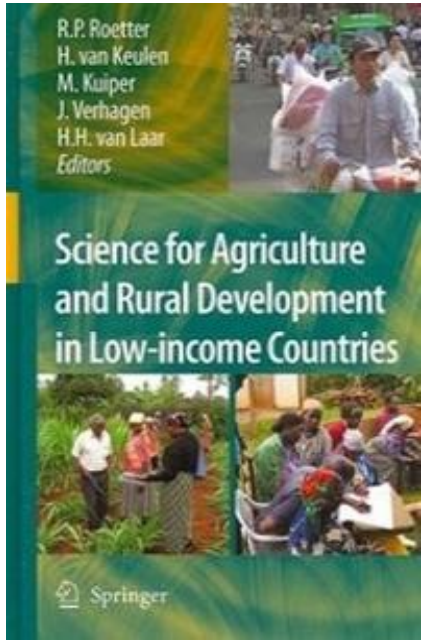


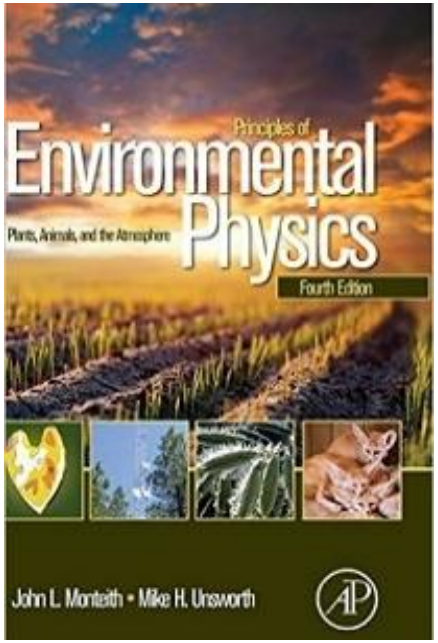


TEACHING

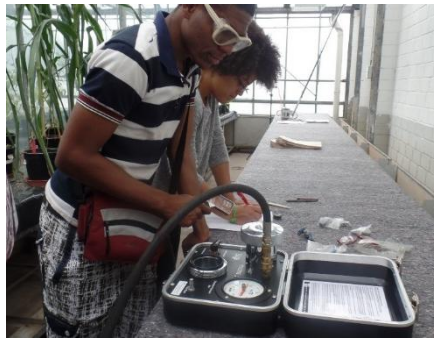
- Management of tropical plant production systems
- Introduction to tropical and international agriculture
- Tropical agro-ecosystem functions





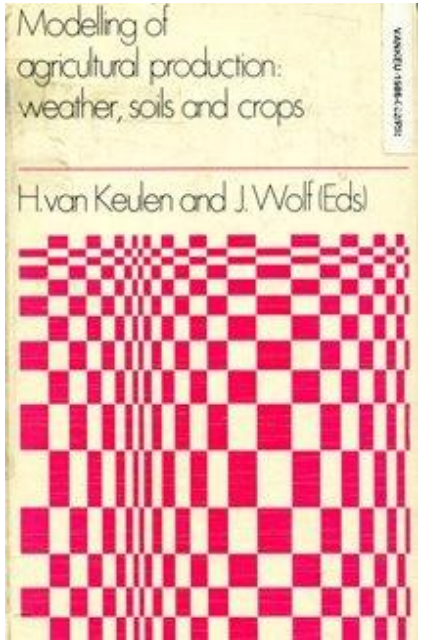


TEACHING

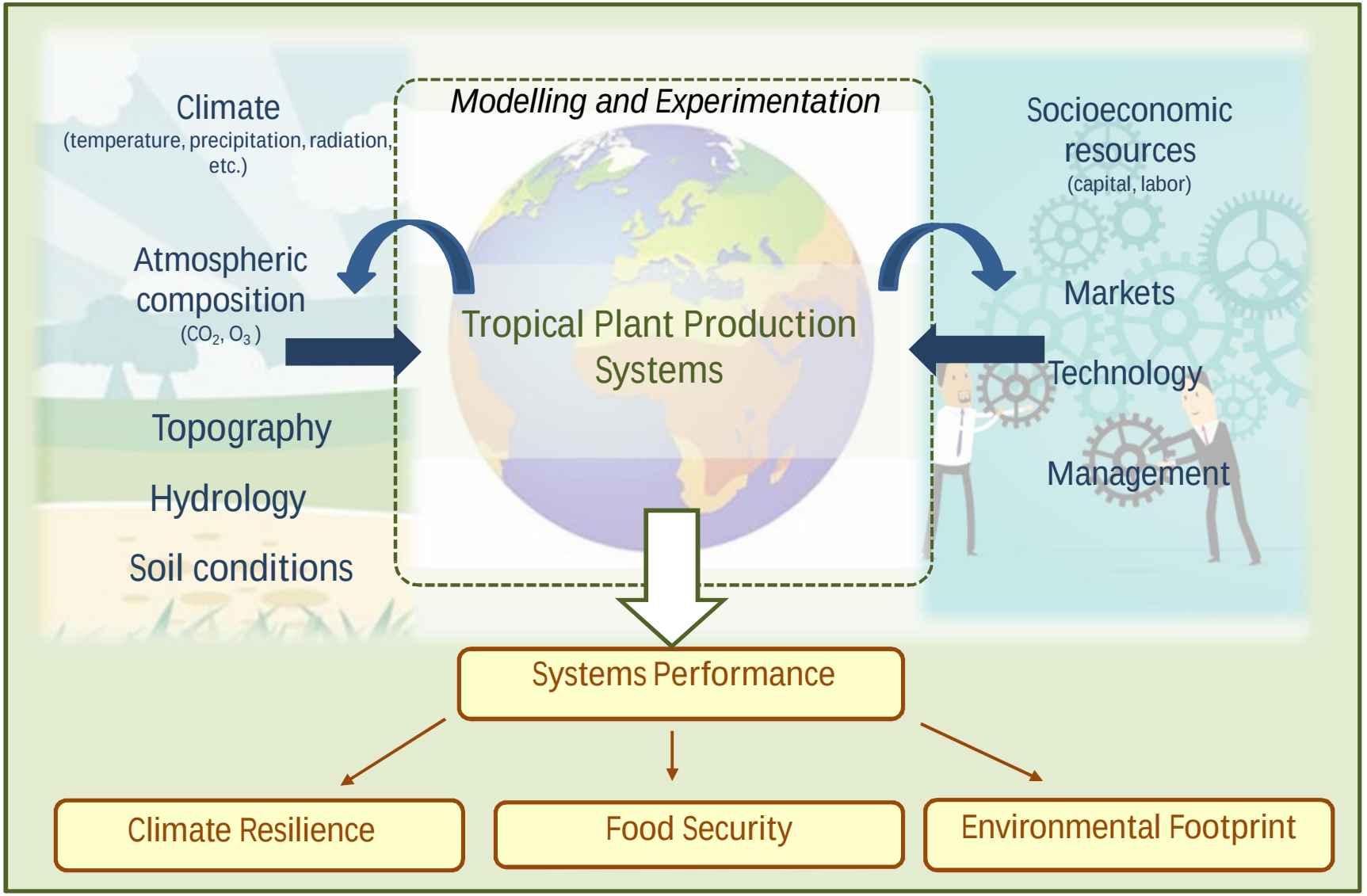


Measurment of water potential and scarification experiment, summer term 2016, Photos: E.K-D.,2016

- Crop modelling for risk management
- Experimental techniques in tropical agronomy
- Exercises: Acker- und pflanzenbauliche Übungen (bi-lingual)



RESEARCH – ANALYTICAL FRAMEWORK



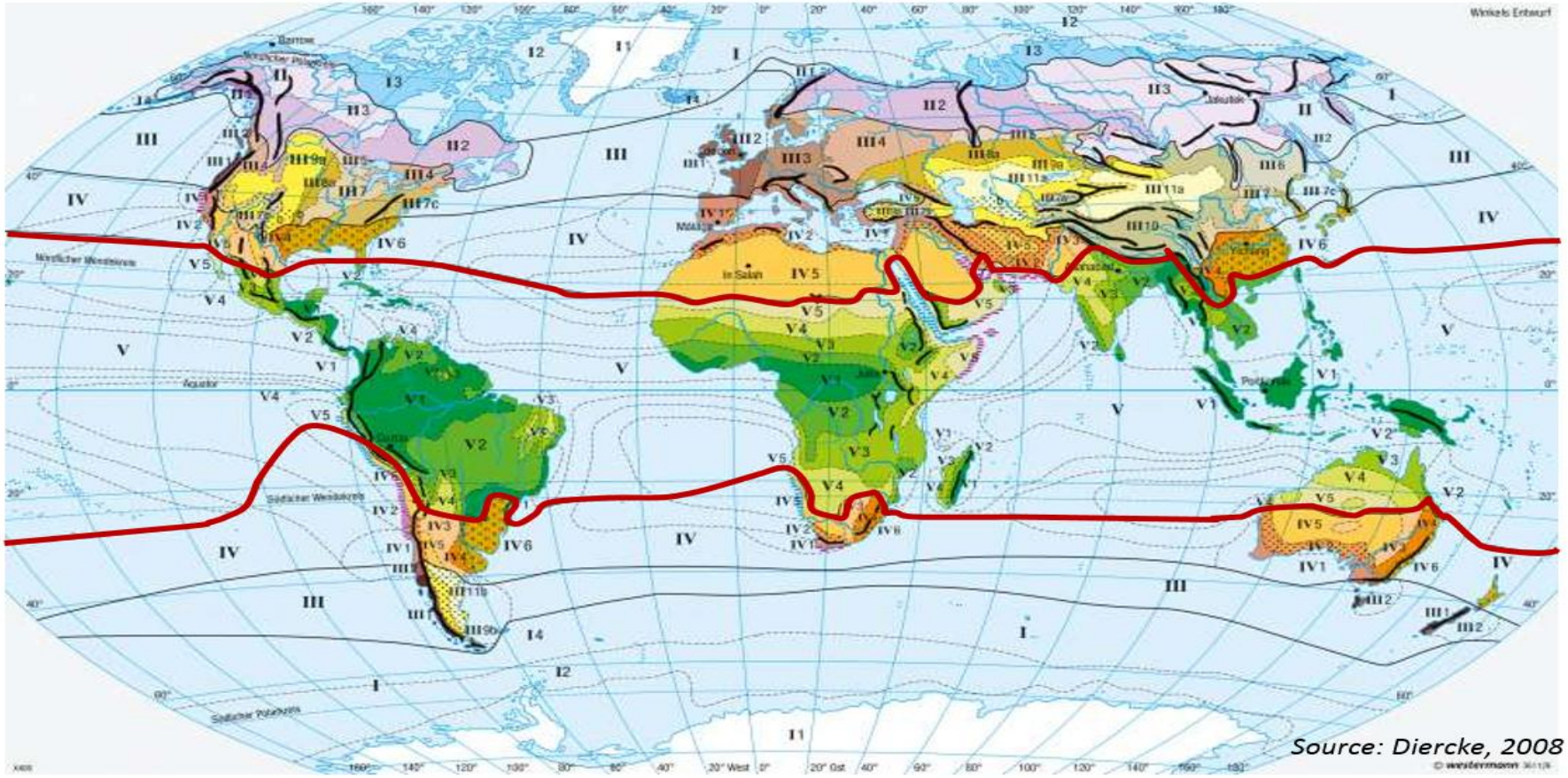
RESEARCH FOCI

- 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

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OUR PARTNERS

TROPAGS WEBPAGE

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

PROJECTS WITH (FORMER) 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 - Novel genotypes for mixed cropping allow for IMProved sustainable land use ACross arable land, grassland and woodland

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ALEJANDRA SARMIENTO SOLER

Alejandra,
Colombia

Research Topic:

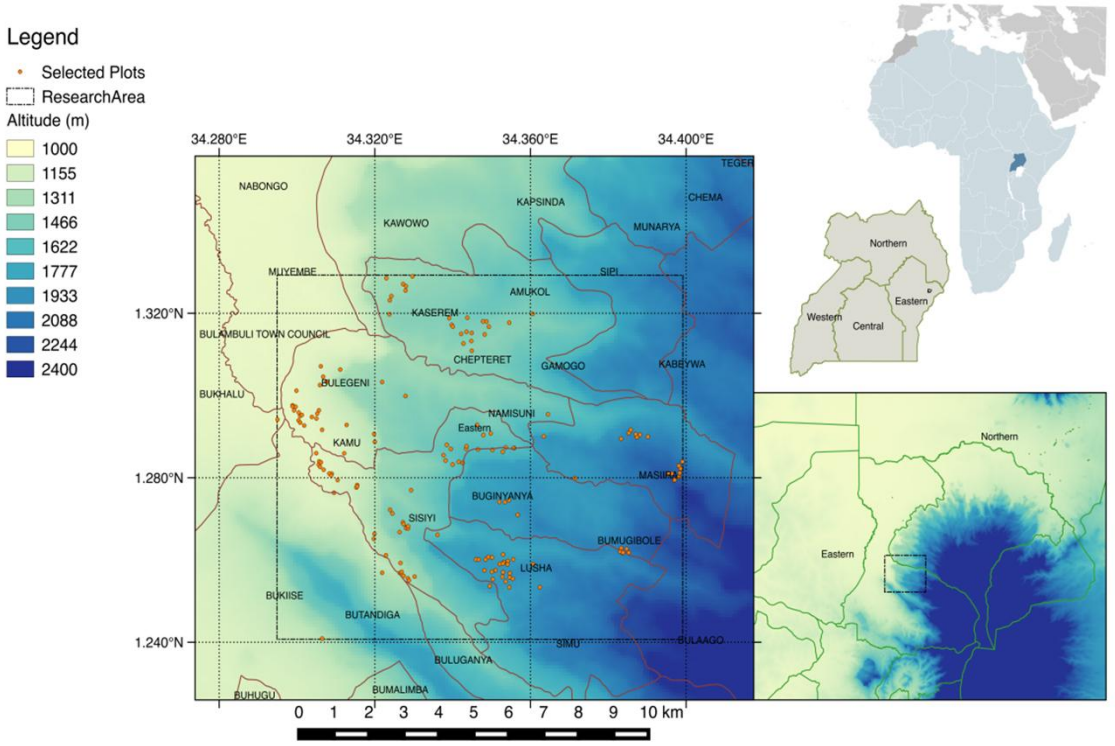
Trade-offs and synergies in climate change adaptation and mitigation in coffee and cocoa systems

Bundesministerium für
wirtschaftliche Zusammenarbeit
und Entwicklung

OBJECTIVES

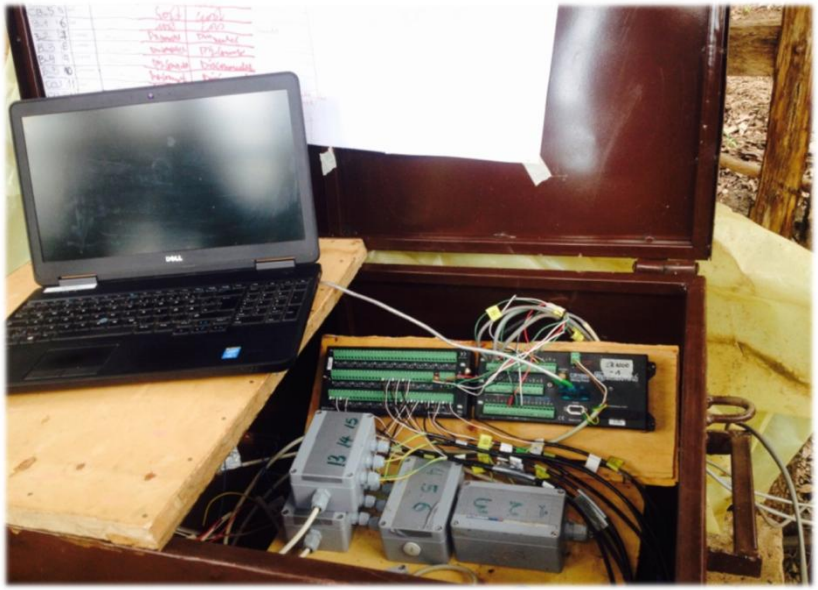
Identifying opportunities for climate adaptation and increased resilience of coffee cultivation systems through:

- 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



Photos: A. Sarmiento, 2015

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

Photos: A. Sarmiento, 2015

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DR. ISSAKA ABDULAI

Issaka,
Ghana

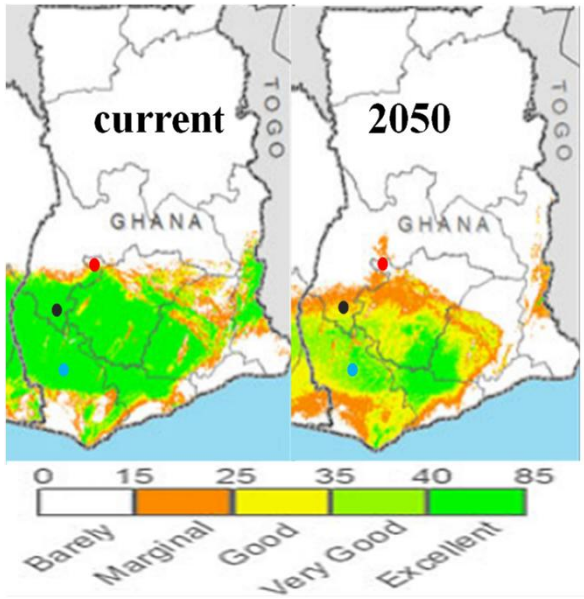
Research Topic:

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)

Photos: I. Abdulai, 2012

Precipitation and soil water measurements – Asnakragua, Ghana

Photos: I. Abdulai, 2015

Transportation to research location – Asnakragua, Ghana

Photo: I. Abdulai, 2014

DR. WILLIAM NELSON

William, 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

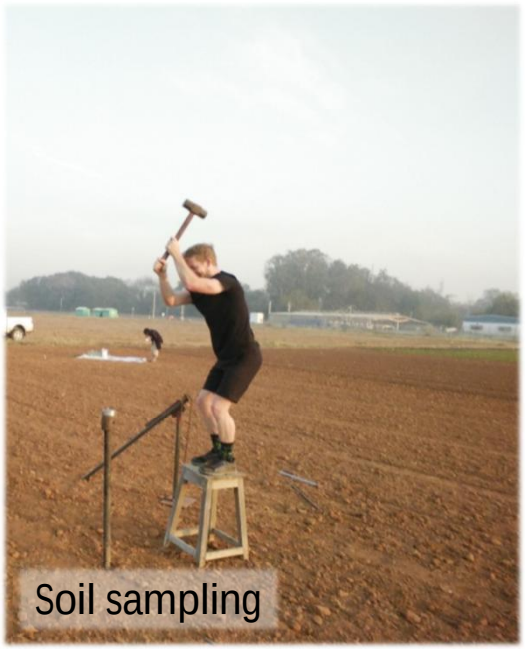
Stem height measurement

Trial plots, ICRISAT campus, India

Photos: W. Nelson/K. Schell, 2016

Field trial – Hyderabad, India


Crop upper limit tent


Soil sampling


Weeding


Data collection

Photos: W. Nelson/ K. Schell, 2016

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Field Trial – Experimental Station Reinshof

Photos: W. Nelson, 2015


Cowpea-pearl millet intercropping


Soil sampling


Millet pest


Data collection

Field trial – Niger

Photos: W. Nelson, 2016

DR. RATUNKU GABRIEL LEKALAKALA

Gabriel, Limpopo, South Africa

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?

Photos: G. Lekalakala, 2012

RESEARCH PROJECTS AND COOPERATIONS

AgMIP

SIA

Limpopo Living Landscapes

UNIVERSITY OF HELSINKI

IMPAC³

barista
FOR SUSTAINABLE BARLEY

CBL
Centre of Biodiversity
and sustainable Land Use

SUSTAg

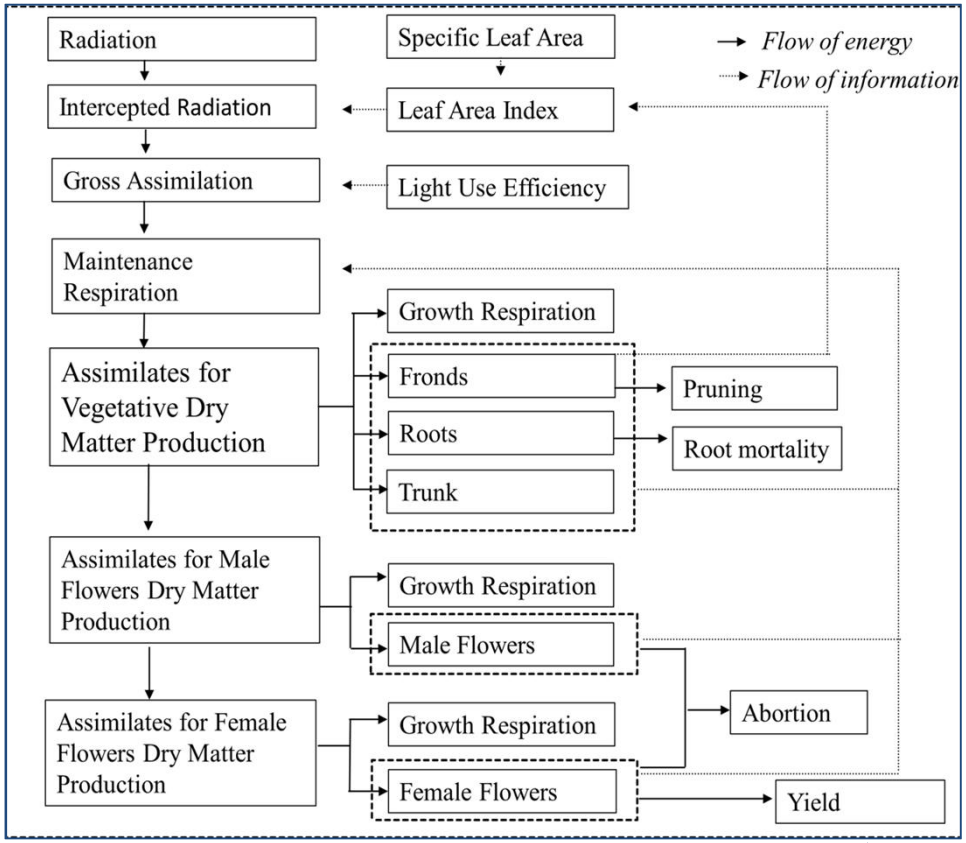
MACSUR

Bundesministerium für
wirtschaftliche Zusammenarbeit
und Entwicklung

IPNI

SALLnet

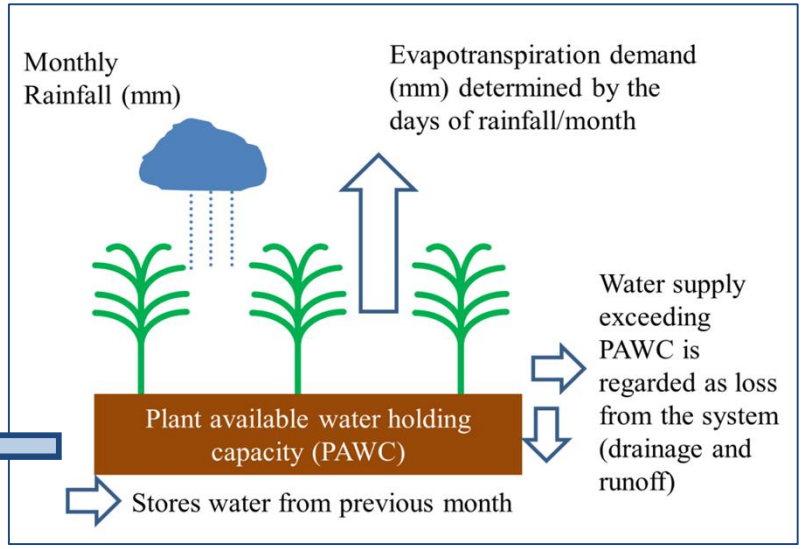
PALMSIM - A PLANT GROWTH MODEL



WAGENINGEN UNIVERSITY & RESEARCH

IPNI INTERNATIONAL PLANT NUTRITION INSTITUTE

Webinar about PALMSIM:
https://www.youtube.com/watch?v=r4oVtaoNVuU



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 - SALLNET

Follow-up project of SPACES - Limpopo Living Landscapes

Mission

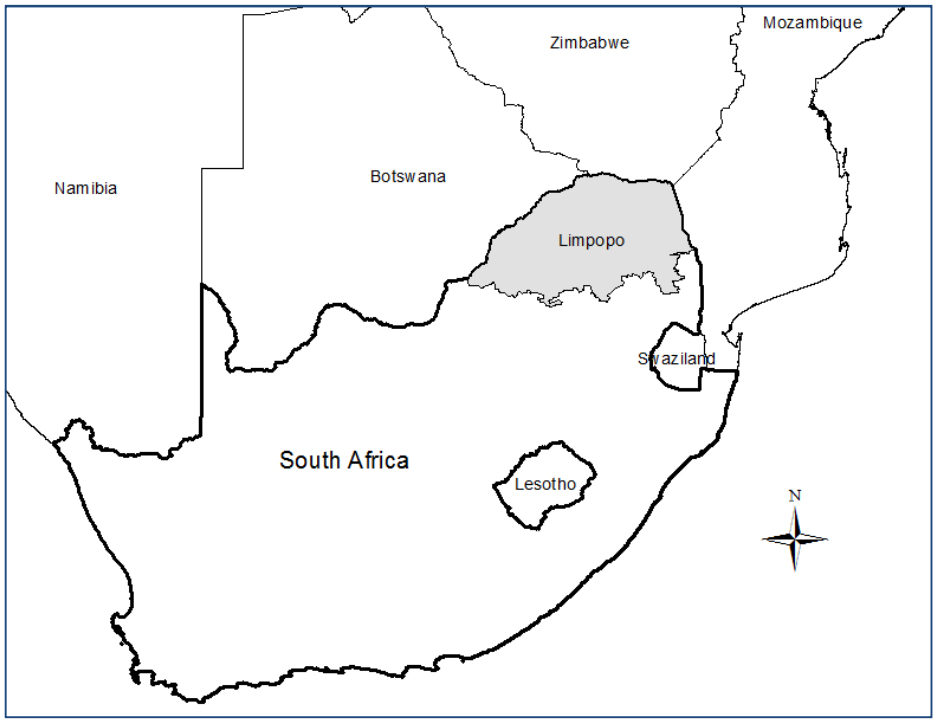
Enhancing the food security, multi-functionality and resilience of South African Limpopo landscapes under global change.

Photos: C. Westphal

SPACES – SALLNET

SALLnet Kick-off Meeting in Göttingen, 2018

SPACES – LIMPOPO LIVING LANDSCAPES



Source: M. Hoffman; data from www.gadm.org

Photo: M.Hoffman, 2016

Bundesministerium
für Bildung
und Forschung

UNIVERSITY OF LIMPOPO

University of Venda
Creating Future Leaders

Limpopo Living Landscapes

Field survey – Limpopo, South Africa

Photo: E. Fichtler, 2013

SUMMARY OF

ONGOING RESEARCH ACTIVITIES

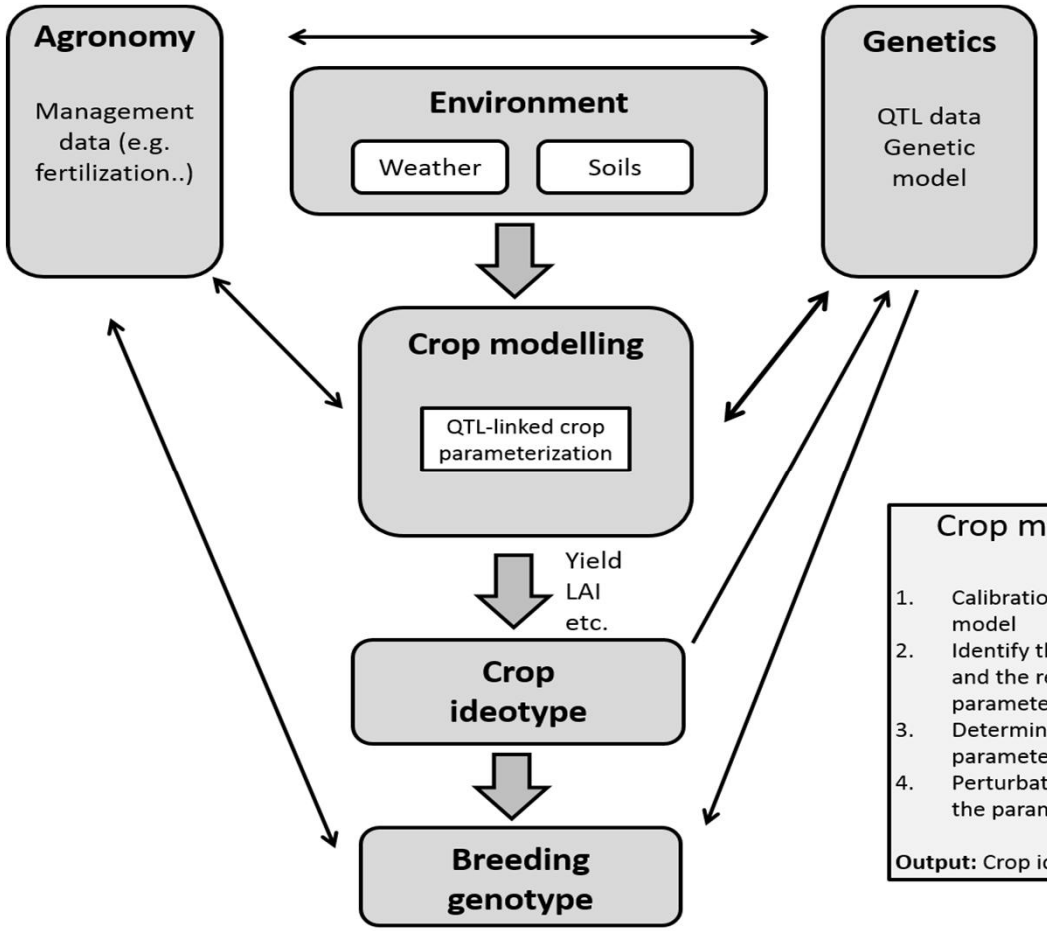
AT TROPAGS

ONGOING RESEARCH PROJECTS

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

METHODOLOGY DEVELOPMENT AND APPLICATION

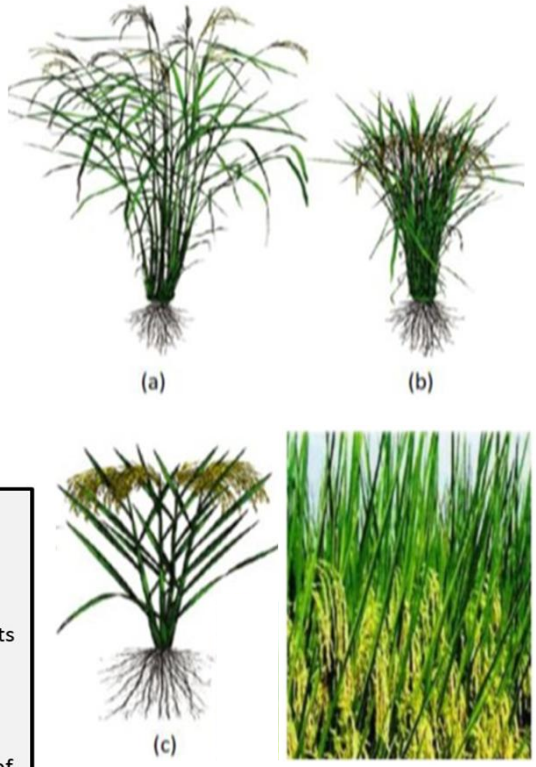
Model aided ideotyping of climate resilient crop cultivars



Crop modelling steps

1. Calibration and validation crop model
2. Identify the key phenotypic traits and the related crop model parameters
3. Determine the ranges of the parameters
4. Perturbation and optimization of the parameters

Output: Crop ideotypic traits



Source: Rötter RP., et al. 2015 (JEXBOT)

MACSUR/AGMIP

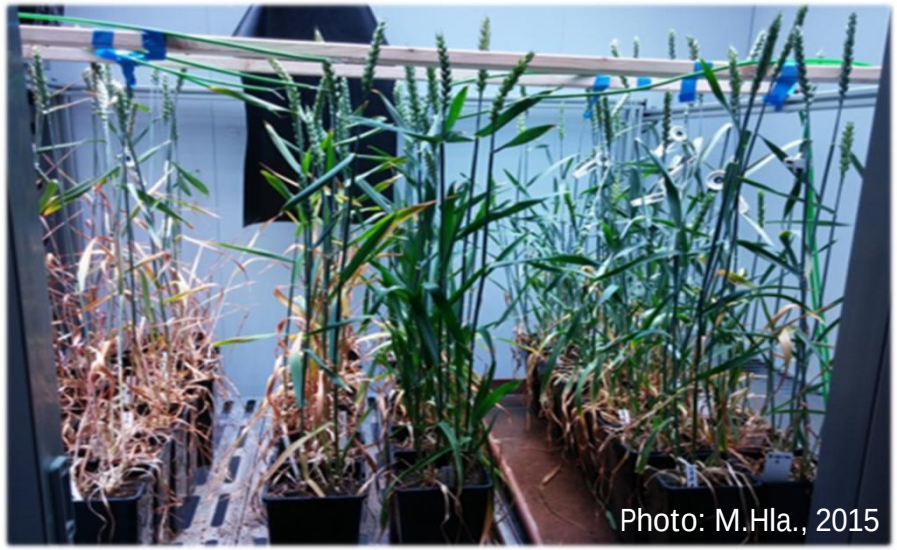
Experimentation to improve models for better quantification of extreme weather effects

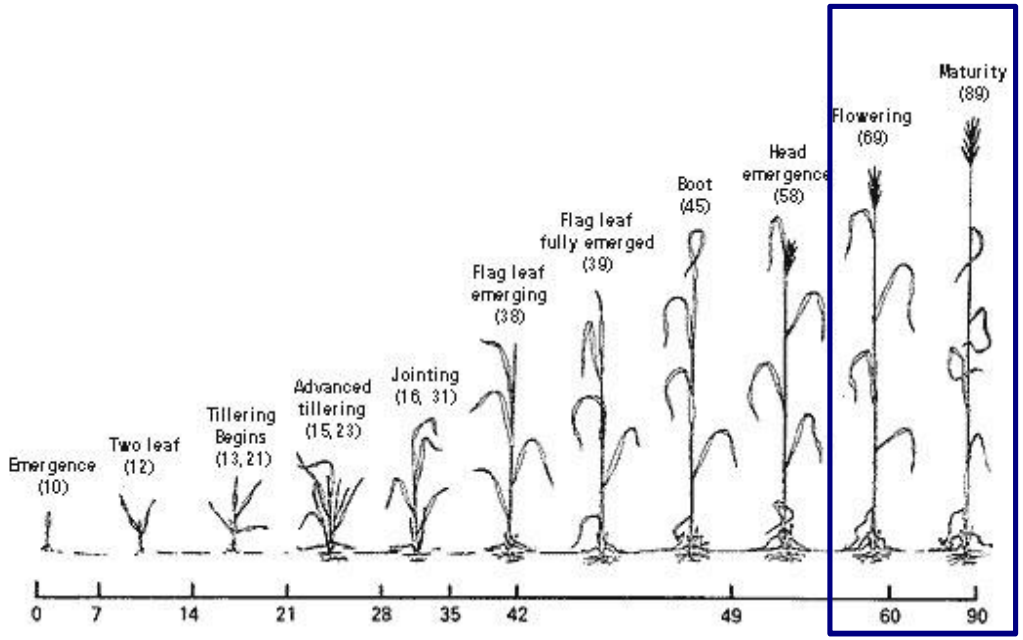


Photos: E. Fichtler., B. Bode, 2016

Why wheat experiments?

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

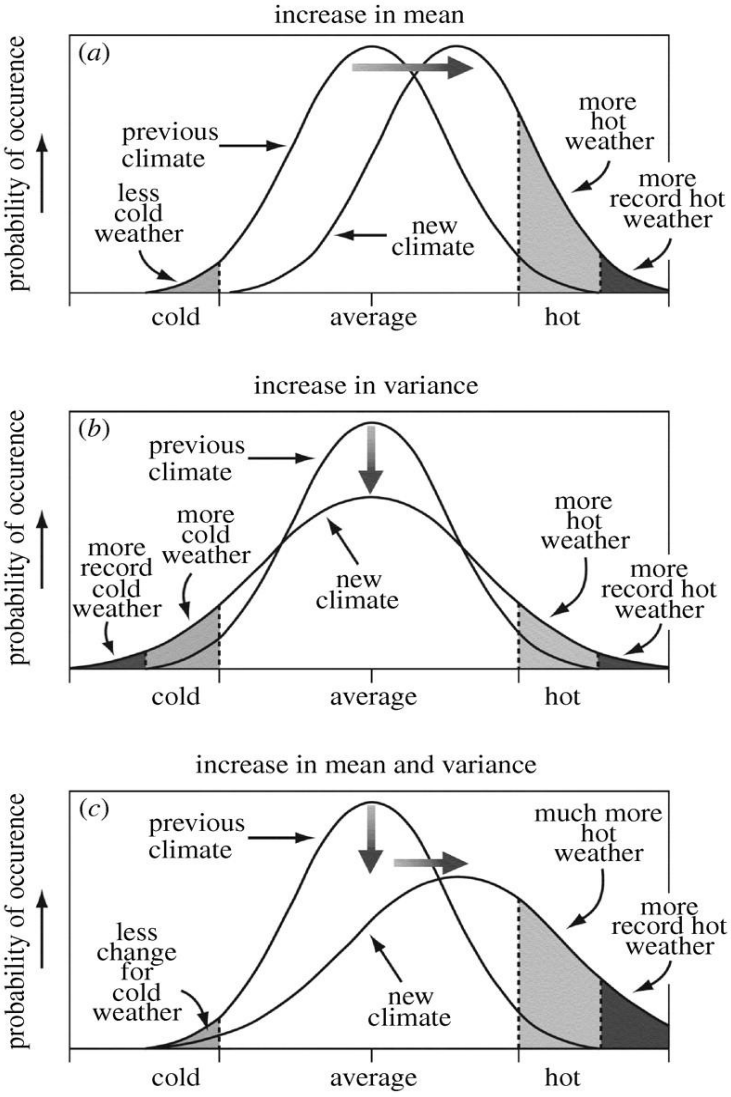


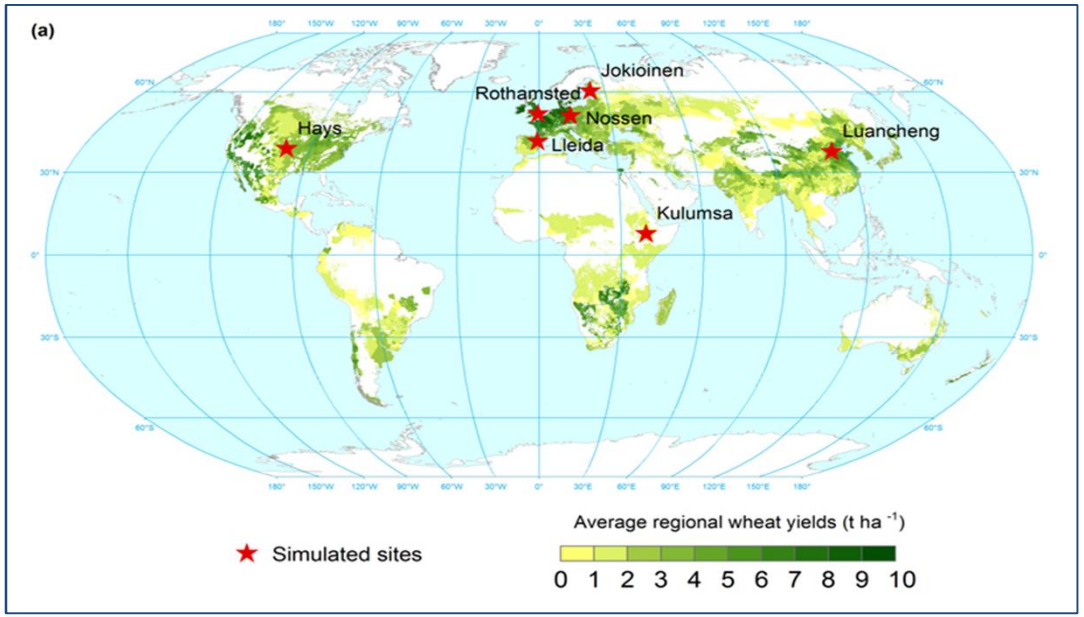


Why heat and drought stress?

- 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

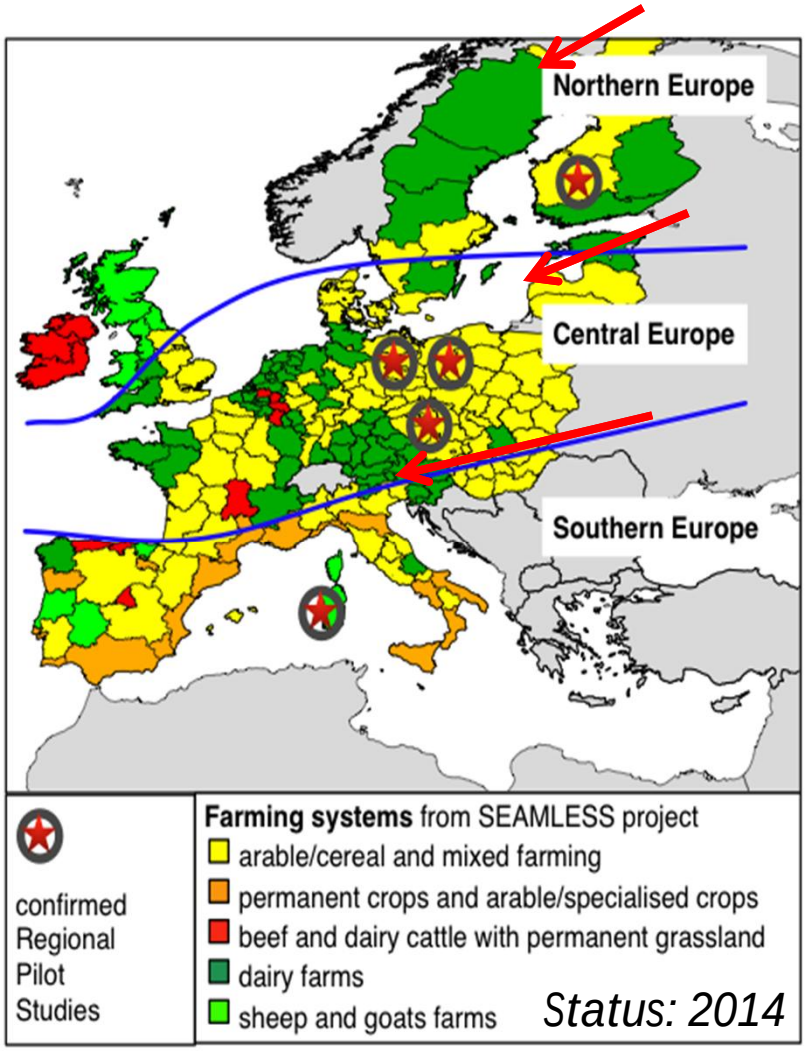




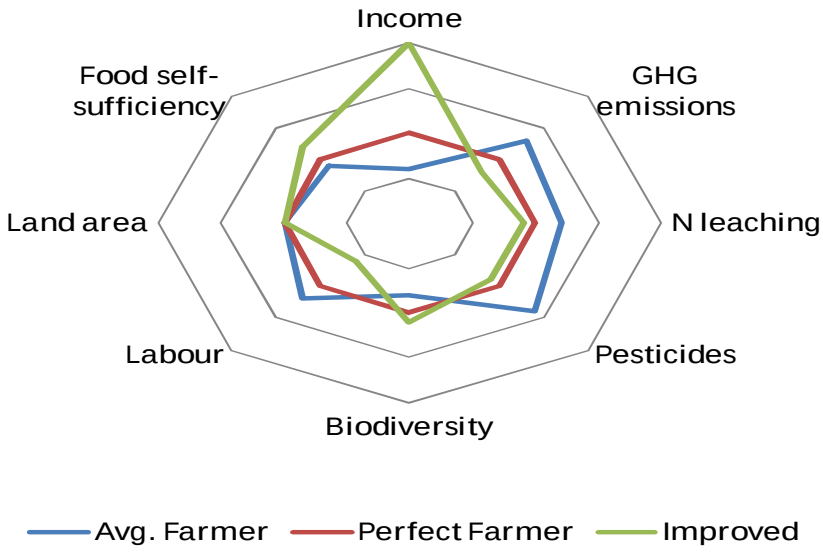
Top: New AgMIP-MACSUR Study, YGV: How does inter-annual variability of attainable yield affect the magnitude of yield gaps? (Source: Hoffmann, MP., et al., subm. to AgSystems)

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

INTEGRATED REGIONAL ASSESSMENTS FOR CLIMATE ADAPTATION



Multitude of appoaches for assessing adaptation options – one direction is upscaling from farm level (for typical farm types) of mitigative adaptation options via region/national to supra-national scales – also taking into account other Sustainable Development Goals (see, e.g. www.mtt.fi/modags/)



Multiple goal achievements under alternative management/ag-technologies

www.macsur.eu

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

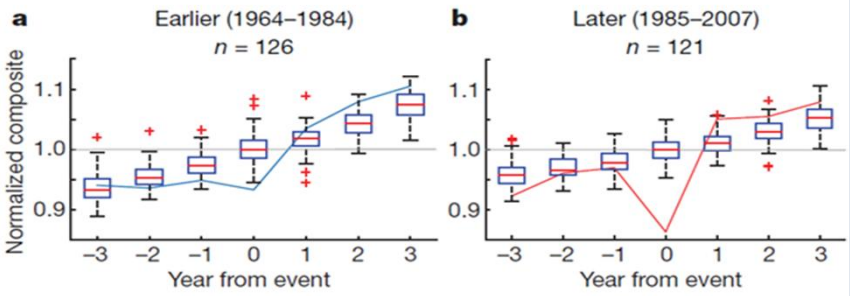
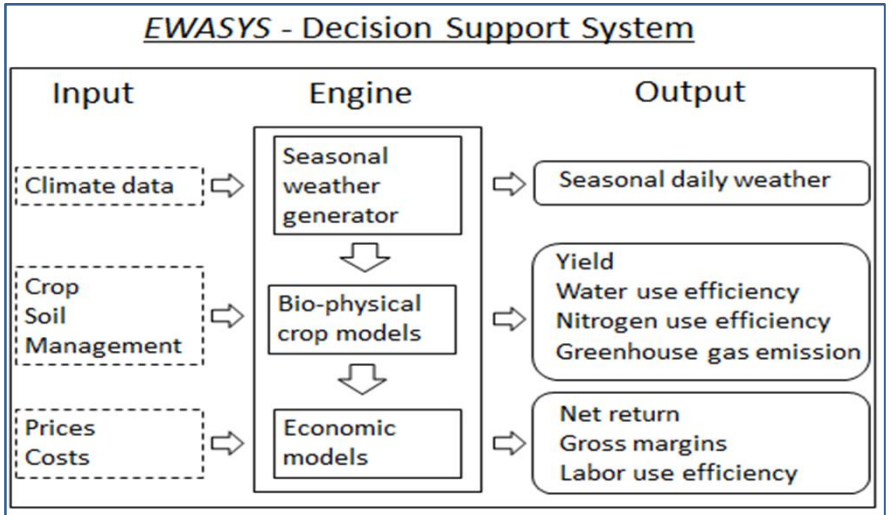
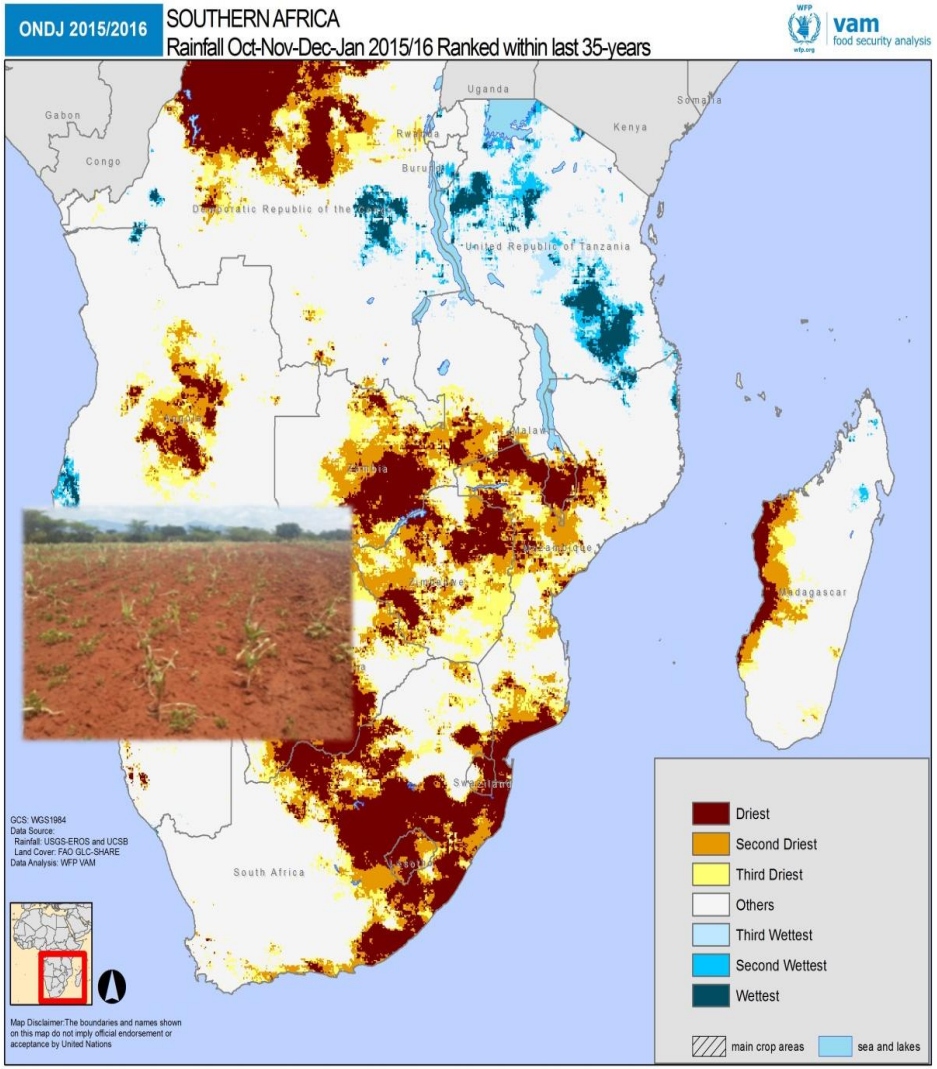


Figure 5 | A temporal analysis of the influence of drought. **a**, **b**, Production composites for earlier (1964–1984, $n = 126$) (**a**) and later (1985–2007, $n = 121$) (**b**) droughts, with boxplots of 100 respective control composites. In later instances, mean drought-year production losses were 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)



PLANNED RESEARCH TOPICS
TROPAGS 2019/20

- 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 system

RESEARCH PROJECTS ON TOPIC ...

v 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
v 1+2: ClimBar	Model aided ideotyping of climate resilient barley cultivars
v 3: IMPAC^3	Modelling genetic diversity and ecosystem services of intercropping
v 4: SPACES-SALLnet	Completion and conductance of Master- and PhD-theses on soil cultivation and soil carbon; food security; integration of results from subprojects; ENAFRICA – Sustainable management of smallholder cassava production systems Ghana
v 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

Teff cultivation– Ziway, Ethiopia

Photo: R. Rötter, 2002

Teff threshing – Ziway, Ethiopia

Photo: R. Rötter, 2002

Coffee farm – Mt. Elgon, Uganda

Photo: M. Pyrek, 2015

Low-input systems in semi-arid eastern Kenya

Photo: A. Sennhenn, 2013

Field trial with grain legumes – Machakos, Kenya

Photo: A. Sennhenn, 2013

Low-Input maize system – Limpopo, South Africa

Photo: M. Hoffmann, 2015

22nd April 2015

6th June 2015

28th July 2015

19th August 2015

Cocao – Ghana

Photos: I. Abdulai, 2012

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

Photos: I. Abdulai, 2012

Cowpea in field trial –Hyderabad, India

Photo: W. Nelson, 2015

Cowpea/pearl millet intercropping, field trial – Hyderabad India

Photo: W. Nelson, 2016

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

Photo: W. Nelson, 2016

IRRI, Rice trial plots – Los Banos, Philippines

Photo: R. Rötter, 2002

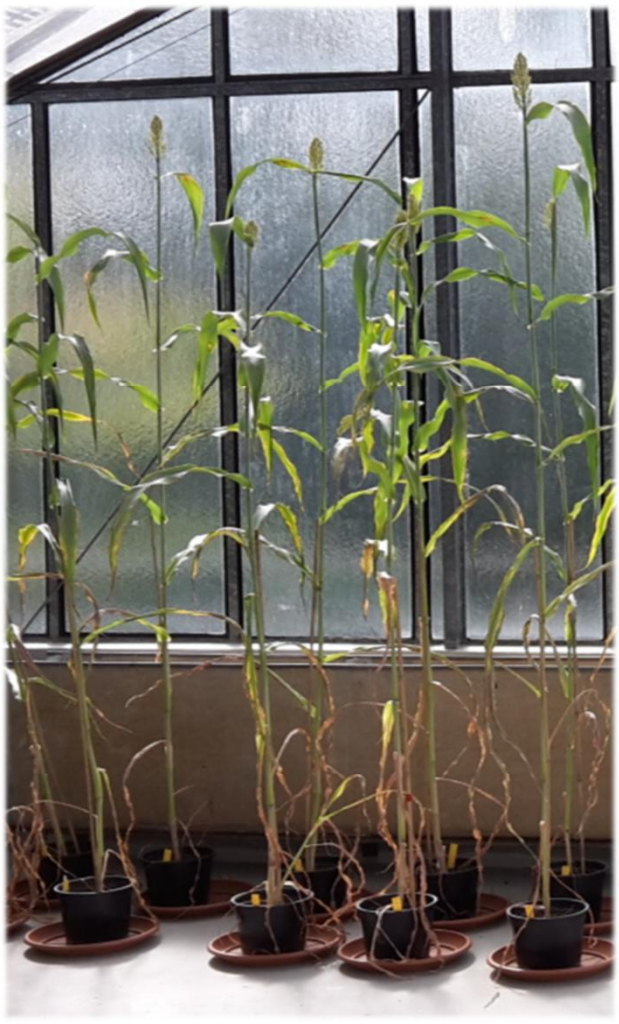
Heat stress trial with sorghum – Greenhouse /DNPW Uni Göttingen

Photo: B. Bode, 2016

Heat stress trial with sorghum – Greenhouse /DNPW Uni Göttingen

Photo: B. Bode, 2016

Photosynthesis measurements



Plants during drought stress

Leaf area measurement

Drought stress trial with sorghum – Greenhouse /DNPW Uni Göttingen

Photos: B. Bode, 2016

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