Celebrating 30 years of
integrated climate impact research
at the Potsdam Institute.

Climate Services in Agriculture

Final EPICC Workshop

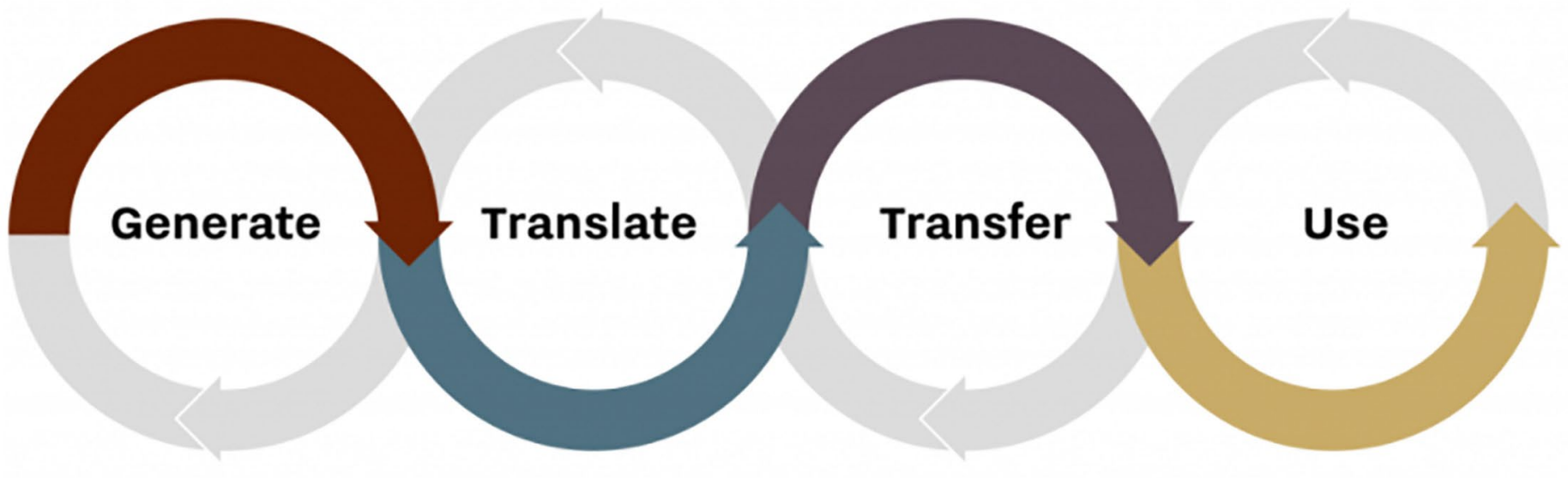
Rahel Laudien, Christoph Gornott, Abel Chemura, Ponraj Arumugam

22 June 22

Session: Climate Services in Agriculture

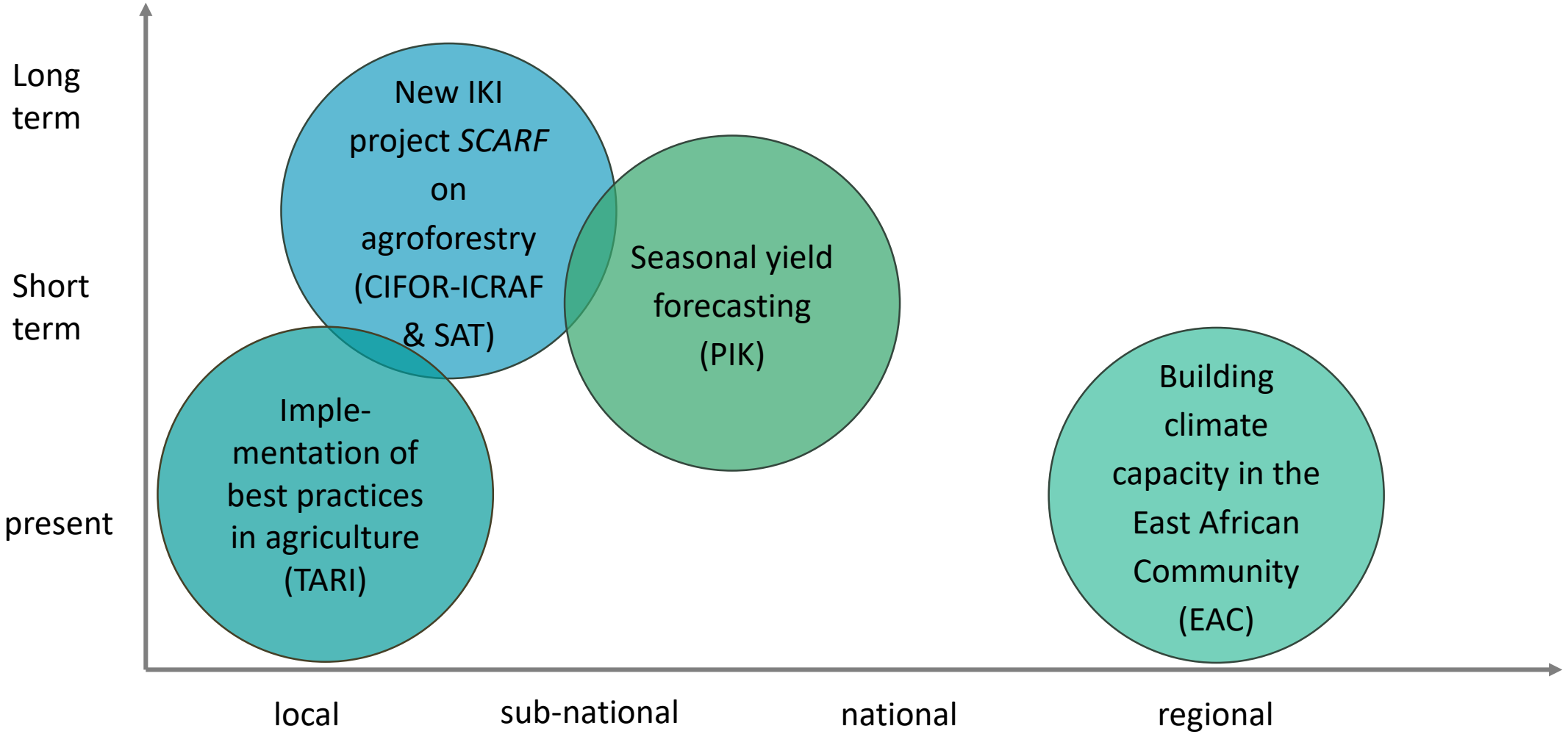
Climate information to support climate risk management in agriculture at different spatial scales

Climate services involve different processes



› Providing useful information to support decision-making on climate adaptation

Climate services are needed at different scales



Agenda session

- **Mr. Elirehema Swai**, Tanzania Agricultural Research Institute Makutupora (TARI)

Climate information to support the implementation of best practices in agriculture at the local level in Tanzania

- **Ms. Rahel Laudien**, Potsdam Institute for Climate Impact Research (PIK)

Seasonal yield forecasting to anticipate risks in agriculture

- **Mr. Valerian Kidole**, East African Community (EAC)

Building climate capacities and supporting the harmonization of data in agriculture in the East African Community

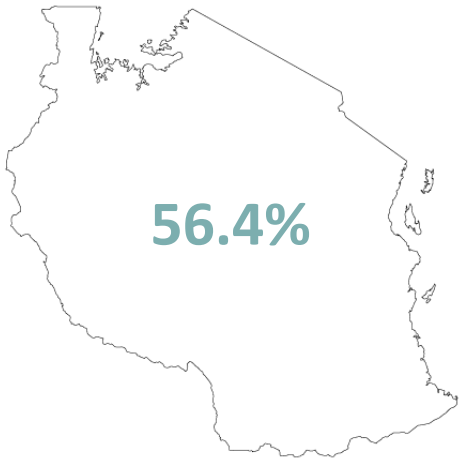
- **Mr. Emmanuel Temu**, World Agroforestry (CIFOR-ICRAF) & **Yohana Haule**, Sustainable Agriculture Tanzania (SAT)

Presentation of new IKI project "Scaling agroforestry for holistic climate resilience-building in rural Tanzania" (SCARF)

Seasonal yield forecasting to anticipate risks in agriculture

Rahel Laudien (Potsdam Institute for Climate Impact Research (PIK)

Why forecasting yields?



People affected by moderate or severe food insecurity (FAOstat 2018-2020)

› Yield forecasts can help to take actions before the food crises occurred.

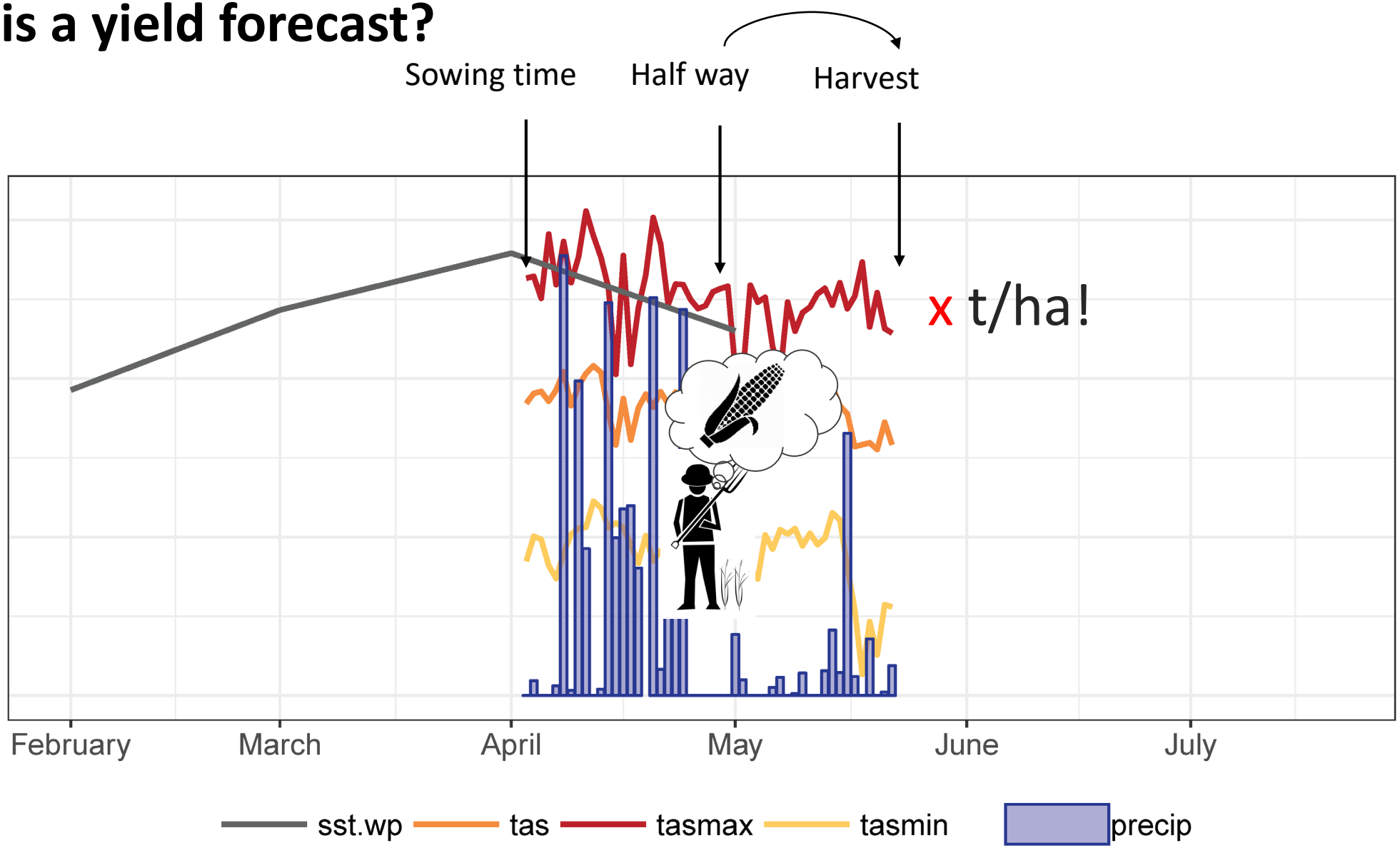
› Yield forecasts can be used to:

  › adjust food imports and exports

  › organise food aid

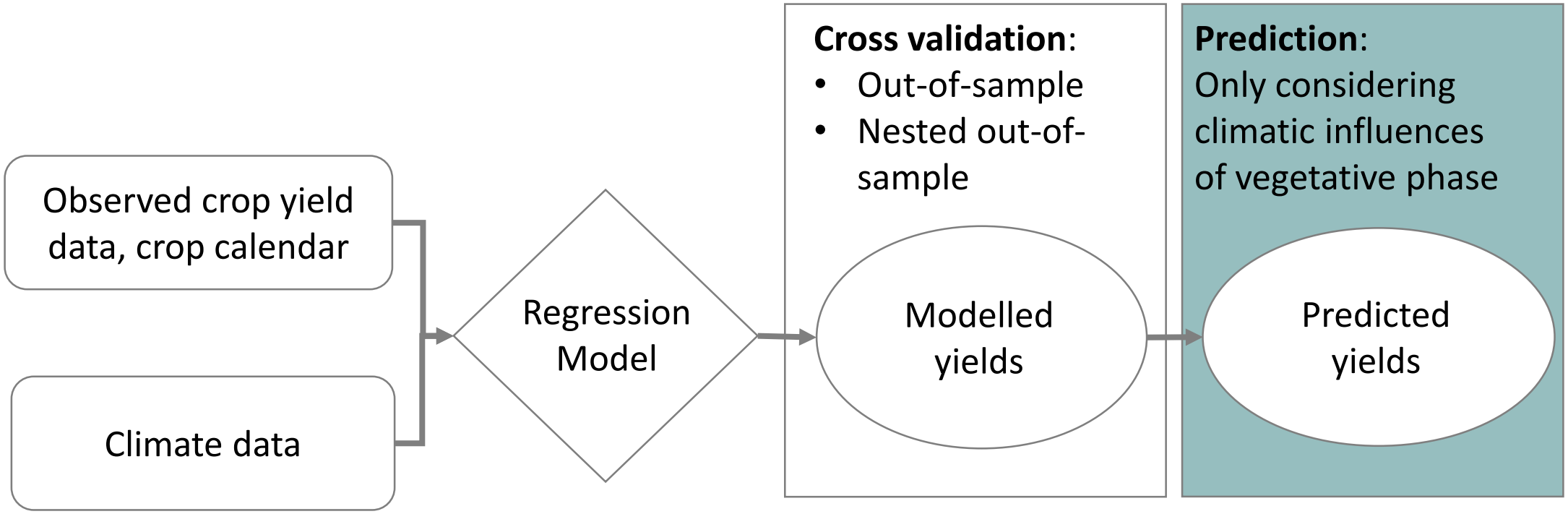
→ Yield forecasts can improve food security.

What is a yield forecast?

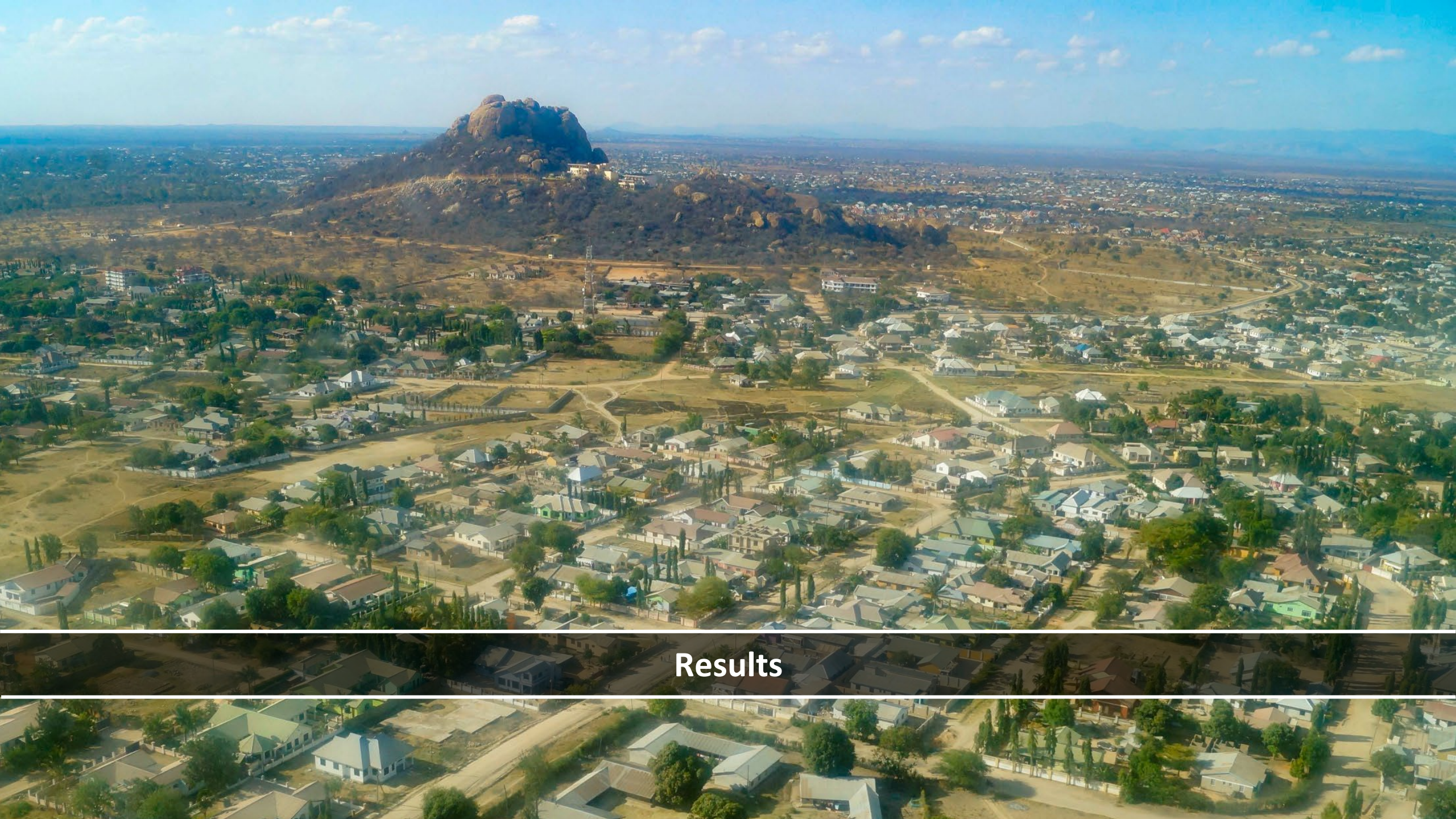


Methodology

Statistical crop model driven by climate influences



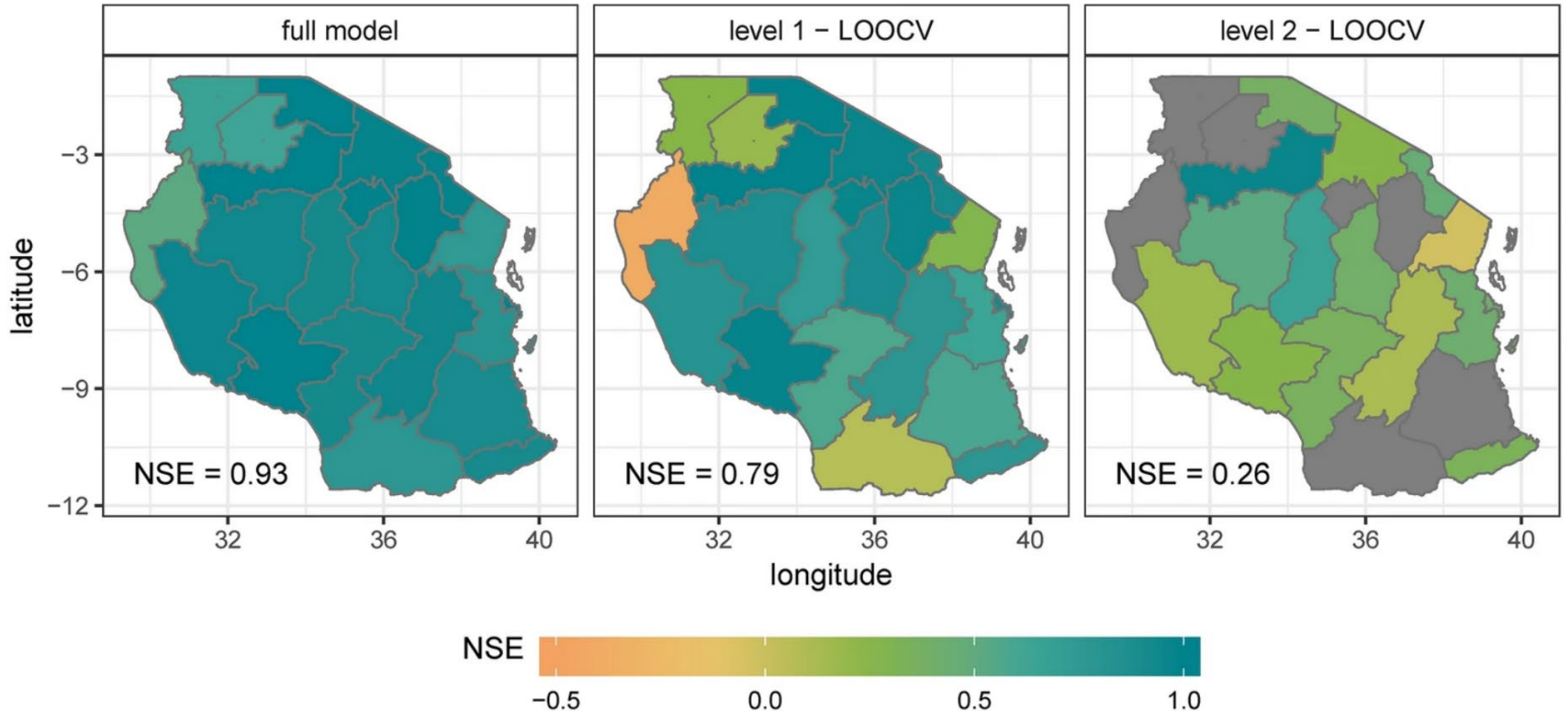
› Novel approach: Rigorous and transparent validation based on a two-stage validation to gain certainty in the skill of the forecast.



Results

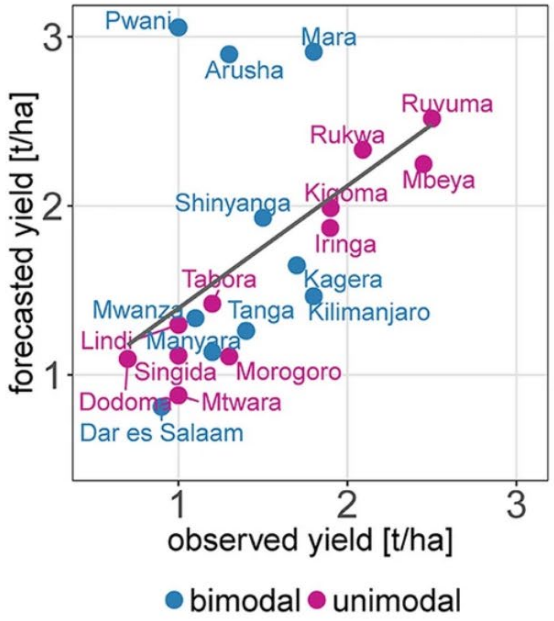
Main findings

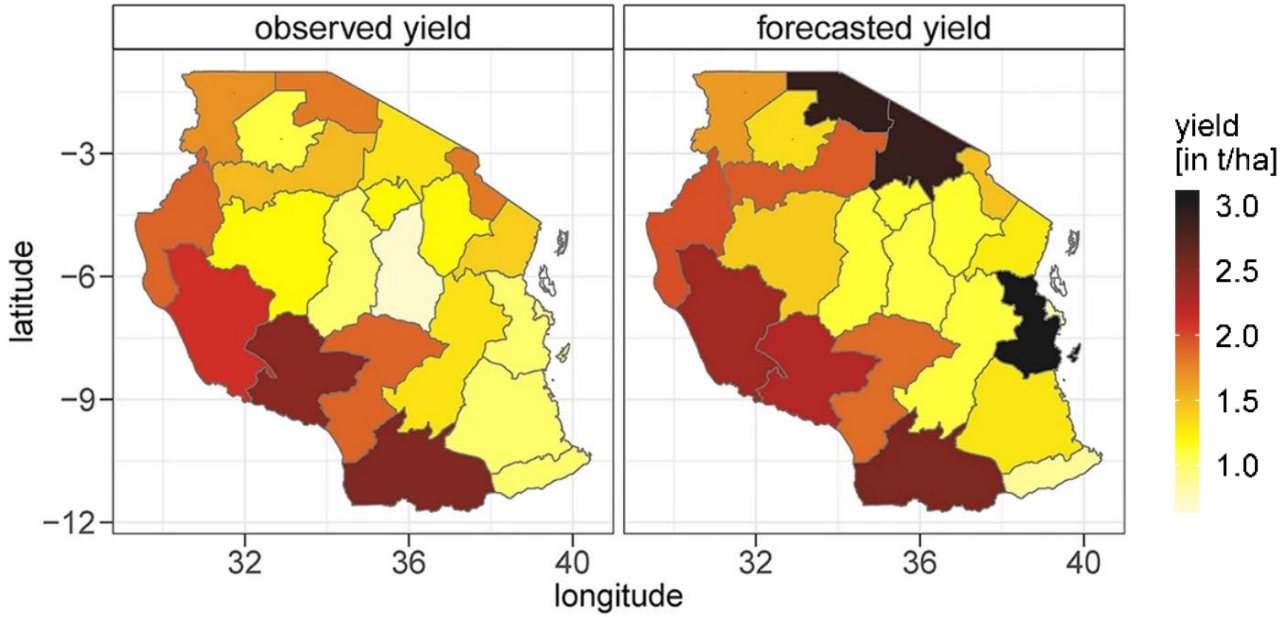
- High forecasting performance even with only 10 years of observed yield data used in training
- First nested out-of-sample validation applied for crop yield models
- Best predictor: cdd5 → high influence of extreme weather conditions on maize yields



Main findings

- Independent forecast for year 2019 reveals high performance for unimodal regions
- North and coastal regions might be impacted by the outbreak of the fall armyworm

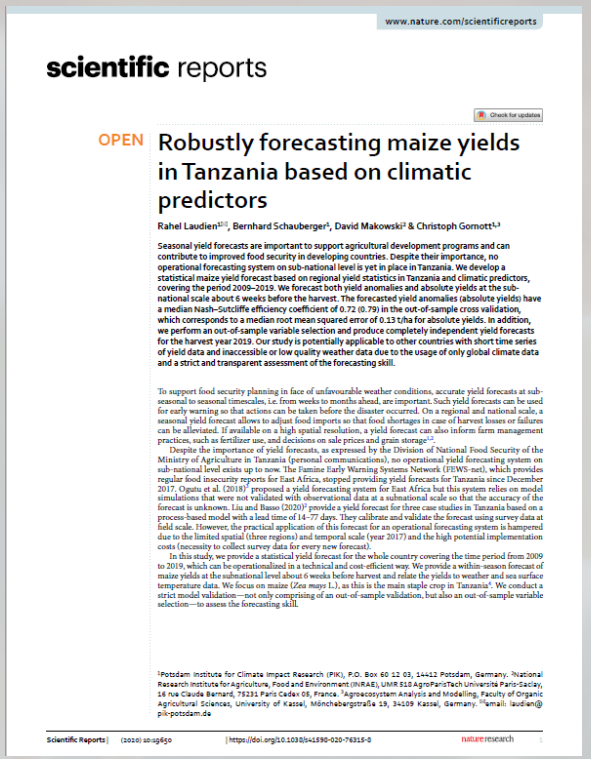




	unimodal (n = 11)		bimodal (n = 10)	
Level 2 – LOOCV	NSE =	0.89	NSE =	-7.73
	R^2 =	0.90	R^2 =	0.03
	RMSE =	0.21	RMSE =	0.92

Distribution of results & follow up

Publication in Nature Scientific Reports



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scientific reports

OPEN

Robustly forecasting maize yields in Tanzania based on climatic predictors

Rahel Laudien[1,2], Bernhard Schauberger[1], David Makowski[2] & Christoph Gornott[1,3]

Seasonal yield forecasts are important to support agricultural development programs and can contribute to improved food security in developing countries. Despite their importance, no operational forecasting system on sub-national level is yet in place in Tanzania. We develop a statistical maize yield forecast based on regional yield statistics in Tanzania and climatic predictors, covering the period 2009–2019. We forecast both yield anomalies and absolute yields at the sub-national scale about 6 weeks before the harvest. The forecasted yield anomalies (absolute yields) have a median Nash–Sutcliffe efficiency coefficient of 0.72 (0.79) in the out-of-sample cross validation, which corresponds to a median root mean squared error of 0.13 t/ha for absolute yields. In addition, we perform an out-of-sample variable selection and produce completely independent yield forecasts for the harvest year 2019. Our study is potentially applicable to other countries with short time series of yield data and inaccessible or low quality weather data due to the usage of only global climate data and a strict and transparent assessment of the forecasting skill.

To support food security planning in face of unfavourable weather conditions, accurate yield forecasts at sub-seasonal to seasonal timescales, i.e. from weeks to months ahead, are important. Such yield forecasts can be used for early warning so that actions can be taken before the disaster occurred. On a regional and national scale, a seasonal yield forecast allows to adjust food imports so that food shortages in case of harvest losses or failures can be alleviated. If available on a high spatial resolution, a yield forecast can also inform farm management practices, such as fertilizer use, and decisions on sale prices and grain storage[1,2].

Despite the importance of yield forecasts, as expressed by the Division of National Food Security of the Ministry of Agriculture in Tanzania (personal communications), no operational yield forecasting system on sub-national level exists up to now. The Famine Early Warning Systems Network (FEWS-net), which provides regular food insecurity reports for East Africa, stopped providing yield forecasts for Tanzania since December 2017. Ogutu et al. (2018)[3] proposed a yield forecasting system for East Africa but this system relies on model simulations that were not validated with observational data at a subnational scale so that the accuracy of the forecast is unknown. Liu and Basso (2020)[4] provide a yield forecast for three case studies in Tanzania based on a process-based model with a lead time of 14–77 days. They calibrate and validate the forecast using survey data at field scale. However, the practical application of this forecast for an operational forecasting system is hampered due to the limited spatial (three regions) and temporal scale (year 2017) and the high potential implementation costs (necessity to collect survey data for every new forecast).

In this study, we provide a statistical yield forecast for the whole country covering the time period from 2009 to 2019, which can be operationalized in a technical and cost-efficient way. We provide a within-season forecast of maize yields at the subnational level about 6 weeks before harvest and relate the yields to weather and sea surface temperature data. We focus on maize (*Zea mays* L.), as this is the main staple crop in Tanzania[5]. We conduct a strict model validation—not only comprising of an out-of-sample validation, but also an out-of-sample variable selection—to assess the forecasting skill.

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Authors:

- Rahel Laudien
- Bernhard Schauberger
- David Makowski
- Christoph Gornott

Title: Robustly forecasting maize yields in Tanzania based on climatic predictors

Accepted: October 2020

Journal: Nature Scientific Reports

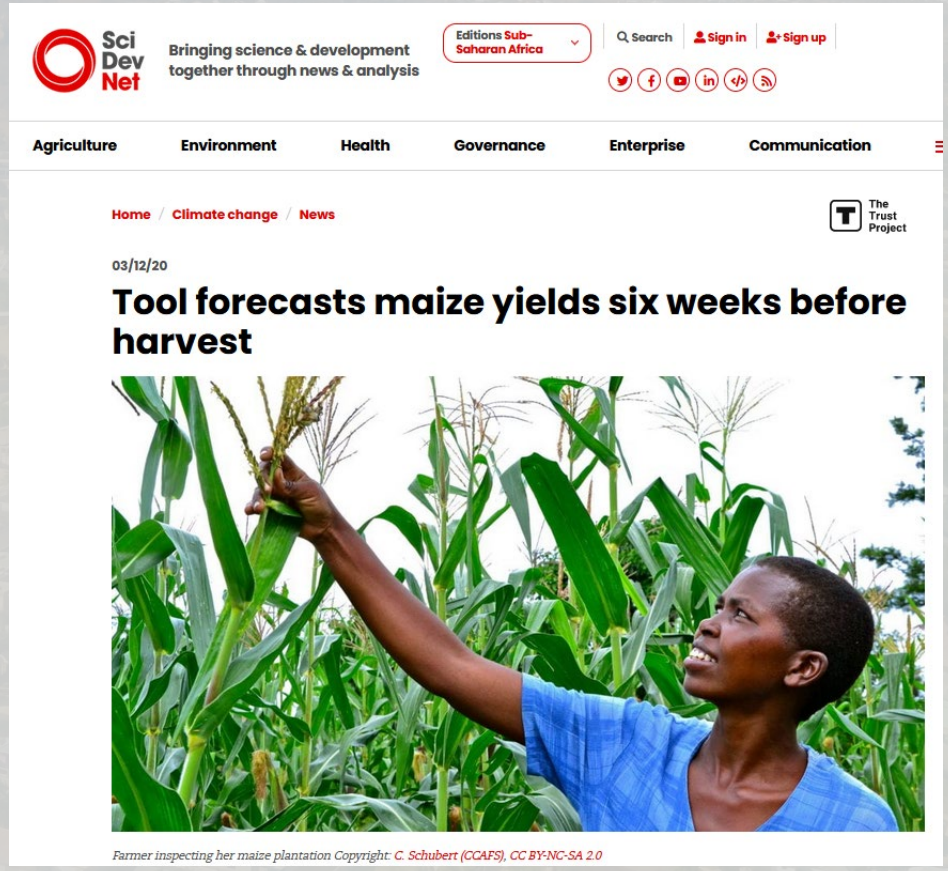
News article in SciDevNet

Title: Tool forecasts maize yields six weeks before the harvest

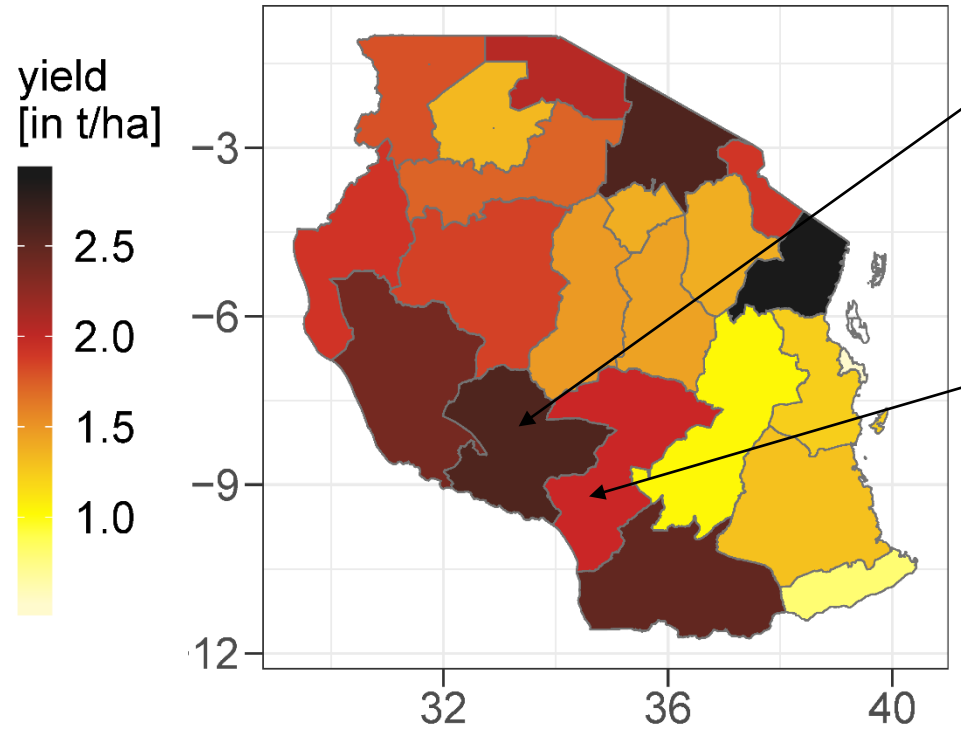
Date: 03 Dec 2020

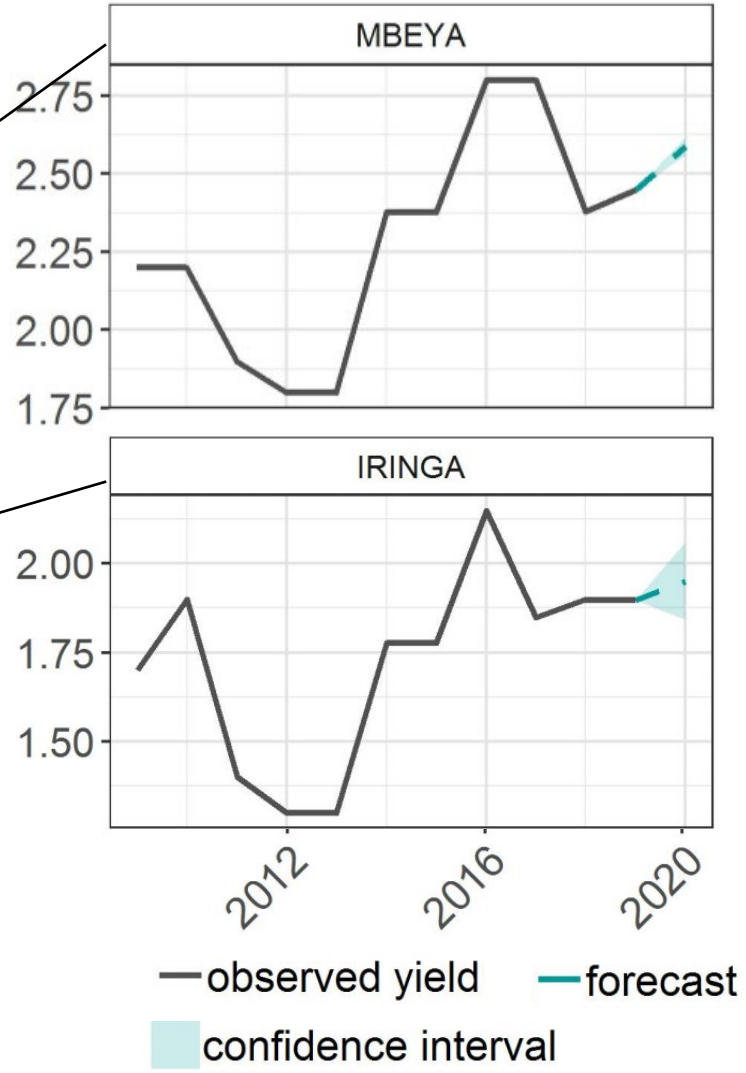
Source:

https://www.scidev.net/sub-saharan-africa/news/tool-forecasts-maize-yields-six-weeks-before-harvest/



Forecast shared with MoA for 2020



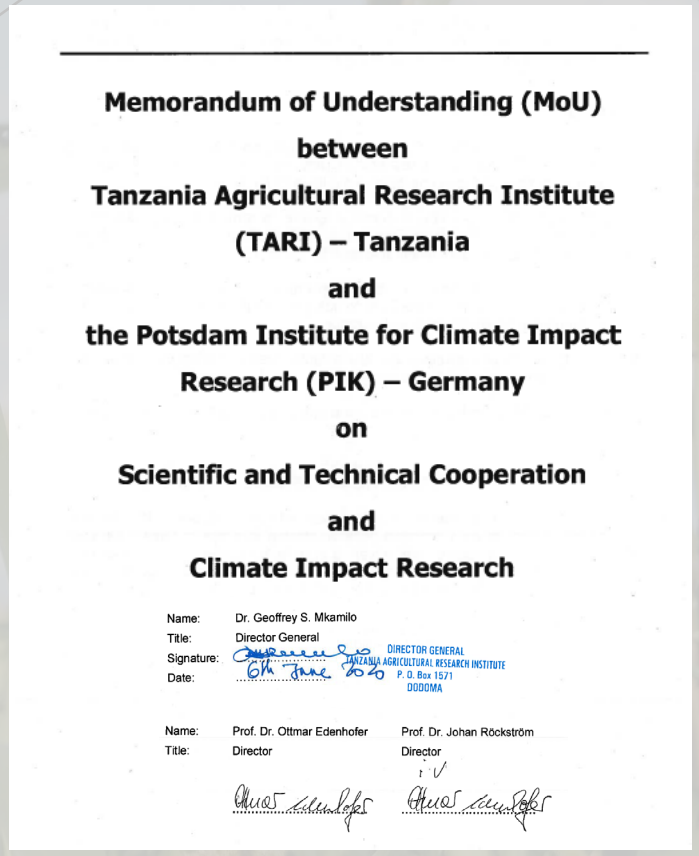


MoU signed between TARI and PIK

Areas for cooperation:

- Promote **research exchange** and joint research
- **Exchange of information and materials**
- **Organize study visits**
- Conduct **joint seminars and conferences** and **training** programmes
- Preparation of **joint scientific publications**

Date: 06 June 2020



Memorandum of Understanding (MoU)
between
Tanzania Agricultural Research Institute
(TARI) – Tanzania
and
the Potsdam Institute for Climate Impact
Research (PIK) – Germany
on
Scientific and Technical Cooperation
and
Climate Impact Research

Name: Dr. Geoffrey S. Mkamilo
Title: Director General
Signature:
Date: 6th June

DIRECTOR GENERAL
TANZANIA AGRICULTURAL RESEARCH INSTITUTE
P. O. Box 1571
DODOMA

Name:	Prof. Dr. Ottmar Edenhofer	Prof. Dr. Johan Röckström
Title:	Director	Director

Conclusion

Conclusion

- robust maize yield forecast in Tanzania with a lead time of 6 weeks is possible with high accuracy
- study is potentially useful for operational forecasts because of:
  - low input requirements
  - high spatial coverage
  - strict and transparent validation
- forecast should be integrated with local expert knowledge
- forecasts can contribute to increasing food security

Thank you!

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Photos taken by Rahel Laudien in Tanzania