Project Title: *Food Sustain - Network for Sustainable crop production under climate change: designing and testing regional climate adaptation measures through enhanced ecohydrological modelling*

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Project Summary: This project aims to enhance the SWAT+ hydrological model by incorporating region-specific, remote sensing (RS)-based crop biophysical parameters to improve crop yield simulation and water balance prediction in two contrasting watersheds—the Upper Godavari Basin (India) and the Kielstau watershed (Germany). Through field surveys, machine learning, and interdisciplinary collaboration between IIT Roorkee, CAU, and AVV, the study will improve model accuracy by regionalizing leaf area index (LAI) and root biomass parameters. The enhanced model will be used to evaluate future crop yields and hydrological responses under climate change scenarios, contributing to food and water security while supporting SDG-aligned sustainable agriculture practices.

Expected Outcomes:

1. *Enhanced SWAT+ Model:* Integration of region-specific RS-based crop biophysical parameters (e.g., LAI and root biomass) into SWAT+ for improved simulation of crop yield and hydrological processes.
2. *Improved Crop Yield Prediction:* More accurate estimation of crop growth under present and future climatic conditions, enhancing decision-making in agricultural planning.
3. *Quantification of Water Balance Components:* Refined understanding of evapotranspiration, runoff, groundwater recharge, and soil water storage influenced by regional crop characteristics.
4. *Climate Change Impact Assessment:* Simulation of future crop yields using SSP-based climate projections, supporting adaptive strategies for food and water security.
5. *Scalable Modeling Framework:* A transferable modeling methodology for other watersheds with similar agro-hydrological contexts across the globe.
6. *Capacity Building:* Training of early-career researchers and students through courses, workshops, and fieldwork, promoting interdisciplinary knowledge sharing.
7. *Academic Deliverables:*
   - Two international training courses on crop modeling and SWAT+ model integration.
   - At least two peer-reviewed publications and one book/monograph.
   - Workshops on sustainable agriculture under climate change.
8. *Strengthened Indo-German Collaboration:* Establishment of long-term academic and research partnerships between IITR, CAU, and AVV aligned with SDGs 2, 4, 6, 13, 16, and 17.

<u>Work Progress</u>:

Currently researchers from IITR and AVV have reached CAU by the first of August. Their initial focus on improving the crop yield simulation in the SWAT+ model using GIS-based crop-specific biophysical parameters for the Kielstau watershed (Germany). Which requires detailed knowledge about various types of crops cultivated in the Kielstau watershed and crop management scheduling. The real-time crop and land use mapping (Fig. 1) already started by 8th August 2025 to prepare a high-resolution map, which will be used at a later stage for crop yield modeling. Major crop types are wheat, barley, rye, oats, rapeseed, and maize. Other vegetables are potato, sugar beet, asparagus, broad bean, and tomato. Grasslands are properly maintained and used for livestock feeding. The most frequently observed animals in this region are cows, horses, and deer.

Fig. 1| Various types of crops and land use. (A) digital interface of real-time land use mapping instrument, (B) wheat crop, (C) Maize, (D) sugar beet, (E) potato, (F) cultivated grass for livestock, (G) Strawberry, (H) automatic weather station (AWS).

<u>Crop and land use mapping</u>:

The Kielstau watershed is divided into 5244 numbers of polygon, where each polygon represents a unique land use or crop class. Surveyors will visit each and every polygon and record particular crop or land use class. The location of any polygon can be understood based on live location of surveyor tracked by a GPS, which is represented by a black cross circle (Fig. 1A) on the digital interface of real-time mapping instrument. Currently more than 50% of area surveyed by 21-Aug 2025.

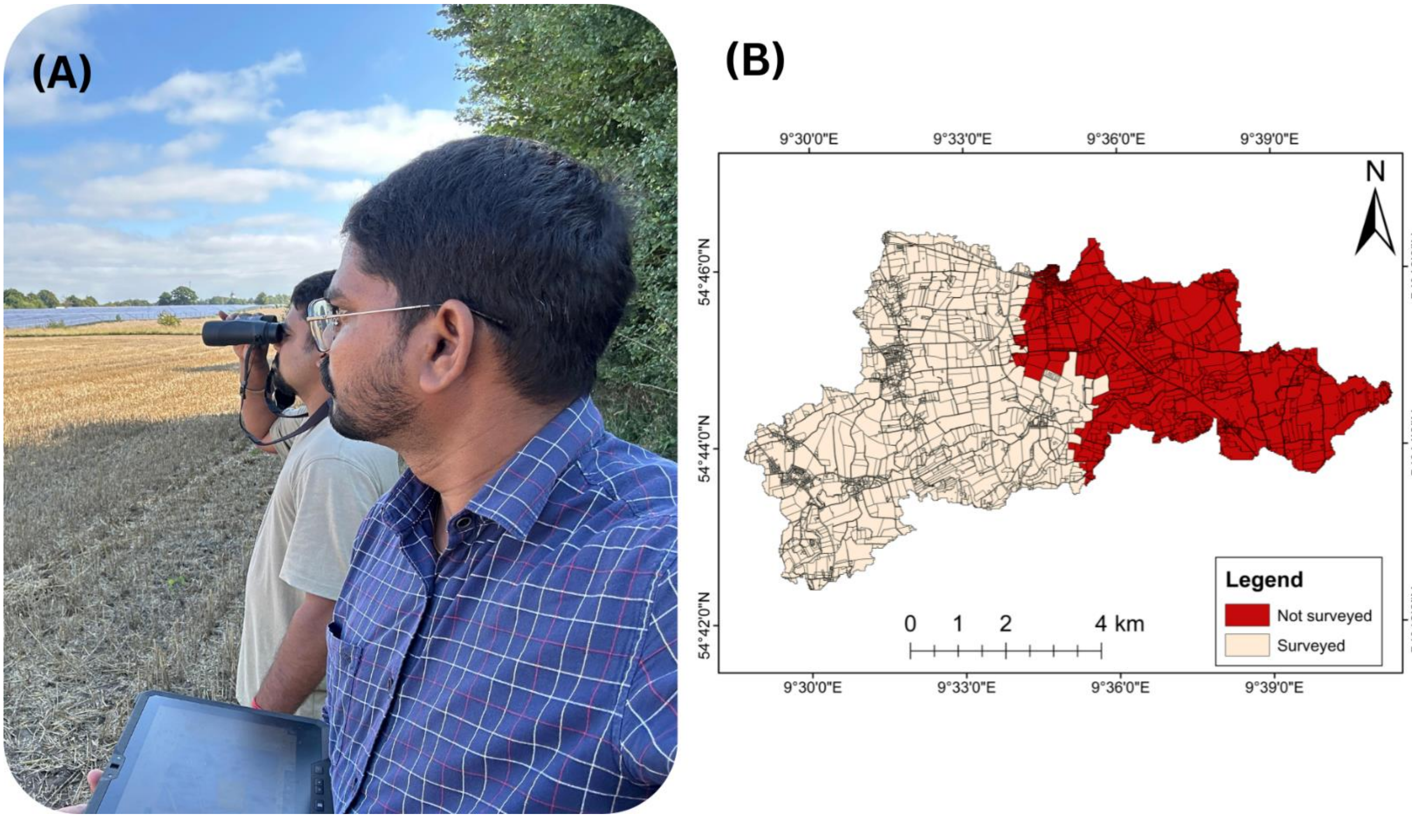

Fig. 2| Surveyors and survey status. (A) Long-distance crop monitoring (for inaccessible locations) using binoculars; (B) cream-colored polygons represent survey work that is completed, and dark red-colored polygons need to be surveyed.