**Phenotyping of crop development to dissect GxE into small-effect responses to environmental covariates**

The discipline of “High Throughput Field Phenotyping” (HTFP) has substantially increased our ability to monitor and quantify field experiments and breeding nurseries at multiple scales. We expect that classical red-green-blue imaging sensors carried by ground vehicles will become the workhorses of breeders. Besides supporting or replacing breeders’ ratings in the field, imaging techniques can help to quantify genotype-specific developmental pattern. HTFP enables a repeated measurement of traits. Based on such longitudinal data, the timing of phenology and the response to changing weather pattern can be quantified. Thus, while classical multi-environment trials sample overall environmental effects on yield, HTFP may sample many short-term environmental responses throughout the growing season. Even without a measurable effect on yield, genotype-specific responses to drying soil, freezing or changing temperatures may be used in crop growth models to scale to more extreme situations. Using wheat as a model crop, we aim to evaluate how this phenomics concept may be used for a targeted selection of different ideotypes.

The classical multi-stage phenomics modelling workflow includes feature extraction from images (e.g. canopy cover, canopy hight or ear counts) as first step. Nowadays, neural networks are mostly used for this task. Here, I will manly focus on dynamic modelling of the extracted features and the modelling of the response to environmental covariates. Dynamic modelling aims to summarize repeated measurements. We believe that an important first step is the quantification of defined time points marked by rapid changes in the development. Such points are very important in the context of a crop modelling framework, they for example mark full emergence, jointing, heading and physiological maturity. Knowing them is important to parametrize further traits such as tiller counts, temperature-response or functional stay green. The overall modelling workflow requires a range of different modelling approaches, depending on the modelling step. It includes deep learning, classical machine-learning, spatial and temporal modelling and non-linear dose-response models. In the case of temperature-response, we combined irregular and long trait measurement intervals (days) with constant and short covariate measurement intervals (hours) using maximum-likelihood optimization. Such modelling approaches were not yet applied under field condition. The results of several years of phenotyping of a diverse association panel (GABI-Wheat) suggest, that genotypes adapted to the different regions of Europe show a distinct temperature–response pattern. In further work we aim to fine-tune the models (e.g. by taking vapor pressure deficit or soil water content into account) and validate them.