Article title	A trait-based model ensemble approach to design rice plant types for future climate
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Abstract	Crop models are powerful tools to support breeding because of their capability to explore genotype × environment×management interactions that can help design promising plant types under climate change. However, relationships between plant traits and model parameters are often model specific and not necessarily direct, depending on how models formulate plant morphological and physiological features. This hinders model application in plant breeding. We developed a novel trait-based multi-model ensemble approach to improve the design of rice plant types for future climate projections. We conducted multi-model simulations targeting enhanced productivity, and aggregated results into model-ensemble sets of phenotypic traits as defined by breeders rather than by model parameters. This allowed to overcome the limitations due to ambiguities in trait-parameter mapping from single modelling approaches. Breeders' knowledge and perspective were integrated to provide clear mapping from designed plant types to breeding traits. Nine crop models from the AgMIP-Rice Project and sensitivity analysis techniques were used to explore trait responses under different climate and management scenarios at four sites. The method demonstrated the potential of yield improvement that ranged from 15.8% to 41.5% compared to the current cultivars under mid-century climate projections. These results highlight the primary role of phenological traits to improve crop adaptation to climate change, as well as traits involved with canopy development and structure. The variability of plant types derived with different models supported model ensembles to handle related uncertainty. Nevertheless, the models agreed in capturing the effect of the heterogeneity in climate conditions across sites on key traits, highlighting the need for context-specific breeding programmes to improve crop adaptation to climate change. Although further improvement is needed for crop models to fully support breeding programmes, a trait-based ensemble approach represents a major step towards the integration of crop modelling and breeding to address climate change challenges and develop adaptation options.

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