varietal adaptation, but also on better rotation design, soil management, and input regulation. Overall, the production status and ecological characteristics of legume crops in Zhejiang are defined by a diverse planting structure, a humid subtropical resource base, and multiple interacting production constraints. These features make Zhejiang a suitable setting for comparing yield stability among legume species across contrasting ecological and management environments.

3 Data Sources and Methods for Yield Stability Evaluation

3.1 Data sources and research materials

The yield stability evaluation in this study should be based on multi-environment trial data, because this design is the standard framework for judging crop adaptability and stable performance across contrasting production conditions. In legume research, multi-environment trials have been used to compare grain yield across locations, seasons, and years so that genotype or species performance can be evaluated under realistic production variability (Hu et al., 2025). Accordingly, the data source for this study can be defined as yield records collected from replicated field experiments on major legume species grown in representative ecological zones of Zhejiang, with each site-year combination treated as an independent environment. This structure makes it possible to separate average productivity from environmental sensitivity and provides the basic dataset needed for subsequent stability analysis.

The research materials should include several legume species with practical production relevance in Zhejiang, together with replicated observations from multiple environments. Existing legume stability studies typically use a randomized block or lattice design with three replications, which helps reduce field error and improves the reliability of yield comparisons (Habtegebriel and Abebe, 2023). Similar work in soybean has also used multi-location trials with elite lines and check cultivars across several environments, showing that replicated comparative testing is appropriate for identifying widely adapted and stable materials (Abebe et al., 2024). On this basis, the present study may use soybean, mung bean, adzuki bean, cowpea, and other locally important legumes as research materials, arranged in a uniform experimental design across test sites, with grain yield as the core trait and key agronomic characteristics recorded as auxiliary indicators.

3.2 Evaluation indicators

Yield stability should be evaluated from both productivity and response consistency, because high mean yield alone does not guarantee reliable adaptation across heterogeneous environments. Earlier soybean work showed that selection for yield alone often sacrifices some stability, while selection for stability alone may also reduce yield, so combined evaluation is more reasonable. Therefore, this study should first use mean yield as the primary performance index, and then combine it with classical stability statistics such as the coefficient of variation, regression coefficient, deviation from regression, Wricke’s ecovalence, and Shukla’s stability variance. These indices reflect different concepts of stability and can jointly describe whether a legume species performs consistently across favorable and unfavorable environments.

Recent studies indicate that no single stability parameter is sufficient for all breeding or agronomic decisions, so a composite indicator system is preferable. In lentil, significant positive relationships were reported among many parametric, non-parametric, and AMMI-based statistics, suggesting that several indices can be used together within the dynamic stability framework (Hossain et al., 2023). At the same time, some indicators behave differently because they emphasize distinct aspects of stability, and even the conventional coefficient of variation may require cautious interpretation when variance depends systematically on mean yield. For this reason, the present study can combine mean yield, CV, ASV, WAASB, and yield-stability ranking indices, so that both static consistency and high-yield adaptability are reflected in the final evaluation.

3.3 Data analysis methods

The statistical analysis should begin with combined analysis of variance, because ANOVA is the basic method for testing whether genotype or species effects, environmental effects, and their interactions are significant in multi-environment yield trials. When the interaction term is significant, further stability analysis becomes necessary, since changes in rank across environments mean that simple average yield cannot fully explain