

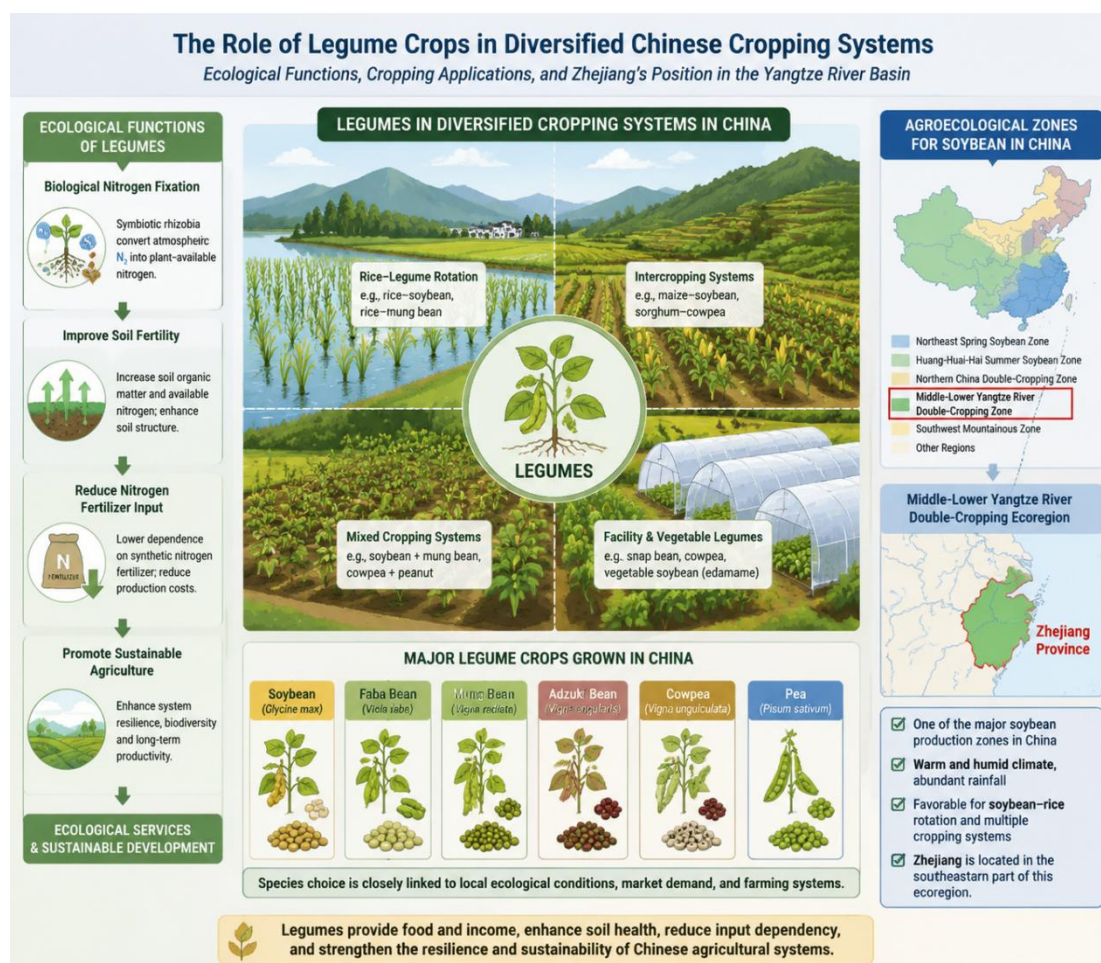


Figure 1 Conceptual framework illustrating the ecological functions of legume crops within Chinese diversified cropping systems and the position of Zhejiang Province within the middle-lower Yangtze River soybean adaptation zone

2.3 Limiting factors

The limiting factors affecting legume production in Zhejiang are multiple and should be understood as the interaction of abiotic, biotic, management, and socio-economic constraints. Comparative work on food-crop systems identifies these four categories as the main contributors to yield gaps, with the specific combination varying by crop and farming system. More general crop-production research similarly shows that low productivity commonly results from drought or excess moisture, soil constraints, diseases and insect pests, lack of improved varieties, weak infrastructure, and insufficient input efficiency. Under Zhejiang conditions, this means that yield instability in legumes is unlikely to arise from a single stress; rather, it is likely to reflect the combined effects of humid subtropical weather, fragmented land use, uneven soil conditions, and differences in management intensity across regions. Because precipitation and temperature are central drivers of yield variation in Chinese cropping systems, climate-related fluctuations remain a basic source of production risk (Gao et al., 2022).

For legume crops specifically, several constraints are especially relevant. Mungbean, one of the representative short-season legumes suited to diversified systems, is constrained by insect pests, diseases, drought, waterlogging, salinity, and heat stress, illustrating the broad stress spectrum that legume crops may face in production. In China, another major bottleneck is continuous cropping: because limited arable land often forces repeated planting of the same legume on the same plot, continuous-cropping obstacles have become common and can seriously impair yield formation through soil degradation and crop-soil interaction problems (Lei et al., 2023). This issue is highly relevant to Zhejiang's intensive farming context, where land scarcity and high cropping intensity may encourage short rotations or repeated use of the same fields for similar legume types. In addition, subtropical production systems can face nutrient surplus, declining nutrient-use efficiency, and soil acidification under intensive management, suggesting that sustainable improvement of legume production in Zhejiang depends not only on