uncertainties in water and fertilizer supply, pest control, canopy regulation, and harvest judgment, thereby causing resource waste and quality fluctuations. In the future, technologies such as sensor monitoring, automated control, machine vision, and artificial intelligence models should be used to monitor soil moisture, nutrient status, canopy light conditions, tree vigor, and fruit maturity in real time, enabling the transition from experience-based management to data-driven management (Sharma and Shivandu, 2024; Soussi et al., 2024).

Facility cultivation and controlled-environment technologies will become important directions for precision cultivation of Chinese bayberry. In protected cultivation systems, LED supplemental lighting can improve fruit quality through precise regulation of light intensity and spectral composition. Studies have shown that optimized LED lighting can increase fruit weight, soluble solids, and vitamin C content while reducing organic acid content, especially in the cultivar ‘Black Charcoal’, indicating that genotype-specific “light recipe” management has considerable application potential (Tang et al., 2025). Insect- and rain-proof nets can reduce pest damage and fruit cracking, improve fruit size, sugar-acid ratio, and economic returns, and simultaneously reduce the risks associated with sugar-consuming and pathogenic microorganisms by regulating fruit-surface microbial communities, thereby achieving coordinated regulation of microenvironment, microbial populations, and fruit quality (Yu et al., 2021). Intercropping with ryegrass can improve rhizosphere nutrient conditions, microbial structure, and metabolite composition, while increasing fruit sugars, vitamin C, and flavonoid contents and reducing acidity, thus providing an ecological model for region-specific precision water and fertilizer management (Li et al., 2023).

Intelligent sensing and robotic technologies will also play increasingly important roles in Chinese bayberry orchard management. A Chinese bayberry fruit recognition model based on an improved YOLOv7-tiny network and attention mechanisms achieved a fruit detection recall rate of 97.6% under natural conditions, while maintaining a lightweight architecture suitable for deployment on mobile harvesting robots (Zheng et al., 2025). In addition, lightweight instance segmentation models combined with multi-feature regression can be used for field fruit maturity recognition, thereby providing real-time decision support for timely harvesting and selective picking. In the future, considering the complex canopy structure of Chinese bayberry trees, severe fruit occlusion, concentrated harvesting periods, and the susceptibility of fruits to mechanical damage, research should focus on the development of maturity recognition, intelligent harvesting, non-destructive sorting, and integrated postharvest cold-chain systems.

7.3 Construction of green and high-quality production systems

The construction of green and high-quality production systems is an important direction for achieving sustainable development in the Chinese bayberry industry. Although traditional high-input cultivation systems have improved yield to some extent, excessive application of chemical fertilizers and pesticides may lead to soil degradation, increased ecological pressure, and declines in fruit quality. Future Chinese bayberry production should place greater emphasis on resource-use efficiency, ecological environmental protection, fruit safety, and farmer profitability, thereby promoting the transformation of the industry from a purely high-yield orientation toward green, high-quality, efficient, and sustainable development (Liu et al., 2020; Sharma and Shivandu, 2024).

The establishment of green production systems requires greater adoption of organic fertilizer substitution, biological control, ecological regulation, and orchard biodiversity management. Ryegrass intercropping can improve soil structure and rhizosphere microecological environments while increasing fruit sugars, vitamin C, and flavonoid contents and reducing acidity, thereby achieving both ecological benefits and quality improvement simultaneously (Li et al., 2023). Insect- and rain-proof net technologies not only improve yield and quality but also reduce pesticide use and pest contamination, making them more compatible with green and low-residue production systems (Yu et al., 2021). Therefore, future green production of Chinese bayberry should focus on developing integrated technical systems combining “organic fertilizer substitution-orchard grass cover-biological control-rain shelter cultivation-precision water and fertilizer management-intelligent monitoring”.

Future green and high-quality production systems should also be integrated with postharvest preservation, cold-chain logistics, deep processing, and brand development. Chinese bayberry possesses high nutritional and