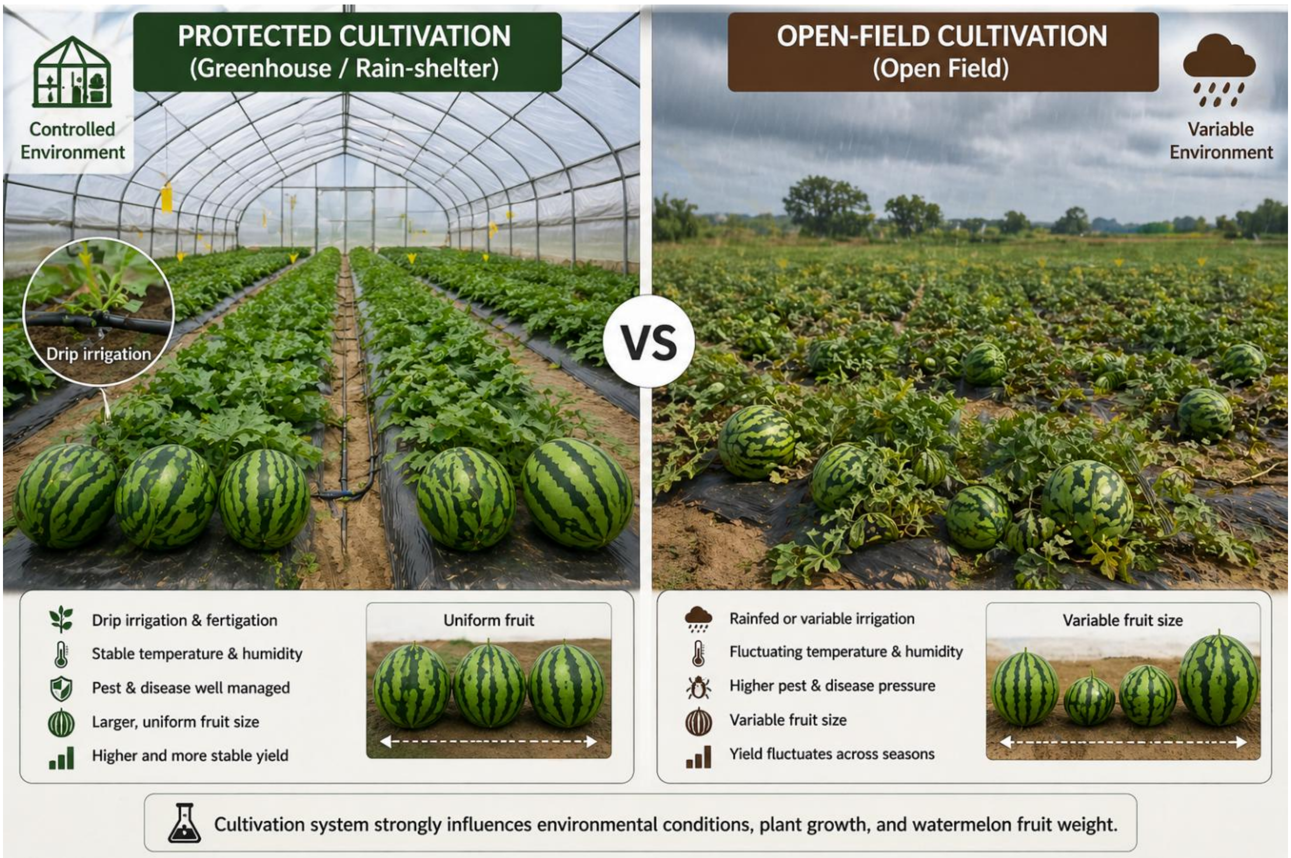

Figure 3 Comparison of protected cultivation and open-field systems used as data sources for watermelon fruit weight modeling under contrasting environmental conditions

Additional environmental contrasts arise from agroforestry versus sole-cropping and from seasonal variation in tropical open fields. In a semi-arid Chinese apple-watermelon agroforestry system, three irrigation quotas were combined with two planting patterns, generating three-year time series for soil water content, photosynthesis, fruit weight, and total yield under systematically different light and water regimes (Qiang et al., 2024). In tropical Tanzania, cultivar trials across dry and wet seasons recorded vine growth and fruit weight under markedly different rainfall and temperature conditions, showing that environmental seasonality significantly modifies yield traits and thus should be reflected in regional fruit weight prediction datasets.

7.2 Analysis of prediction results from watermelon fruit weight models under different environmental scenarios

Non-destructive, image-based models illustrate how fruit weight can be predicted across environments where direct weighing is impractical. A U-Net segmentation plus machine-learning pipeline used simple geometric ratios from fruit images to predict watermelon weight, achieving best training performance with Random Forest and Decision Tree models ($R^2 \approx 0.91$), and highlighting that larger variation in fruit size and image occupation can reduce accuracy relative to other fruits (Koç and Kayra, 2024). An IoT system integrating soil moisture, temperature, humidity, light, and CNN-based image analysis in melon-watermelon cultivation further reported very high sensor reliability and fruit weight prediction accuracies from 99.25% to 99.93%, demonstrating the potential of combining environmental sensing and imaging for real-time prediction under variable field conditions (Sarosa et al., 2024).

Where explicit process-based crop models are used, environmental scenarios such as deficit irrigation and mulching regimes can be evaluated through calibrated simulations. In Ethiopia, an AquaCrop application used soil physical data, climate, and crop records from factorial combinations of water application (50% vs. 100% soil-moisture depletion levels), mulching, and four watermelon varieties to predict yield responses; model performance for mulching-deficit irrigation effects on productivity was acceptable, with RMSE 0.70,