FELIX INSTRUMENTS
APPLIED FOOD SCIENCE
www.felixinstruments.com
sales@felixinstruments.com
(360) 833-8835

AvoAI Validation Report

January 2026

Abstract

This study presents a validation of the new AvoAI dry matter prediction model developed for the Felix Instruments F-750 Produce Quality Meter and F-751 Avocado Quality Meters. Performance was evaluated relative to the current production model using a geographically diverse hold-out dataset, an independent retail validation, and bin-averaging analysis. Results demonstrate improved linearity, reduced bias at analytical extremes, and lower prediction error across both instruments.

Introduction

Near-infrared (NIR) spectroscopy is widely used for non-destructive estimation of avocado dry matter. While the existing global calibration models for the F-750 Produce Quality Meter and F-751 Avocado Quality Meter perform adequately across mid-range values, systematic bias often emerges at the low and high ends of the analytical range. The AvoAI model was developed to address these limitations through expanded training data and updated modeling strategies. This study evaluates whether those improvements translate into measurable gains under independent validation conditions.

Materials and Methods

A total of 100 avocado fruit were withheld from all stages of model development and used exclusively for hold-out validation. Fruit were selected to provide uniform coverage across the analytical dry matter range and originated from the United States, Mexico, Peru, Chile, Australia, New Zealand, South Africa, and Kenya. Each fruit was measured using both F-750 and F-751 instruments. Predictions from the current production model and the AvoAI model were compared against laboratory reference dry matter values. Model performance was assessed using coefficient of determination (R^2), root mean square error (RMSE), mean absolute error (MAE), regression slope, and residual analysis.

www.felixinstruments.com
sales@felixinstruments.com
(360) 833-8835

Results - Hold-Out Validation

Scatter plots comparing predicted and reference dry matter values show that the AvoAI model more closely follows the ideal 1:1 relationship across the full analytical range. Regression slopes for AvoAI are substantially closer to unity for both instruments, indicating improved calibration linearity. Statistical metrics confirm reduced error relative to the current model.

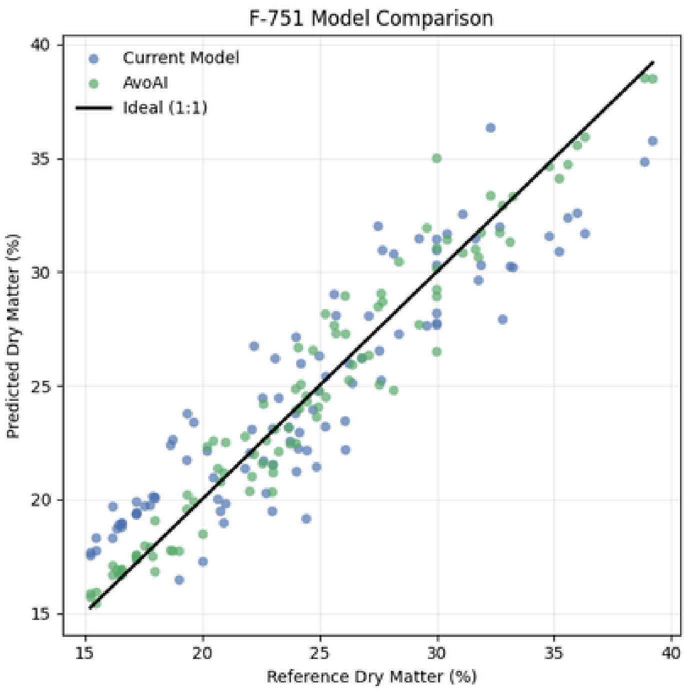

Figure 1. Hold-out validation scatter plot comparing predicted versus reference dry matter for the F-751 using the current model and AvoAI.

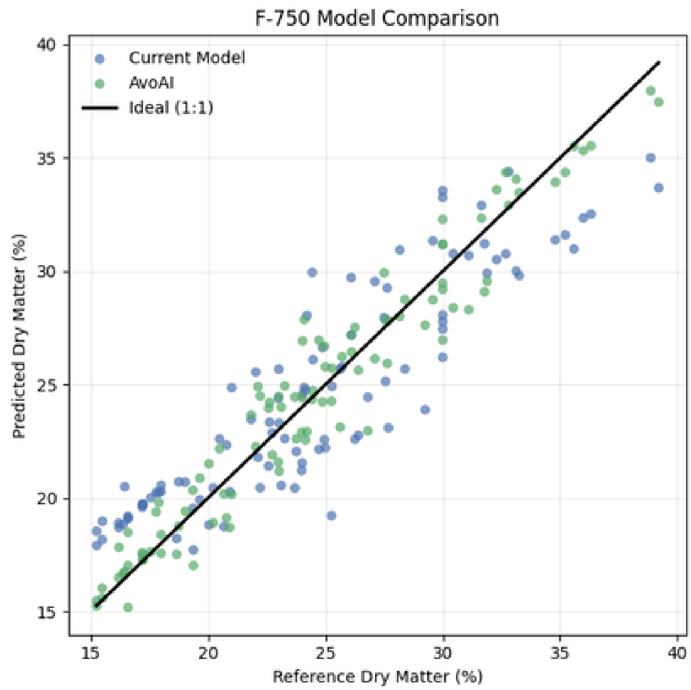

Figure 2. Hold-out validation scatter plot comparing predicted versus reference dry matter for the F-750 using the current model and AvoAI.

Table 1. Statistical summary of the hold-out validation comparing the current avocado model and AvoAI

	R^2	RMSE	MAE	Slope
F-751 Current Model	0.85	2.323	1.756	0.791
F-751 AvoAI	0.92	1.705	1.367	0.973
F-750 Current Model	0.81	2.614	1.892	0.746
F-750 AvoAI	0.88	2.106	1.607	0.956

Results - Residual and Bias Analysis

Residual plots reveal systematic bias in the current model, particularly at low and high dry matter values. The AvoAI model significantly reduces both the magnitude and trend of residuals across the analytical range. Quantitative analysis of low-end (14–18% DM) and high-end (34–40% DM) subsets demonstrates lower bias and RMSE for AvoAI on both instrument platforms.

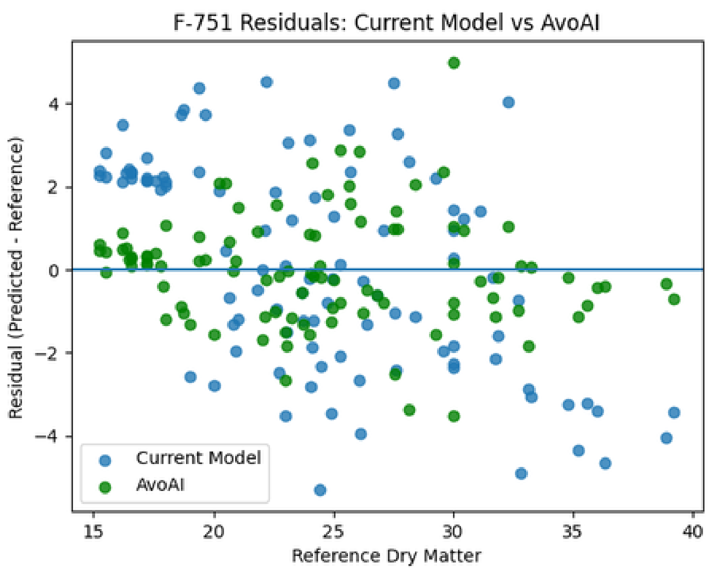

Figure 3. Residuals versus reference dry matter for the F-751, illustrating reduced bias and improved symmetry for AvoAI.

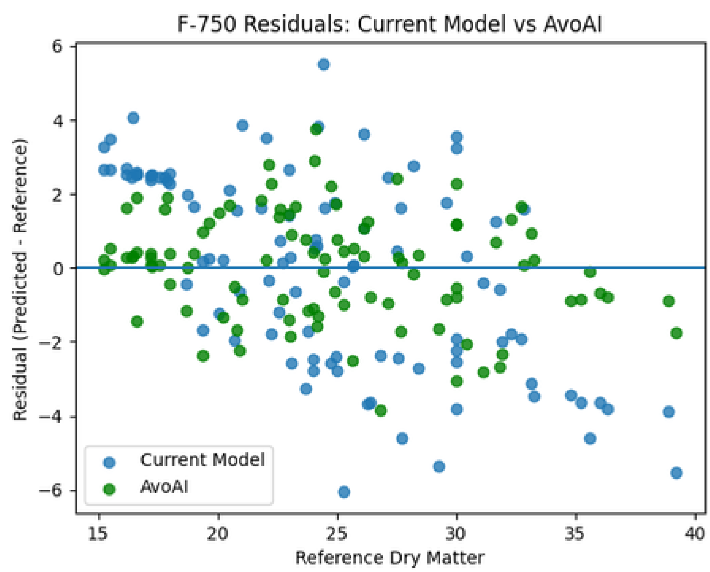

Figure 4. Residuals versus reference dry matter for the F-750, illustrating reduced bias and improved symmetry for AvoAI.

Table 2. Comparison of low- and high-end dry matter prediction bias and error metrics between current and AvoAI models

	Low-End Bias (14-18% DM)	Low-End RMSE (14-18% DM)	Low-End Overprediction Rate	High-End Bias (34-40% DM)	High-End RMSE (34-40% DM)	High-End Underprediction Rate
F-751 Current Model	1.242	2.474	0.773	-5.766	6.018	1.0
F-751 AvoAI	0.241	2.045	0.591	-0.24	1.585	0.6
F-750 Current Model	2.53	3.268	0.909	-2.844	5.373	0.8
F-750 AvoAI	0.536	2.652	0.636	-2.25	4.643	0.8

Results - Independent Retail Validation

An independent validation was conducted using 20 avocado fruit sourced from a retail outlet in Michigan, USA in January 2026 and were of confirmed Mexican origin, reflecting realistic post-supply-chain conditions. Despite the limited sample size, AvoAI maintained improved slope, reduced scatter, and lower error metrics compared to the current model, confirming robustness beyond curated datasets.

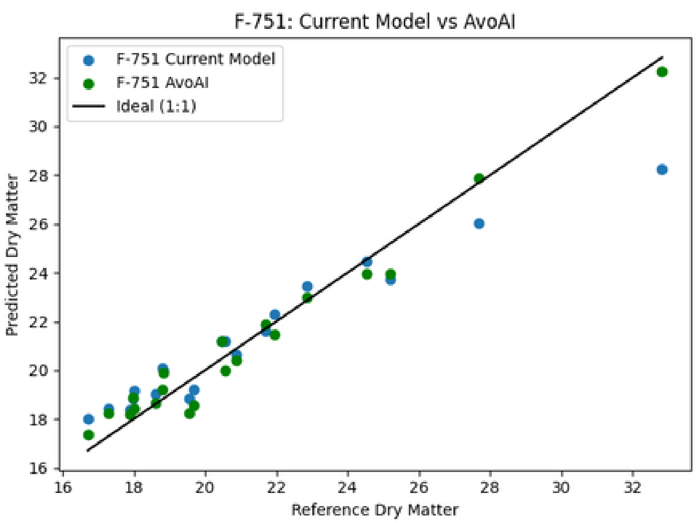

Figure 5. Independent retail validation scatter plot for the F-751 comparing current model and AvoAI predictions.

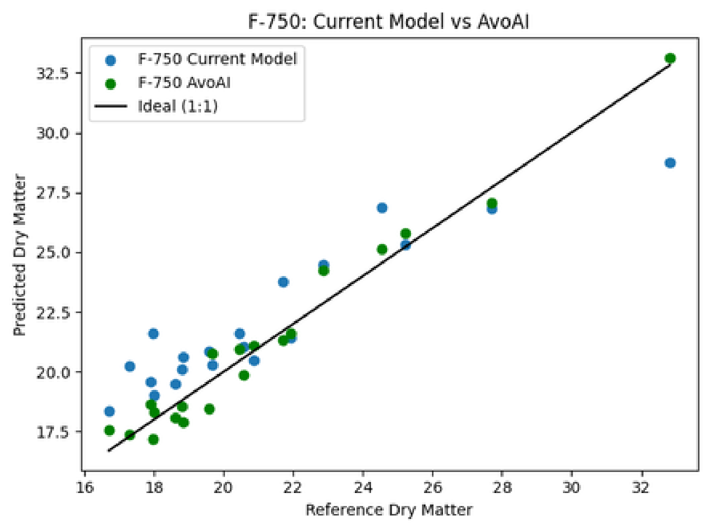

Figure 6. Independent retail validation scatter plot for the F-750 comparing current model and AvoAI predictions.

Table 3. Statistical summary of the independent validation comparing the current model versus AvoAI

	R^2	RMSE	MAE	Slope
F-751 Current Model	0.95	1.354	0.967	0.688
F-751 AvoAI	0.97	0.722	0.618	0.918
F-750 Current Model	0.87	1.846	1.524	0.690
F-750 AvoAI	0.97	0.698	0.615	1.016

Results - Effect of Fruit Averaging

Prediction accuracy improved substantially as the number of fruit averaged increased. Mean absolute error decreased rapidly at small bin sizes and approached near-laboratory precision at larger bin sizes. These results demonstrate that AvoAI is well suited for both single-fruit assessment and lot-level averaging workflows.

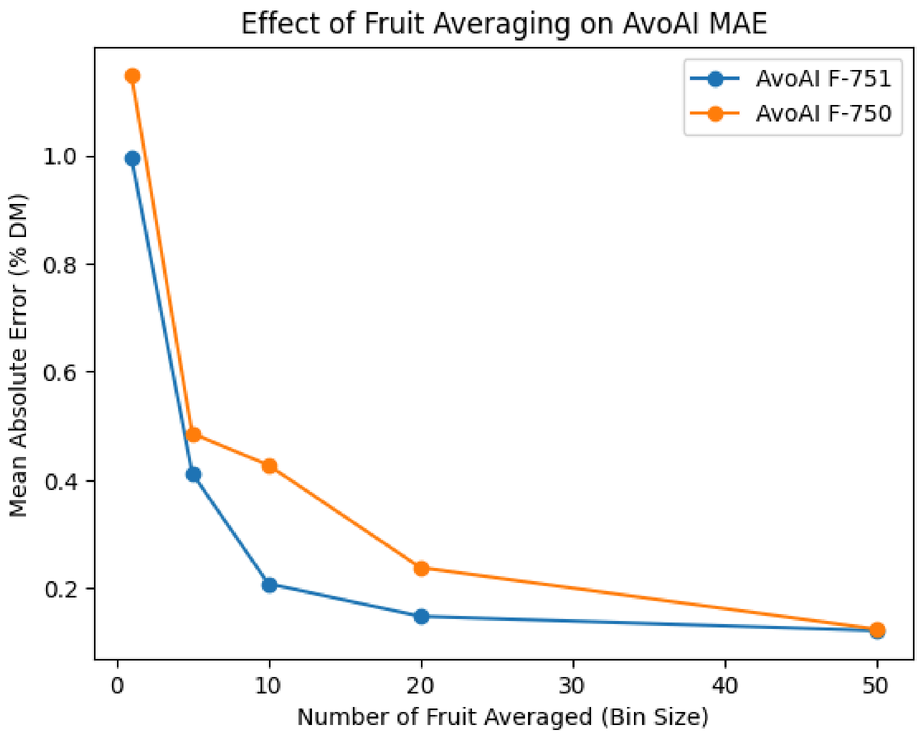

Figure 7. Effect of fruit averaging (bin size) on mean absolute error for AvoAI on F-750 and F-751 instruments.

FELIX INSTRUMENTS
APPLIED FOOD SCIENCE
www.felixinstruments.com
sales@felixinstruments.com
(360) 833-8835

Discussion and Conclusions

The AvoAI model delivers meaningful improvements over the current production model, particularly in reducing bias at analytical extremes where commercial decision-making is most sensitive. Improvements are consistent across instruments, validation types, and averaging scenarios. These results support deployment of AvoAI as a more reliable and scalable dry matter prediction model for commercial avocado applications.