Maturity of mango and its effect on quality and shelf life

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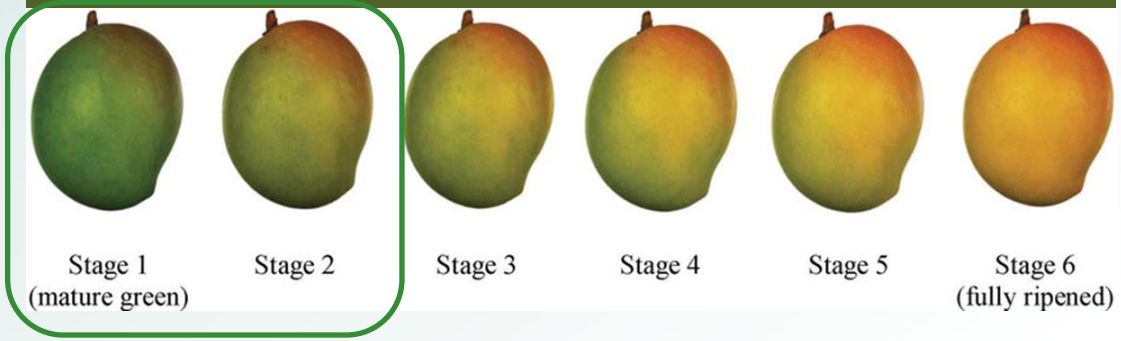
Introduction

Why Harvest Maturity Matters?

Harvest maturity determines the maximum quality potential of the fruit

Optimum Harvest maturity → **Ripening** → **Fruit quality** → **Shelf life** → **Consumer satisfaction** → Export Competitiveness



"Every export/local market carton begins with one decision—when to harvest"

Harvested too early
- Low dry matter, poor ripening, hard texture, inferior flavour

Commercial maturity
- Optimum dry matter , uniform ripening, export-ready quality

Harvested too late
- Soft fruit, increased decay, reduced shelf life & marketability

Current Industry Challenges

Current Approach

- **Fruit size**
- **Shoulder development**
- **Peel and Flesh colour**
- **Firmness**
- **Brix**
- **Titratable acidity**

Challenges

❌ Subjective

❌ Inconsistent quality

❌ No standardised objective maturity for South African cultivars

“How can we make harvest decisions more objective and consistent to ensure high fruit quality?”

Measuring Harvest Maturity

Standard Maturity Assessment
Destructive Methods

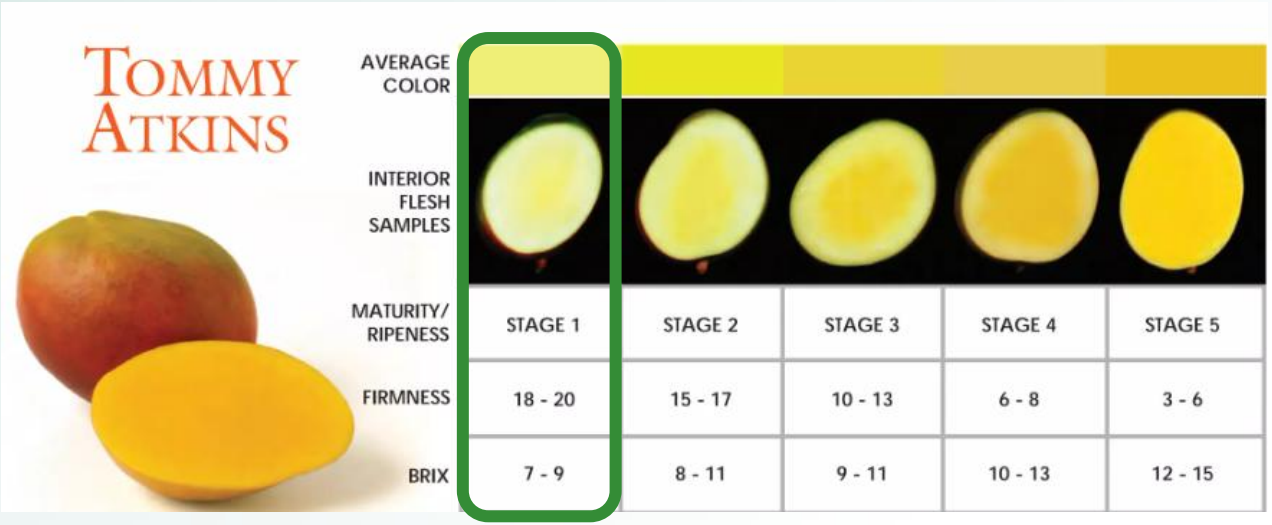
Quality Analysis

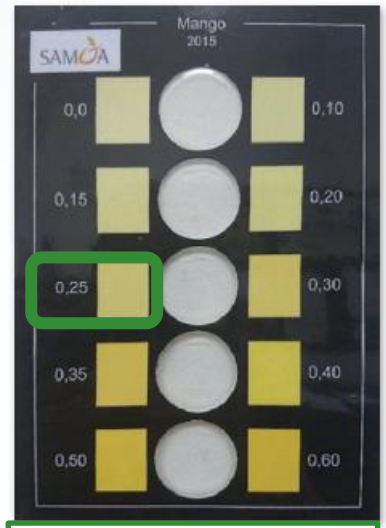
- Dry Matter (%)
- Total Soluble Solids (°Brix) , Titratable Acidity (%)
- Firmness (N)
- Peel & Flesh Colour

Non-destructive Maturity Assessment
NIR Spectroscopy

Instant Prediction (with developed model)

- Dry Matter (%)
- Total Soluble Solids (°Brix)





Botha, 2018

Advances in NIRS for Mango Maturity Assessment

Country / Research Group	Key Innovation
Australia (Central Queensland University & Australian Mango Industry), Anderson *et al*., 2020	Developed robust multi-season, multi-cultivar models for **non-destructive dry matter prediction**.
Australian Mango Industry Association (AMIA)	Introduced minimum dry matter thresholds as commercial harvest standards. **Portable NIR devices are used to objectively support harvest decisions.**
Spain (Téllez-García *et al*., 2025)	Prediction of **dry matter, soluble solids, colour, firmness & maturity**.
Brazil (De Freitas *et al*., 2022)	Demonstrated that **dry matter at harvest is strongly associated with eating quality**, irrespective of season.

NIR BEYOND MATURITY - MONITORING PHYSIOLOGICAL DISORDERS

Monitor susceptibility and incidence of internal physiological disorders in mango fruit (da Silva Alves *et al*., 2025)

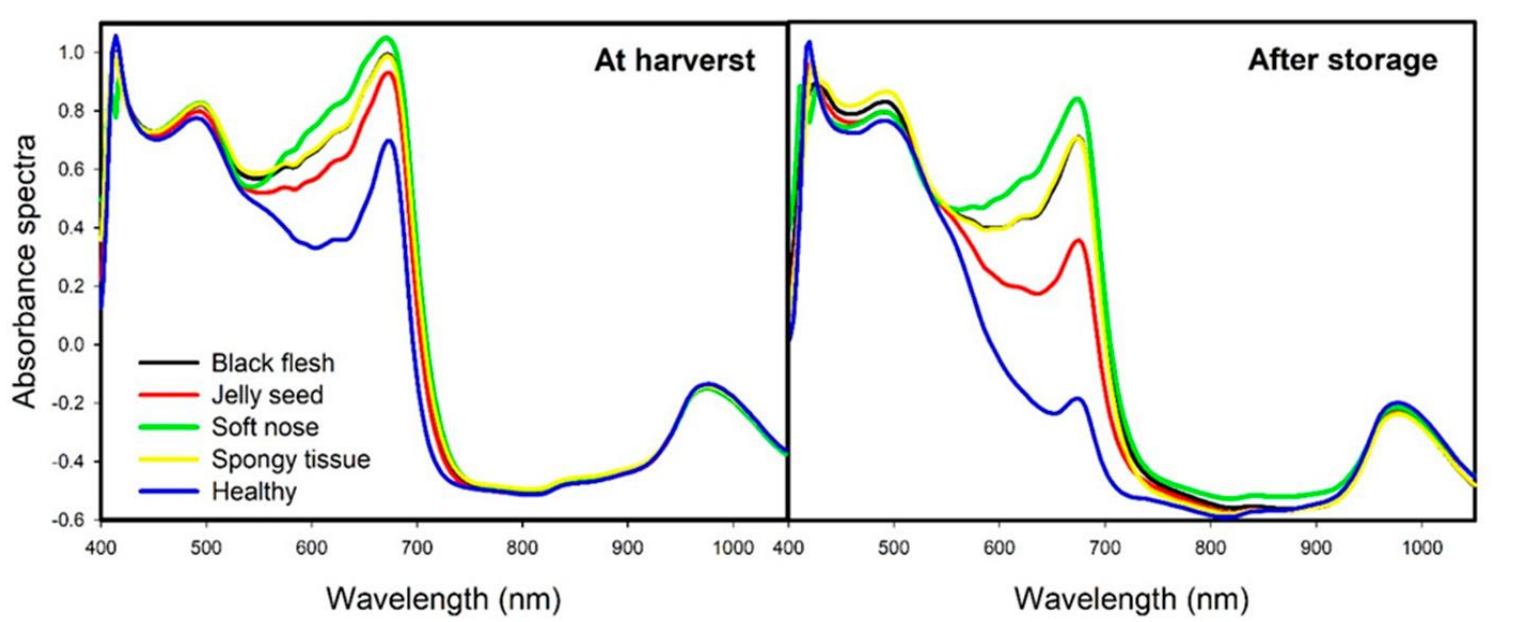


Figure 4. Mean Vis-NIR absorbance spectra of 'Palmer', 'Keitt', and 'Tommy Atkins' mango fruit at harvest (**left** panel) and after storage at 12 °C (**right** panel). The spectra were obtained at 24 °C. After storage, the fruit were destroyed for assessment as healthy or with symptoms of black flesh, soft nose, spongy tissue, or jelly seed.

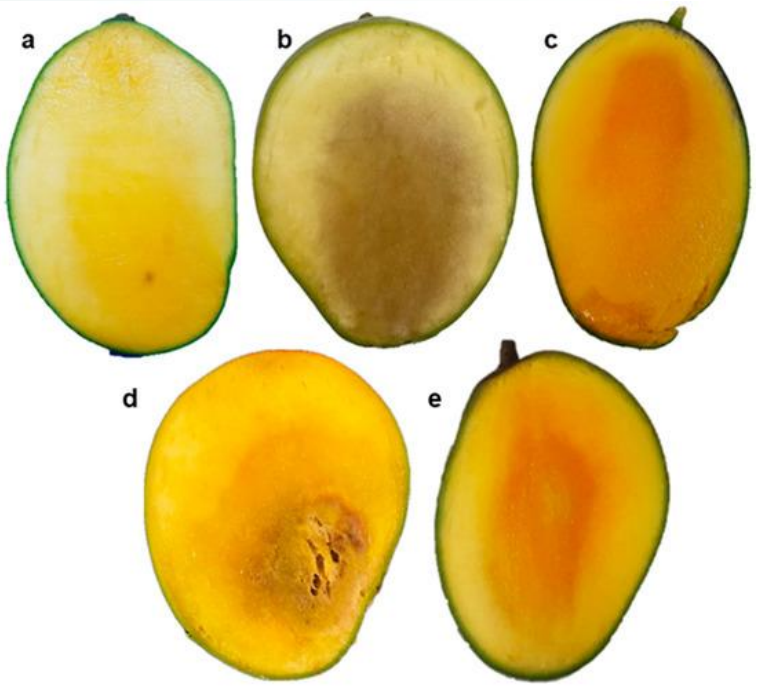


Figure 3. Visual appearance of mangoes with (**a**) healthy flesh; (**b**) black flesh, (**c**) soft nose, (**d**) spongy tissue, and (**e**) jelly seed.

Knowledge Gap: Why South Africa Needs Local Mango Maturity Standards

🌍 What exists internationally	Current gap in South Africa
✓ Dry matter maturity standards are used commercially	✕ No cultivar-specific dry matter standards
✓ NIR predicts maturity rapidly and non-destructively	✕ Lacks locally validated maturity standards
✓ Harvest decisions supported by objective measurements	✕ Harvesting guidelines are limited & subjective
	✕ Post-harvest quality issues – linked to maturity

Research Opportunity

- Develop cultivar-specific dry matter thresholds and validate portable NIR technology for South African mango industry.

Project Aim and Objectives

Aim:

To determine cultivar-specific harvest maturity and develop objective harvest standards using Near-Infrared Spectroscopy (NIR) to improve fruit quality, shelf life and market competitiveness of six mango cultivars (‘Keitt’, ‘Kent’, ‘Tommy Atkins’, ‘Shelly’, ‘CH31-M17+18’, ‘CH31-M21+22’).

Specific Objectives:

- To determine cultivar-specific maturity patterns using physiological parameters.
- To establish relationships between maturity stages, dry matter content, fruit quality and shelf life.
- To develop and validate NIR prediction models for dry matter and maturity for different mango cultivars.

Near-Infrared Spectroscopy (NIR)

Felix F751 Mango Quality Meter

- Non-destructive
- Instant measurement
- Field and packhouse use
- Measures internal fruit quality

- **Dry Matter:** 8-26%
- **Brix:** 4 - 25^{o}
- **NIR Spectrum:** 640 – 1050 nm
- **Build in Models:** Varieties – **Tommy Atkins, Keitt, Kent**, Honey Gold, Ataulfo, Calypso

Felixinstruments.com

NIRS can predict both maturity and internal physiological disorders.

PRINCIPLE OF NIR APPLICATION

Non-destructive assessment of internal quality in seconds

1 NIR Light Emission

The F751 emits near-infrared light (640–1050 nm) onto the mango surface.

2 Light Penetrates the Fruit

NIR light passes through the peel and penetrates into the flesh (mesocarp).

3 Interaction with Internal Components

Light interacts with water, dry matter, sugars and other components. Each absorbs and scatters light differently.

4 Reflected Light Detected

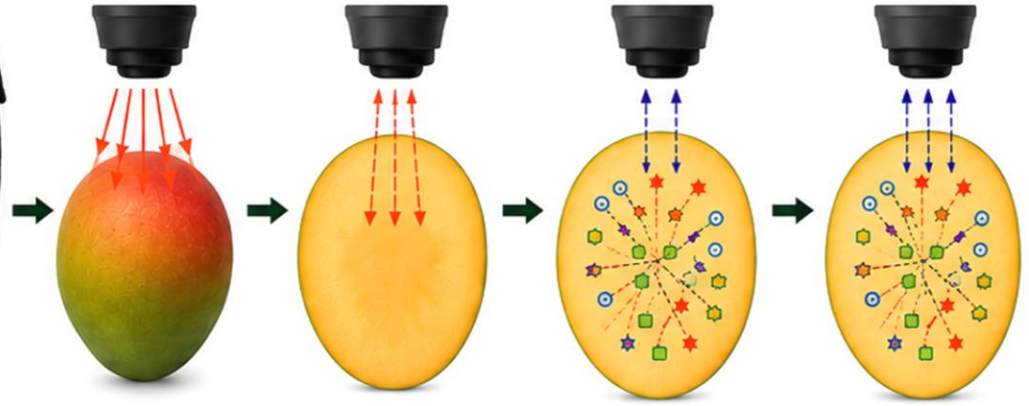
Reflected light returns to the instrument and is captured by the detector.

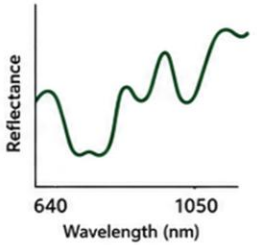
5 Spectral Data Acquired

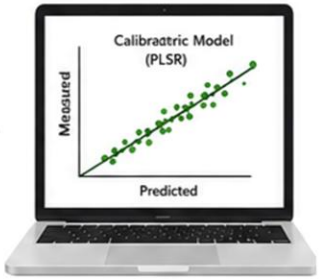
The detector records the reflectance spectrum (unique "fingerprint" of the fruit).

6 Chemometric Model & Prediction

The spectrum is analysed using chemometric models (PLSR/PCA) calibrated with reference data to predict quality attributes.







Quality Prediction (in seconds)

Dry Matter
16.5 %
Total Soluble Solids (°Brix)
17.2 °Bx

The F751 predicts internal quality non-destructively in 8–12 seconds, allowing objective harvest decisions in the orchard.

Why NIR Works

Water strongly absorbs NIR light, while dry matter and soluble solids influence how light is absorbed and scattered. These interactions create a spectral pattern that relates to the fruit's internal composition.

Key Advantages

- Non-destructive – fruit remains intact
- Fast – results in seconds
- Objective and repeatable
- Measures many fruit easily in the orchard

Wavelength Range
640 – 1050 nm (Near-Infrared)

Quality Attributes Predicted
- Dry Matter (%)
- Total Soluble Solids (°Brix)

NIR
640–1050 nm

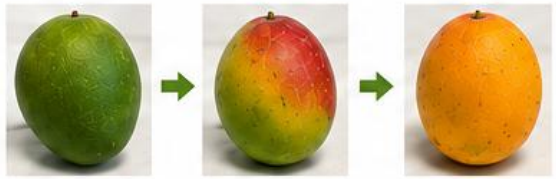
Developing cultivar-specific harvest maturity models

1 Sample Collection

- Six commercial mango cultivars 'Keitt', 'Kent', 'Tommy Atkins', 'Shelly', 'CH31-M17+18', 'CH31-M21+22'
- Three maturity stages

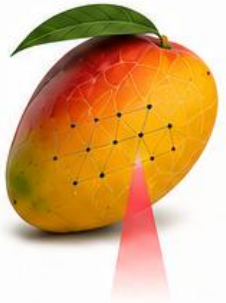
Maturity Stages

1	2	3
Immature (Green)	Commercial (Mature)	Fully Ripe (Yellow)



Seasonal reps

2 Non-destructive NIR Assessment



NIR
640–1050 nm

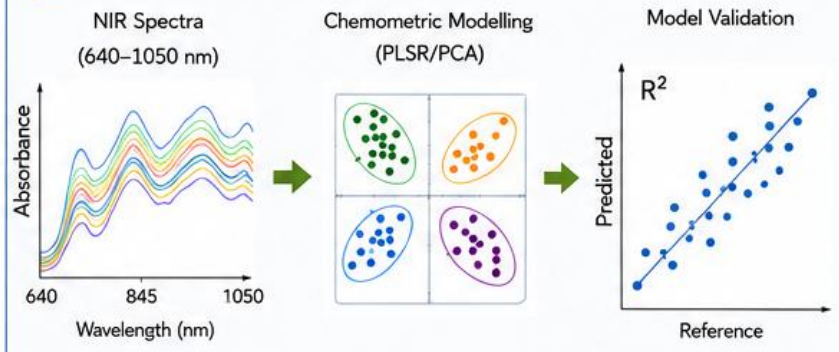
- ✓ Scan intact fruit
- ✓ Acquire NIR spectra (640–1050 nm)
- ✓ Rapid, non-destructive measurements

3 Reference Quality Measurements

Dry Matter (%)	Total Soluble Solids (°Brix)	Firmness (N)	Titratable Acidity (%)	Peel & Flesh Colour

Laboratory analyses on the same fruit as NIR measurements

4 Model Development & Validation



NIR spectra correlated with reference data

Develop cultivar-specific prediction models

Evaluate accuracy (R^2, RMSE, MSE)

Expected Outputs

📈 **Developed cultivar-specific maturity standards for local and export markets:** Development of maturity indexes for (‘Keitt’, ‘Kent’, ‘Tommy Atkins’, ‘Shelly’, ‘CH31-M17+18’, ‘CH31-M21+22’) cultivars.

📈 **Validated (Felix F-751) calibration models:** Development and validation of cultivar-specific NIRS calibration models for non-destructive prediction of harvest maturity.

📄 **Knowledge dissemination:** Publication of research findings through popular articles, the South African Mango Growers’ Yearbook, peer-reviewed scientific journals, and presentations at symposia.

📄 **Harvest maturity guidelines protocol.**

Industry Impact

✓Objective maturity assessment for South African Mango cultivars

✓ Portable NIRS enables rapid, non-destructive harvest decisions

✓ Improved fruit quality consistency and longer shelf life

✓ Improved export competitiveness and consumer satisfaction

Objective NIRS-based harvest decisions can improve quality consistency, extend marketable shelf life, reduce losses, and strengthen export competitiveness.

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Thank You!
Any Questions?

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Harvest maturity is not just the start of the supply chain—it determines final fruit quality.