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RELOAD
REDUCING LOSSES
ADDING VALUE

Reduction of Losses and Value Addition of Agricultural Products Through Advanced Drying Processes

Kuma G. Erko and Katrin Jödicke

with contributions from

Saskia Arendt and Dr. Addisalem H. Taye

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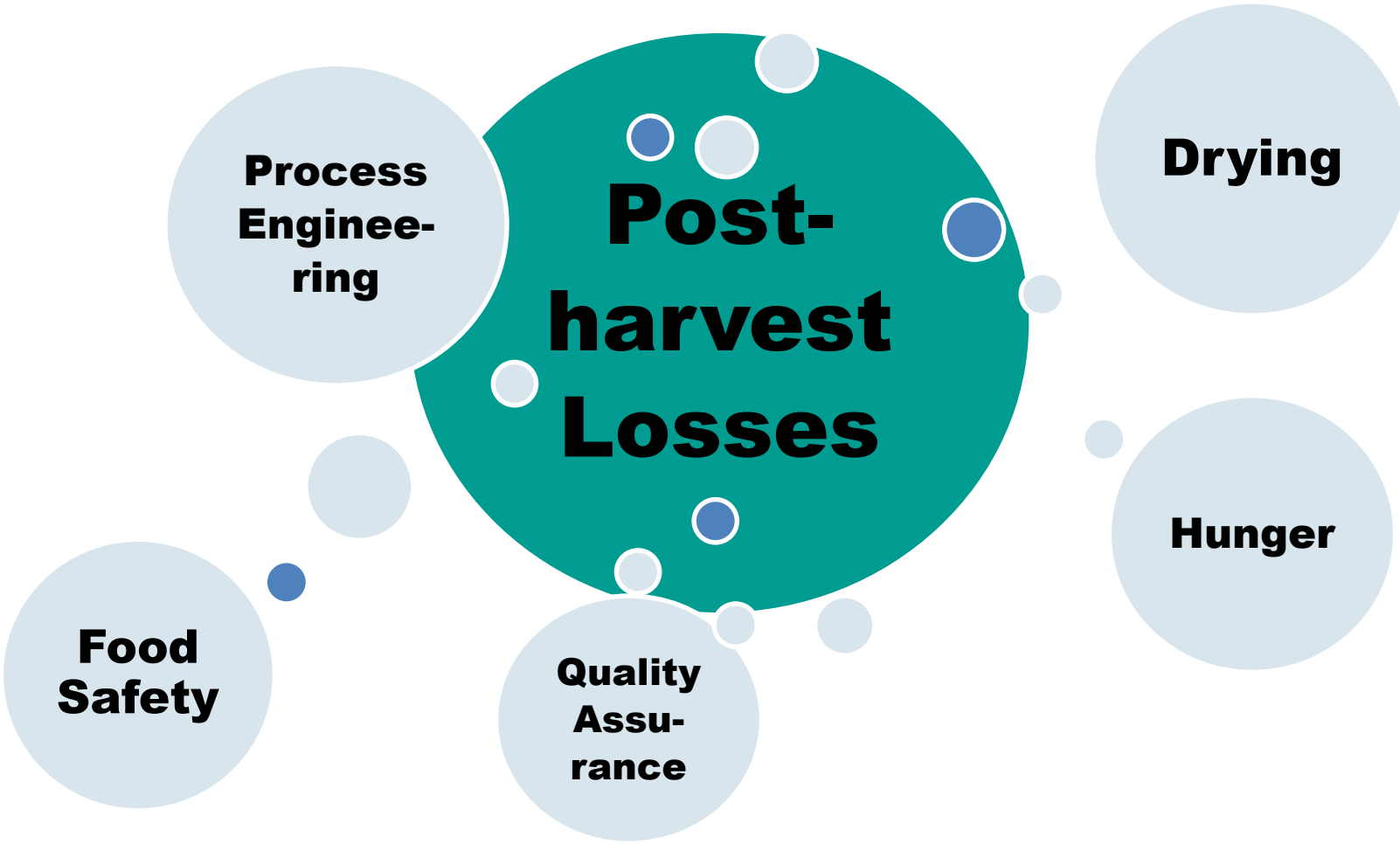
ADDING VALUE

Recap



Recap: Post-Harvest Handling

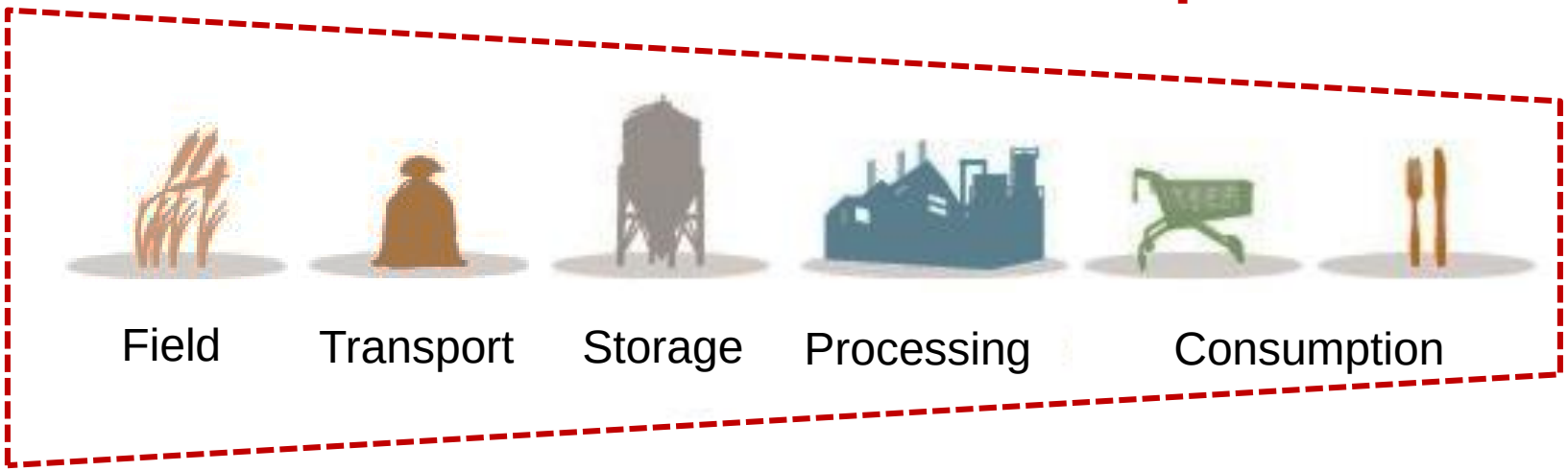
Harvest

Field Transport Storage Processing Consumption

2018, adapted from Wageninen University and Research

Recap: Post-Harvest Losses

Up to 30% - 60%



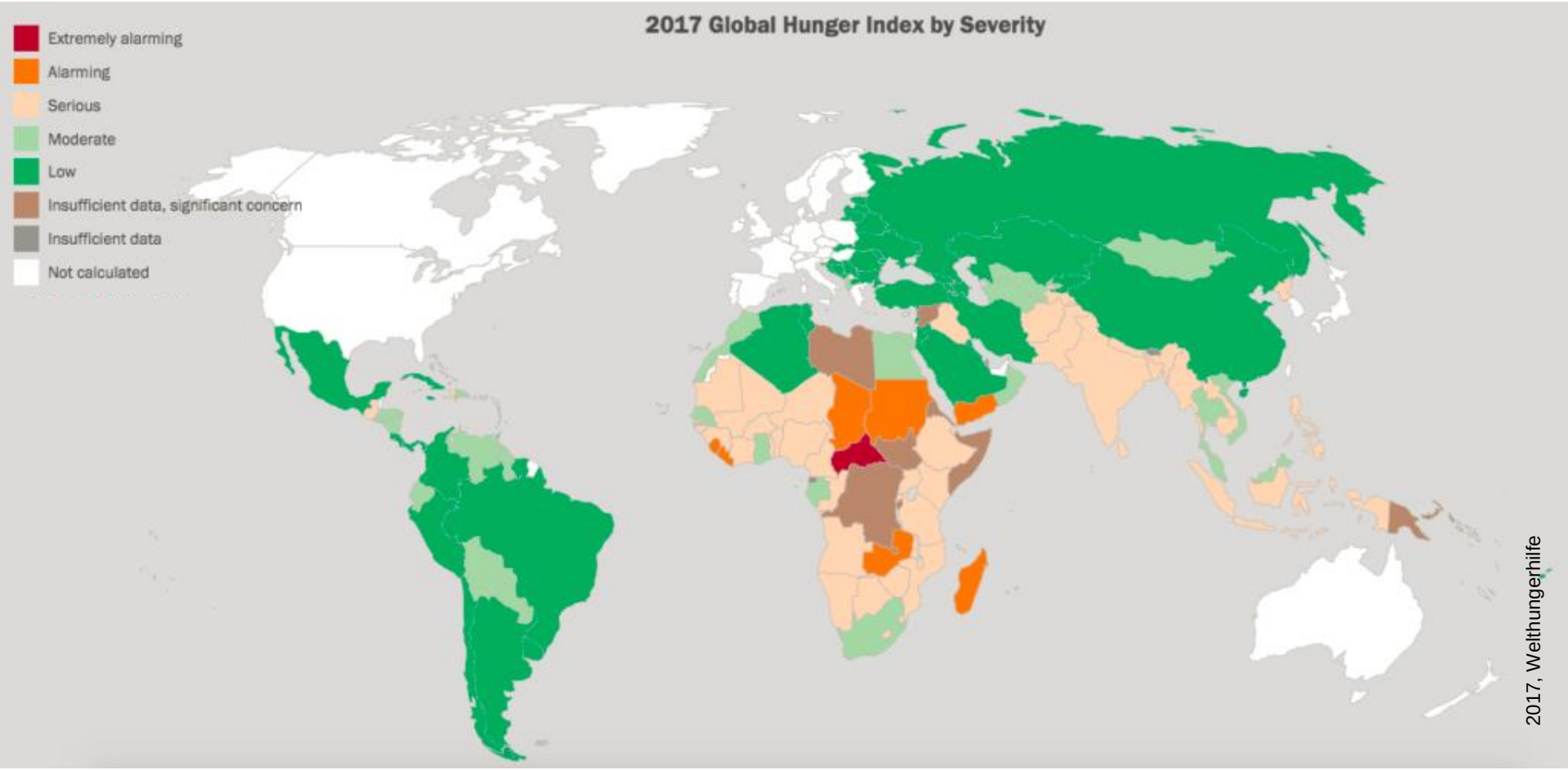
2018, adapted from Wageninen University and Research

Recap: Mal- and Undernourishment

- **800 million people are undernourished (12% of the world‘s total population)**
- **UN’s millennium goal 1:**
  - **Reduce hunger by 50% in 2015**
  - **Remains unreached**

2018, UN

Recap: Mal- and Undernourishment



Recap: Mal- and Undernourishment

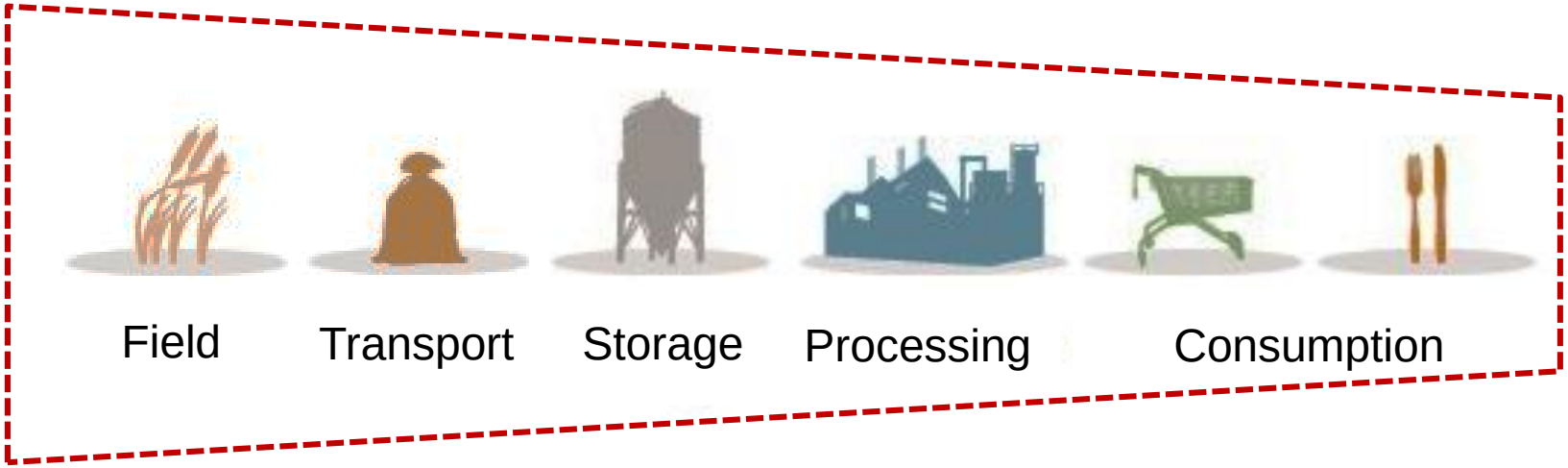
- By 2050 population exceeds 9 billion
- To reduce hunger to zero food production would have to increase by 70%

...or...

2018, UN

Recap: Post-Harvest Losses

Up to 30% - 60%



2018, adapted from Wageninen University and Research

Recap: Post-Harvest Losses

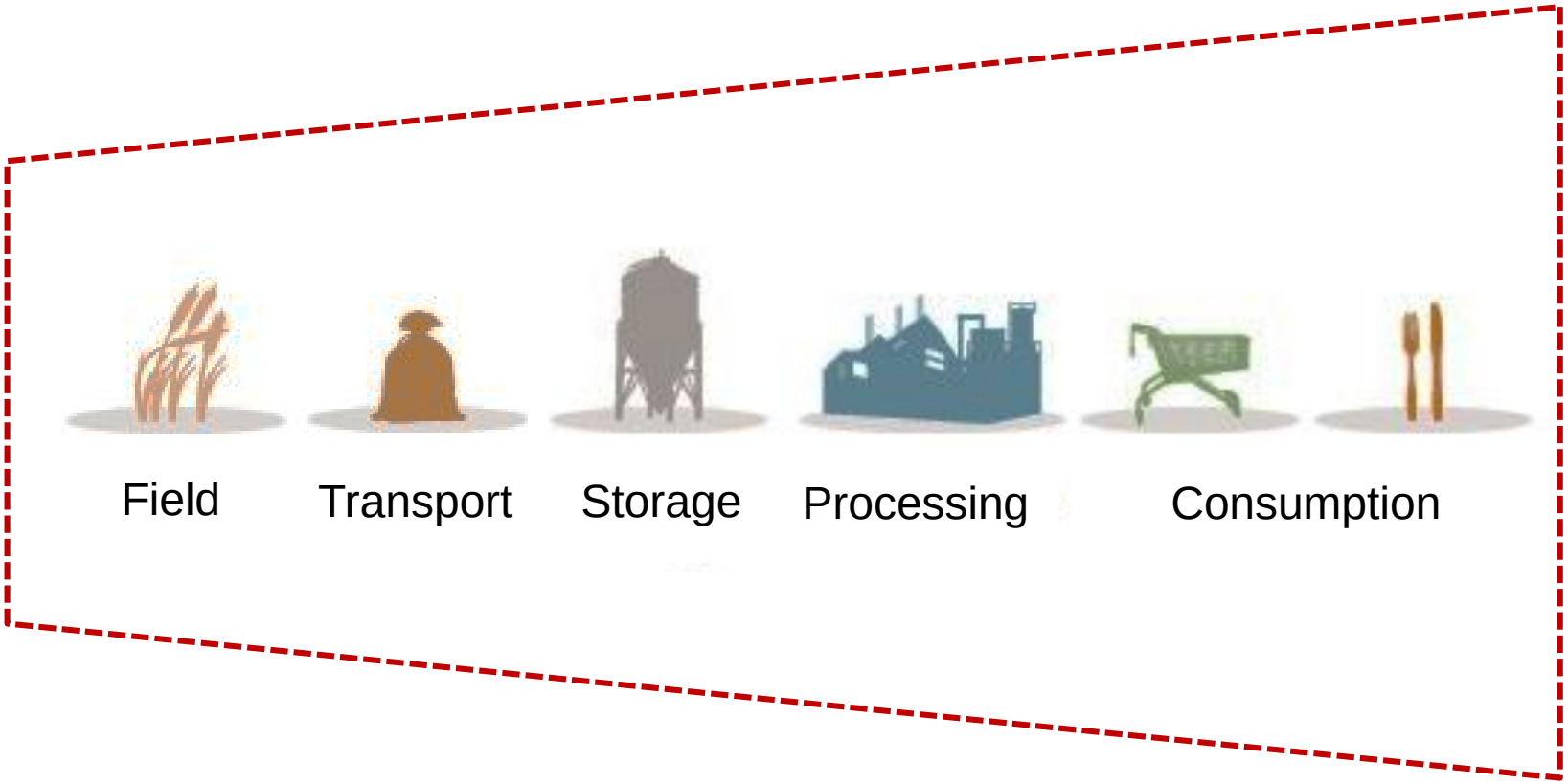
Reduction

Harvest

2018, adapted from Wageninen University and Research

Recap: Post-Harvest Losses

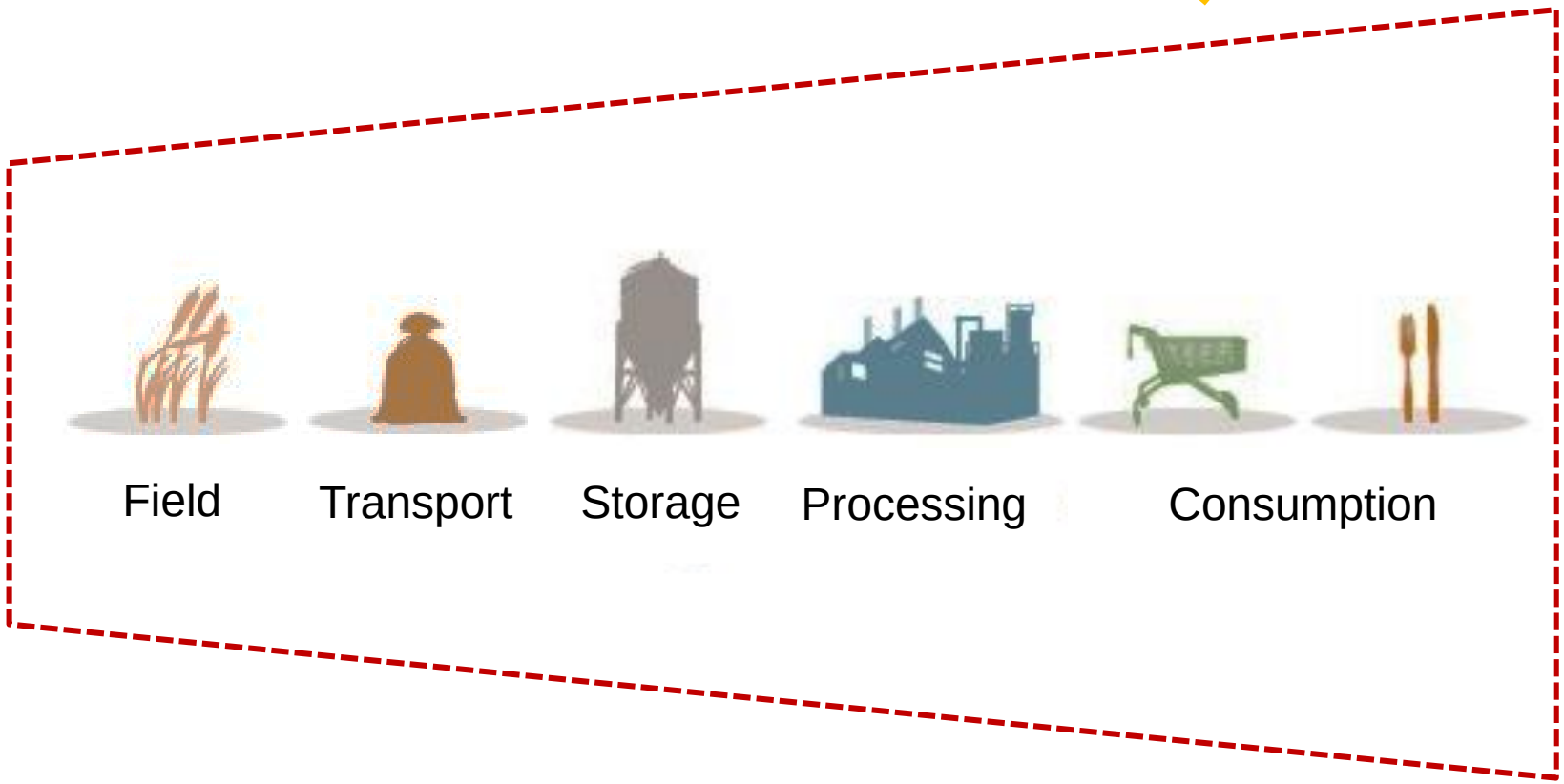
Value Addition



2018, adapted from Wageninen University and Research

Recap: Post-Harvest Losses

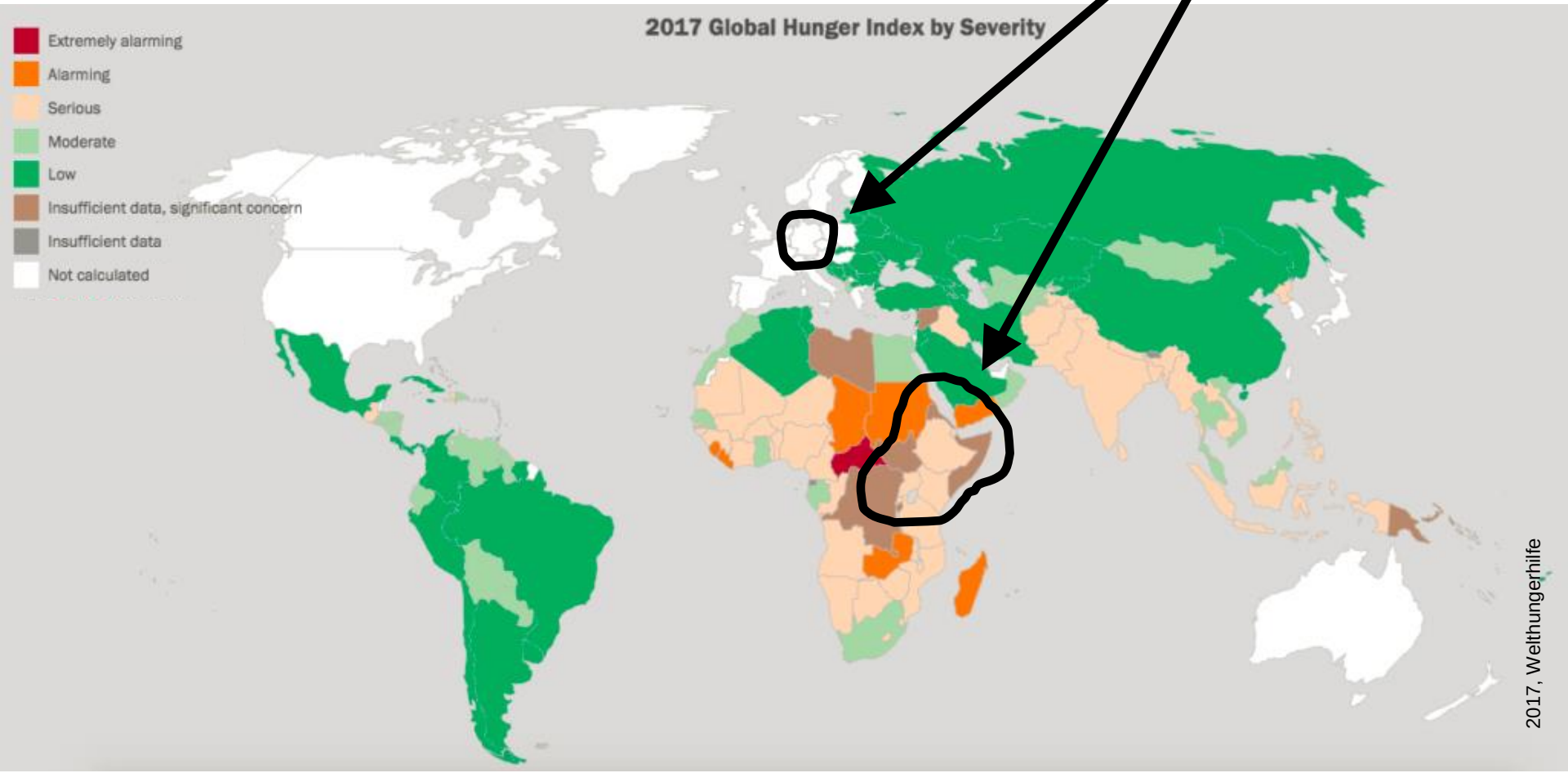
Reduction and Value Addition



2018, adapted from Wageninen University and Research

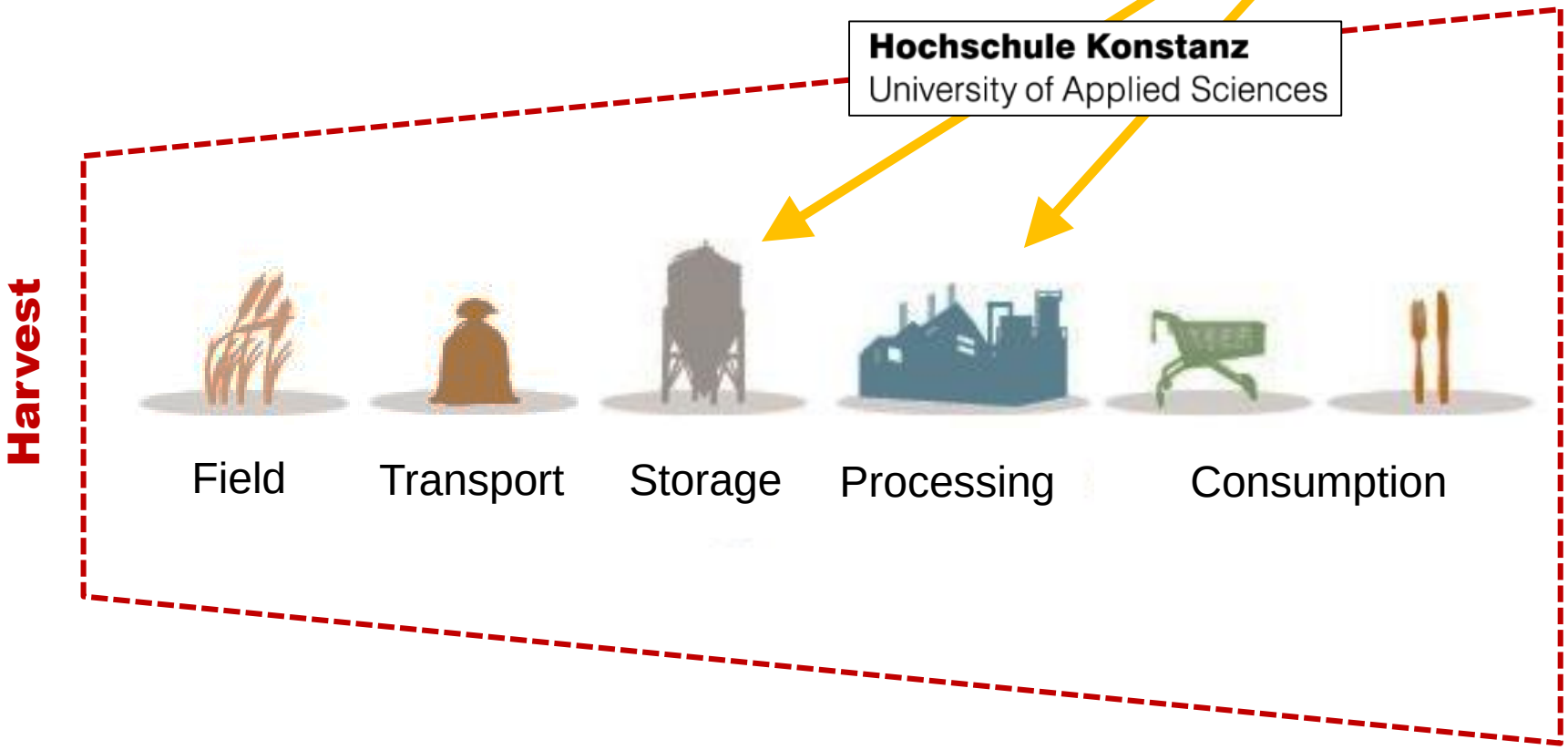
Recap: Post-Harvest Losses

Reduction and Value Addition



Recap: Post-Harvest Losses

Reduction and Value Addition



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2018, adapted from Wageninen University and Research

Drying Technology

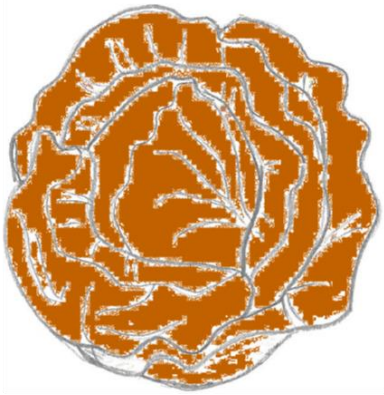
- **Reduce water in the product**
- **Minimize activity of microorganisms**
- **Get stable and long lasting products**
- **Achieve high quality dried products**

Drying Technology

Optical

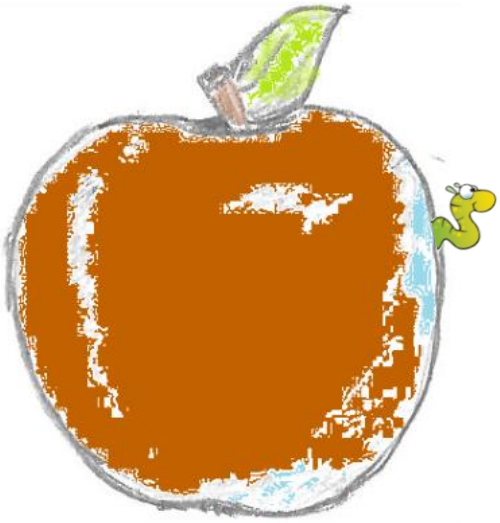
Drying Technology

Mechanical



Drying Technology

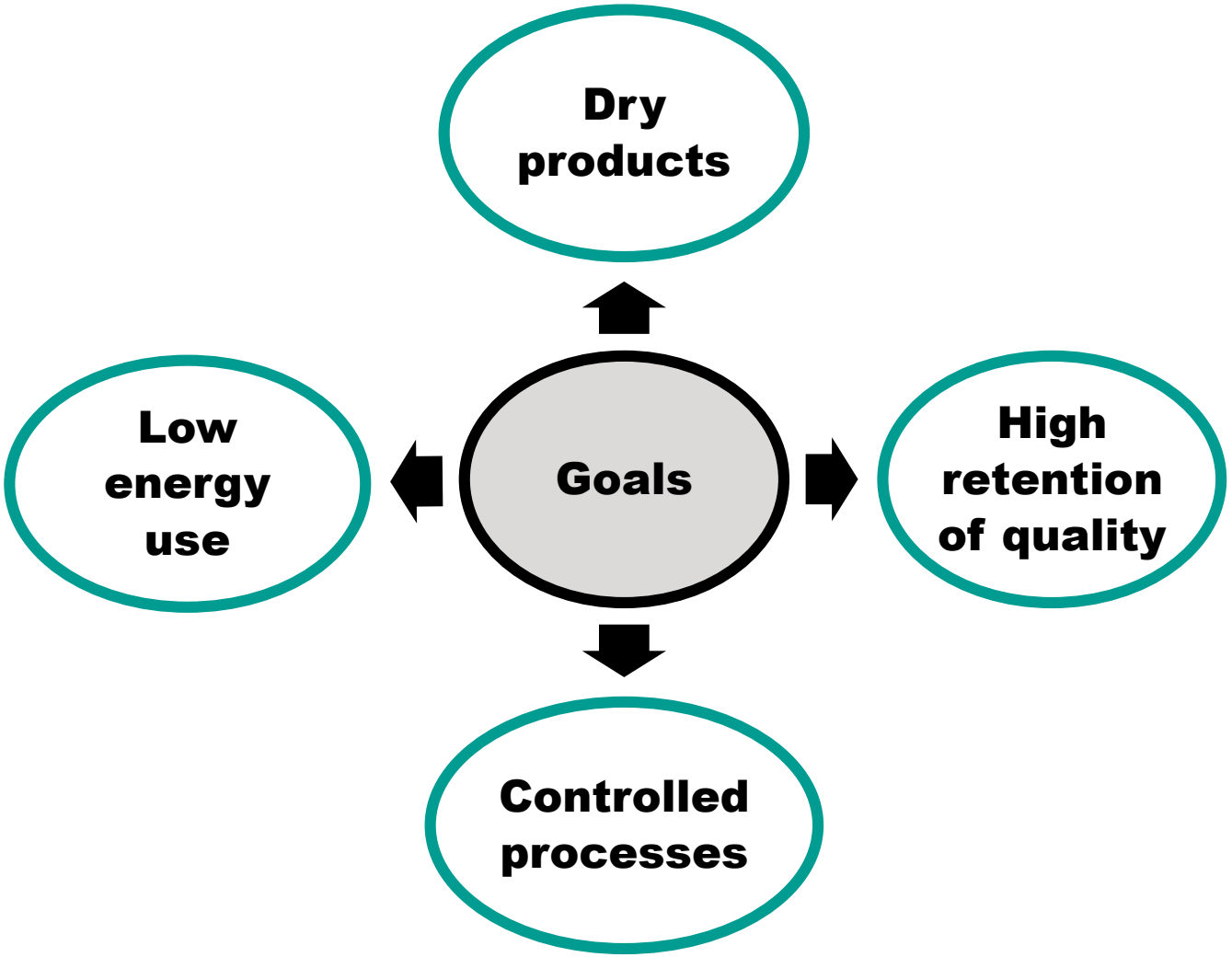
Nutritional



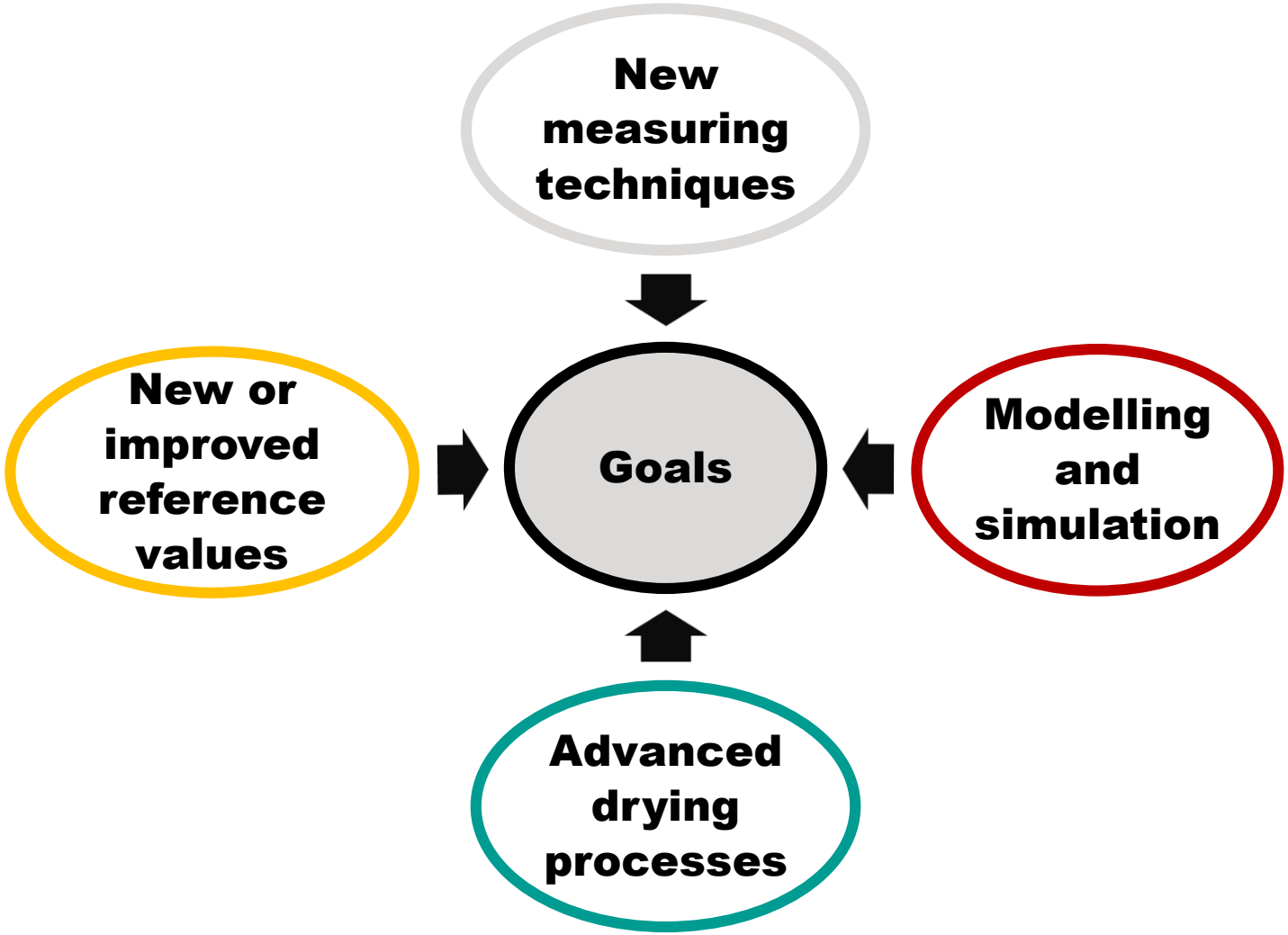
Drying Technology

Energy efficiency

Drying Technology



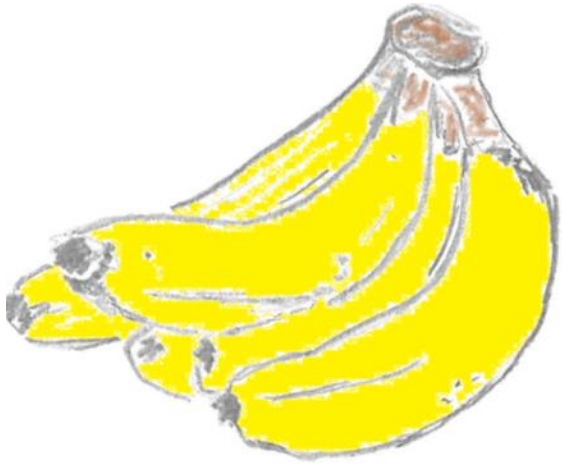
Drying Technology



Drying Technology

New measuring techniques

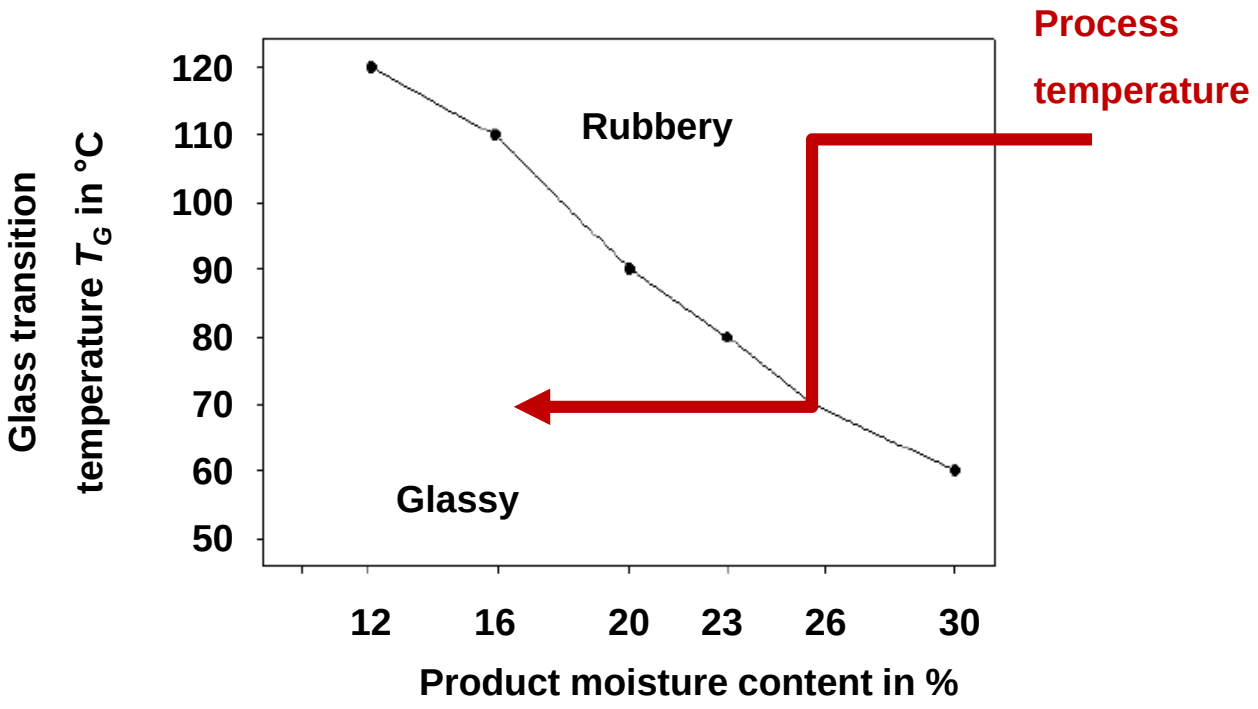
Concept of glass transition temperature



Drying Technology

New measuring techniques

Concept of glass transition temperature

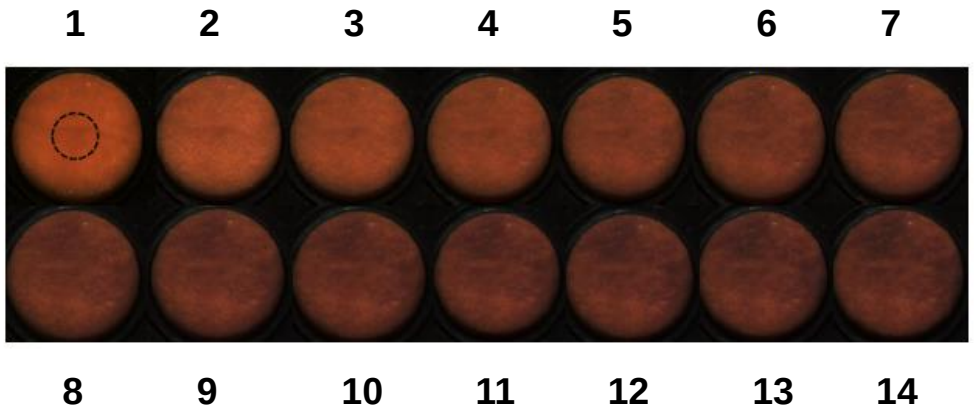


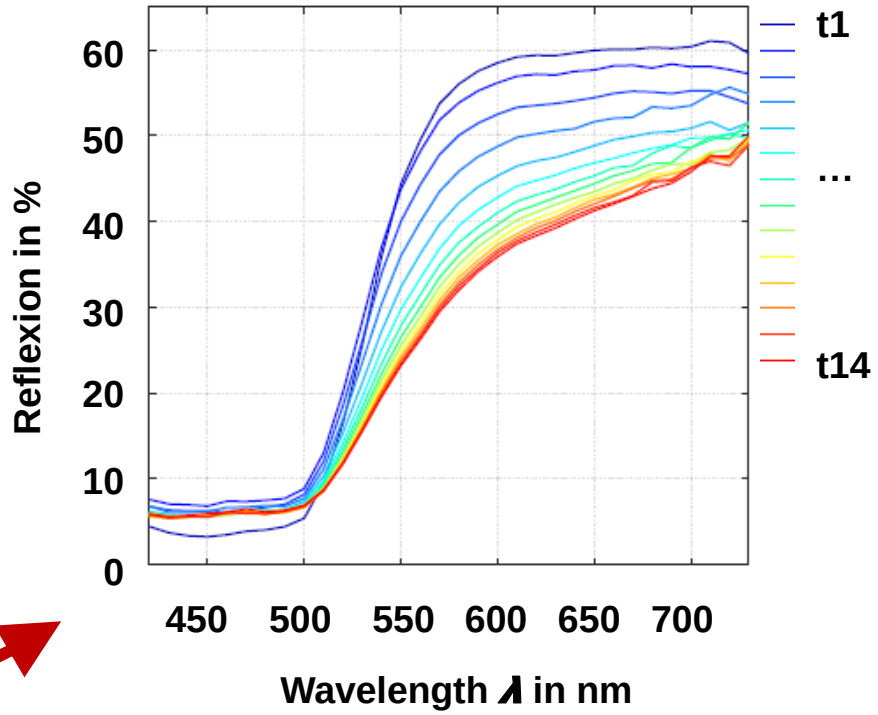
2018, adapted from A. H. Taye

Drying Technology

New measuring techniques

Colour and spectra

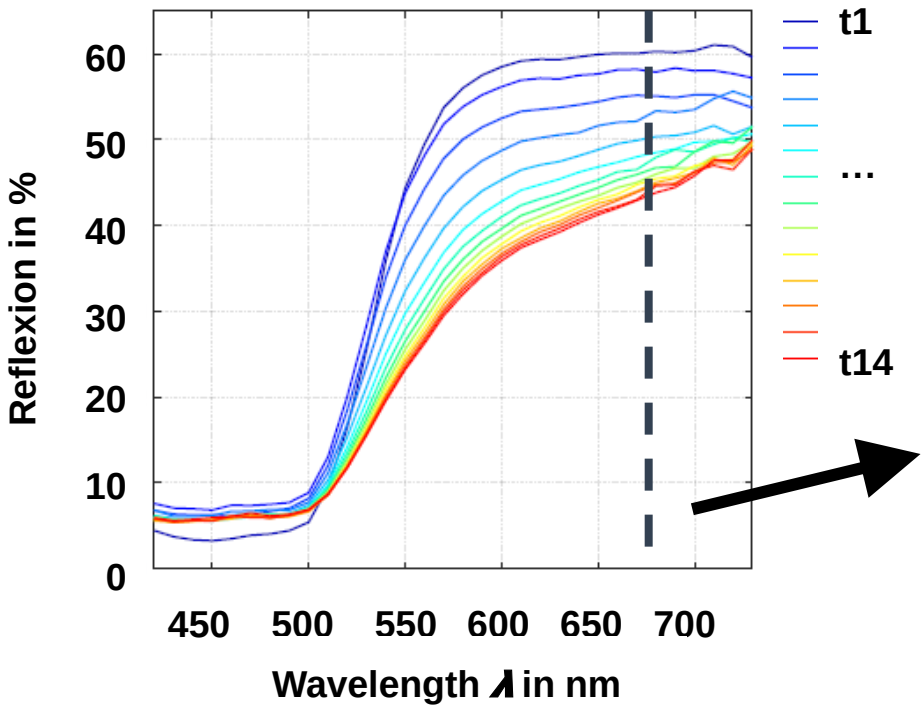




Drying Technology

New or improved reference values

Links between criteria

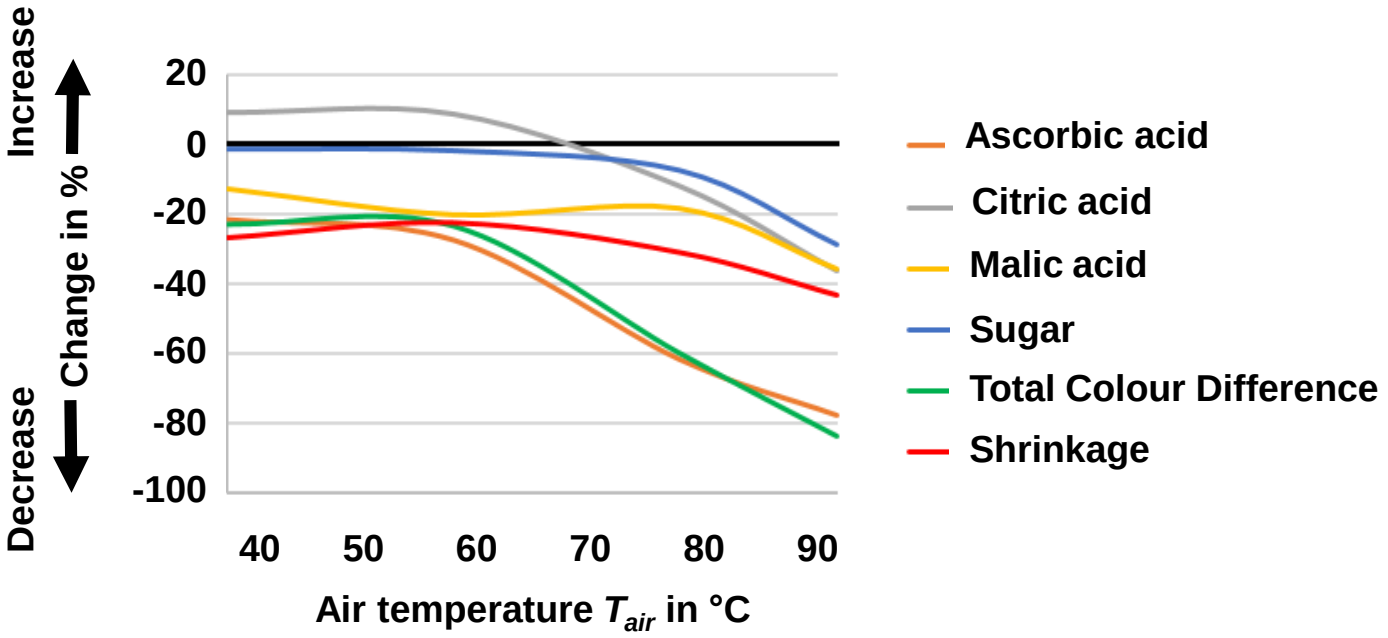


sugar measurement

Drying Technology

New or improved reference values

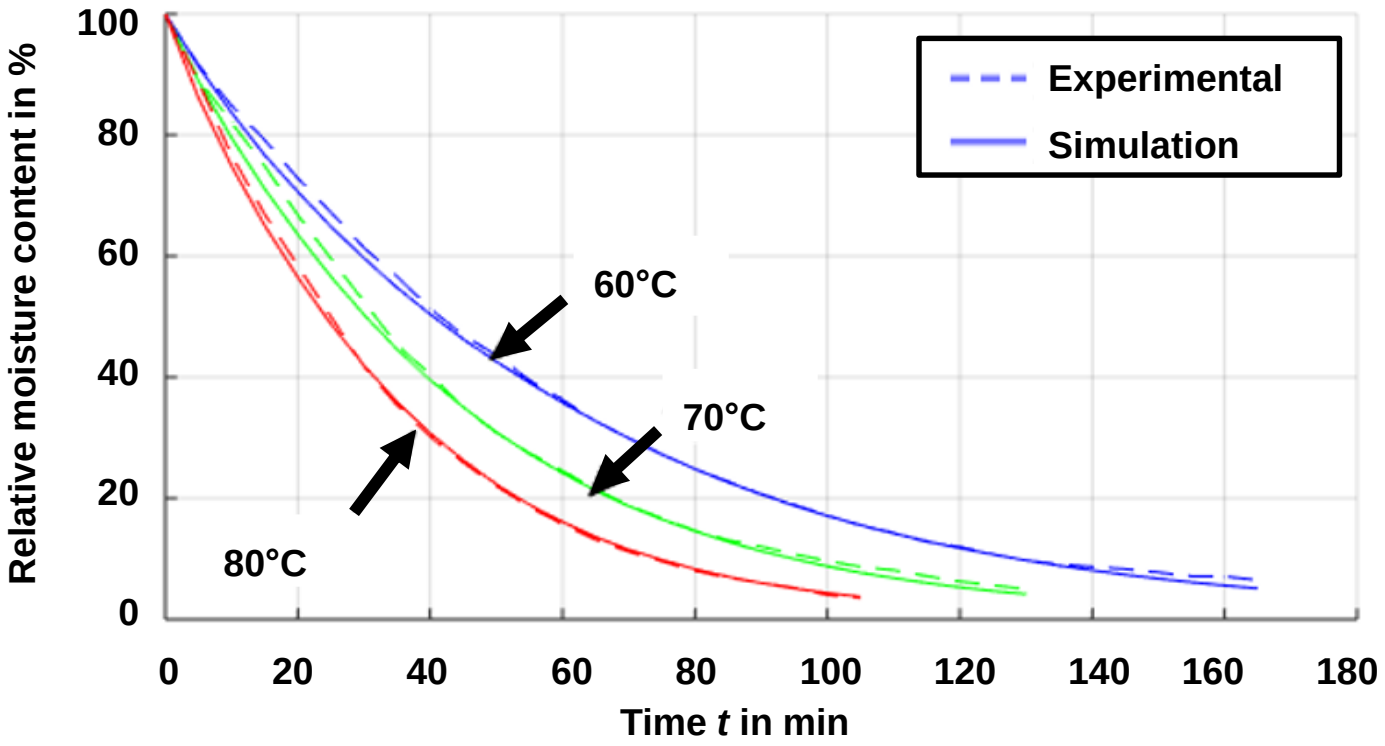
Damage diagrams



Drying Technology

Modelling and simulation

Prediction of moisture content over time

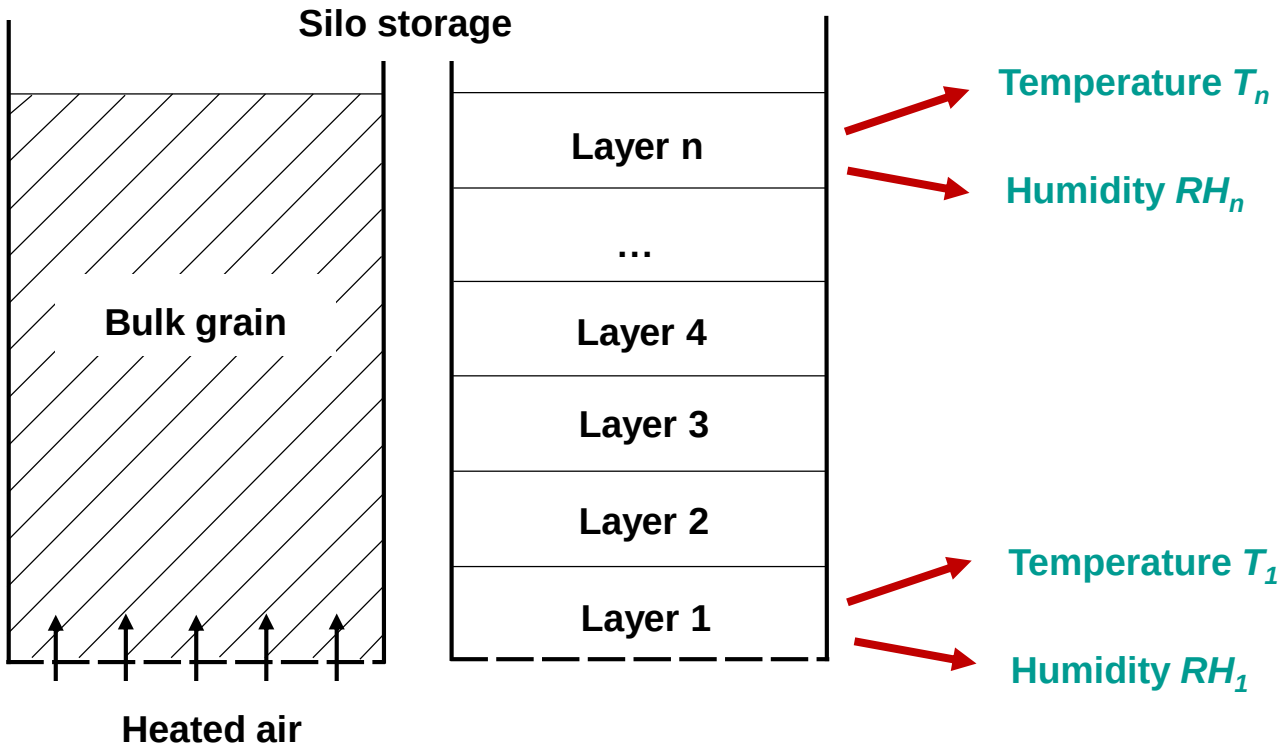


2017, adapted from K. G. Erko

Drying Technology

Modelling and simulation

Prediction of microbiological contamination

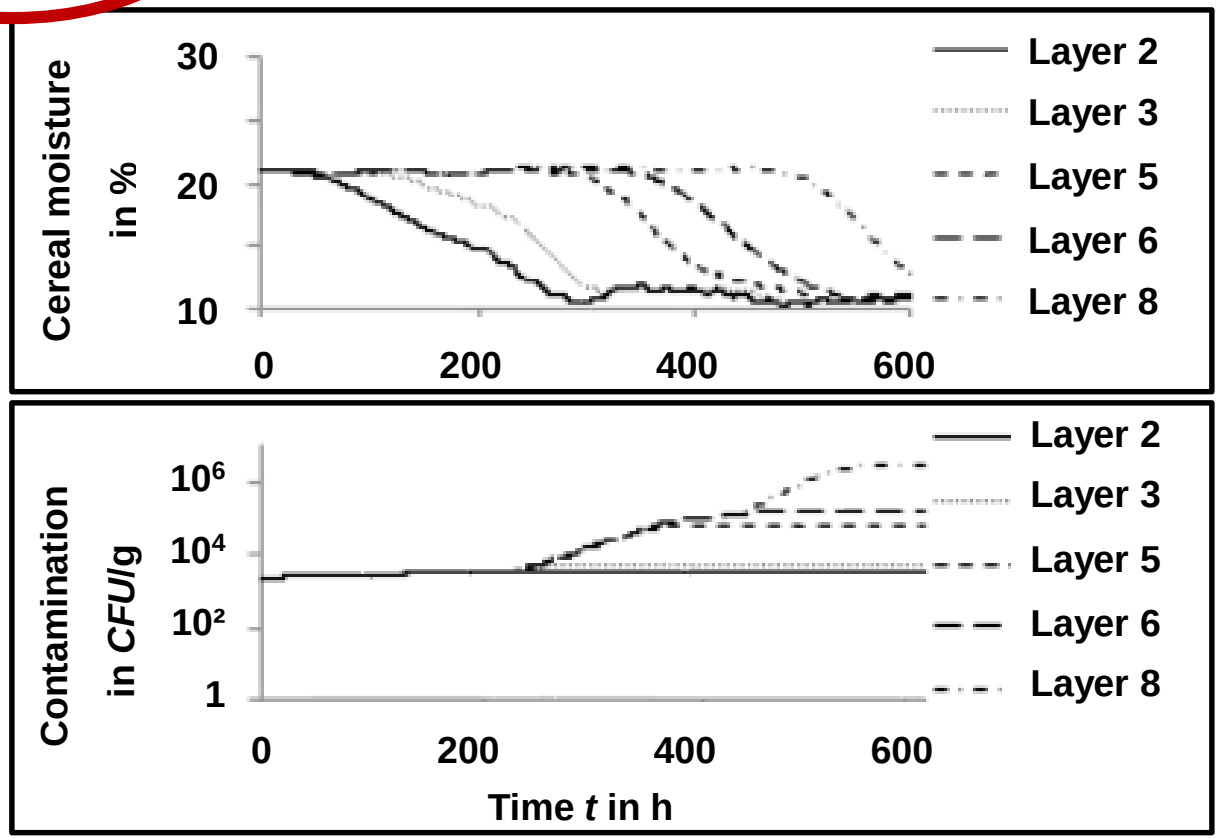


2018, adapted from J. Schemminger

Drying Technology

Modelling and simulation

Prediction of microbiological contamination



CFU = Colony forming units

2018, adapted from J. Schemminger

Drying Technology

Advanced drying processes

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Small-Scale Drying of Agricultural Products using Constant & Continuous Strategies

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Small-Scale Drying of Agricultural Products using Constant & Continuous Strategies

Sub-contents:

- **Methods and Materials**
- **Results**
- **Summary**

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Methods and Materials

Methods and Material used:

Parameters	Products	
	Potato (Balena)	Carrot
Air temperature (T_a)	50°C-90°C	40°C-75°C
	60°C-80°C	40°C-75°C
Air velocity (v_a)	0.85m/s-1.25m/s	0.95m/s-1.25m/s
Relative humidity (Rh)	10%-50%	10%-20%

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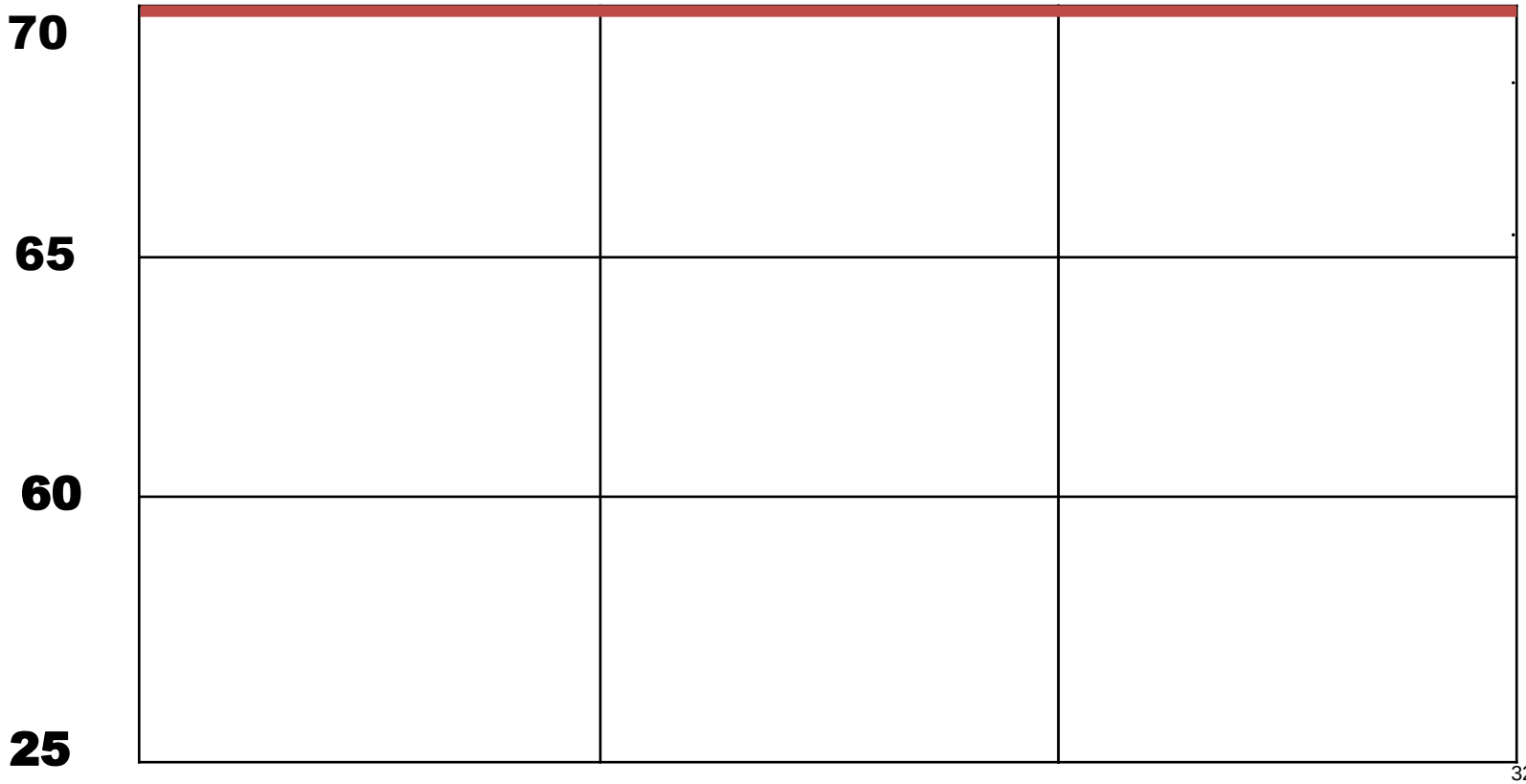
Methods and Materials

Methods and Fresh Material used: Constant Drying



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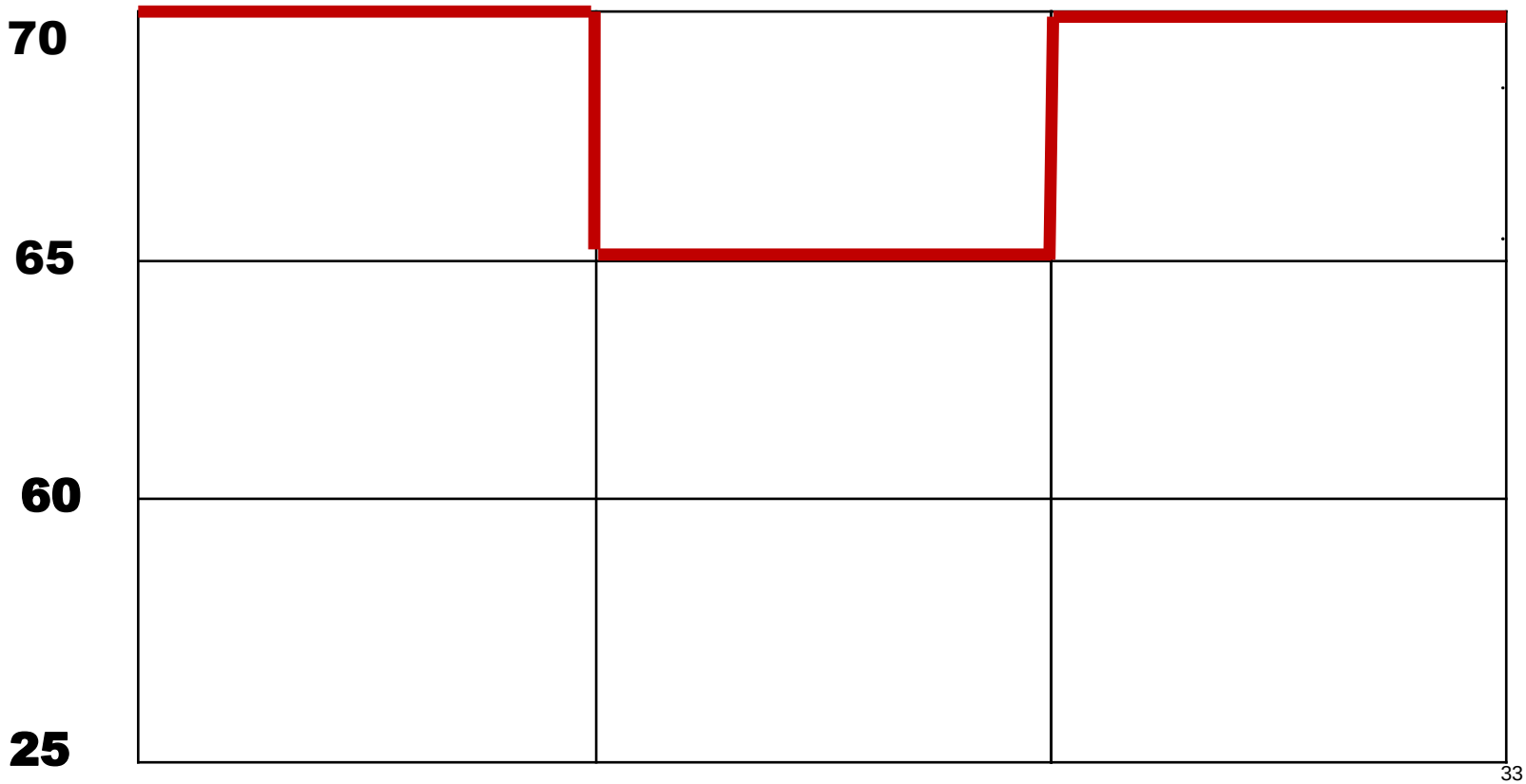
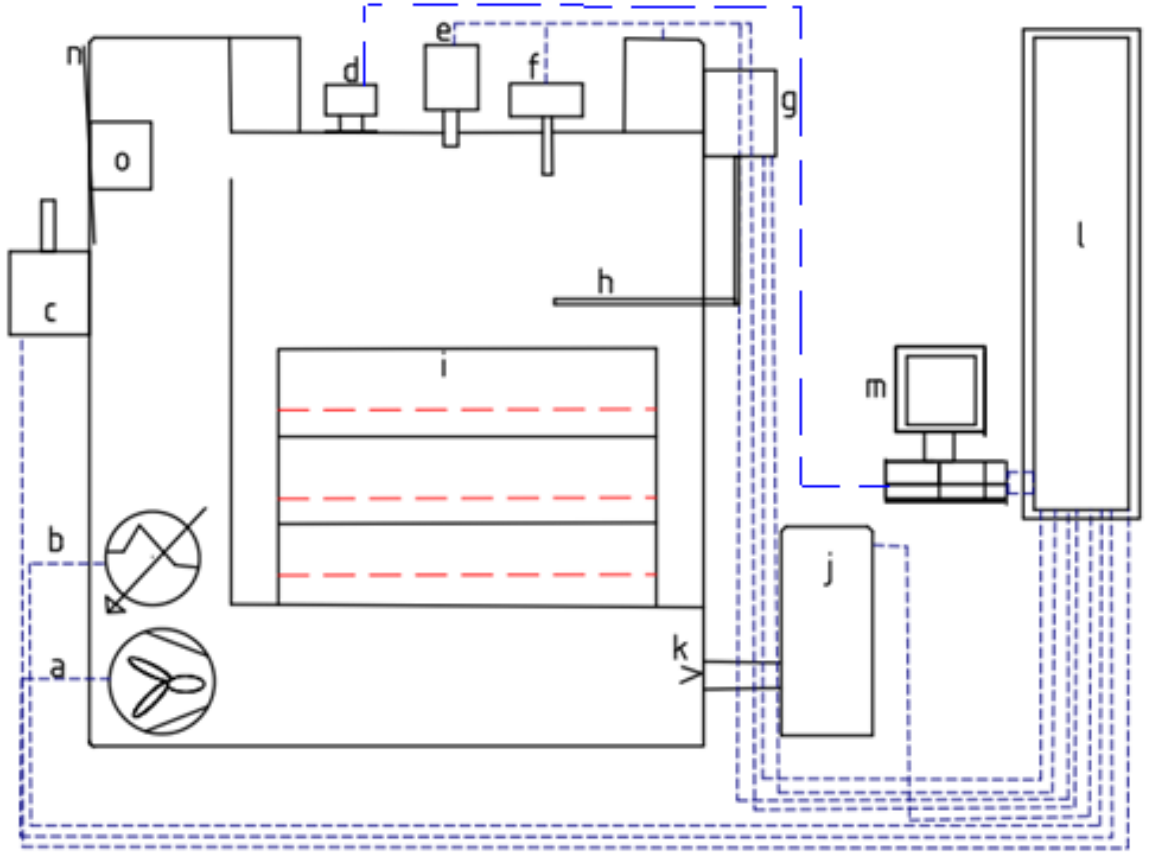
Methods and Materials

Methods and Fresh Material used: Continous Drying



Methods and Materials

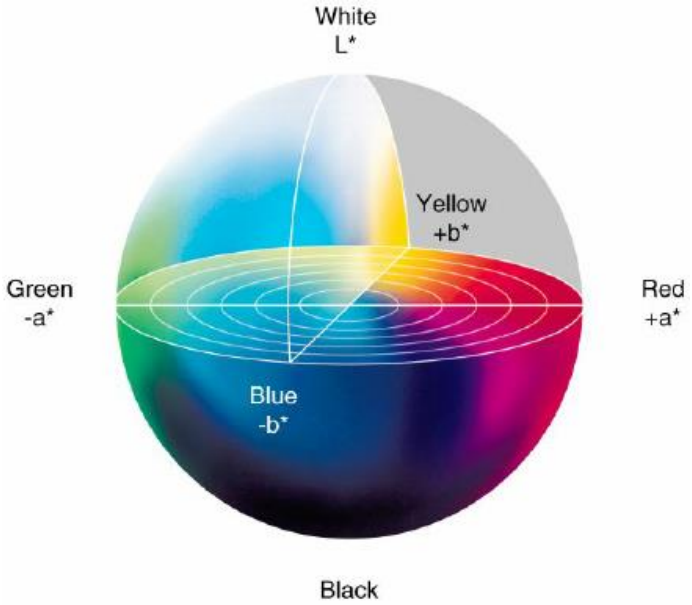
Dryer used: small-scale air-recirculating cabinet dryer



- **a = radial fan**
- **b = heater**
- **d = CCD camera**
- **e = pyrometer**
- **f = temp. & Hum.**
- **j = steam gen.**
- **l = system contr.**
- **m = computer**

Methods and Materials

Image Capturing and Analyzing : color change CIELab 1976



$$\Delta L^* = L^* - L_o$$

$$\Delta a^* = a^* - a_o$$

$$\Delta b^* = b^* - b_o$$

$$\Delta E = \sqrt{(\Delta L^*)^2 + (\Delta a^*)^2 + (\Delta b^*)^2}$$

Methods and Materials

Surface area shrinkage :

- **Pixels of the particle surface were counted**

$$S = \left(1 - \frac{A}{A_0}\right) \times 100\,\%$$

- S = **Shrinkage (%)**
- A = **Area at time** t
- A_0 = **Initial area**

Methods and Materials

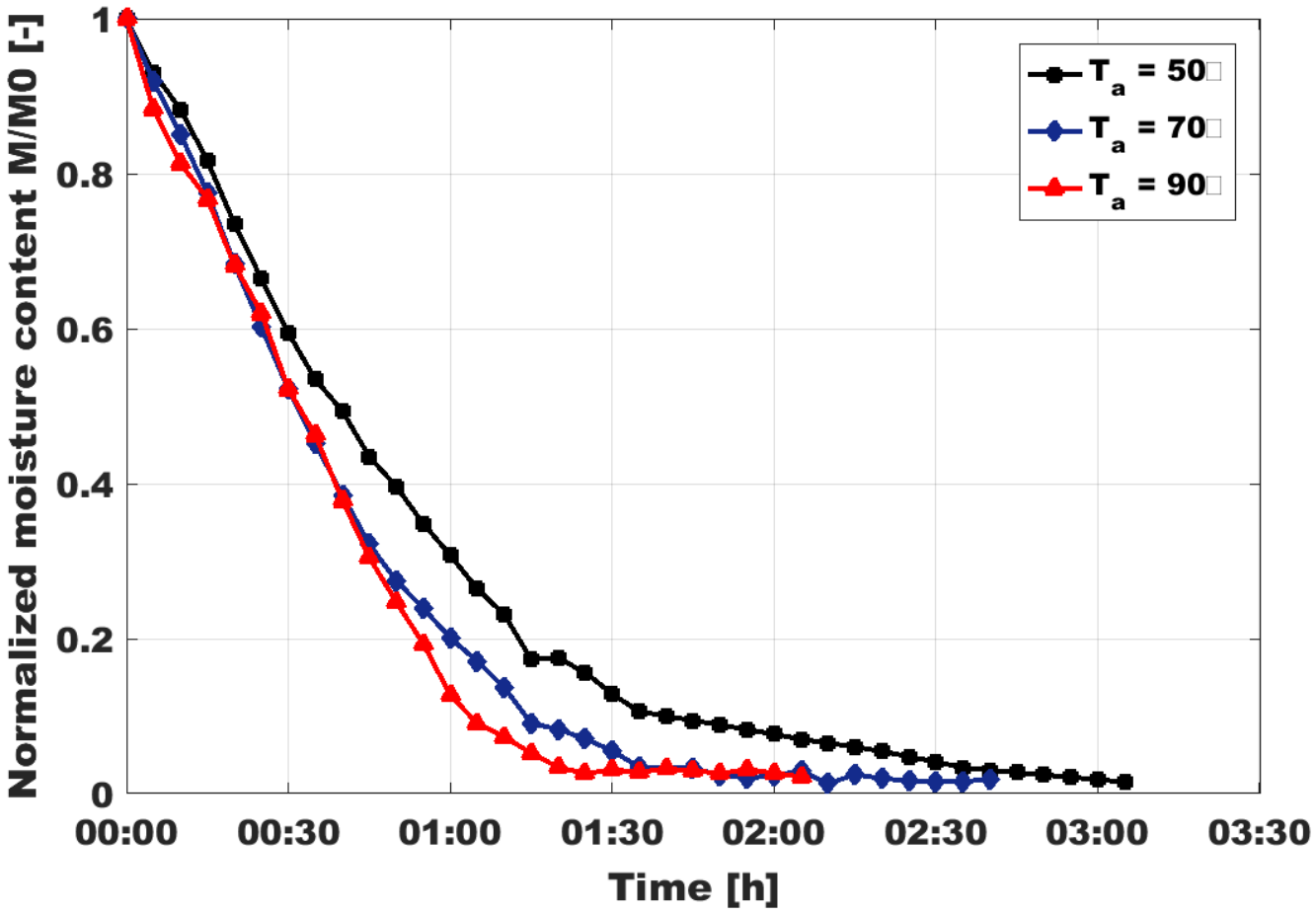
Drying kinetics: Moisture removal

- **Moisture removal was continuously recorded**
- **Weight deviated was corrected**
- **Initial and end mass was measured using standard balance**

$$MR = \frac{M - M_e}{M_0 - M_e} = \frac{M}{M_0}$$

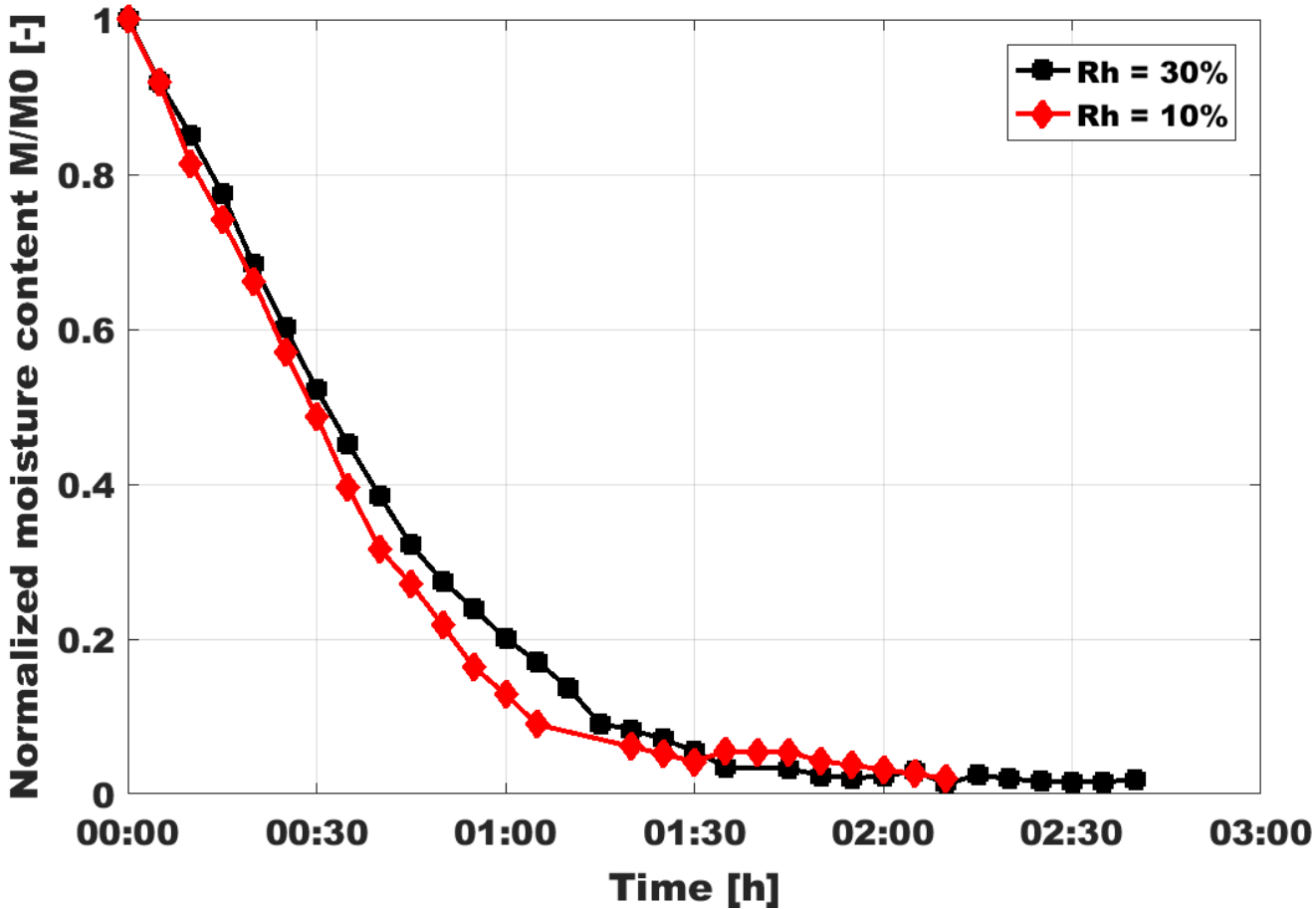
Results and discussion

Drying Kinetics: potato at v_a = 0.95m/s and *Rh* = 30%



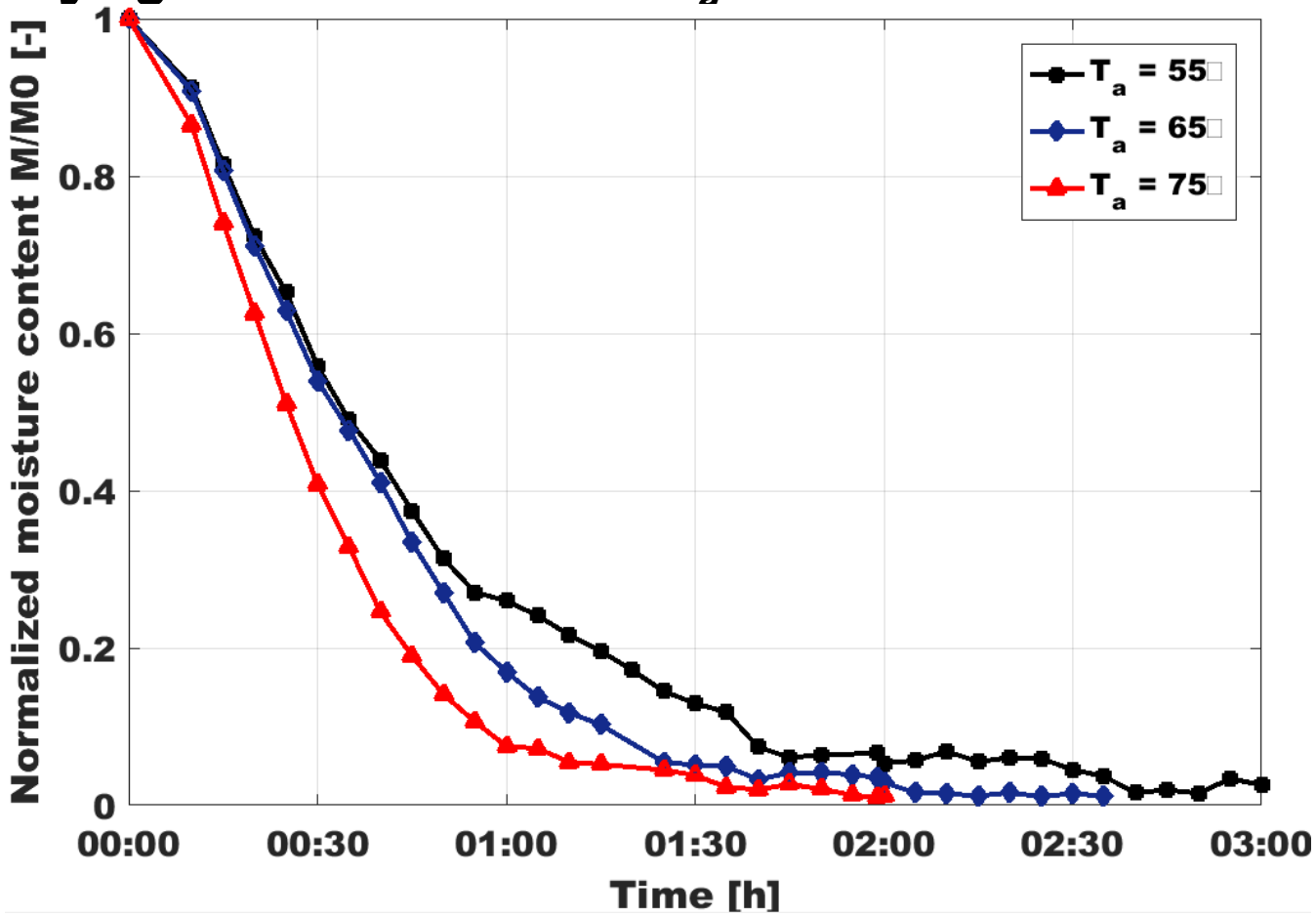
Results and discussion

Drying Kinetics: potato at T_a = 70°C and Rh = 30%



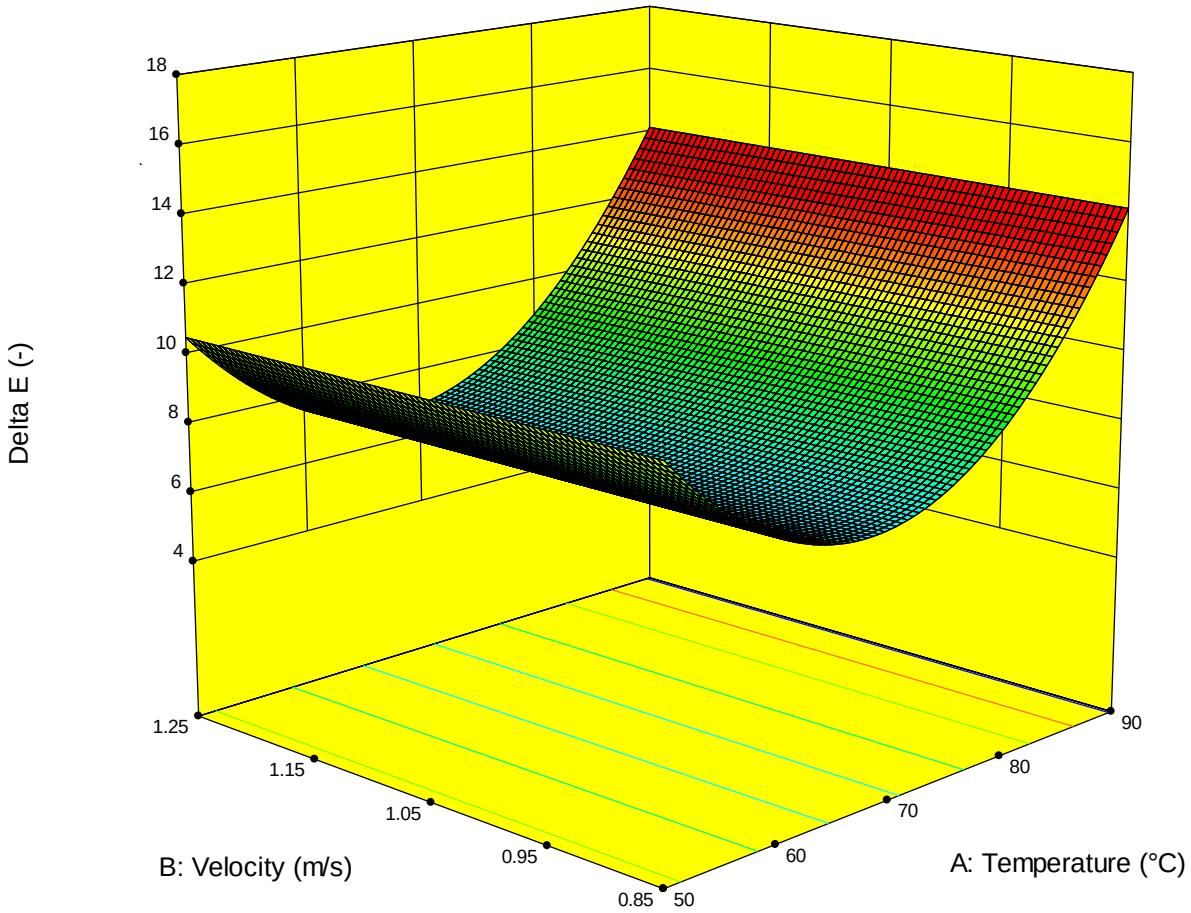
Results and discussion

Drying Kinetics: carrot at v_a = 0.95 m/s and *Rh* = 20%



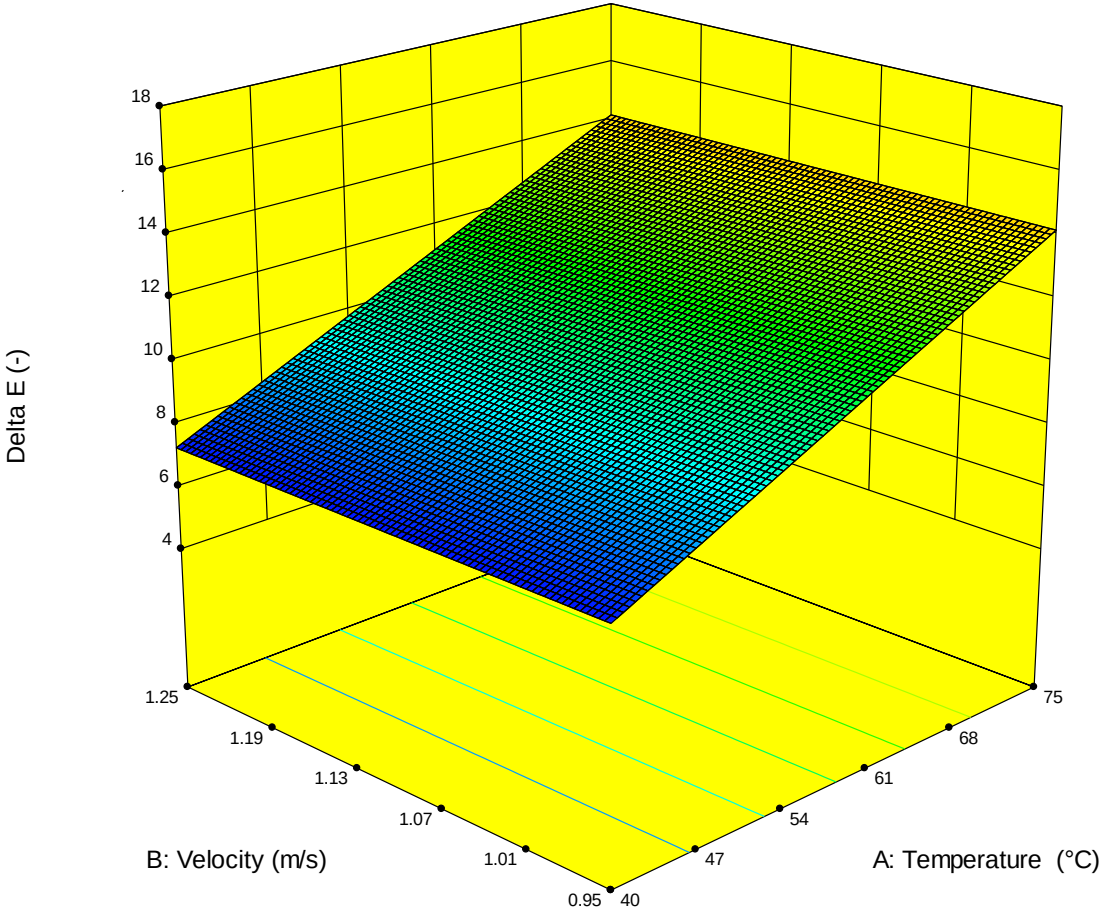
Results and discussion

Color change optimized: total color change of potato



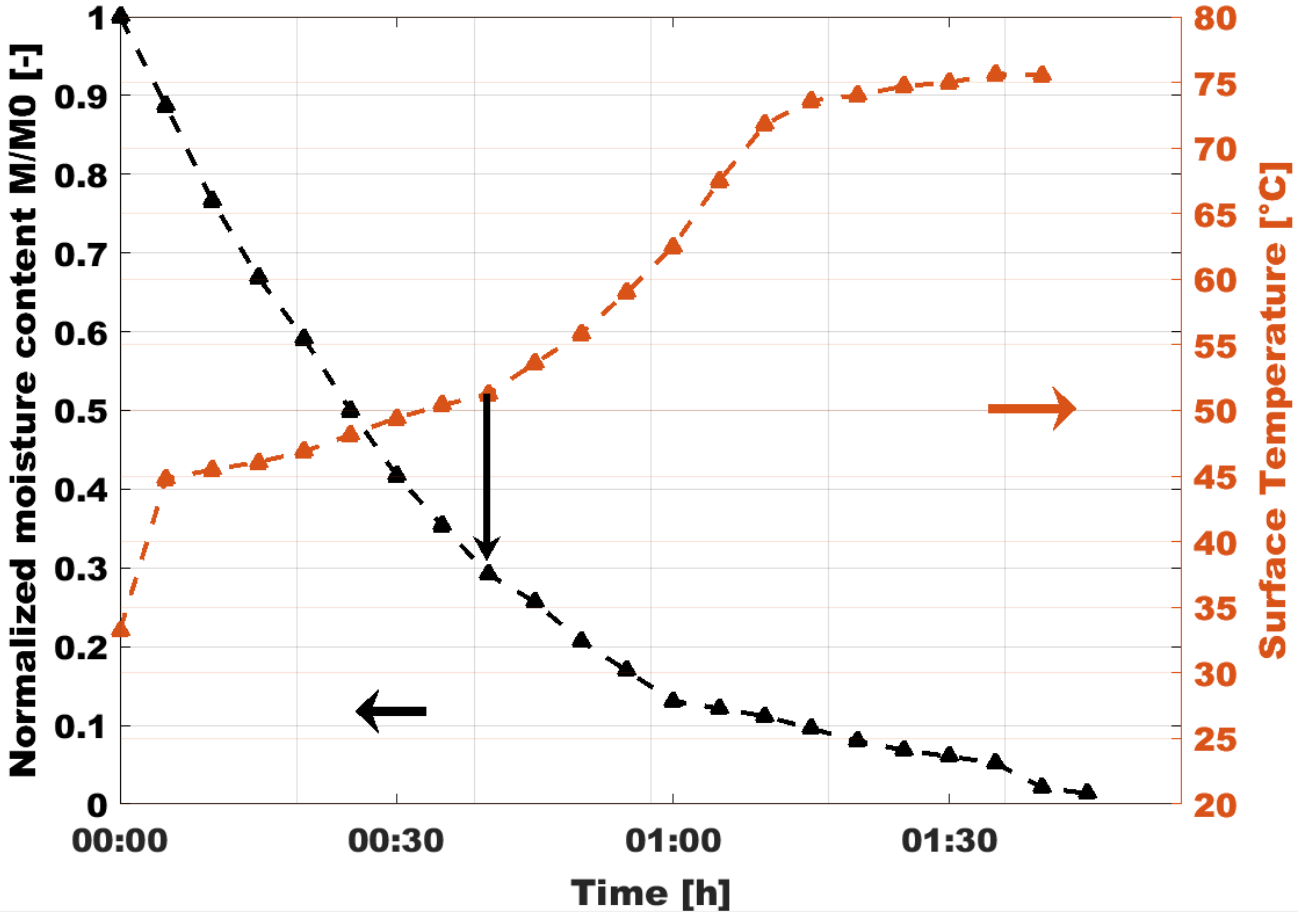
Results and discussion

Color change optimized: total color change of carrot



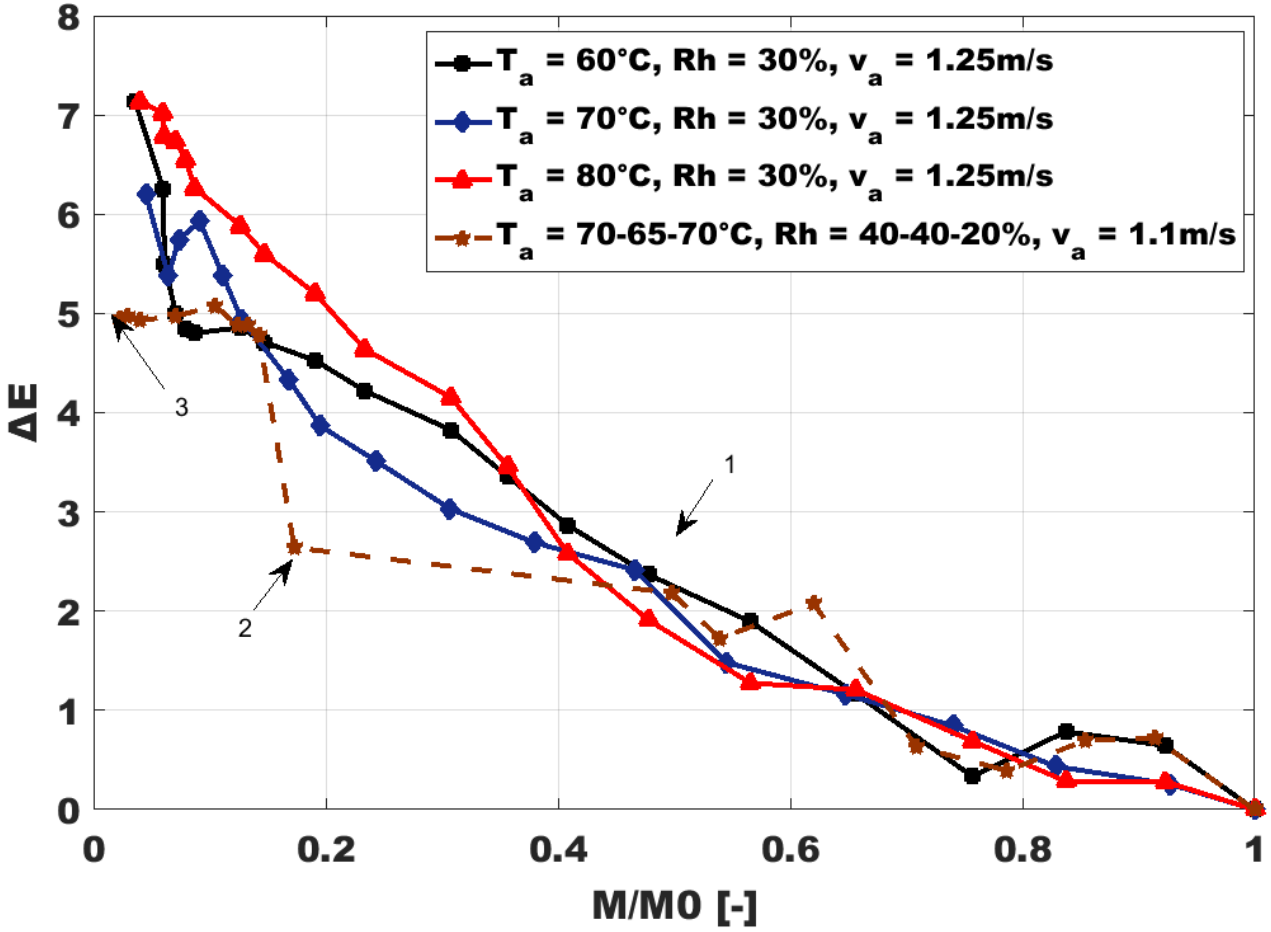
Results and discussion

Techniques used for further optimization:



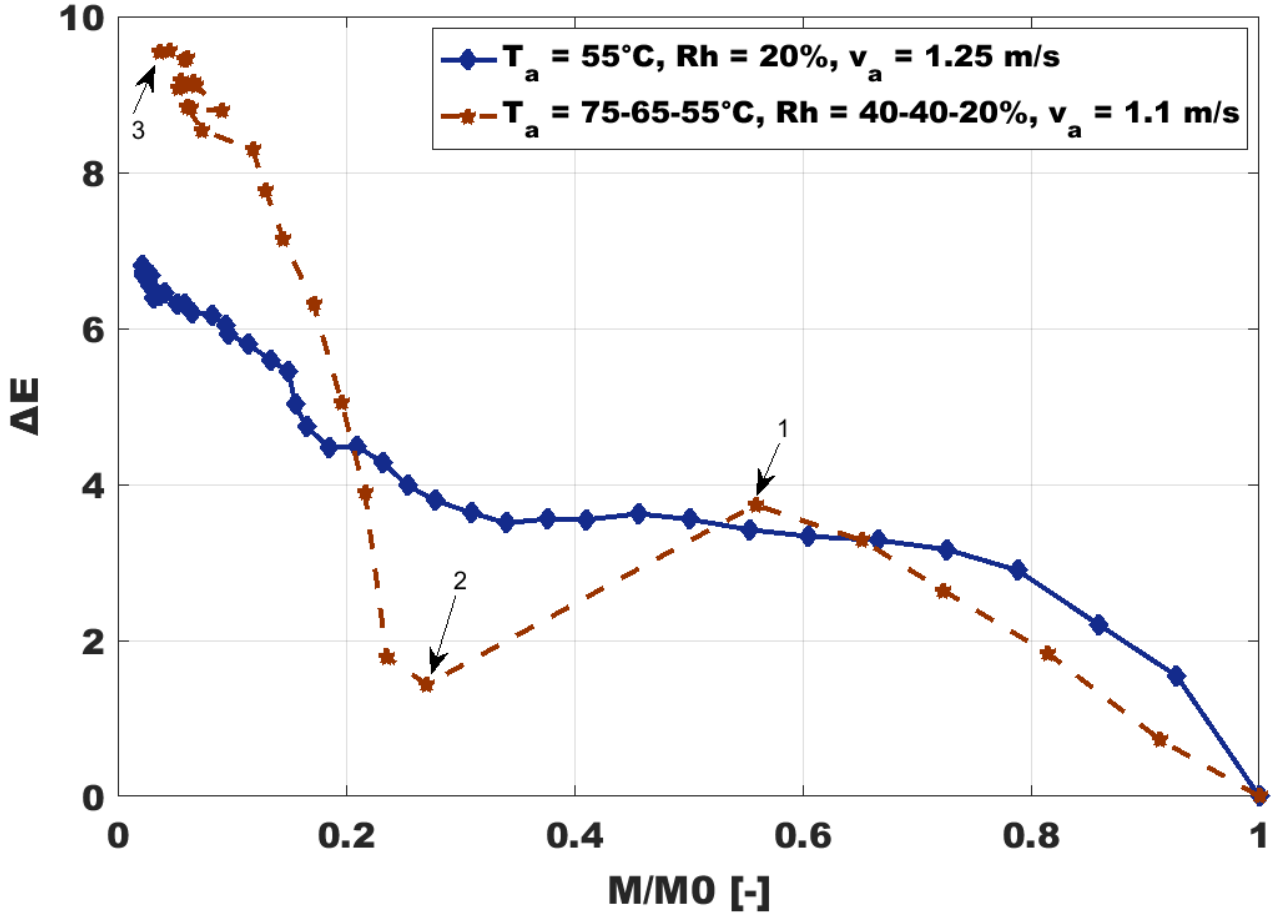
Results and discussion

Color change optimized: cont. drying techniques



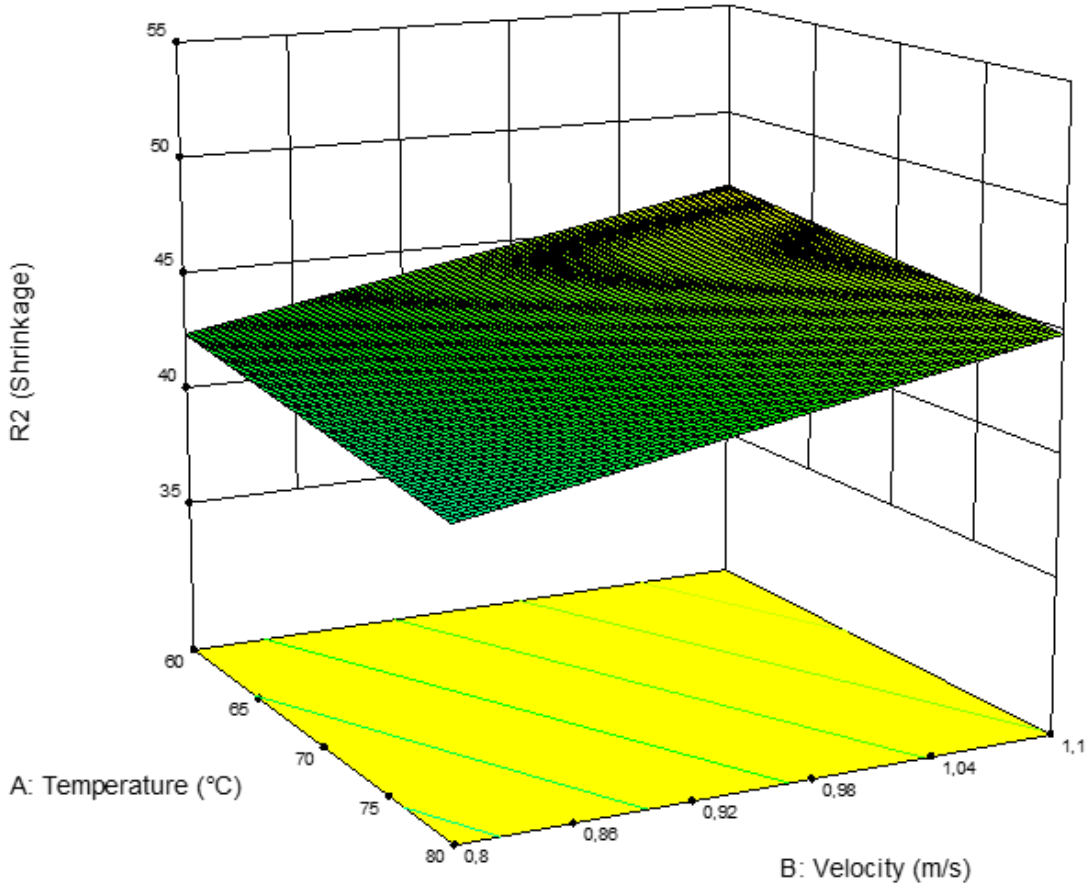
Results and discussion

Color change optimized: cont. drying techniques



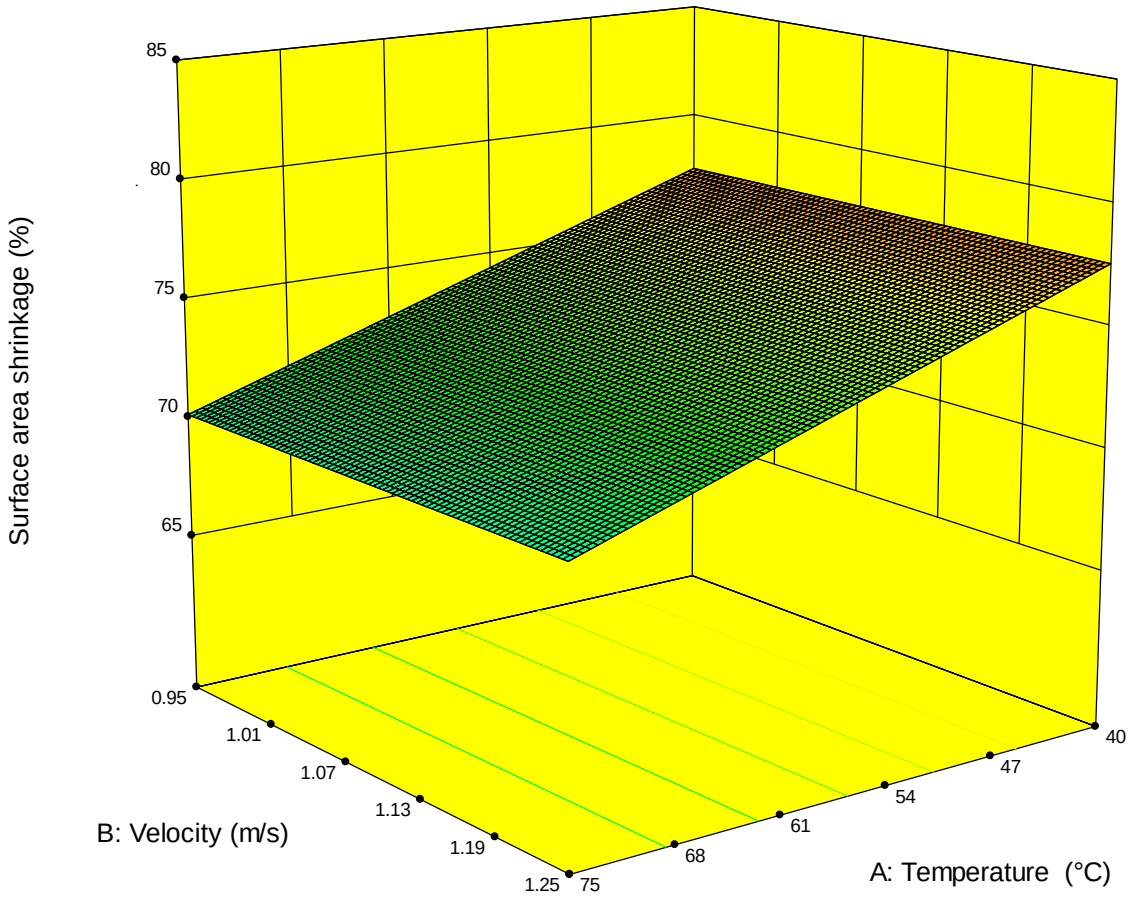
Results and discussion

Surface area shrinkage: potato



Results and discussion

Surface area shrinkage: carrot



Results and discussion

Result summary:

Product	Air temperature (°C)	Air velocity (m/s)	Relative humidity (%)	Drying time (min)	*ΔE*	*S* (%)
Potato	67.46	1.25	10	124	6.92	35.5
Carrot	49	0.95	20	250	7.32	77.45
Potato	65-70-65	1.1	40-40-20	120	4.9	-
Carrot	75-65-55	1.1	40-40-20	190	9.3	-

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Summary

What achieved by using constant and continuous drying strategies is:

- **Better processing techniques has been developed**
- **Optimum drying parameters (fruits and vegetables)**
- **Value addition (retention of high quality)**

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Thank you

for your attention!