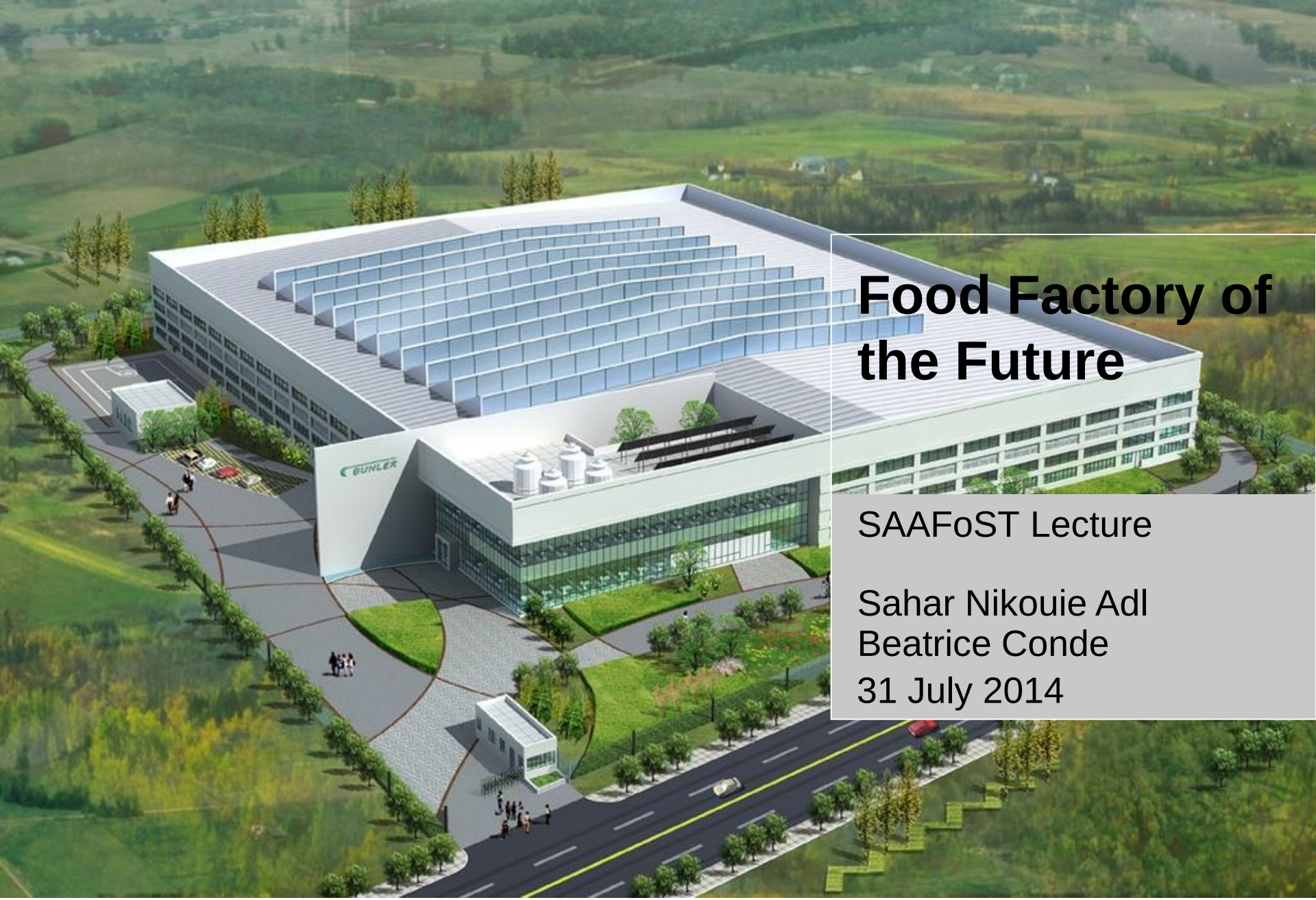


Food Factory of the Future

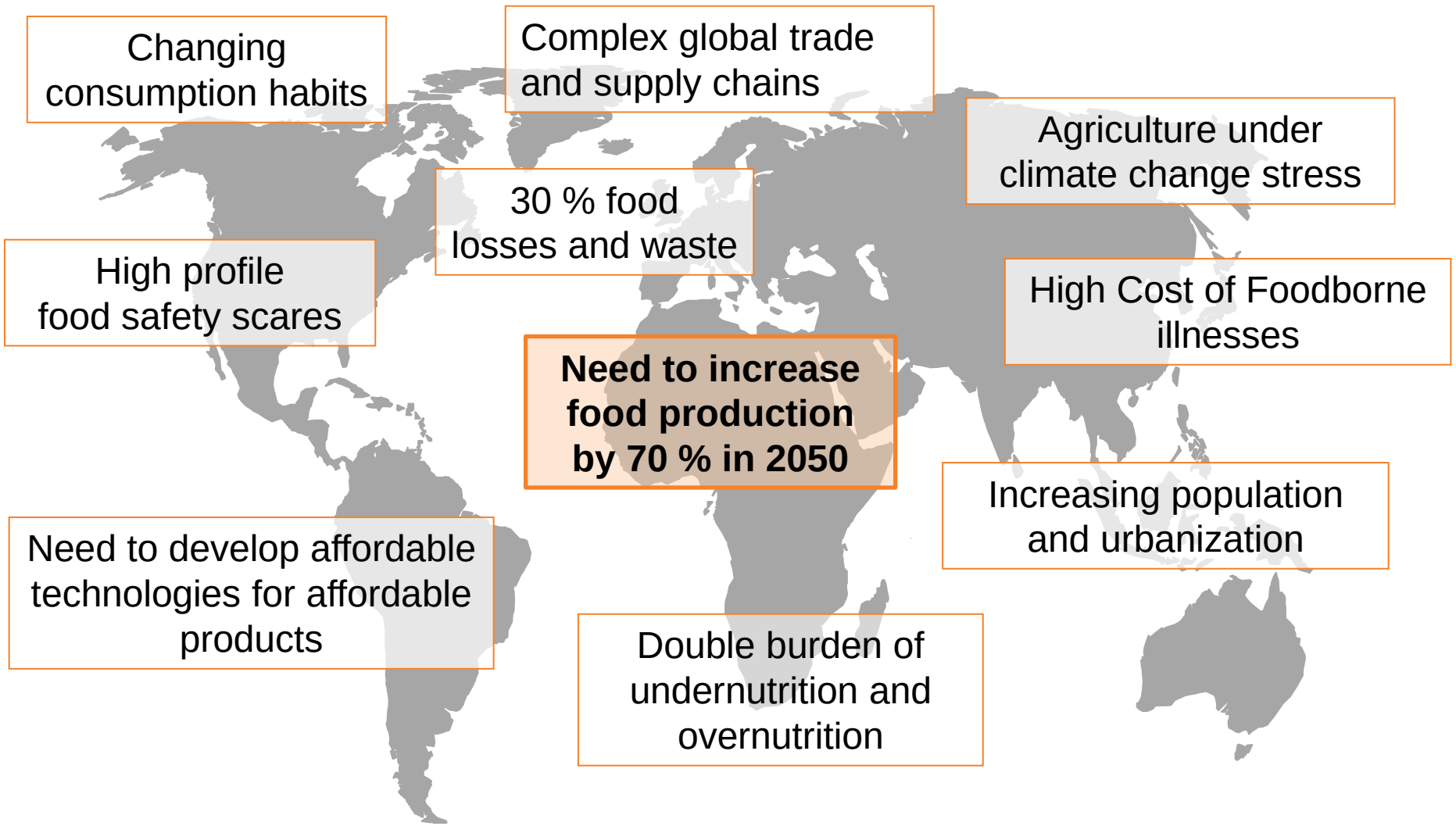
SAAFoST Lecture

Sahar Nikouie Adl
Beatrice Conde

31 July 2014

BÜHLER

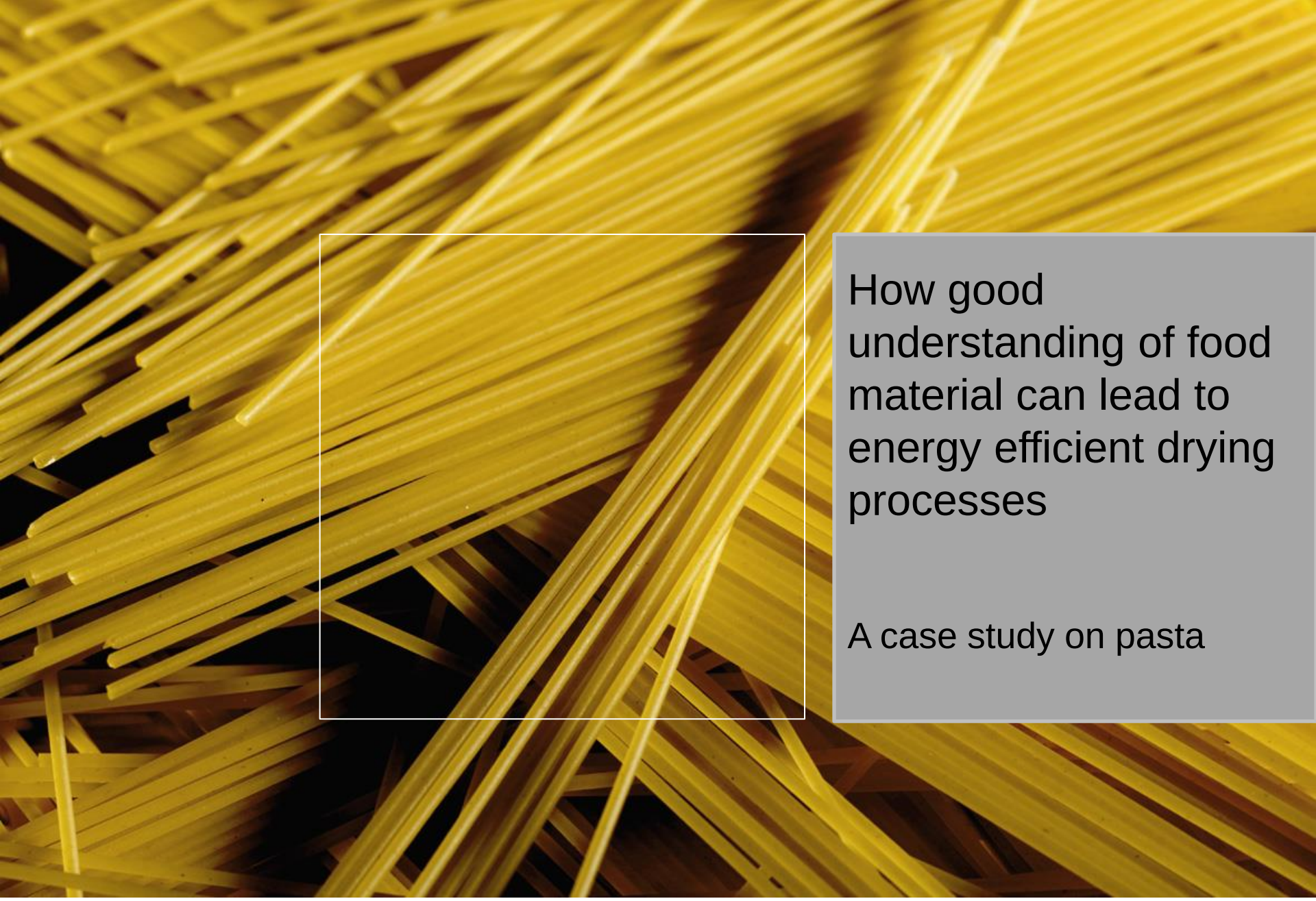
Challenges in nourishing the world within the limits of our planet



The factory of the future needs to…

- ❑ Process food more efficiently requiring less energy
- ❑ Apply new affordable technologies for affordable food products
- ❑ Deliver food that is nutritious and meets local taste and culture
- ❑ Ensure high food safety standards
- ❑ Operate intelligently
- ❑ Create new job opportunities

Energy Efficiency



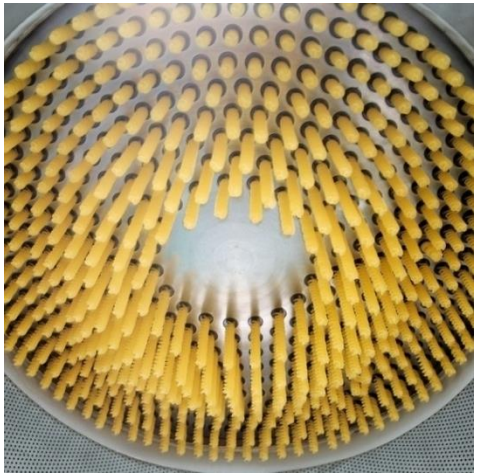
How good understanding of food material can lead to energy efficient drying processes

A case study on pasta

Pasta drying is key for stabilizing pasta and adjusting the cooking properties of pasta

Wheat Pasta:

Produced by mixing durum wheat semolina and water (approx 30 %) and shaping it



Pasta drying

Is key for pasta stabilization and for adjusting the cooking properties

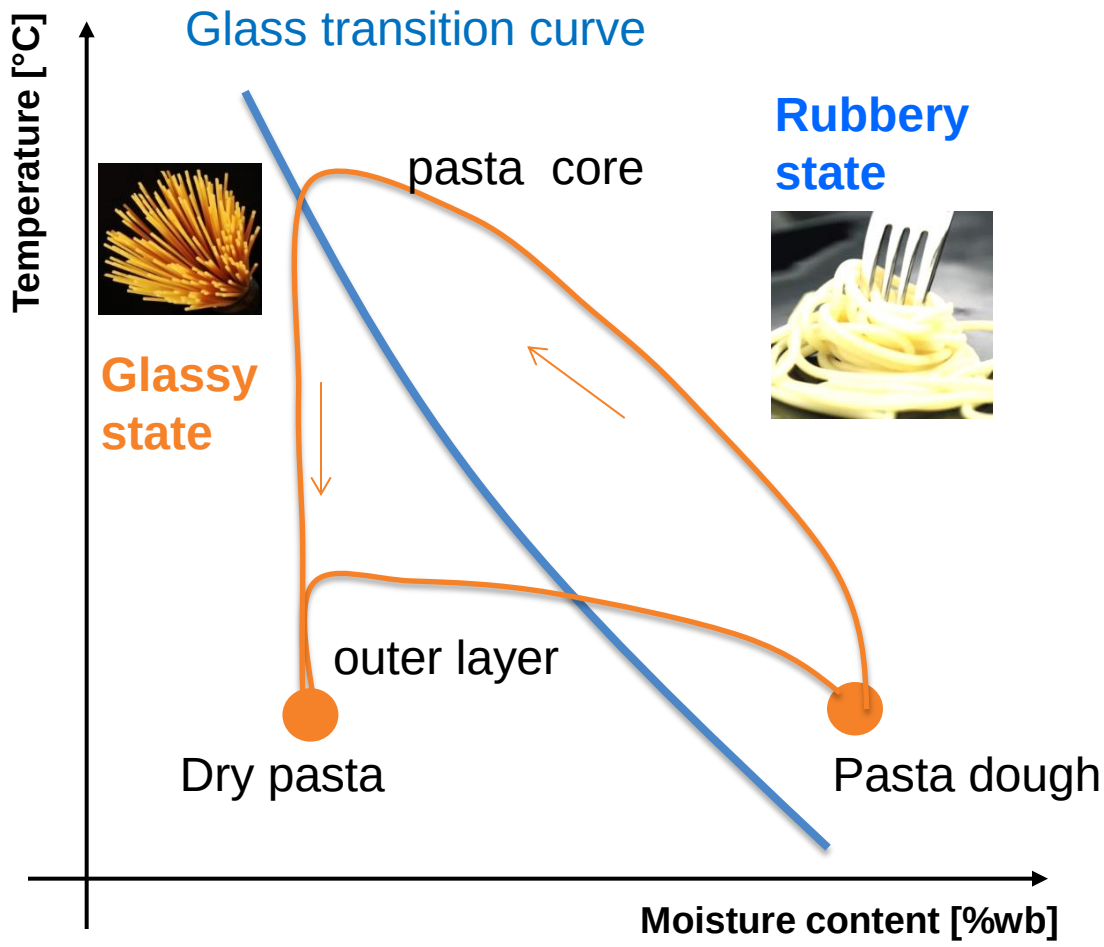
Typical drying is done at 80 to 90 °C for up to 8 h.

Energy-intensive process step

Traditional pasta drying allows early setting into glass state

Allows a fast setting of the outer layer into the glassy state

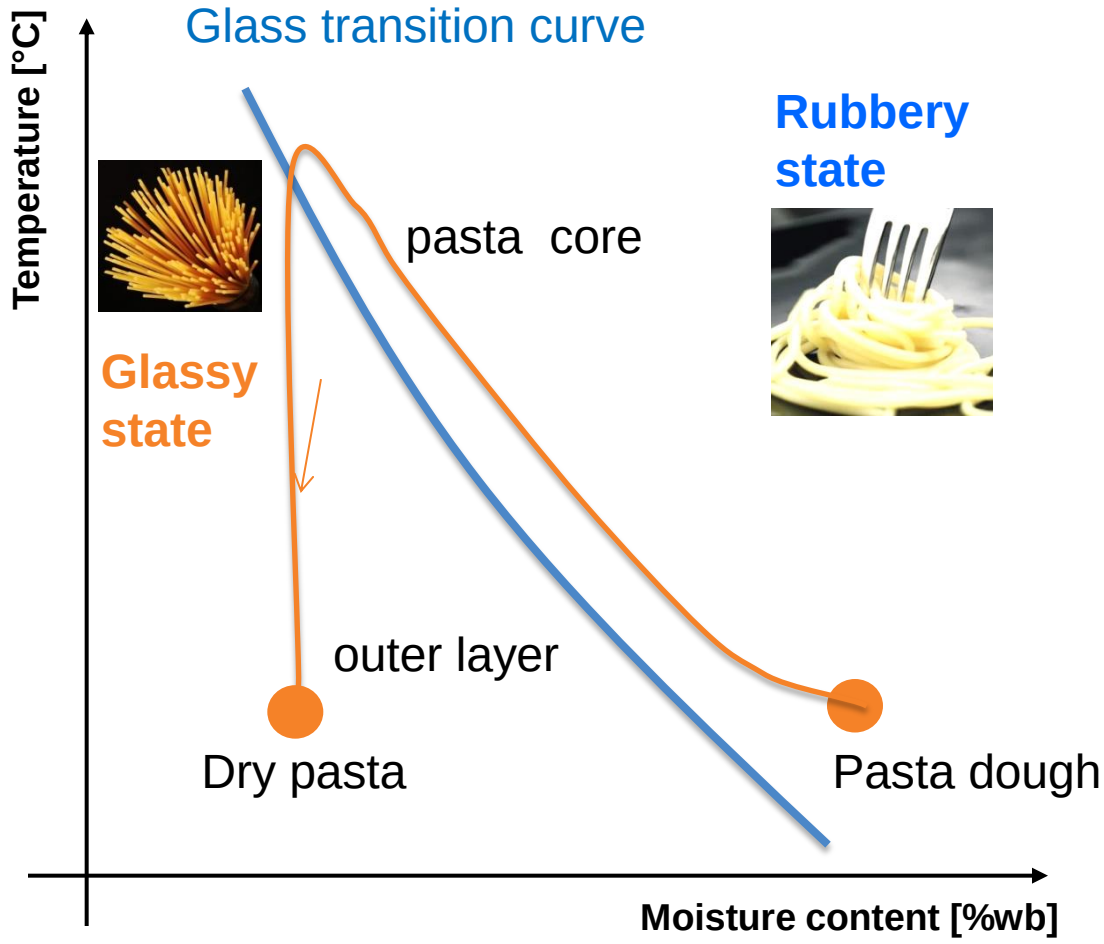
- build up of moisture gradients
- glassy outer layer slows down drying
- long drying (stabilization) to prevent cracks



Novel pasta drying allows drying in the rubbery state

The drying concept dries in the rubbery state along the Tg curve

- low moisture gradients
- higher drying rate
- more efficient drying



New drying concept allows 30 % energy savings of 115 kWh/t

This means around 1 % lower production costs

Cost structure Pasta production:

Raw material	60%
Packaging material	10%
Depreciation pasta line	**3%**
Energy pasta line	**3%**
Labor cost pasta line	**2%**
Maintenance pasta line	**1%**
Labor cost packaging line	8%
Logistics	5%
Maintenance packaging line	4%
Depreciation others	3%
Energyothers	1%
Total cost w/o sales	**100%**

Pasta line w/o packaging & building:

400 kWh/t total consumption

115 kWh/t total savings

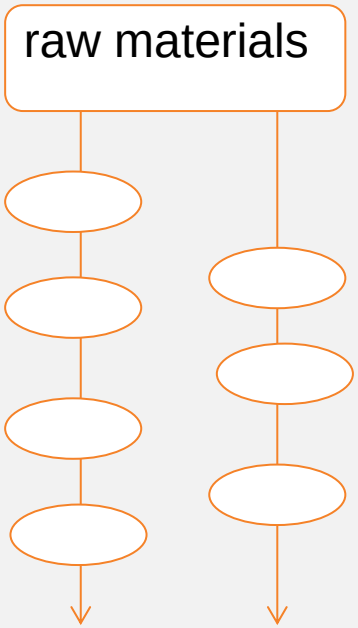
→ 30% less energy consumption

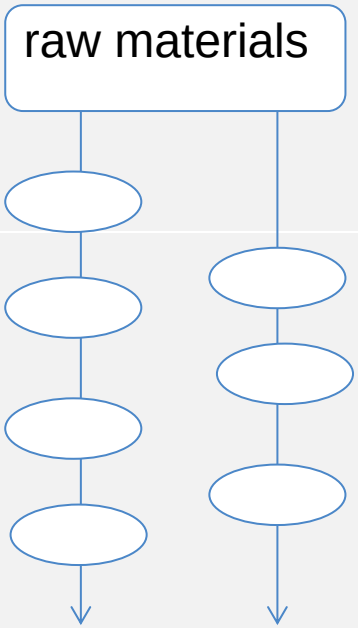
- 40% thermal → 100 kWh/t
- 20% cooling → 15 kWh/t
- 10% electrical → 10 kWh/t

} 15 kWh/t electrical

→ 1% lower Pasta production cost

→ green label pasta / less CO_2





Food processing along different steps and shortcuts can make processing more efficient

Breakfast cereals
Chocolate

Diagram for Batch Cooked and Indirect Expanded Flaked Products – Corn Flakes, Wheat Flakes

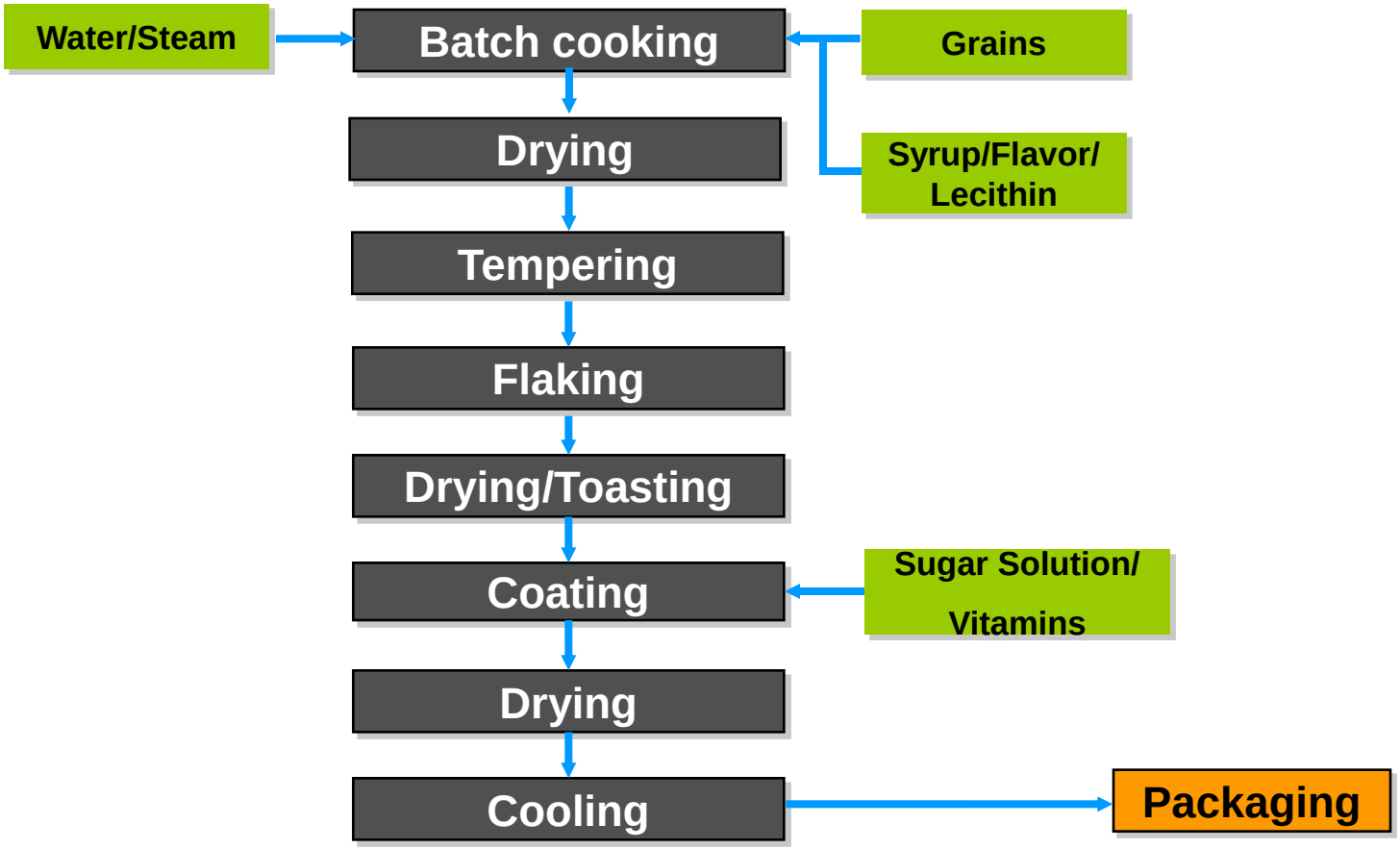
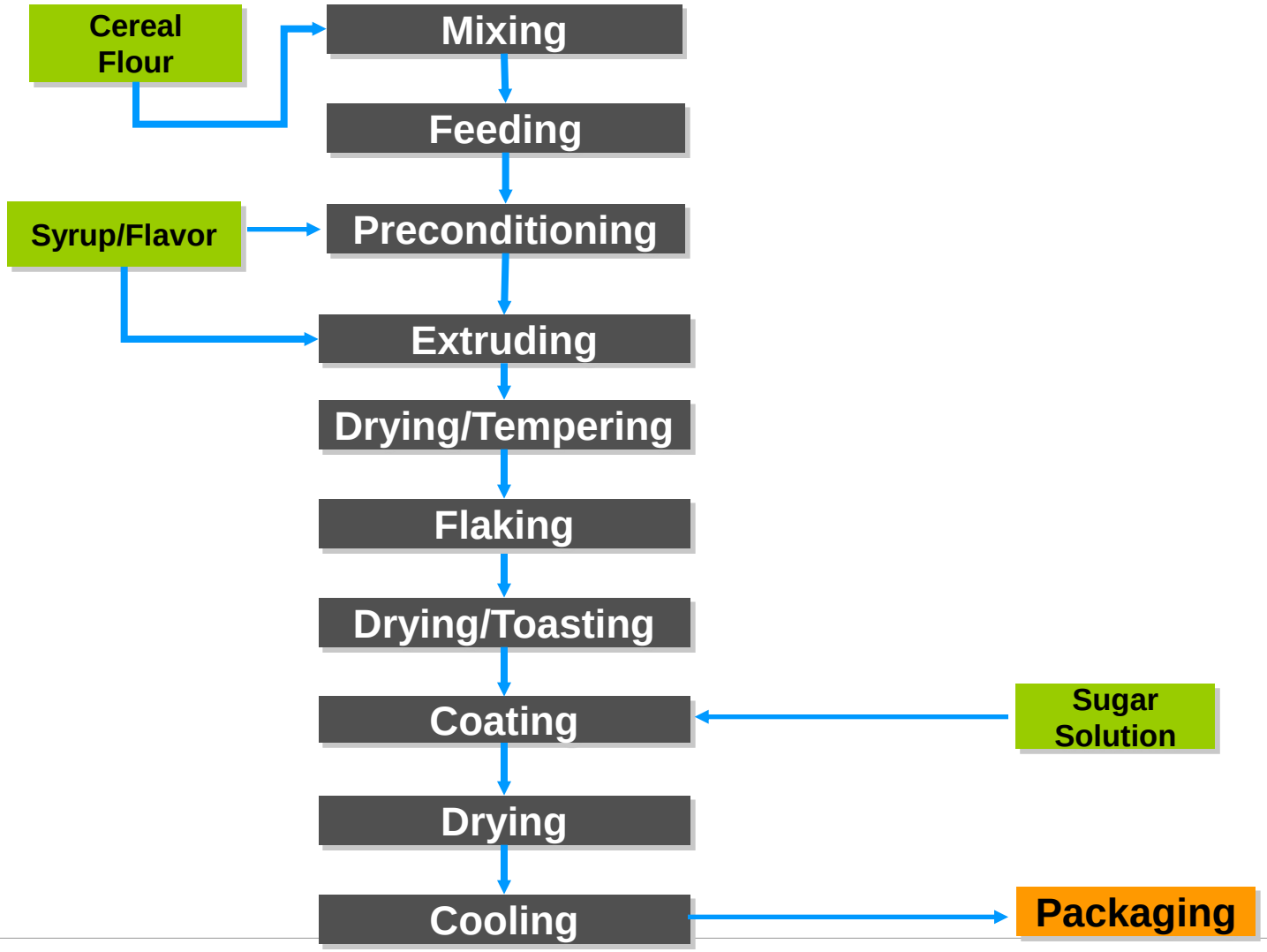


Diagram for Extrusion Cooked and Indirect Expanded Flaked Products – Corn Flakes, Wheat Flakes



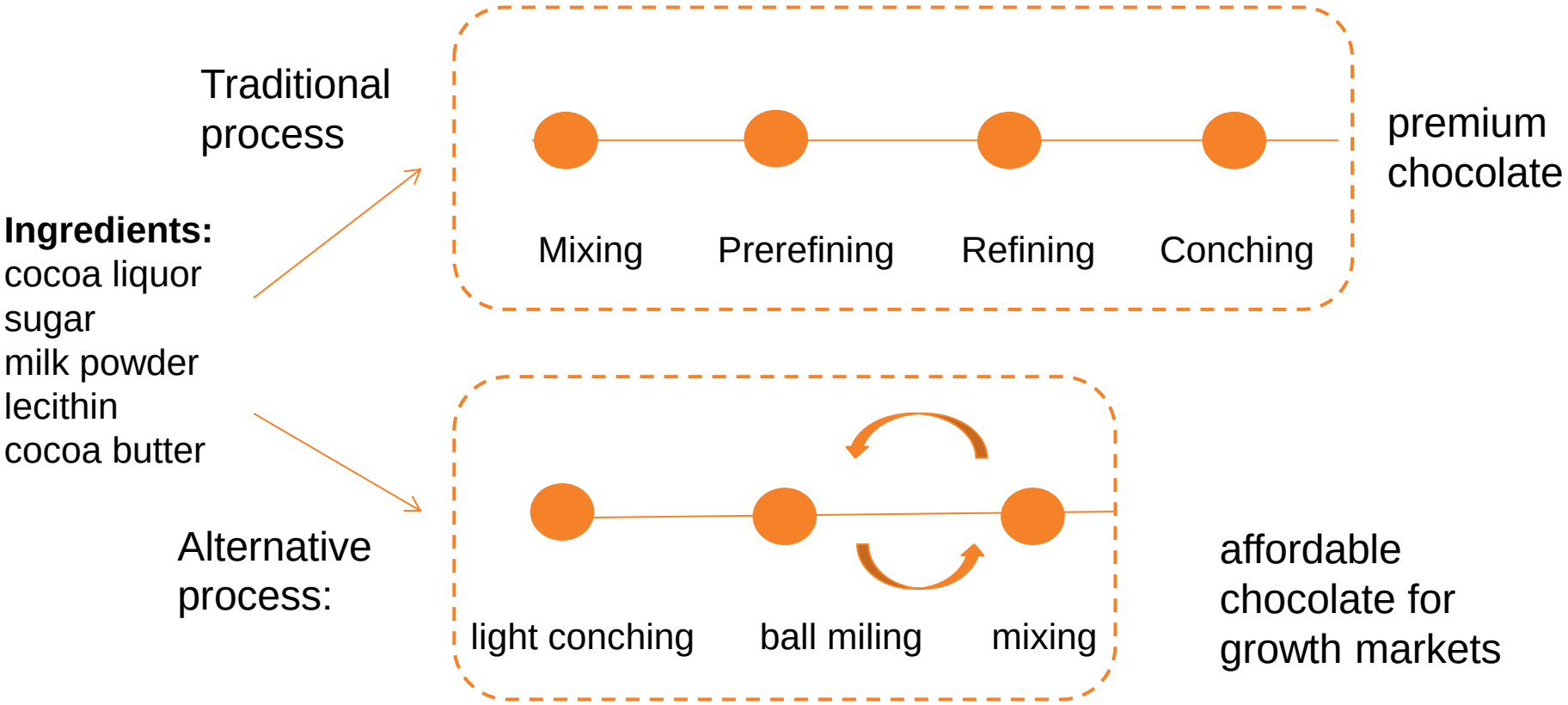
Batch versus Continuous Cooking

Comparison of main parameters (based on 800 kg/hr)

Data for relative comparison purposes only, effective figures are prepared on case-by-case consideration	**Batch**	**Continuous**
Processing time:	**~ 5 h**	**~ 0,5 h**
Production start/stop ramp:	**> 5 h**	**> 0,5 h**
Tuning of process:	👎 ☹	👍 ☺
Required moisture level:	**30 % H_2O**	**23 % H_2O**
Energy consumption:	**460 kW**	**195 kW**
Investment cost:	**So Expensive**	**Reasonable**
Raw material cost:	**100 %**	**75 ... 125 %**
No. of operators required:	**2**	**1**

Increasing line* efficiency *through new processing routes

New strategy for chocolate mass production for growth markets



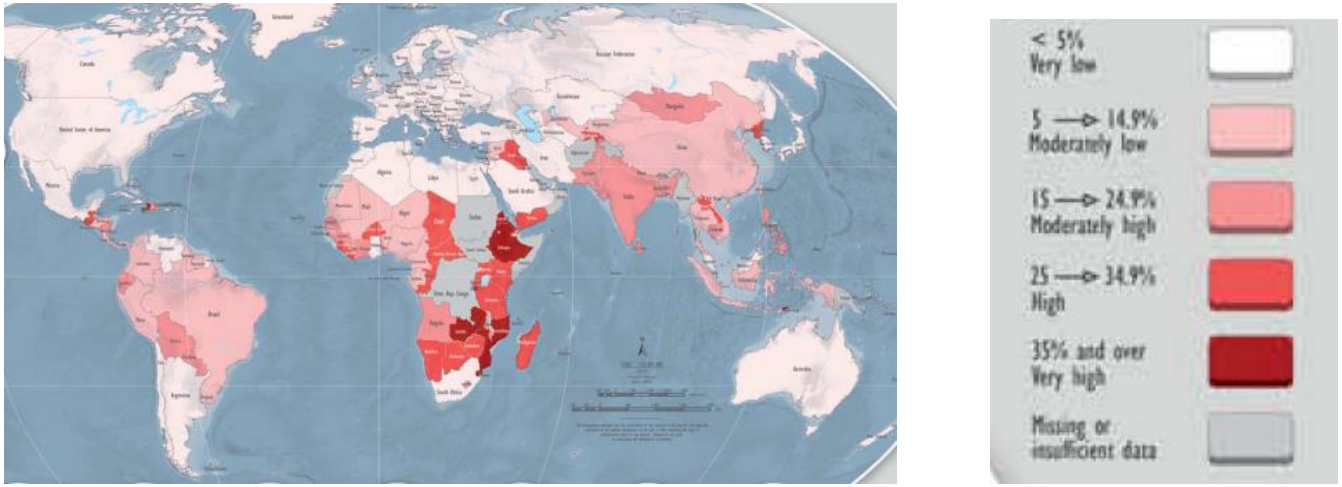
Nutrition

The factory of the future needs to focus on nutritional value of food

Two billion people in the world suffer from various forms of malnutrition

The most common micronutrient deficiencies are: iron, iodine, zinc and Vit A

Global view of undernutrition



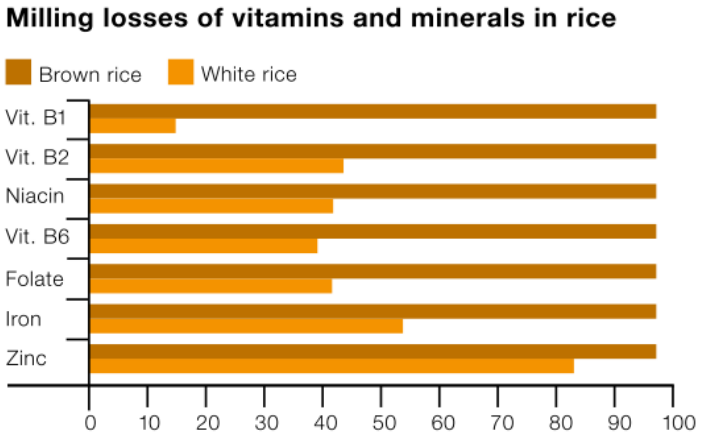
http://www.fao.org/hunger/en/

Rice is the main staple in the world but generally consumed as white rice depleted of bran micronutrients

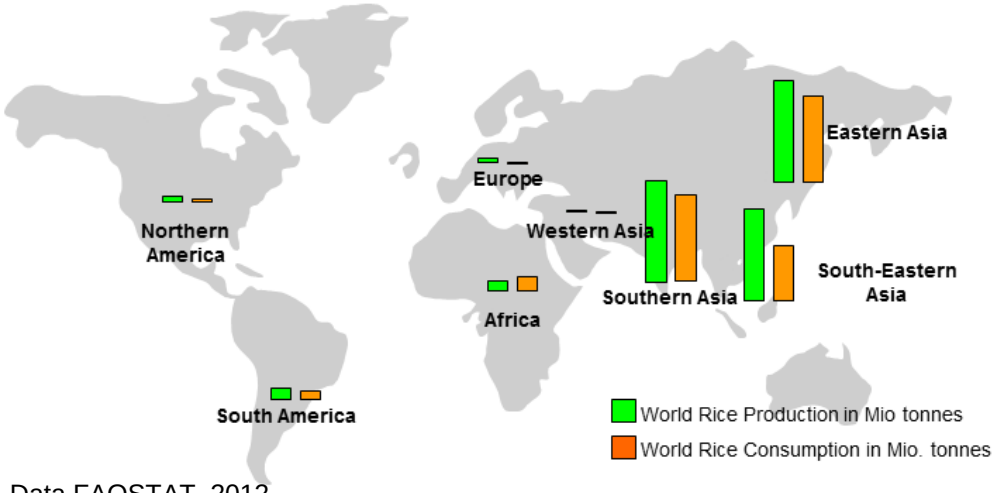
720 Mio tons
global paddy rice production

↓ -32 % removal of husk and bran

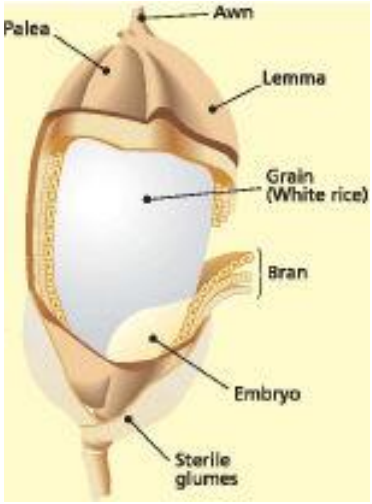
490 Mio tones of white rice



Global rice production and consumption



Data FAOSTAT, 2012



www.knowledgebank.irri.org/

Although brown rice is richer in micronutrients from the bran most consumers prefer white rice

Neutral taste and appealing texture & color

White rice is shelf stable (brown rice becomes rancid)

White rice cooks quicker than brown rice

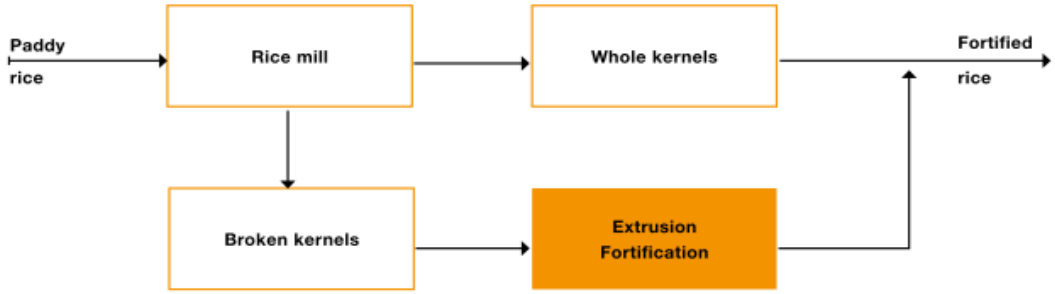
Removing the bran reduces contaminants (heavy metals, myxotoxins, etc.)

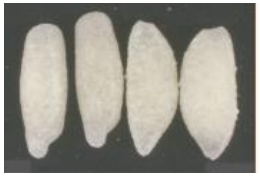
Tradition and eating habits

...although white rice is depleted from micronutrients.
Fortification is a possible solution to increase nutritional value.

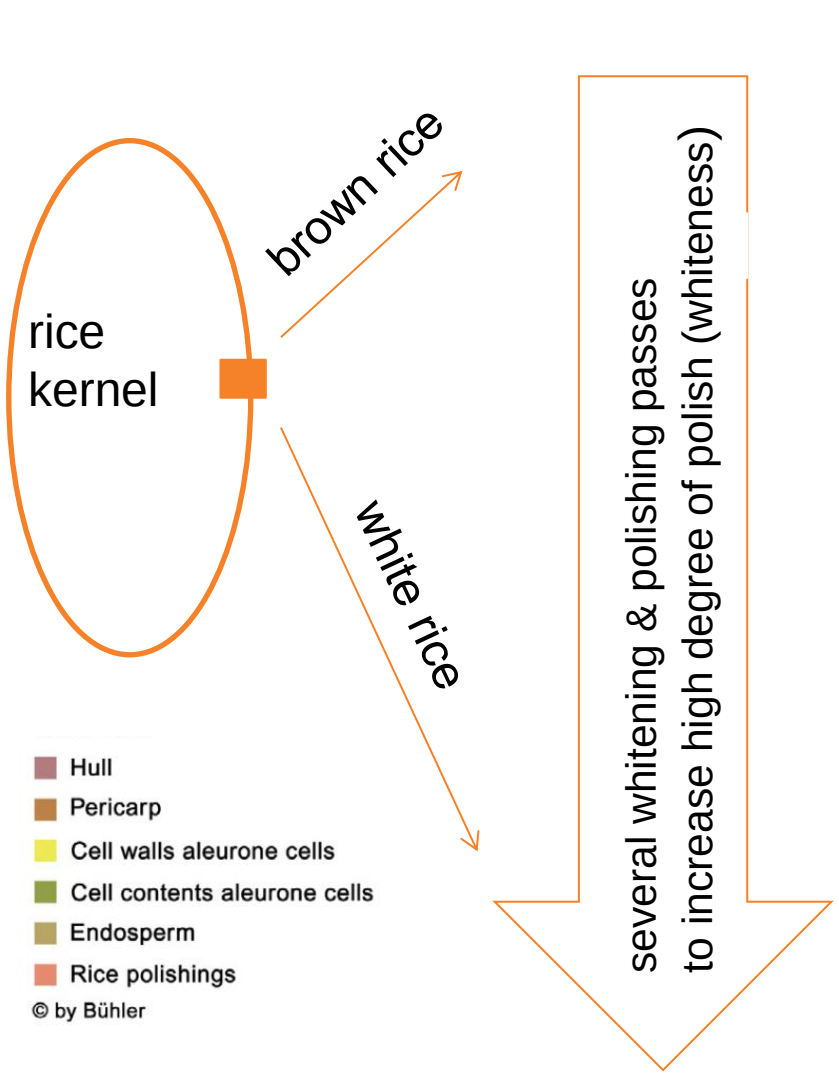
Fortification with micronutrients is one solution to improve rice nutrition

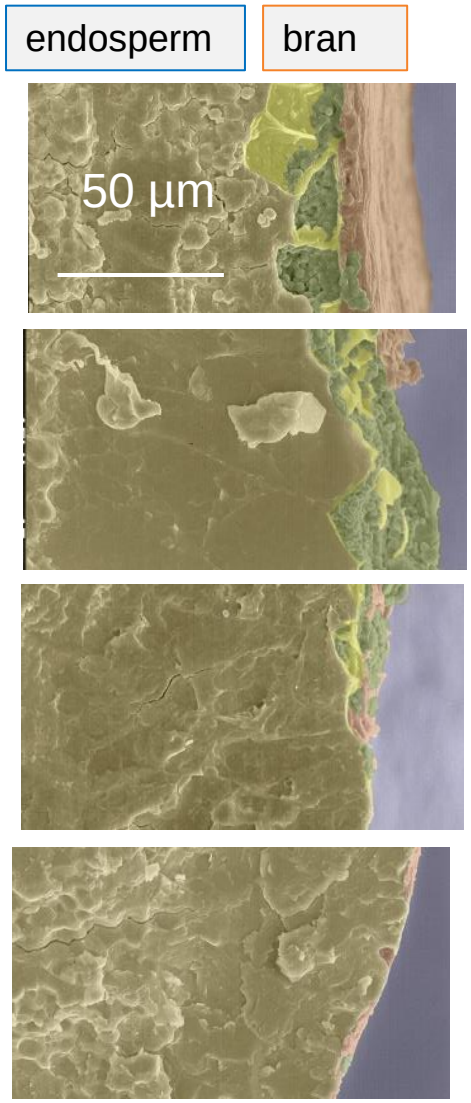
NutriRice™: recomposed fortified rice developed in partnership with DSM





But promoting underpolished rice would be a more sustainable solution for better nutrition





target in future?

less white, but partial retention of micronutrients

target today

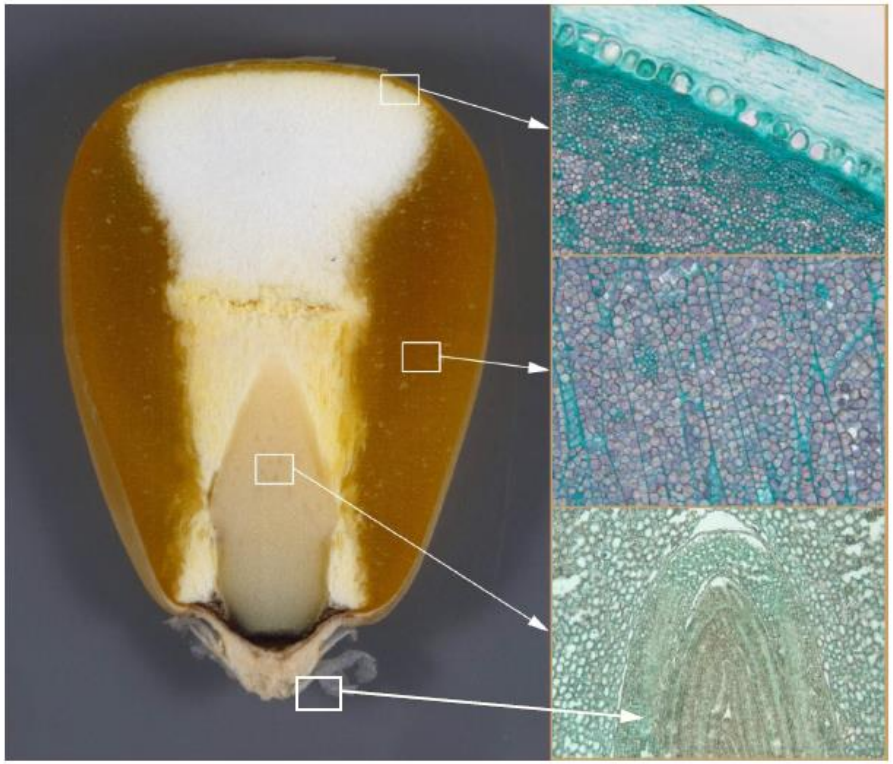
white, but little micronutrients

Images published by Nadina Mueller-Fischer in 'Nutrient Focused Processing of Rice.' In: Agricultural Sustainability. Eds: Gurbir S. Bhullar, Navreet K. Bhullar. Oxford, Academic Press 2012, pp 197 – 220,

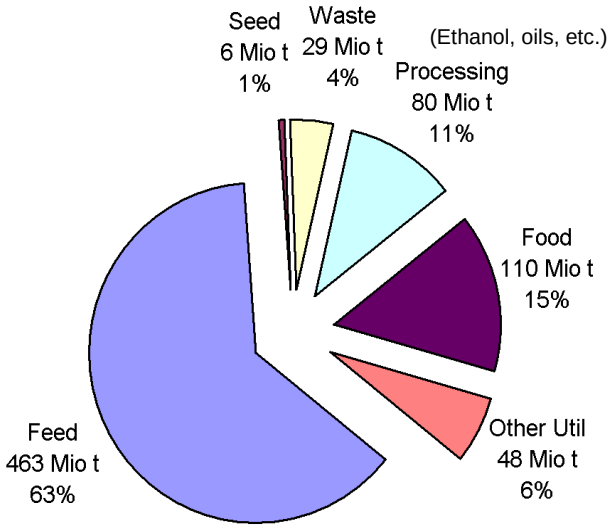
The factory of the future produces traditional food that meets urban lifestyle

Imparting convenience to maize

Maize: most abundant cereal, but little direct use for food



Global production
870 Mio t in 2012



Imparting convenience to a traditional South African food

The traditional dish

Maize-based product obtained by cooking of coarse maize flour for 30 – 40 min

The goal:

A shelf stable flour, but with 10 times shorter cooking time

The challenge:
Industrial process to add convenience to a traditional product

Instant / Quick Cooking Maize Meal.
A Buhler Innovation (patented technology)

Traditional maize meal requires **approx. 30min.** 40 minof cooking.

Instant / Quick Cooking maize meal requires **approx. 3min.** of cooking.

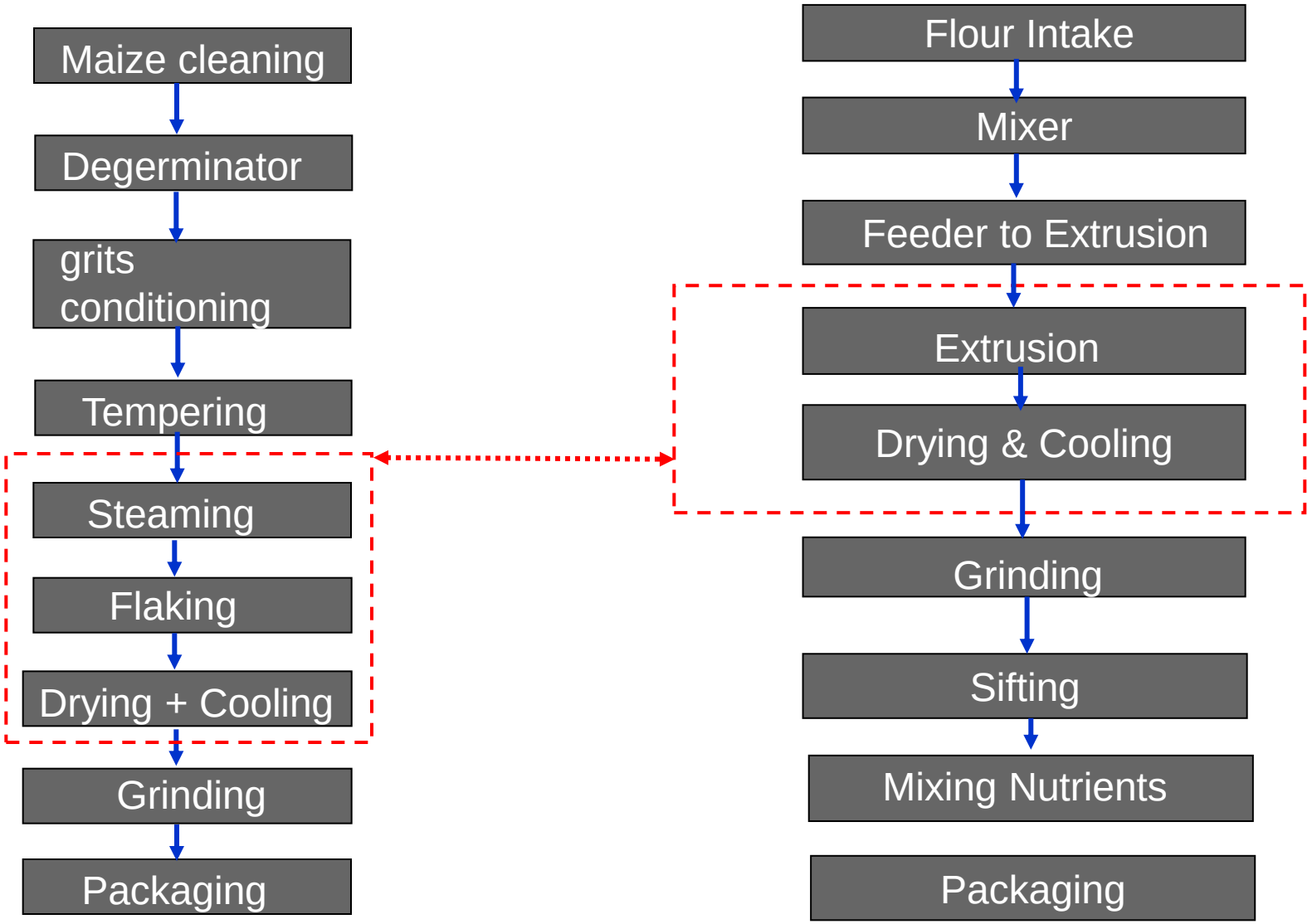
Shelf life > 6months; steaming at high temperatures during process results in top Food Safety

Same texture, elasticity and mouthfeel as traditionally prepared maize meal.

Initial target market

- Urban middle class consumer with high quality awareness.
- In Africa for Africa

Quick Cook / Instant Maize Porridge Process Flow.



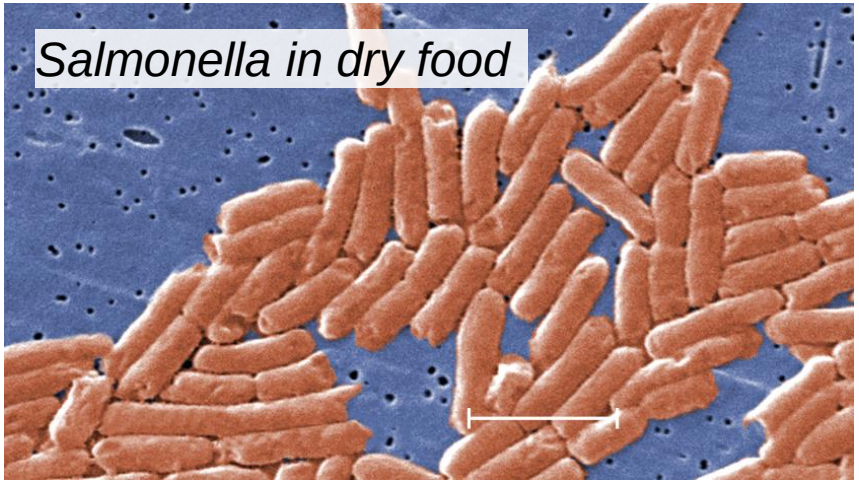
Food Safety


INCOMES
DEMAND
HIGH
LOW
HIGH-TECH FOOD
PROMOTE HEALTH.
QUALITY FOOD
MAINTAIN HEALTH.
FOOD SAFETY
ABSENCE OF DISEASE.
FOOD SECURITY
ACCESS TO FOOD.

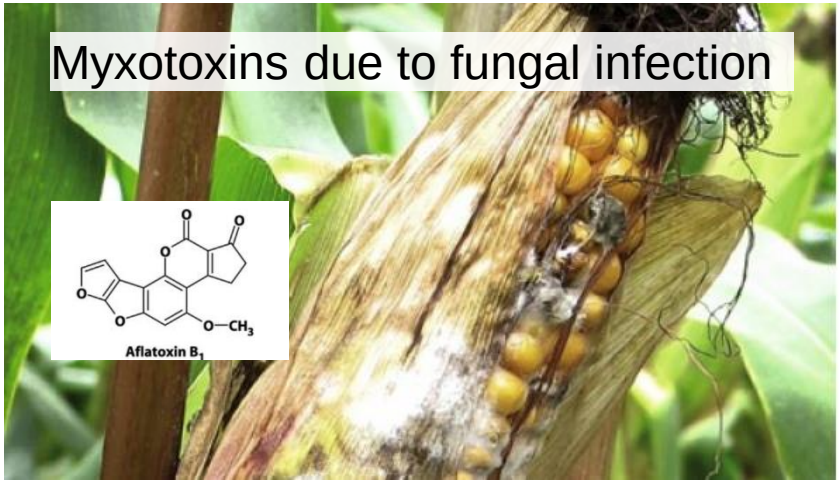
Food Safety is the game changer for the factory of the future

From hygienic processing environments of solutions for making food safe

Food Safety challenges and trends



Changing food habits



New regulations

§

Food Safety concerns all factors along the value chain

Pressure to act builds up from the end product / consumer side

Farmers | Traders | Agro-food convertors | Food processors | Retailers | Consumers/ Society

The big food & feed safety hazards

biological hazards

Pathogenic bacteria like Salmonella, Listeria, E. Coli, etc. that may lead to food-borne diseases

Pest like insects, mammals, birds, etc.

Spoilage microorganism that lead to losses and waste.

chemical hazards

Mycotoxin in food & feed due to mold growth

Undeclared allergens like gluten, nuts, soy, milk protein, etc. in food

Natural toxins like lectins in dry beans or glycocyanids in cassava

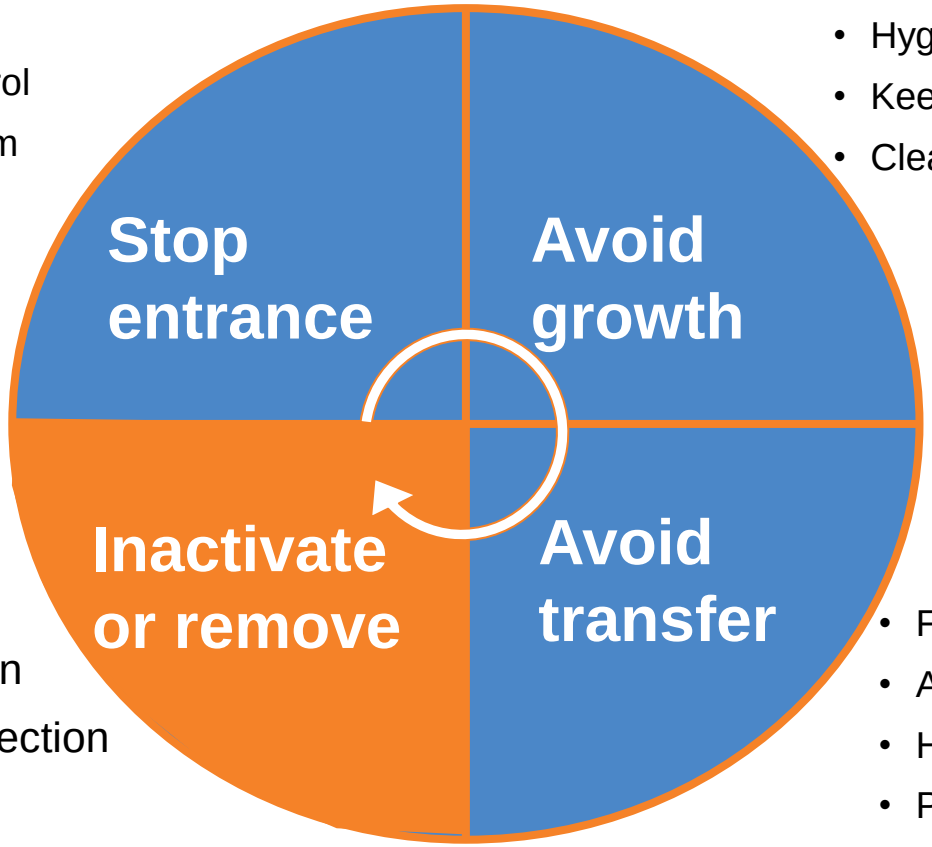
Chemical contaminants from environment, food contact material, processing or adulteration

physical hazards

Foreign matter like glass, metal, plastic, wood, etc. in food

Controlling pathogenic bacteria in food processing

- Raw material control
- Facility Design from roof to drain
- Control access



- Hygienic design
- Keep dry (war on water)
- Cleaning & disinfection

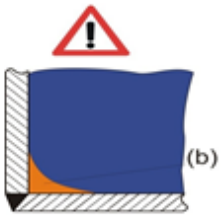
- Process validation
- Cleaning & disinfection
- Hygienic design

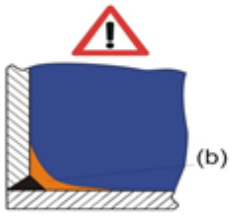
- Factory design & zoning
- Air/ water/ waste management
- Hygienic design
- Packaging
- Personnel hygiene

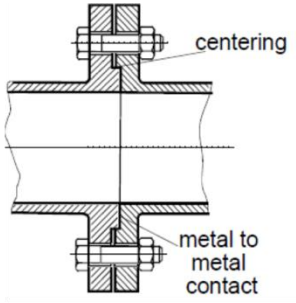
Hygienic Design from factory, over equipment to people

Hygienic design allows the **timely and effective cleaning** of the entire manufacturing asset (equipment, infrastructure, building,…) and **minimizes risks of product contamination** during the whole working life.

Internal angels and corners

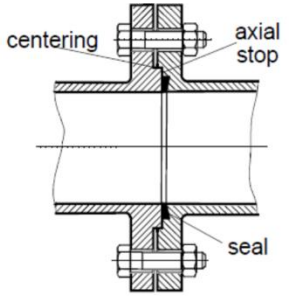






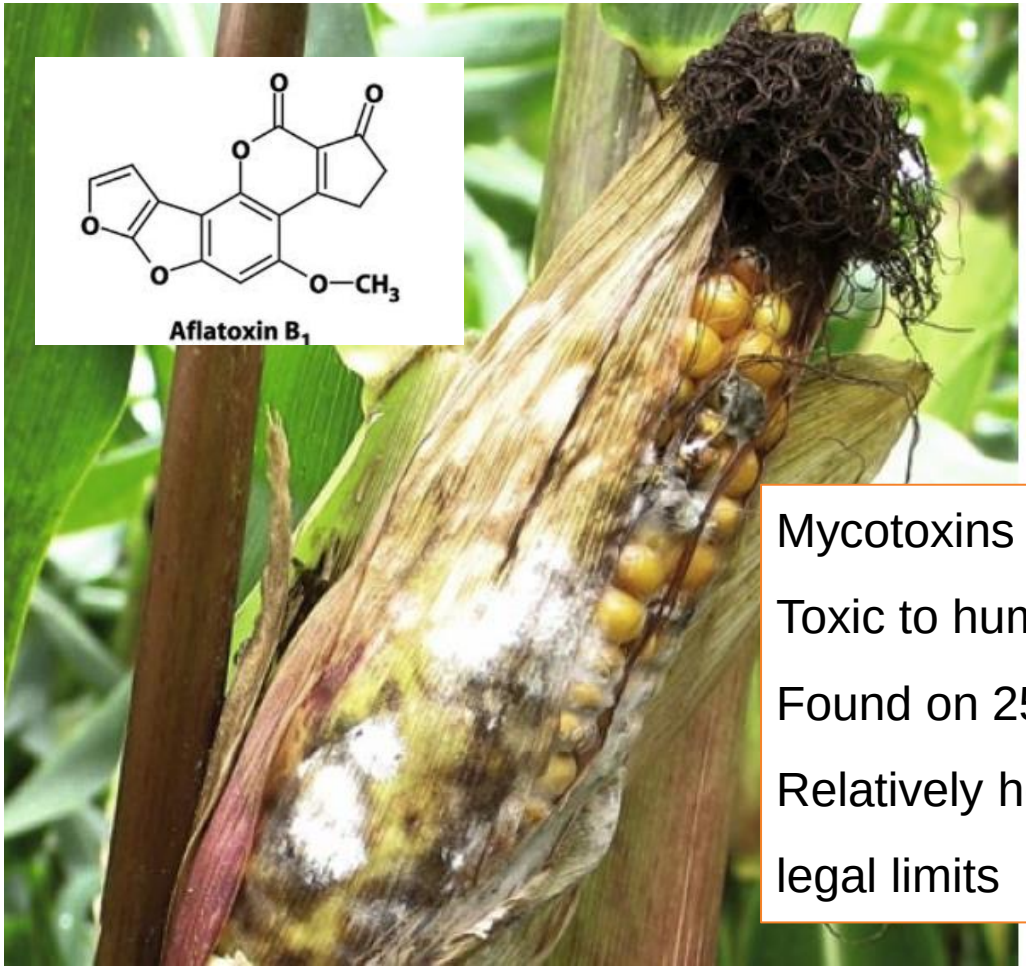
Centered flange connection, sealed metallically or with O-ring

→ **Only suitable for dry cleaning**



Hygienically designed flange connection with sealing for wet cleaning

Mycotoxins – the silent food & feed safety threat



Mycotoxins :

Toxic to humans and animals

Found on 25 % of food crops

Relatively heat stable

legal limits

Mycotoxin control requires action at all stages of the value chain

Safe storage conditions

Analytical monitoring

?

no decontamination available to date

Field — **Collection Points** — **Transport & storage** — **Mill reception** — **Milling** — **Food & Feed Processing**

Harvest — **Drying**

Stabilization by drying

optical sorting

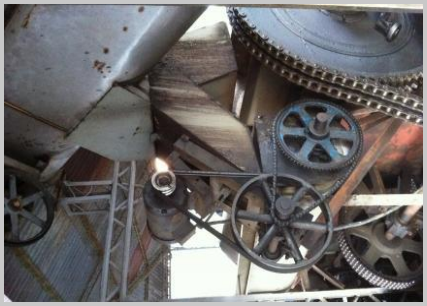
- **Cleaning**
  - Sorting: optical
  - Aspiration
  - Surface cleaning
- **Degermination**
- **Grinding**
- **Storage**

Intelligent Processing

4th Industrial Revolution

End of
18. Century

1st industrial revolution



Introduction of mechanical production lines

Begin of
20. Century

2nd industrial revolution

Mass production of goods

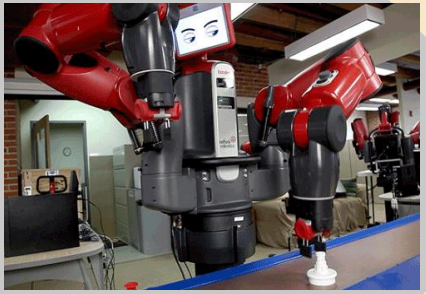
Mid 70s

3rd industrial revolution

Automation with PLC and miniaturization

From 2020

4th industrial revolution



Autonomous control and decision making networks in real time

Intelligent Processing – On line Sensors

Sensors

- On-line
- In-line
- At-line

Online Particle Size Measurement.

- Combines laser diffraction and image processing in one system.
- Continuous online monitoring of particles in the range of 10-5000 microns.
  - → Monitoring and control of grinding processes and product granulation.
  - → Finished products with a consistent particle size distribution.
  - → Detection of oversize grains.

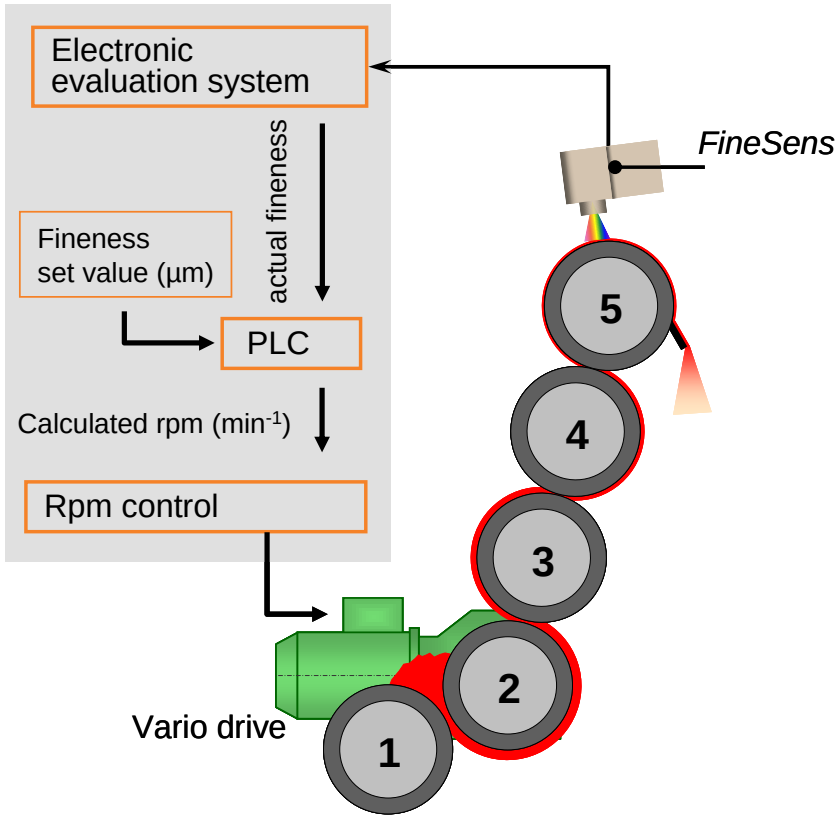
Optical Sorting.

- Optical sorting is used to remove defective material from good product.
- Typical products: Cereal grains, pulses, nuts, dried fruit, frozen vegetables, confectionary, seeds, coffee, plastics.
- Types of defects: Colour, spot defects, geometry, near-infrared.

Intelligent Processing – On line Sensors

NIR Multi Online Analyzer

- 1 spectrometer for up to 6 measuring points (optical multiplexer).
  - → cost reduction per measuring point.
  - → Parallel analysis of the raw material, intermediate and end products. Allowing smart and continuous control of ongoing production.

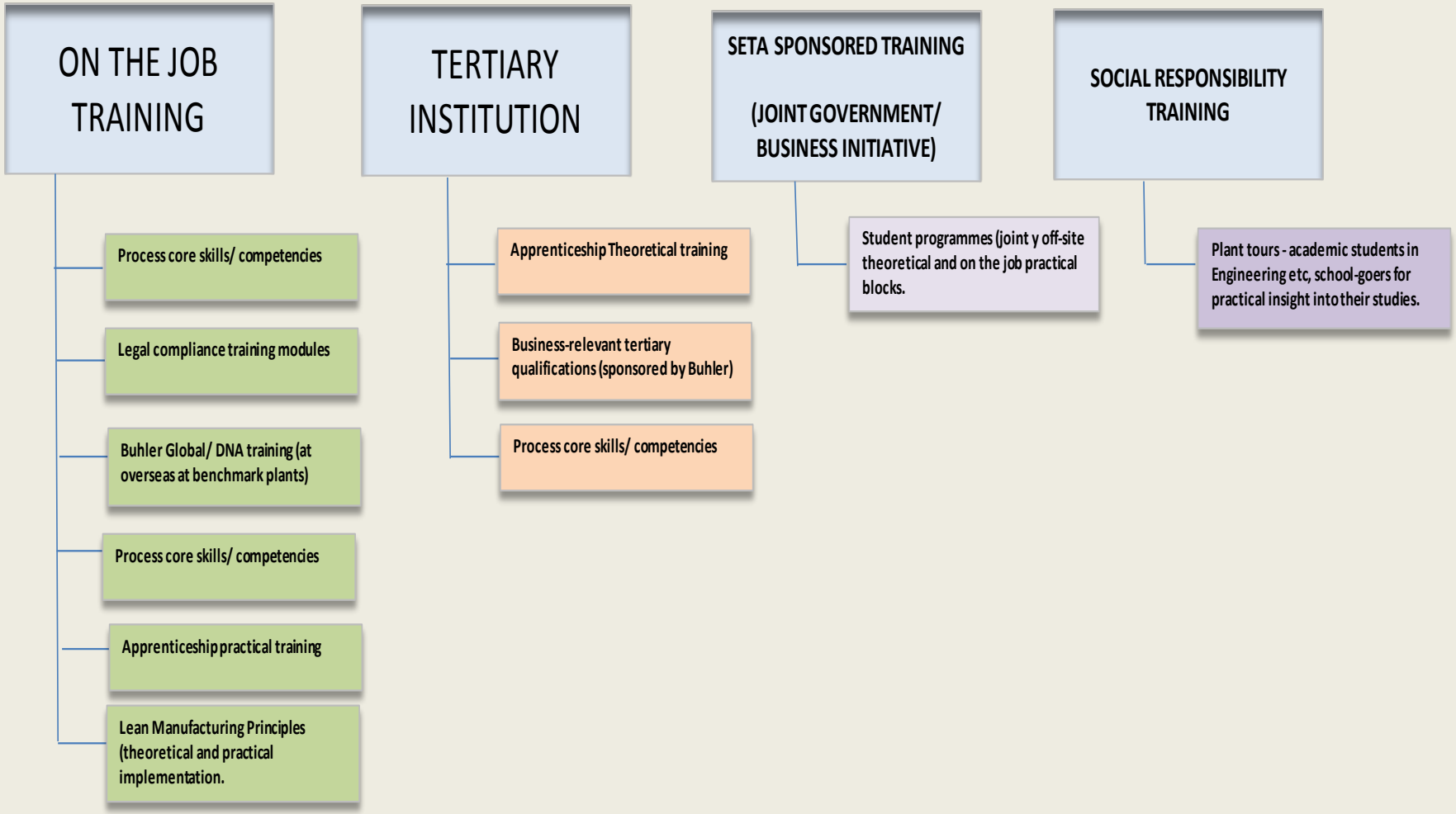


Applications:

- Coffee online Degree of Roast
- Hydroken sensor in Cocoa bean roaster
- FineFilm / FineSense sensors on 5th roll of 5Roll Refiner in Chocolate production

Education

Summary of Training opportunities



www.buhlergroup.com