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FMS Dairy Workshop
Wageningen 18 Jan 2013
Roadmapping Methodogogy and a first start…

Henne van Heeren, Patric Salomon, enablingMNT

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January 2013

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- Draft Emulsification roadmap
- Other testing needs

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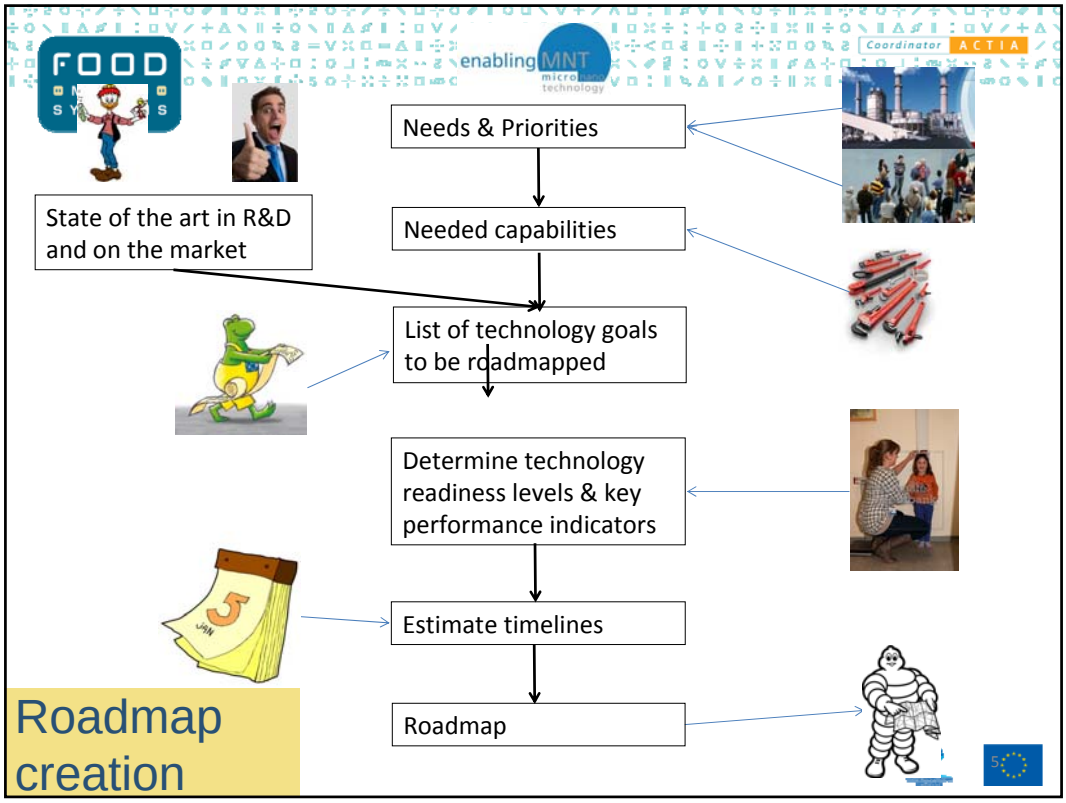
INTRODUCTION



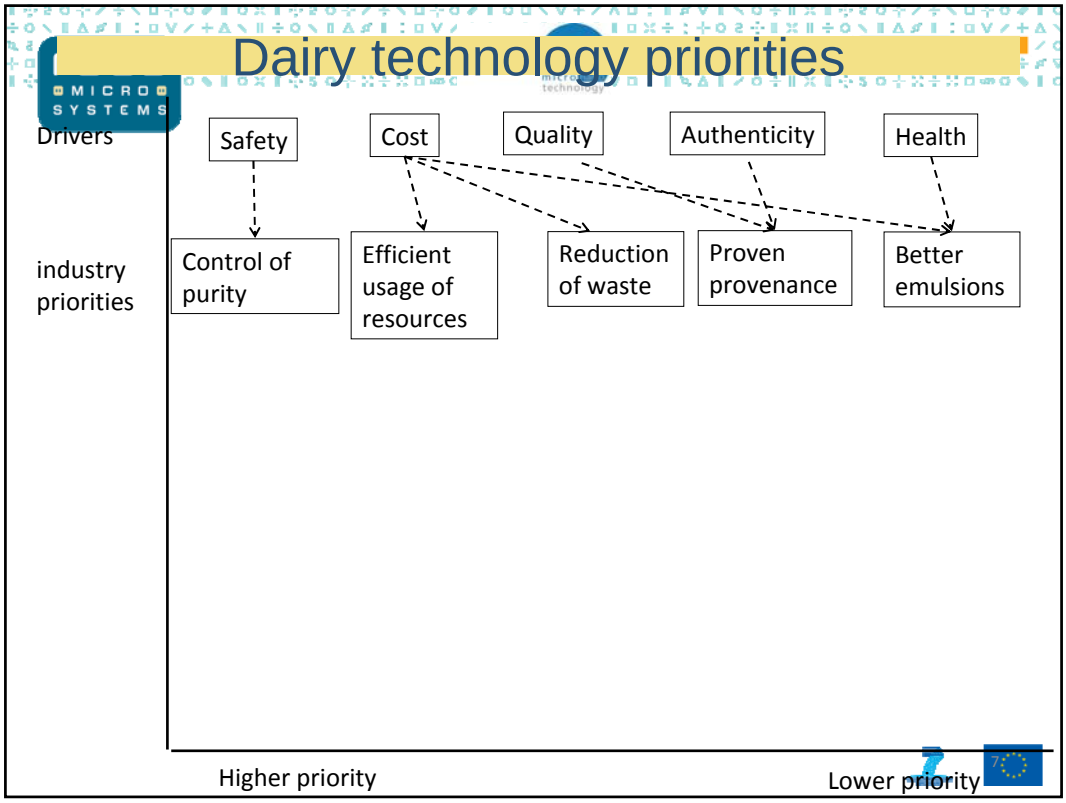
Main drivers dairy innovations

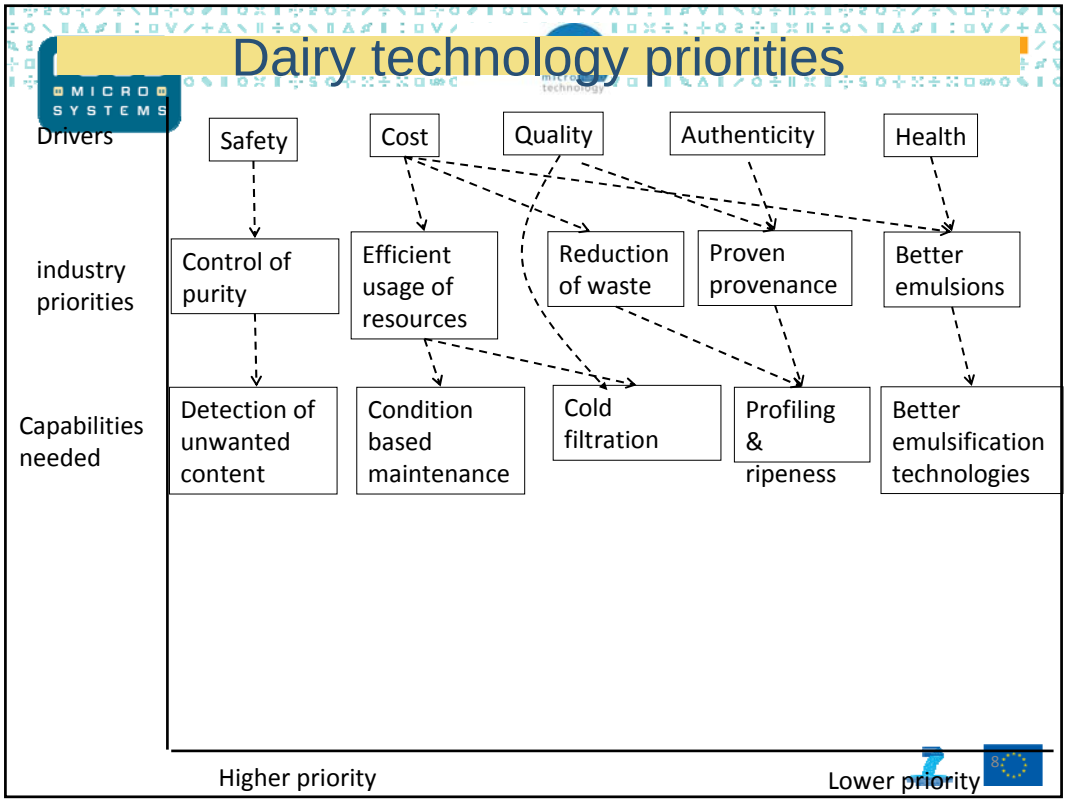
From a consumer perspective:

1. Cost & safety.
2. Quality, authenticity, health etc.

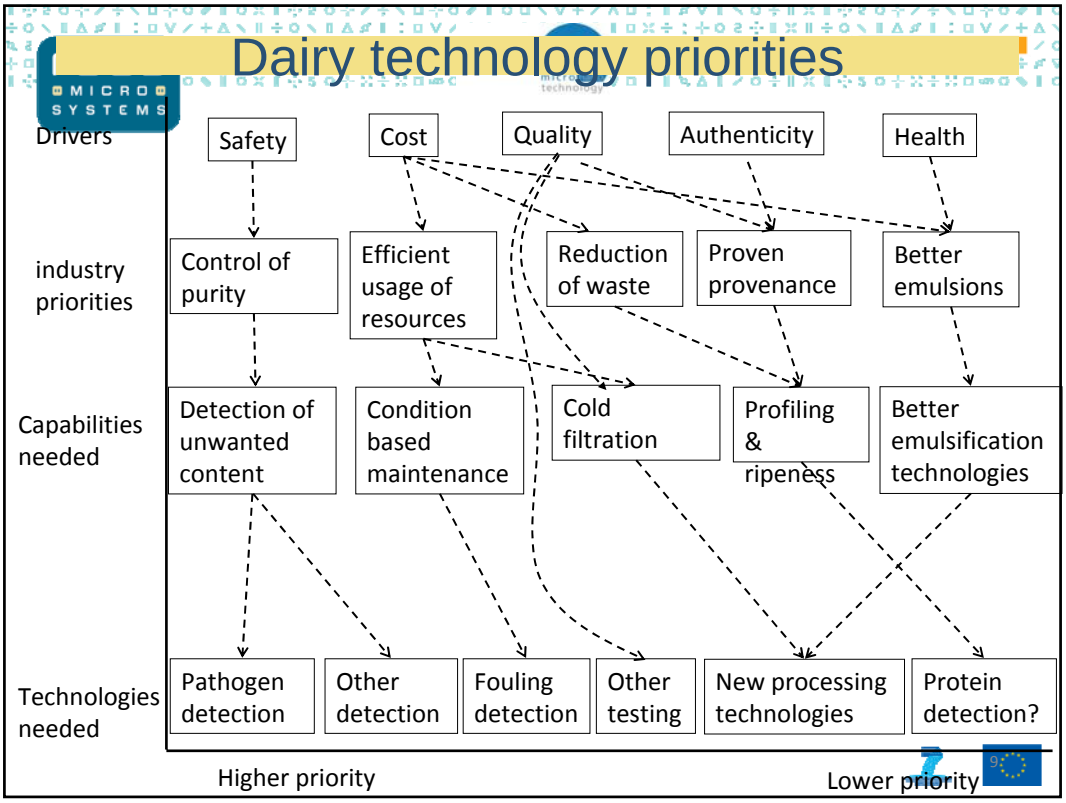
From an industry perspective:

1. Efficient usage of resources.
2. Reduction of waste.
3. Detection of unwanted content.
4. Profiling etc.


Dairy technology priorities
Drivers
Safety
Cost
Quality
Authenticity
Health
industry priorities
Control of purity
Efficient usage of resources
Reduction of waste
Proven provenance
Better emulsions
Higher priority
Lower priority


Dairy technology priorities
Drivers
Safety
Cost
Quality
Authenticity
Health
industry priorities
Control of purity
Efficient usage of resources
Reduction of waste
Proven provenance
Better emulsions
Capabilities needed
Detection of unwanted content
Condition based maintenance
Cold filtration
Profiling & ripeness
Better emulsification technologies
Higher priority
Lower priority

Dairy technology priorities



Of interest for the dairy industry

1. Measurements during the dairy processing (on-line, in-line, off-line)
2. From cow to raw milk (measuring quality, contamination)
3. Quality control (analysis of final dairy product)
4. Specific sensors / analysis for liquid dairy products (e.g. yoghurt, milk)
5. Specific sensors / analysis for creamy to solid airy products (e.g. cheese, butter, cream)

Q: Can we define specifications for them and identify state of the art on the market and in R&D?

Measurements during the dairy processing

- Specifically:
  - pH
  - Cleanliness: thickness and characterization of biofilm, residue of cleaning materials, milkstone
  - Pathogens (draft roadmap in next sheets)
  - Herbicides
  - Pesticides
  - Antibiotics
  - Dioxins / PCBs
  - Allegens
  - Detergents
  - Mycotoxins
  - Heavy metals
  - Other?

Decisive factors: cost and time to result?

Priorities? State of the art?

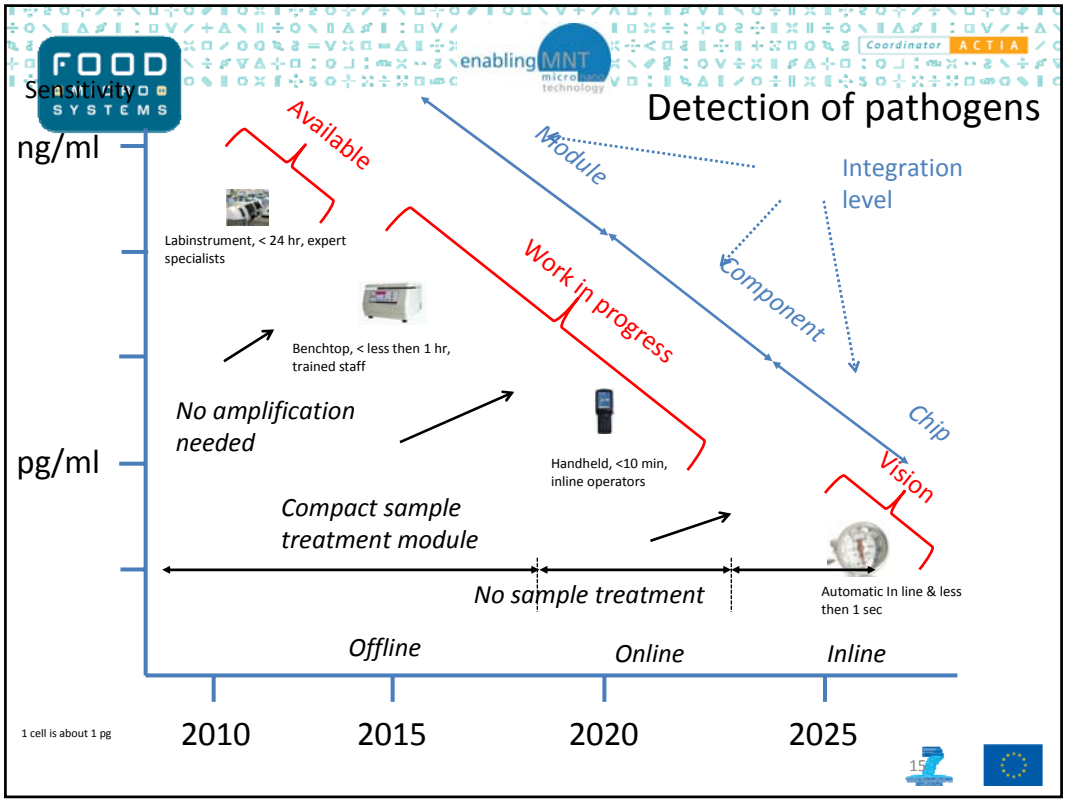
PATHOGEN DETECTION ROADMAP

Pathogen detection: comments on Technology Readiness Level

- Performance indicators:
  - ease of use,
  - Sensitivity,
  - Cost of test,
  - time to result.
- Key technologies: sample treatment and biosensor.
- State of the art sample treatment unit
  - Extraction of fluidic sample from solid sample: lab instrument only, bench top and portable system in research
  - Lysing unit: bench top, < 15 minutes for R&D work
- Much work is being done in pathogen detection for medical diagnostics and environmental testing. Several small, fast systems are in development. Practically all these systems deal with liquid samples.
- It is therefore expected that the testing on pathogens in liquid food will first come to the market.

Technology roadmap pathogen detection

- Step 1: PCR, concentrating, labeling and fluorescence detection.
- Step 2: PCR, concentrating, direct detection with biosensor.
- Step 3: Concentrating, detection with biosensor.
- Step 4: direct detection with biosensor.
- Comments:
  - Decisive factors: cost and time to result.
  - PCR is only suited for offline control due to the inherent complexity and the slowness of this method (high equipment costs only affordable for massive parallel testing).



EMULSIFICATION ROADMAP

New processing technologies

- There have been made huge steps in the development and understanding of the emulsification and encapsulation processes, but the problem of affordable manufacturing in large volumes is still not solved.
- Energy efficient processing: cold sterilization
- Optimizing usage of ingredients: fractionation

Emulsification, drivers & barriers

- Drivers:
  - Controlled release of ingredients (pharma, agriculture, functional foods, packaging)
  - Extended shell life due to increased stability
  - Health: (low fat content)
  - Other
- Barriers:
  - Lack of cost effective reliable and high throughput processes for highly uniform emulsions.

Emulsification

High throughput

Several technologies available

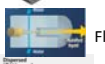
Unlikely?

Vision?

?

Only suitable for high end applications?

Cross flow membrane



Flow focusing

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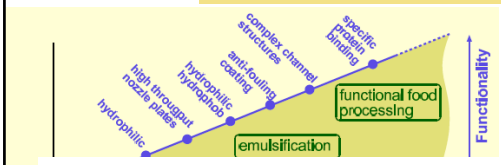
1 mml/hr/channel

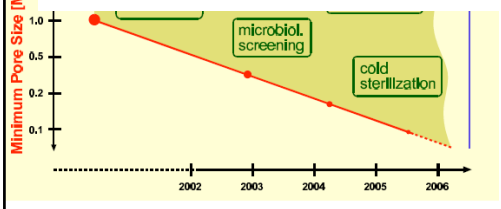
Low throughput

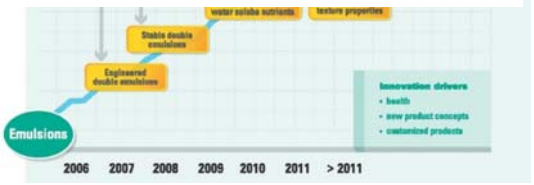
low droplet uniformity high

From older food roadmaps



Commercial feasible concepts failed to emerge!

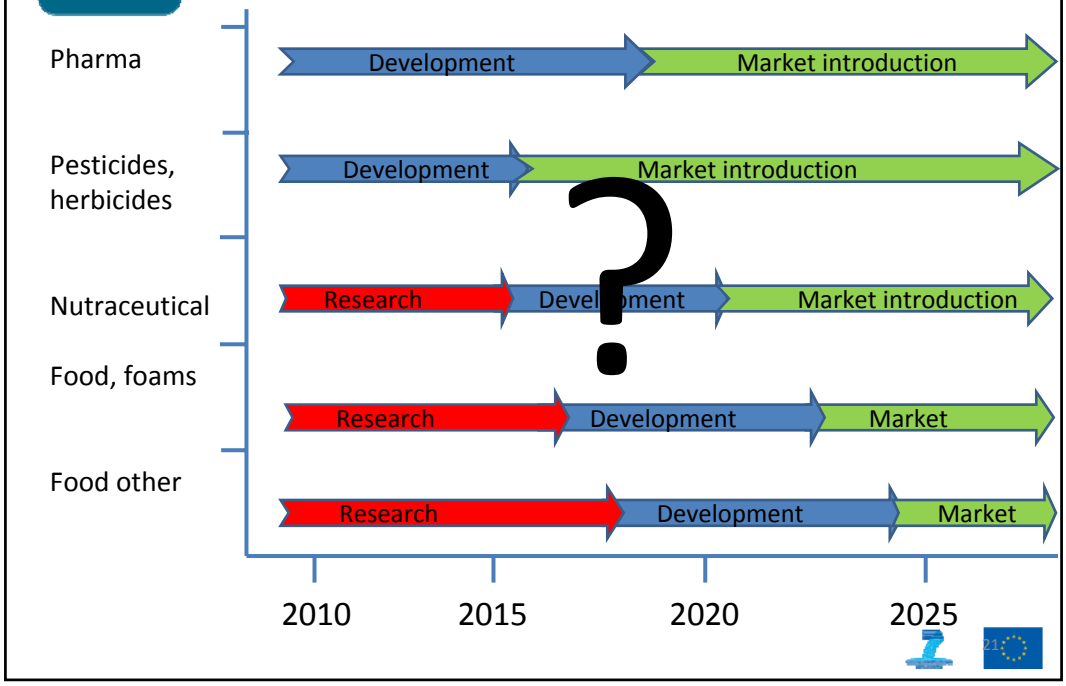




Developments in other market segments might be more successful!

Figure 1: Roadmap for microsystems in the food industry (courtesy Aquamarijn)

Application roadmap emulsification



OTHER TESTING NEEDS

Allergens detection: state of the art

- 2012: Intensive R&D for allergic testing in medical diagnostics, not so much in food industry.
- 2012: State of the art bench top: 5 ppm in 10 minutes (test tube based system).
- 2012: In research: handheld, 20 minutes (test tube based system)
- 2012: on the market: peanut allergen kit <10 minutes, ppm-ppb level, SPR based (Seattle Sensor Systems)

Mycotoxins: state of the art

- State of the art: ELISA autoanalyzer + HPLC
- In development: MiniChemLAB Microfluidic Workstation Prototype Instrument from Minifab. They demonstrated detection of Aflatoxin M1 in raw milk. Sensitivity (0 to 2000ppt), time to result < 5 minutes.

Other testing

- Physical:
  - temperature,
  - humidity (in cheese),
  - density,
  - Ph;
- Chemical:
  - characterization,
  - protein,
  - lactose,
  - dry material,
  - info about cells,
  - somatic cell content,
  - residual chemical from cleaning step,
  - fat content

Definitions:

inline is direct measurement
online is sampled but on the spot analyzed;
offline is sampled and send to a lab.

Priority:

1. knowledge about dry matter content and profiling leads to better process control & less low quality / low price products.
2. Acidification

Fouling detection

- Fixed sensors?
- Pigs? (See oil industry)

Ripeness sensors

- Sensor in package (color change). State of the art?
- Electronic nose in supply chain in research only. State of the art?

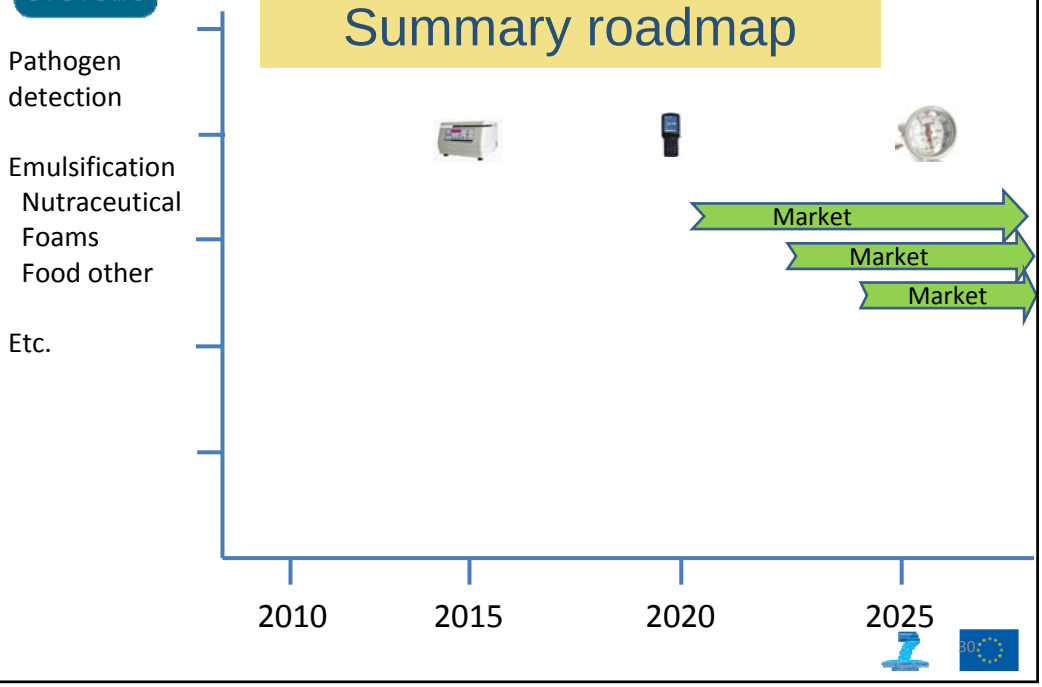
Profiling etc.

- State of the art: soluble protein content in milk within 5 minutes offline by Amaltheys (fluorescence analyzer developed by Spectralys Innovation, enables to measure milksoluble proteins and gives also an indicator of its thermal history.)
- proposed for profiling
  - Capillary electrophoreses systems (electrolytes in liquid)
  - Chromatography
- Profiling wine (counterfeit labels), GMO and halal testing, state of the art?

Other technologies / systems needed

- Surface modification: cost? Durability? Chemical of topology? Many activities, not analyzed yet.
- - bioreactor for testing cheese

Summary roadmap



Roadmapping – Breakout Sessions

Breakout Sessions

topic	how many	proposed Topics for Dairy workshop Wageningen January 2013
1	6	From cow to raw milk (measuring quality, contamination)
2	**12**	**Measurements during the dairy processing (on-line, in-line, off-line) - Process Control**
3	**8**	**Quality control (analysis of final dairy product) - measure the "wanted"**
4	**13**	**Specific sensors/analysis for liquid dairy products (e.g. yoghurt, milk) - measure the "unwanted"**
5	**11**	**Specific sensors/analysis for creamy to solid airy products (e.g. cheese, butter, cream) - measure the "unwante**
6	6	Cleaning of processing equipment (when to clean, cleaning efficiency, contamination by detergents)
7	4	Packaging / transport / tracking
8	3	Quality check throughout retailing sector / consumer
9	**11**	**Process innovations, e.g. micro sieves for pasteurisation / sterilisation / fractionation**
10	**12**	**New / innovative processing steps that require completely new (micro) technologies**

9: Process Innovations

10: New processing, new technologies

Verena/Arnoud

4/5: Sensors/ Analysis for „unwanted“ – long-term vision

4/5: Sensors/ Analysis for „unwanted“ – short-medium term

Elisabeth/ Henne

2: Process control

3: Quality control for „wanted“

Marc/Patric/ Stephane

Thank you for your attention!

- Henne van Heeren
- Patric Salomon

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