Towards efficient milk production

Peter de Jong PhD
Professorship Dairy Process Technology

25 September 2019
Sustainability

Source: David JC MacKay 2009 “Without hot air”
**Example: footprint of cheese manufacturing**

<table>
<thead>
<tr>
<th></th>
<th>CO₂-eq/kg cheese</th>
<th>H₂O kg/kg cheese</th>
<th>Cost (€/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cheese product</td>
<td>9</td>
<td>5000</td>
<td>4</td>
</tr>
<tr>
<td>Cheese manufacturing</td>
<td>1</td>
<td>10</td>
<td>0.4</td>
</tr>
</tbody>
</table>

2. A.Y. Hoekstra, The water footprint of food, 2008
4. DOC annual report 2017
Where is Global Warming Potential coming from?

- >60% from primary sector (CH4 has 25 times higher impact on GWP than CO₂)
- 10-20% from processing
- 15% consumer
Milk is nutritious and sustainable!

CO2-eq per 100 g product compared to nutritional value

- Milk
- Orange juice
- Soy drink

CO2-eq/nutritional value (vitamins, minerals, proteins, calories, ...)

0 0.5 1 1.5 2 2.5 3 3.5 4 4.5

Milk Orange juice Soy drink
Sustainability
Outline

1. Optimization or innovation?
2. Examples of sustainable, efficient technologies
3. New way of process design
2. Optimization or innovation?

Impact of sustainable process design

Example: milk chain
2. Optimization or innovation?

Where to start?
2. Optimization or innovation?

Optimization or innovation?

Improving the old... Innovation...
2. Optimization or innovation?

From optimization to innovation

Effectieve ambitie

Effectief = herontwerp van productieketens gericht op kwaliteit, efficiëncy en duurzaamheid

Efficiënte oplossingen

Efficiënt = optimaliseren van bestaande productiemethoden

Minimaliseren kosten | Verhogen opbrengen

Toegeweegde waarde (€)
2. Optimization or innovation?

Innovation power?!

Drogen (vis)
1600 v.Chr.
door de
Egyptenaren

Bible History Online

Drogen (pasta)
3500 jaar later
door
Europeanen
3. Examples of sustainable technologies

1. Mild processing

Result: 60 day shelf life of pasteurized milk!
3. Examples of sustainable technologies

1. Mild processes

- Aim industry: decrease and control of glycation of proteins in processes

![Diagram showing the relationship between heat load and nutritional value]

- Nutritional value decreases with increasing heat load.
- Protein denaturation and sugar/lactose formation are indicated.

protein → denaturation of protein → sugar/lactose
3. Examples of sustainable technologies

2. Ultrasound add-on

- Ultrasound principle:
3. Examples of sustainable technologies

2. Ultrasound add-on
3. Examples of sustainable technologies

3. Separation technology

- raw material
- membrane
- retentate/concentrate
- permeate
- pore size distribution
- flux
3. Separation technology
3. Examples of sustainable technologies

3. Separation technology

- Rotating Micro Sieves
  - 100 times higher fluxes
  - Long run times
  - Defined retention
3. Examples of sustainable technologies

4. Computer models & sensors

- Safety
- Nutrition
- Taste
- Convenient
Conclusions

1. Optimization of current processes will not really help us, **innovation in the entire production chain** is needed!

2. To avoid high economic risks, companies have to develop innovative process technologies **together**

3. Be critical, be aware of subjective interests and do you your **own calculations** on climate impact of food production (including dairy)