FOOD stars — Innovative Food Product Development Cycle: Frame for Stepping Up Research Excellence of FINS

European Commission

By-product and resource utilisation from dairy processing streams

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Industry
MTL
Food Chemistry
& Technology
Food
BioScience
TFRC Moorepark

MOOREPARK TECHNOLOGY LIMITED

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Liquid Foods & Ingredients

MTL operates an ultra modern pilot plant covering 3,000 sq. metres floor area. Our facility contains the most up-to-date and versatile pilot scale processing equipment.

Pilot Plant Rental

The plant is of sufficient scale to accurately simulate commercial food processing.

Contract Research & Developement

MTL provides highly skilled R&D services that generate new products and help build core expertise

Pre-Commercial Manufacture

A diversity of expertise in food technologies is available at Moorepark to undertake the pre-commercial scale up and manufacture

Technical Advise & Support

In conjuction with Teagasc researchers, MTL provide practical technical supports and advice for food companies in solving technology issues

Providiing commercial pilot plant & research services to the food industry

Our Services

Technologies

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Maecenas male uada elit lectus felis.

Read More Technologies

Product Areas:

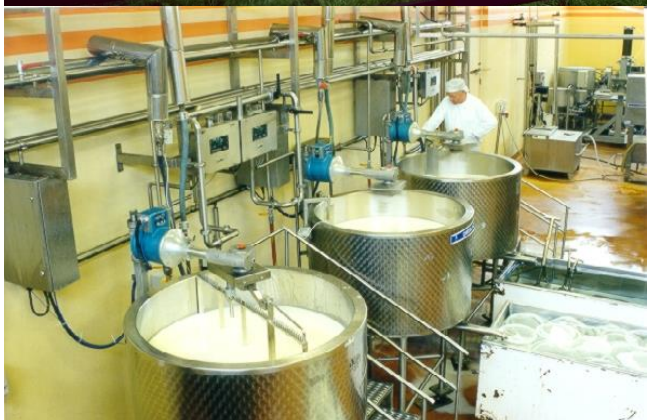
- Dairy Products
- Dried Food Ingredients
- Bioprocessing
- Beverages
- Liquid Food & ingredients
- Yellow Fat Spreads

Kieran Downey

General Manager

Top

Our Clients:



History of the Irish Dairy Industry

1968
Milk Expansion

1995
GATT

2015
End of Quotas

1968 - 1984
- Expansion
- Prices ↑
- Intervention
- Costs ↑

1995 - 2003
- Consumption ↑
- Prices Stabilise
- Stocks ↓

2015 - 2020
- Production ↑
- Exports ↑

1968

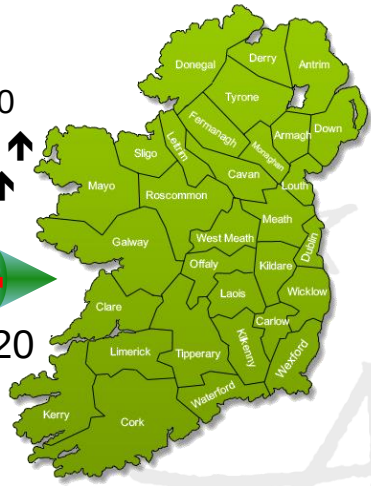
2020

1984 - 1995
- Production Stabilised
- Stocks ↓
- Exports ↑

2004 - 2015
- De-regulation
- Prices ↑↓

1984
Introduction of Quotas

2004
CAP - Reform



Source: EU Dairy Market, IDF world Dairy Summit, Parma 2011: Monika Wohlfarth, Zentrale Milchmarkt Berichterstattung GmbH

Current Dairy Trends

Dairy

€3.06 bn

The estimated value of dairy exports in 2014

55% RISE
in the value of dairy exports from 2009 (€1.96bn) to 2014 (€3.06bn)

In 2014, Irish dairy exports are estimated to have increased by

- **30%** to Asia reaching approximately €530mn, two thirds destined for China
- **18%** to North America with both US and Mexico growing strongly
- **19%** to Middle East, led by Saudi Arabia & UAE

3%
increase in the value of dairy exports in 2014

1,100tn
of farmhouse cheese
A broad range of different types of cheese using cow, goat and ewe milk

172,000 tonnes
of cheese produced

35,000tn
of speciality cheese

40%
of dairy exports are now destined for international markets with trade worth an estimated €1.24bn in 2014, a rise of **20%**.

By 2020, dairy production is expected to grow by
50%
to over 7.5bn litres

China
is now Ireland's 2nd most important export market for dairy compared to 13th in 2008

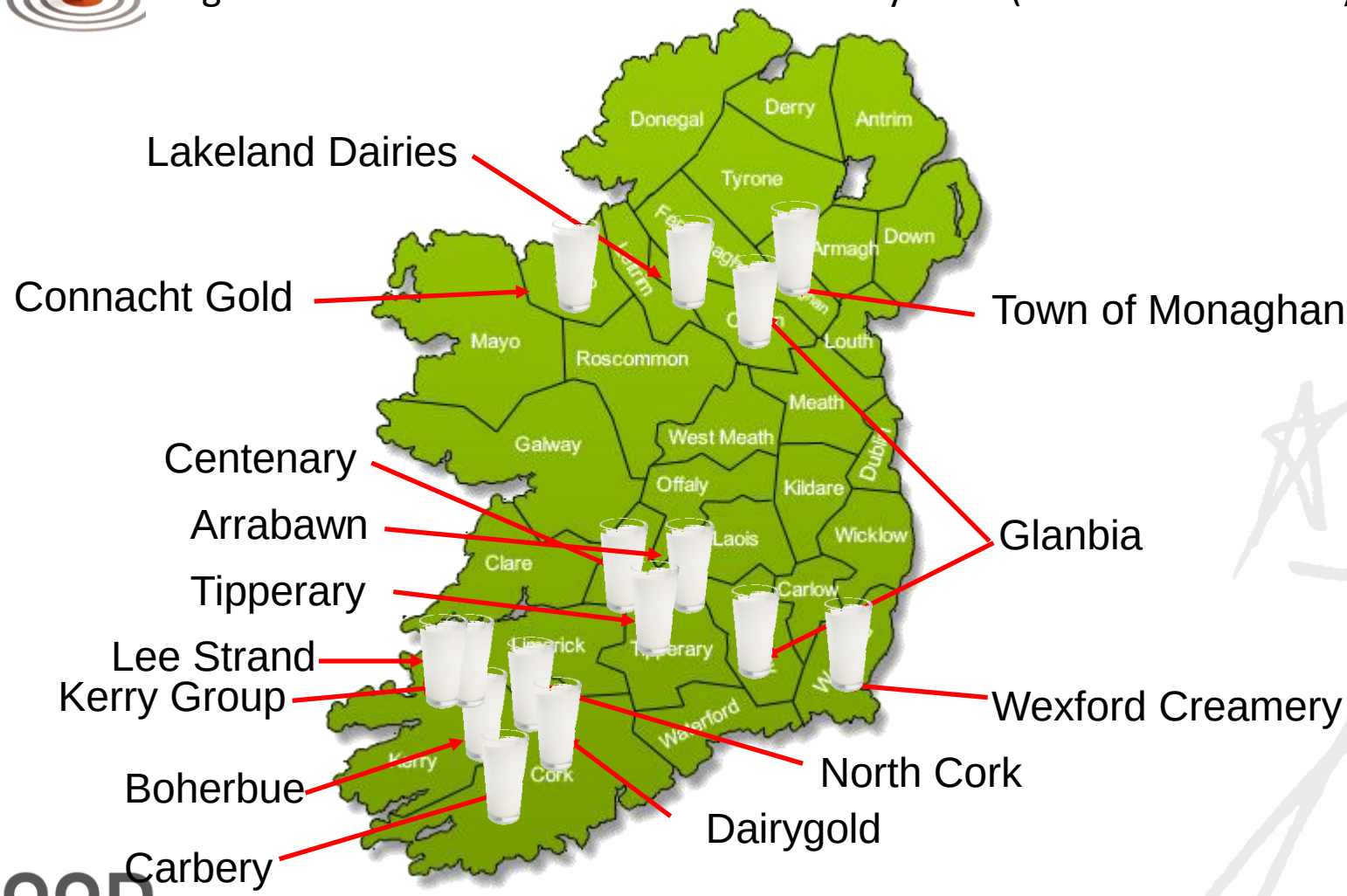
Ireland supplies
10%
of the global infant milk formula despite only having 1% of global dairy production

Ireland has
18,000
dairy farmers,
with over 1 million dairy cows

Ireland exports to **140** markets worldwide. The top 5 markets are the UK, China, Germany, Netherlands & the United States

Major Dairy Processors in Ireland

Targeted 50% Increase in Milk Production by 2020 (Food Harvest 2020)



Produce of the Irish Dairy Industry

Skim Milk

Cheese/Yog
MCI 50-85/ MP
Sweet/Native W
MP
tose
- Milk Salts
charides
mes

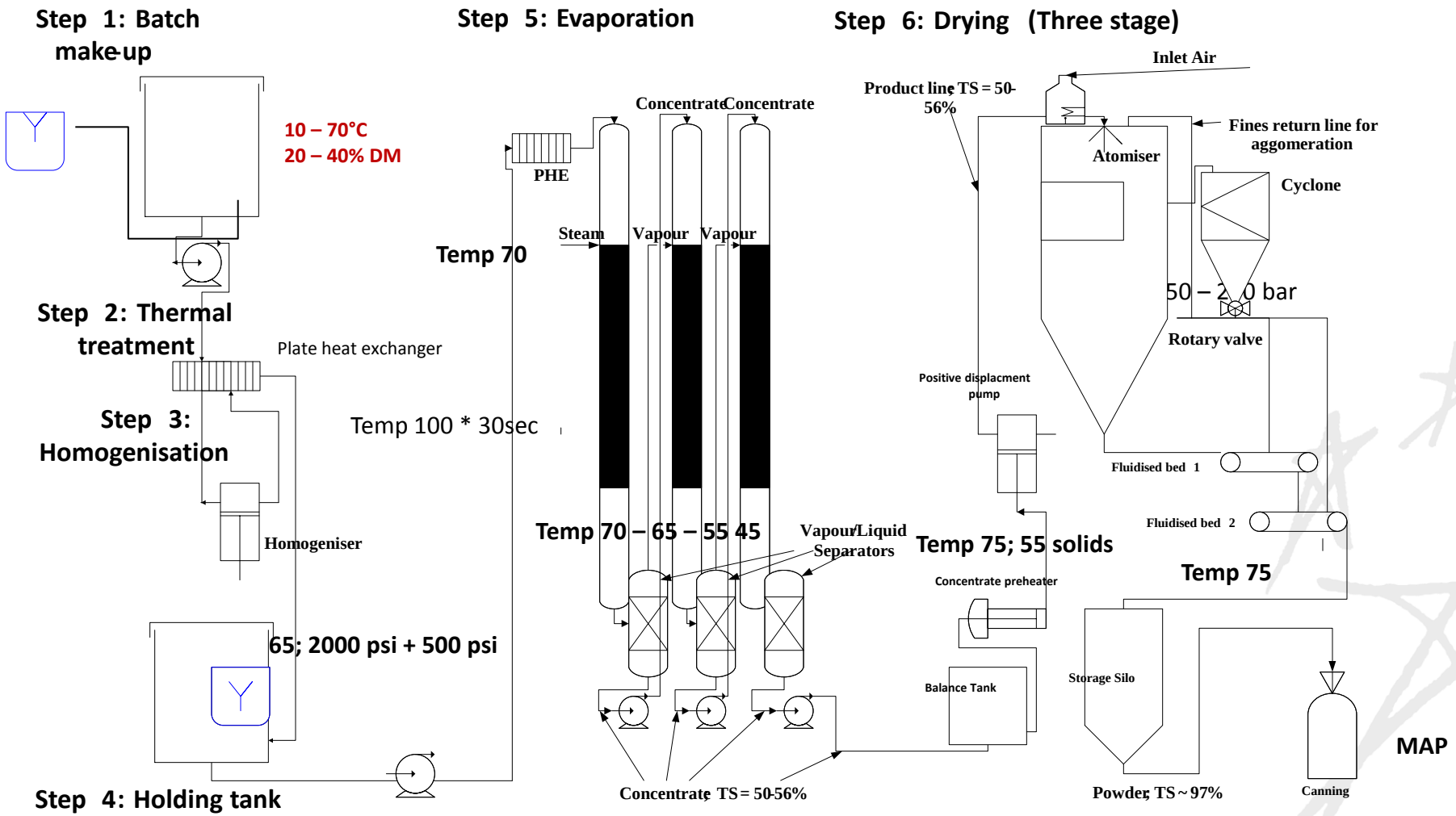
High Added Value

Cream

Profile

Matching product p
business model - Cl

What Does Standard Dairy Processing Look Like



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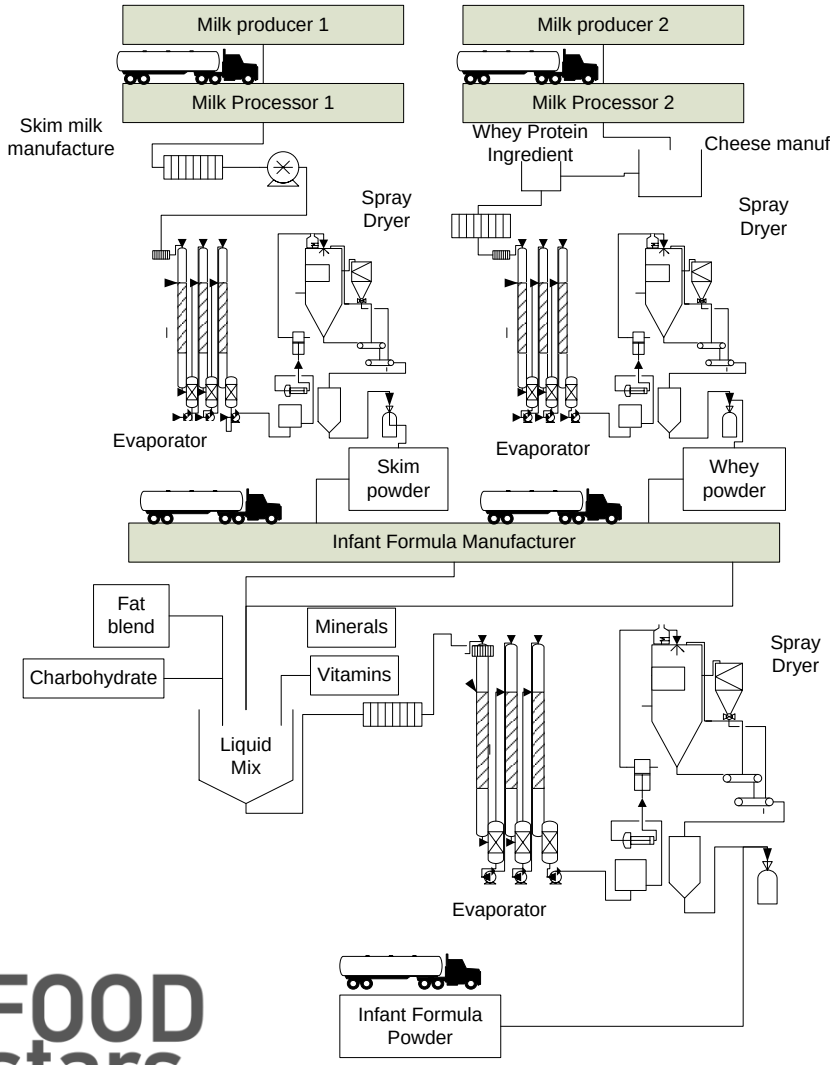
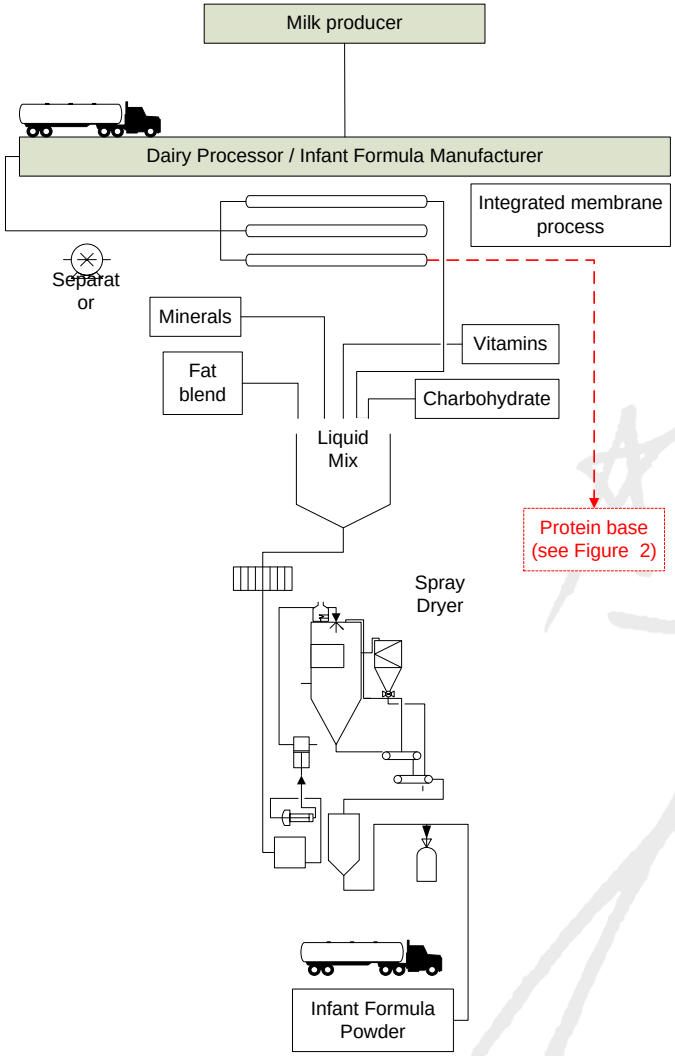
What Does IMF Processing Look Like – Same Challenges

Typical Road Map for Infant Formula Manufacture



Proposed Road Map for Next Generation Infant Formula Manufacture – using a new concept ingredient as a liquid protein base



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WASTE LOSS MANAGEMENT AND CONTROL IN DAIRY PROCESSING

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Definition of wastage

- "Wastage is defined as something expended uselessly or that one fails to take advantage of or that is used extravagantly" (IDF Bulletin 385/2003)

- In milk processing wastage is described as:

"milk purchased that is not sold as primary product"

Material losses in the Irish Dairy Industry

- Historically very high levels of wastage were accepted in the dairy industry
- In the infancy of the dairy industry only milk fat was of interest for processing into butter while skim milk was returned to farmers
- The cheese revolution followed whereby milk solids were converted to a highly stable product – whey became an effluent from this process and was fed to pigs
- Today the dairy industry operates at a very high efficiency due to the low margin on dairy commodities and tight regulations on discharge licenses (Phosphates !!)

Material losses in the Irish Dairy Industry

- Today losses primarily come from:
  - Flushing lines
  - Flushing tanks
  - Product changeovers
  - Deposits in heating equipment
  - Evaporator condensates
  - Spray dryer fines
  - CIP of all of the above
- Recovery mainly focuses on white water recovery by filtration (RO)– use of recovered material can be an issue
- Correct plant design minimises losses

WASTE MANAGEMENT IN THE IRISH DAIRY INDUSTRY

- **UP TO MID '80S - TRADITIONAL APPROACH - GLS, OVERUN IN BUTTER**
- **YIELD CALCULATED IS:**

  MILK FAT IN PRODUCT

  – ***MILK FAT PROCESSED***
- **ACCURATE RECORD OF STOCK, COMPOSITION - A SOURCE OF ERROR YIELDS > 100%?**
- **FROM MID 80'S**

  - *MAJOR INPUT TO OPTIMISE YIELDS***.**
- **DIRECT MEASUREMENT OF LOSSES ADOPTED**
  - DAILY PERFORMANCE APPRAISED
  - MONETARY VALUE OF LOSSES QUANTIFIED
- **PROCESS CONTROL/INVESTMENT - NEW TECHNOLOGIES**
- **COST BENEFIT ANALYSIS**

LOSS MEASUREMENT TECHNIQUE (LMT)

A. *Traditional Method:* Material balance inaccurate for daily use due to stock carryover and error in measurement.

B. *L.M.T.:* Requires measuring all loss sources in each process.

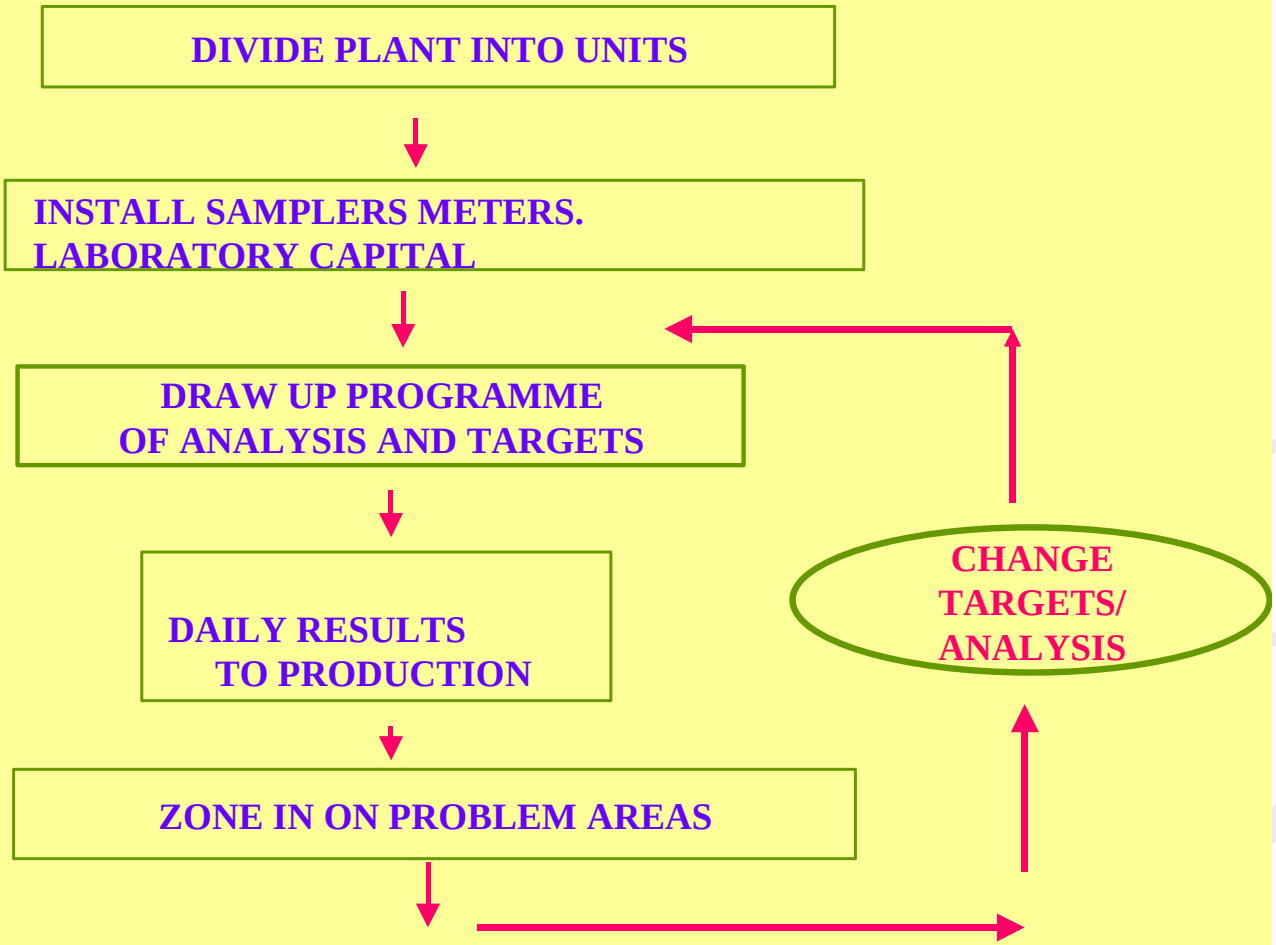
C. *Necessary Inputs:* Flow measurement and sampling equipment analysis of effluent, by-product and product.

D. *Expression of Results*: As kg of product lost/day.

E. *Set Target Figures*: For losses on basis of good operating practice.

F. *Avoidable Loss Kg/Day*: = Total loss - target value

Implementation of L.M.T.



SUCCESS OF WASTE MINIMISATION PROGRAMME IS BASED ON:

- **COMPANY POLICY STRATEGY FOR IMPLEMENTATION**
- **MANAGEMENT COMMITMENT**
- **MONETARY/CAPITAL RESOURCES**
- **A PROGRAMME OF PERSONNEL TRAINING**
- **OVERCOME CULTURAL BARRIERS**
- **INCENTIVE SCHEMES**
- **EMPLOYEE MOTIVATION**
- **INFORMATION FEED BACK**

PROCESS INFORMATION NECESSARY FOR WASTE LOSS APPRAISAL

- **PROCESS DESCRIPTIONS**
- **PROCESS FLOW DIAGRAMS**
- **PIPE AND INSTRUMENT DRAWING**
- **OPERATING MANUALS**
- **DRAINAGE DETAIL AND HISTORY**
- **WASTE ANALYSIS - FLOW OR CONCENTRATION**
- **DISCHARGE LICENCE DETAILS**
- **EMISSION STANDARDS**

Where do losses occur ?

- Spillages to floor and leaks
- Inherent sources such as milk separation ,emission losses in drying
- Waste in pipes that do drain easily
- Heat deposits in heat exchangers
- CIP
- Product losses are also wastage
- Over specification such as excess fat in cheese/powders where accurate standardisation is not employed
- Product returns due to shelf life consideration resulting in downgrading of product – microbiological quality

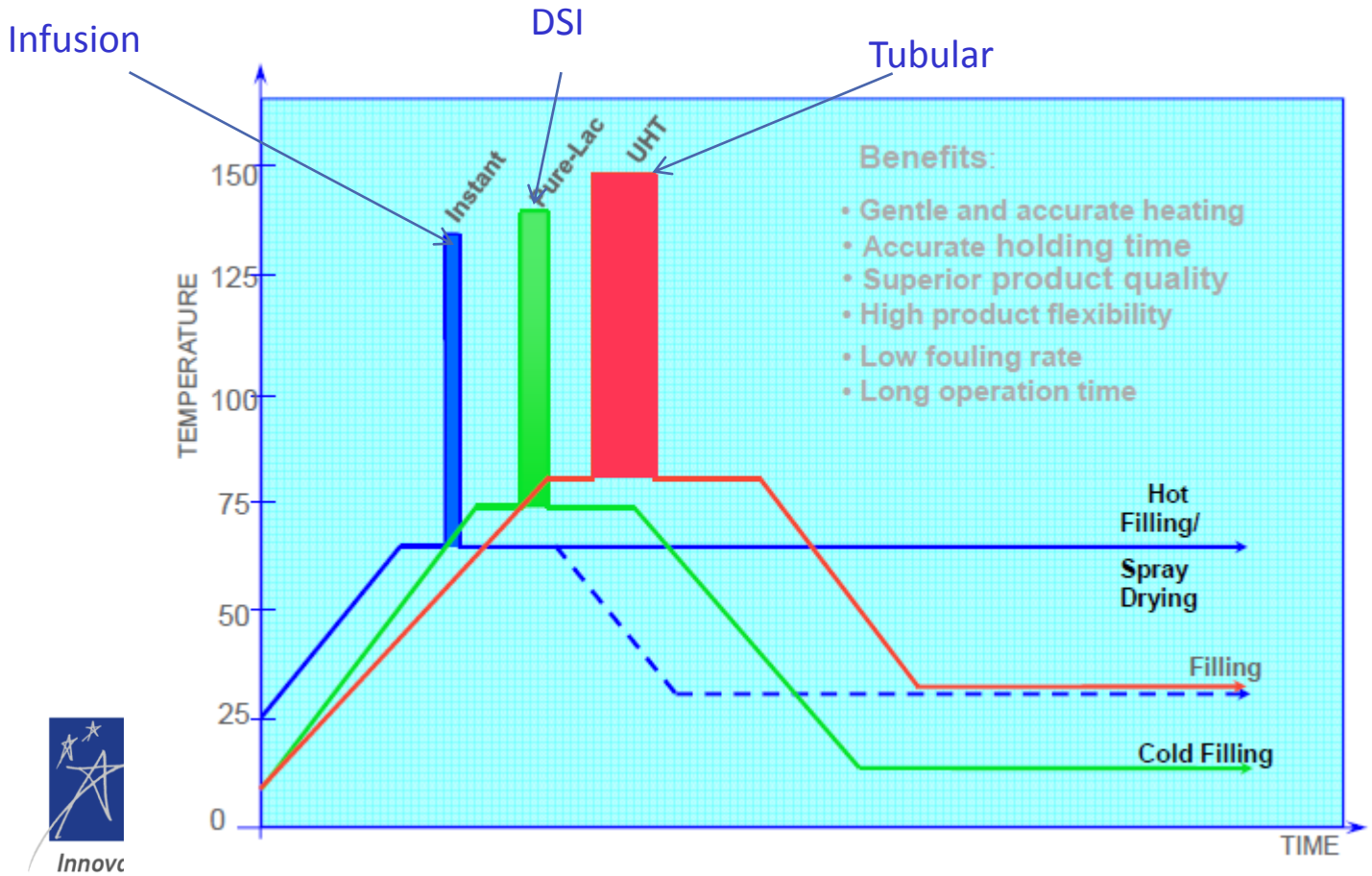
Heating Dairy Products Creates Wastage as Effluent

Effect of heating on bovine milk components

- Microbiological Safety
- Inactivation of enzymes
- Protein structural changes, resulting in inactivation of functional proteins
- Maillardation
- Heat Toxins
- **FOULING !!!!!!**
- **Higher DM + Higher Temperature Exacerbates the Problem**

Many Technologies for HHT - Challenges

- Options include
  - DSI (direct contact of steam with product)
  - Infusion (direct contact of steam with product)
  - Tubular (indirect contact of product with heating medium)



All systems are challenged by high DM processes

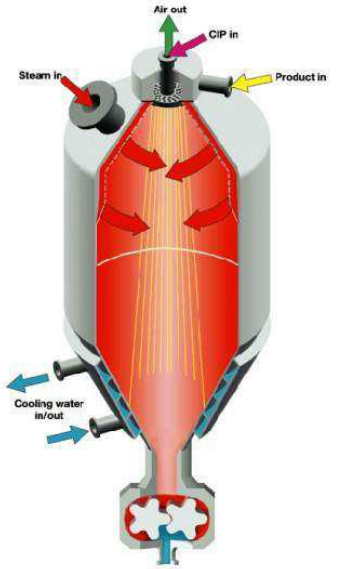
HHT requirements are met primarily in the holding section

Typically the holding tube/section is the initiation zone for fouling

How to reduce effluent related to fouling in heating processes

- Food Safety is still a major challenge
  - Fonterra crisis highlights vulnerability in the sector
  - The dairy industry is considering higher thermal loads
  - Higher thermal loads = higher effluent loading
  - Consider combination processes to meet equivalent microbial reductions
  - Research needs to consider state of the art processes
    - Instant Infusion (SPX), low temperature bactofugation (Westfalia/Seitel), low temperature Microfiltration (TAMI/Synder/Membralox)

Smart Process Design is key!



What are Teagasc' Capabilities in Dairy Recovery

- Complete milk fractionation – MF – UF – NF – RO – ED – IEX
- New concepts for liquids – concentrates – powders
- Robustness studies – plant and membrane performance
- Feasibility studies – mapping macro-micro nutrient partition
- Integrated mass balance and process flow design
- CAPEX OPEX and business case evaluation
- Capability to rapidly modify and construct membranes pilots to meet customer requirements
- Reverse Osmosis drives water recovery and water balance in Dairy plants

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Practical techniques to reduce waste in dairy processing

- **Good operating practices**
  - ***Regular preventative maintenance. Leaking steam valves, product leakage pumps. Calibration of instrumentation and records.***
    - **E.G. Load cells, flow meters**
    - **Depth Controller, pH sensors**
    - **Good communication network.**

- **Segregate various streams and isolate before reaching drain.**

- **Segregate storm and flush/CIP where possible.**

- **Employ on line instrumentation where possible - conductivity, turbidity, or mass flow to give instant alarm.**

Techniques continued

- **Bunding of silos – standard practice**
- **Avoid spillages and identify/remove dead lines.**
- **Remove operator dependency where possible**
- **Increase automation where possible.**
- **Train and motivate employees – bonus schemes**
- **Increase product shelf-life and reduce over specification.**

Technology/process changes

- **Introduce new equipment which produce less waste**
  - ***Automatic valve blocks instead of flow plates/swing bends***
- **Change process conditions such as agitation, flow rate, thermal load, vacuum, air flow,**
- **Redesign equipment to avoid losses at start up and shutdown**
  - ***Minimise mixing of phases***
- **Appraise new technologies**
  - ***Vats, separators, clarifier CIP recovery***

How to Reduce Waste in Dairy Plants –Effluent Load

- Establish waste load reduction targets for your plant and for individual processes within the plant
- Improve maintenance to prevent leaks from valves and piping
- Reduce water use as water used becomes wastewater
- Use condensate from evaporation if available
- Design lines that will allow proper drainage of product rather relying on rinse water to remove product
- Inspect vats and tanks to ensure dairy residues are removed before commencing CIP
- Collect solids from the floor and place in waste containers
- Do not use hoses as brooms
- Seek ideas from employees in reducing waste and implement the best ideas immediately and let them know the outcome
- Train employees toward preventing pollution

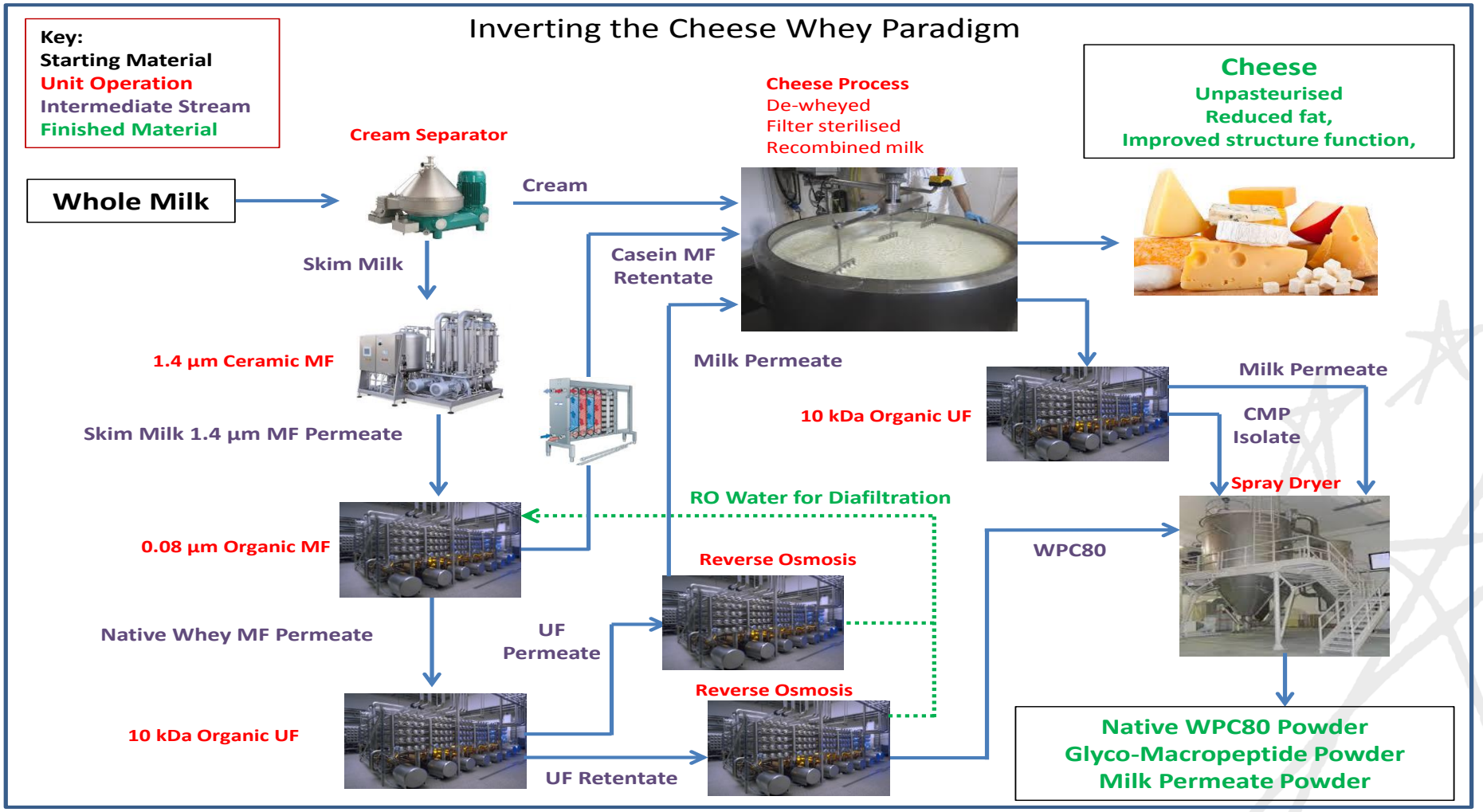
What about irrecoverable milk solids?

- Dairygold needed a wastewater treatment plant that could reliably treat process wastewater containing powdered milk and cheese waste, as well as high-strength salty whey
- This led to the installation of the worlds largest above ground anaerobic digester effluent plants, commissioned in 2012.
- This waste-to-energy system uses effluent from the site to generate gas to contribute to the site's energy requirements.
- The site, located at Mitchelstown, Co Cork, included a 45,000m digester, 78m in diameter, to treat the process dairy waste load

What about whey

- Cheese whey used to be the largest effluent stream in the dairy industry
- Whey is now one of the most valuable commodities produced by the dairy processors
- Perhaps cheese could be considered the by-product (waste) of whey processing due to its high commercial value

Next Generation Process Technologies – Cheese Whey Relationship



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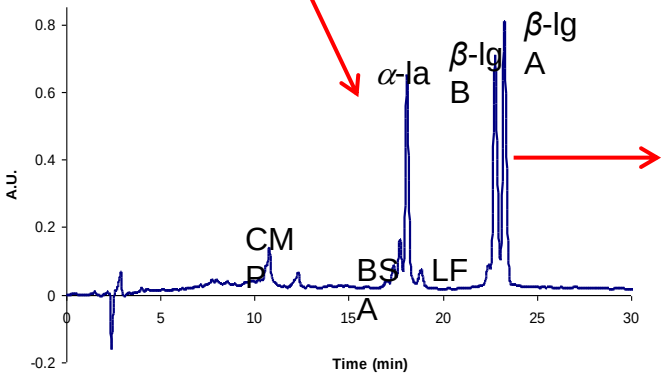
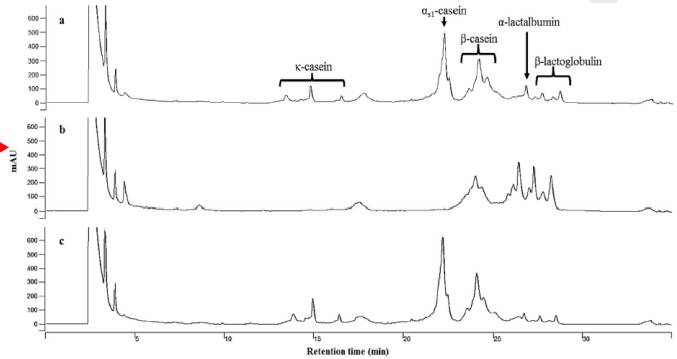
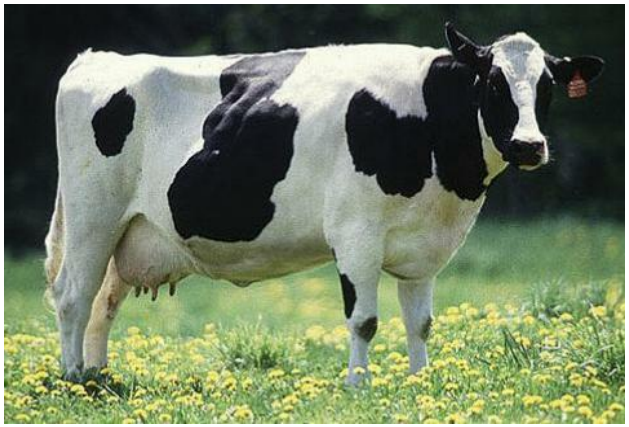
What Areas in Dairy Recovery are hot right now!

- Removal of bacteria and recovery of filtration retentates
- Phospholipid recovery – milk and oil processing
- Enrichment of milk oligosaccharides
- Recovery of targeted enzymes
- Renovation – where can waste streams be recombined in existing products – legislation and regulation - EMP for certain markets
- Retention of higher bioavailability milk salts through selective partition of minerals in demineralization process
- Retention of higher levels of trace minerals and vitamins in demineralization and lactose processing





THANK YOU FOR YOUR ATTENTION



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