Panostus kannatti – teollisuusentsyymit menestyksekästä liiketoimintaa

Bioteollisuus Forum

APR 6th, 2017
Jari Vehmaanperä

INDUSTRIAL ENZYMES

- .. are enzymes, which are produced at large scale and used in industrial applications
- sold typically business-to-business (B2B)

- INDUSTRIAL ENZYMES are mainly
  - Secreted enzymes
  - Microbial enzymes
  - Hydrolases

- INDUSTRIAL ENZYME manufacturing is
  - Bioprocess Technology
  - WHITE BIOTECHNOLOGY

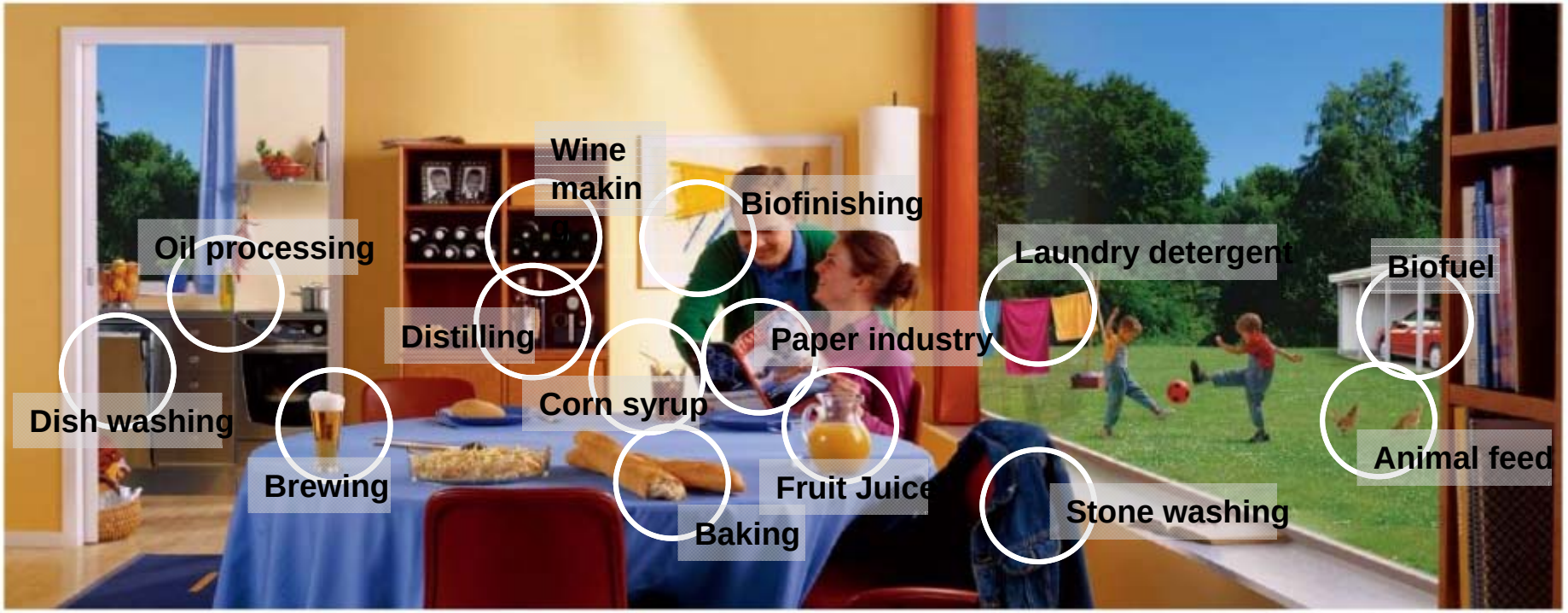
- INDUSTRIAL ENZYME business
  - Uses latest tools in modern biotechnology
    - For enzyme discovery and evolution
    - For developing the proprietary production strains
    - For process optimization
  - Is R&D intensive
  - IP is critical for freedom-to-operate
  - Exploits contained use of GMMs (genetically modified microorganisms)

INDUSTRIAL ENZYMES (2)

- INDUSTRIAL (microbial) ENZYME preparations
  - are basically **spent microbial growth media:**
    the cell biomass removed, and the supernatant concentrated and formulated
  - sometimes purified (e.g., by precipitation or crystallization)

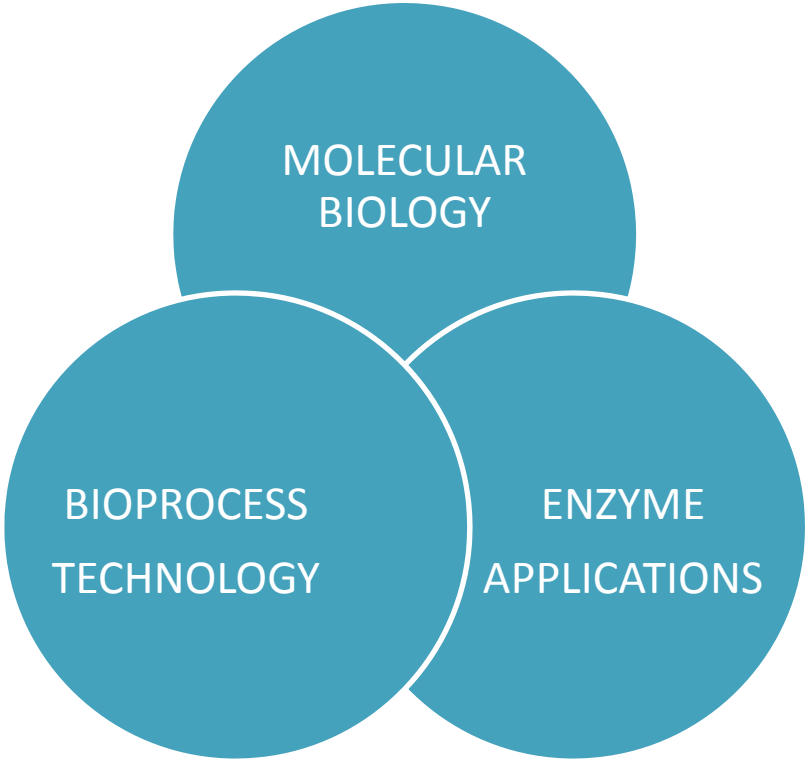
- Some descriptive facts:
  - Typical package size 25 kg canister – 1000 kg big bag
  - Used at concentrations of less than 0.1 kg/ton material treated, or below (100 ppm)
  - Formulated as liquid or dry products (granulated, coated, pelleted)
  - Typical price range 10 €/kg – 200 €/kg product

ENZYMES ARE USED EVERYWHERE



RESEARCH FOCUS

Industrial enzyme research and development take advantage of these disciplines



Enzyme molecules

- Biodiversity screening
- Protein engineering

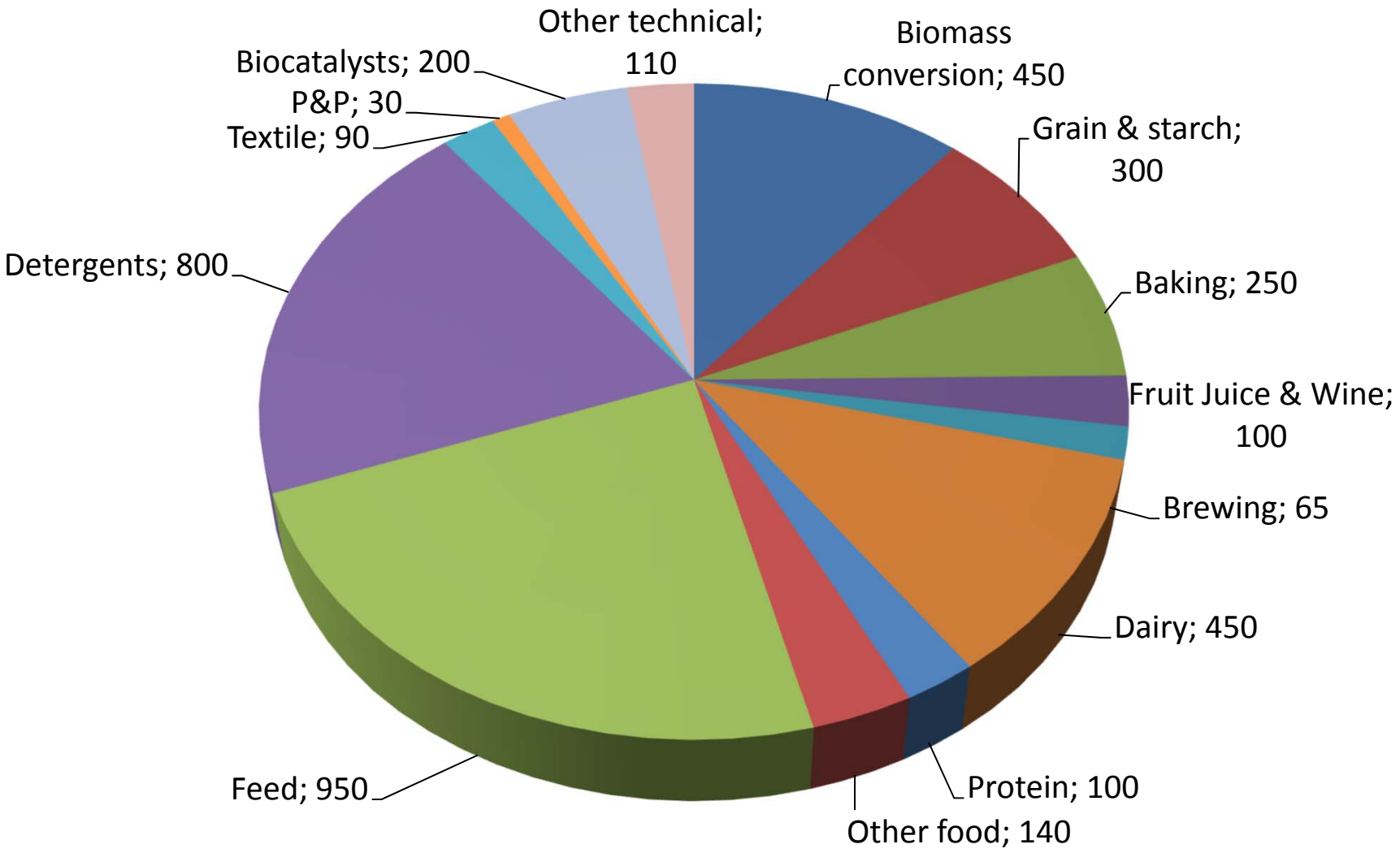
Cell factories - platforms

- Genetically modified strains (GMO)
  - heterologous gene expression
- Classical strains
  - classical mutagenesis + screening
- Process development

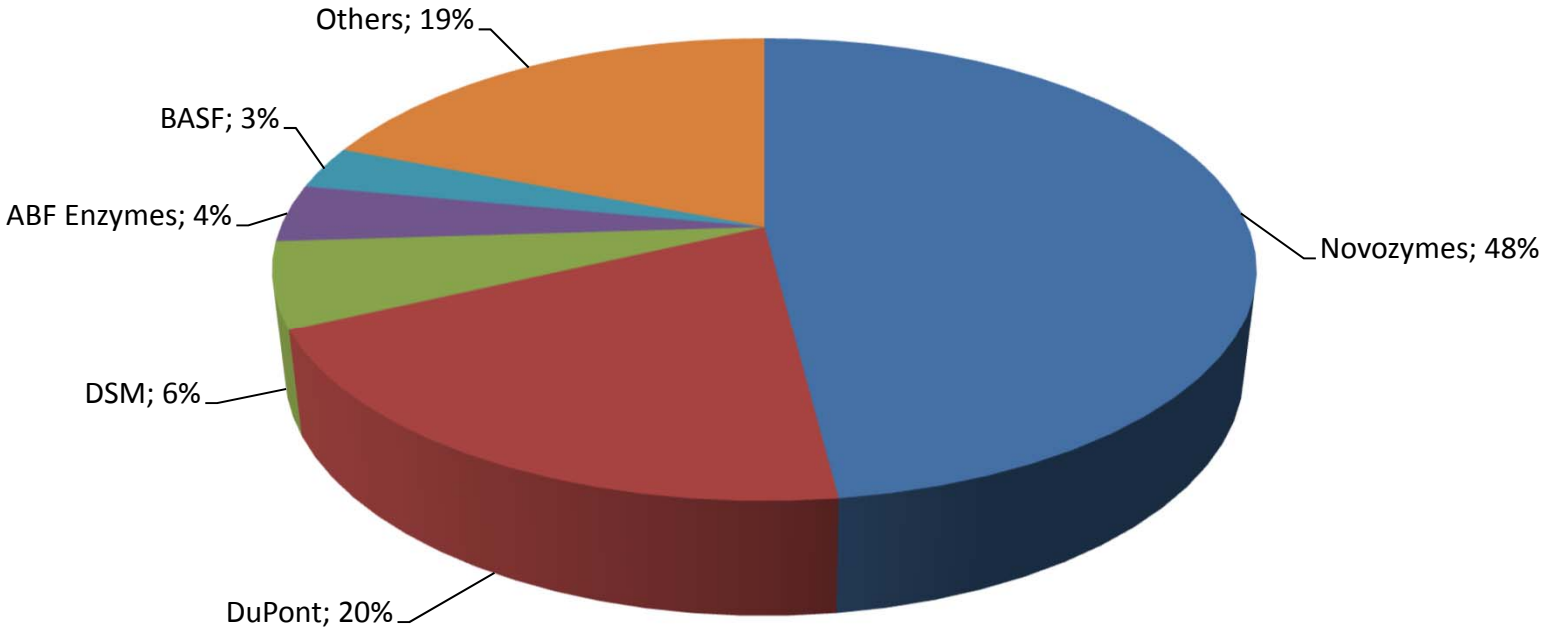
Enzyme technology

- Application know-how

Industrial enzymes markets are about 4 000 M€



INDUSTRIAL ENZYME COMPANIES – MARKET SHARE



Market size about 4 000 M€

ENZYMES INDUSTRY IS STRUCTURALLY ATTRACTIVE

PORTER'S FIVE FORCES:

Threat of new entrants

- IP is critical
- R&D investment high
- Regulatory important

Enzyme business is differentiated and even relatively small players can maintain attractive profits

Supplier power

- Input costs do not play a role

Industry rivalry

- Enzyme performance and innovation form the basis for competition
- Certain segments have price erosion

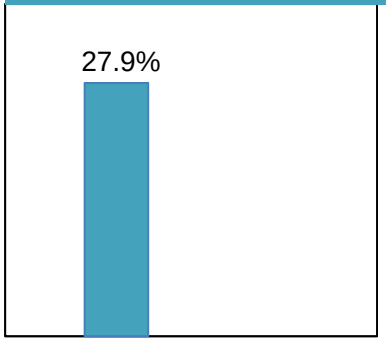
Buyer power

- In some markets relevant

Threat of substitution

- Low probability

Novozymes EBIT 2016



Industrial enzyme business in Finland

DuPont

Genencor International, Inc.®

DUPONT - GENENCOR, THE HANKO SITE

- Enzymes mainly for detergent, starch and textile applications
- Bacterial fermentations
- 1972 Fermion builds a penicillin production plant in Hanko
- 1977 Finnsugar (Suomen Sokeri) buys the plant and started Na-gluconate production
- 1982: Glucose isomerase production starts
- 1989 Cultor (Suomen Sokeri) and Eastman Kodak buy Genencor International
- 1994 - 2001: Investments in fermentation, down stream processing and dry products
- 1999 Danisco buys Cultor and acquires 50% of Genencor
- 2003 Granulation pilot plant in Hanko
- 2005 Danisco acquires the rest of Genencor
- 2006-2007 Investments in fermentation and dry products
- 2011 DuPont acquires Danisco

DUPONT-GENENCOR, THE JÄMSÄNKOSKI SITE

- Enzymes mainly feed, textile and food applications
- Fungal fermentations
- 1974 The plant is built
- Originally used for the PEKILO protein production
- 1981: PEKILO production stops
- 1984: Finnsugar buys the plant for Na-gluconate and enzyme production
- 1989 Cultor (Suomen Sokeri) and Eastman Kodak buy Genencor International
- 1990 Jämsänkoski becomes part of Genencor
- 1999 Danisco buys Cultor and acquires 50% of Genencor
- 2005 Danisco acquires the rest of Genencor
- 2011 DuPont acquires Danisco

ABF

ABF, THE RAJAMÄKI SITE

Location

Rajamäki, Finland

Facility

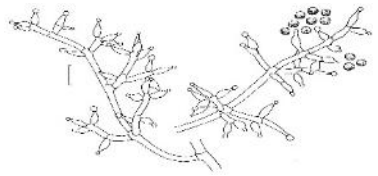
Modern fermentation facility with downstream, drying and mixing capabilities

Capacity

Major continuous investments

Technology

Patented production technology based on *Trichoderma*, *Bacillus* and *Aspergillus* production strains



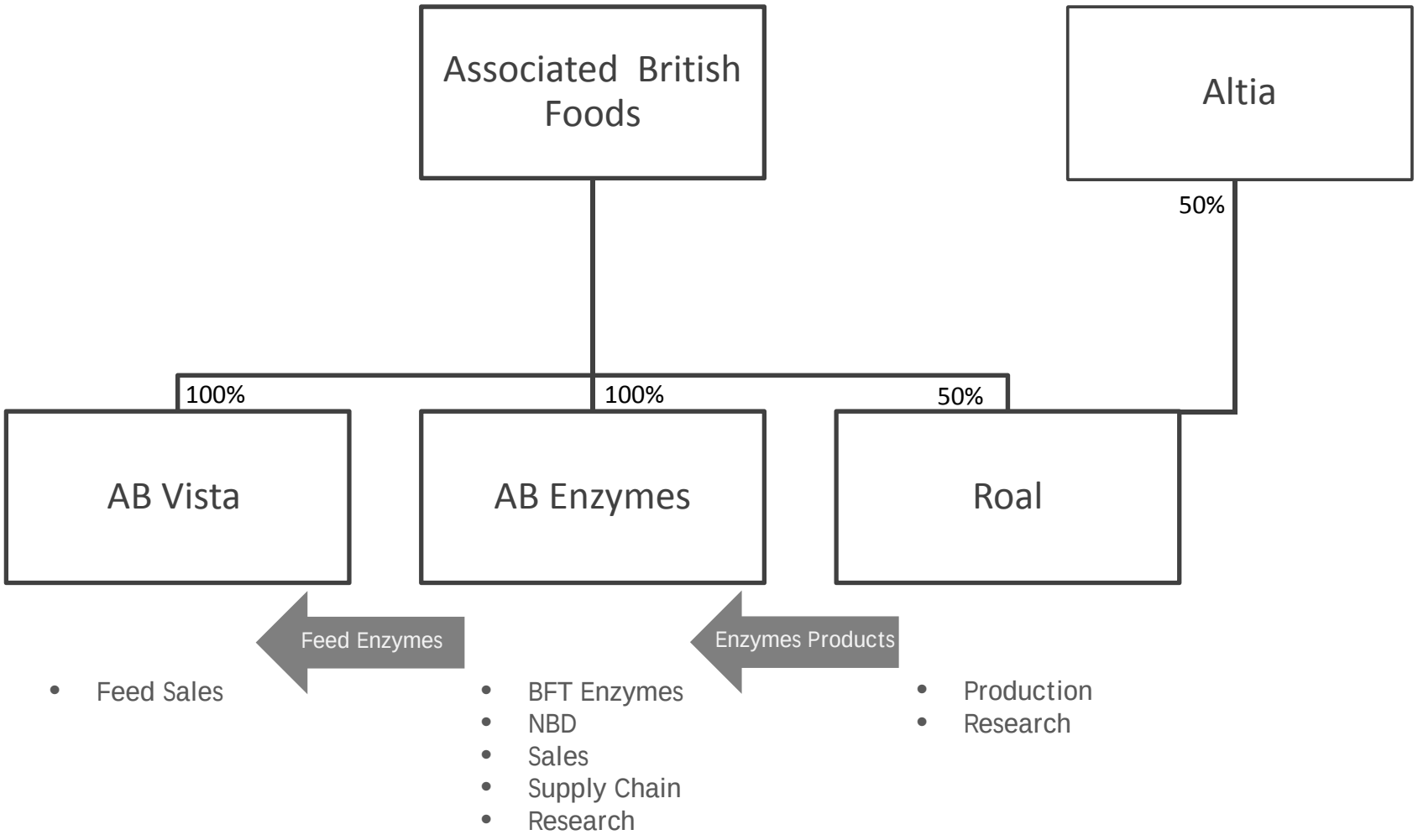
Ownership

Roal Oy, a 50/50 joint venture between Associated British Foods and Altia

Activities

- ✓ Manufacturing
- ✓ Research
- ✓ Process and product development
- ✓ Pilot plant

OWNERSHIP STRUCTURE



ALKO – PRIMALCO / ALTIA - ROAL HISTORY (1)

1888

Hyvinkään Tehtaan Osakeyhtiö spirits and yeast plant established in Rajamäki

1932

Alko, the state-owned Finnish Alcohol Monopoly founded

1954

Alko (today Altia), starts producing microbial enzymes for captive use in grain processing in Rajamäki (Alko)

1961

Full scale production plant built in Rajamäki (Alko)

Early 1970's

Cellulase research starts in cooperation with Finnish Forestry Industry, Alko, VTT and HUT.

1977

Alko microbial enzymes production moved to Koskenkorva

1979

Trichoderma cellulase production begins in Koskenkorva (Alko)

1980

Bacillus secretion vector patent filed (Palva et al.). Genesit Oy was later founded around the technology

1984

First industrial scale GMO cultivation in Koskenkorva in Finland (Bacillus alpha-amylase)

1986

Trichoderma transformation patent filed (VTT). Technology ownership to Alko.

1988

The enzyme production plant starts at Rajamäki (Alko)

1990

Genesit stops operations.

1991

Roal Oy founded.

1993

The Roal capacity expansion starts production.

1995

Alko is divided, Primalco Ltd founded. The enzyme business moved to Primalco Biotec.

1997

Röhm GmbH acquires non-Trichoderma biz of Primalco. Roal Oy retains Trichoderma sales. Röhm Enzyme Finland Oy founded.

1999

ABF Plc´s Abitec Division acquires Röhm Enzyme..

2001

Röhm Enzyme renamed AB Enzymes. Investment in enzyme drying and mixing plant finished at Roal.

ALKO – PRIMALCO / ALTIA – AB ENZYMES/ROAL HISTORY (2)

1986
Trichoderma transformation patent filed (VTT). Technology ownership to Alko.

1988
The enzyme production plant starts at Rajamäki (Alko)

1990
Genesit stops operations.

1991
Roal Oy founded.

1993
The Roal capacity expansion starts production.

1995
Finland joins EU: Alko is divided, Primalco Ltd founded. The enzyme business moved to Primalco Biotec. R&D moved from Salmisaari to Rajamäki

1997
Röhm GmbH acquires non-Trichoderma business of Primalco. Roal Oy retains Trichoderma sales. Röhm Enzyme Finland Oy founded.

1997
Finnish Bioindustries founded

1999
ABF Plc´s ABITEC Division acquires Röhm Enzyme

2001
Röhm Enzyme renamed AB Enzymes. Investment in enzyme drying and mixing plant finished at Roal.

2002
Pilot plant moved to Rajamäki from Salmisaari

2003
ABF Ingredients Group is formed. AB Enzymes and Roal joined to the division.

2005-06
AB Enzymes leadership team reorganized.

2007
Global distribution arrangement for feed enzymes with ABF sister company AB Vista

2009
1st capacity expansion at the manufacturing site in Rajamäki, Finland

2015-16
2nd capacity expansion at the manufacturing site in Finland

2017
3rd capacity expansion at the manufacturing site in Finland

Business turns profitable

INDUSTRIAL ENZYMES – WHY ENZYMES AND WHY FINLAND

Basic development work in Trichoderma cellulase production in 1970‘s

- Classical mutagenesis and screening at VTT for Alko (for bioethanol)

Improving industrial enzyme productivity and tailor-made strains was chosen as the first commercial target for gene technology in early 1980‘s – and proved successful

- Alko and Finnish Sugar (Cultor) invested heavily in modern biotechnology in 1980‘s
- Fruitful cooperation of Alko, VTT and the funding agencies (TEKES)
  - Key patents on Trichoderma technology filed late 1980‘s and early 1990‘s
- Finnish Sugar acquired 50% of Genencor
- Alko and Röhm cooperation
  - Röhm acquired the enzyme business from Primalco

Heterologous enzyme synthesis and secretion remains a model in molecular biology

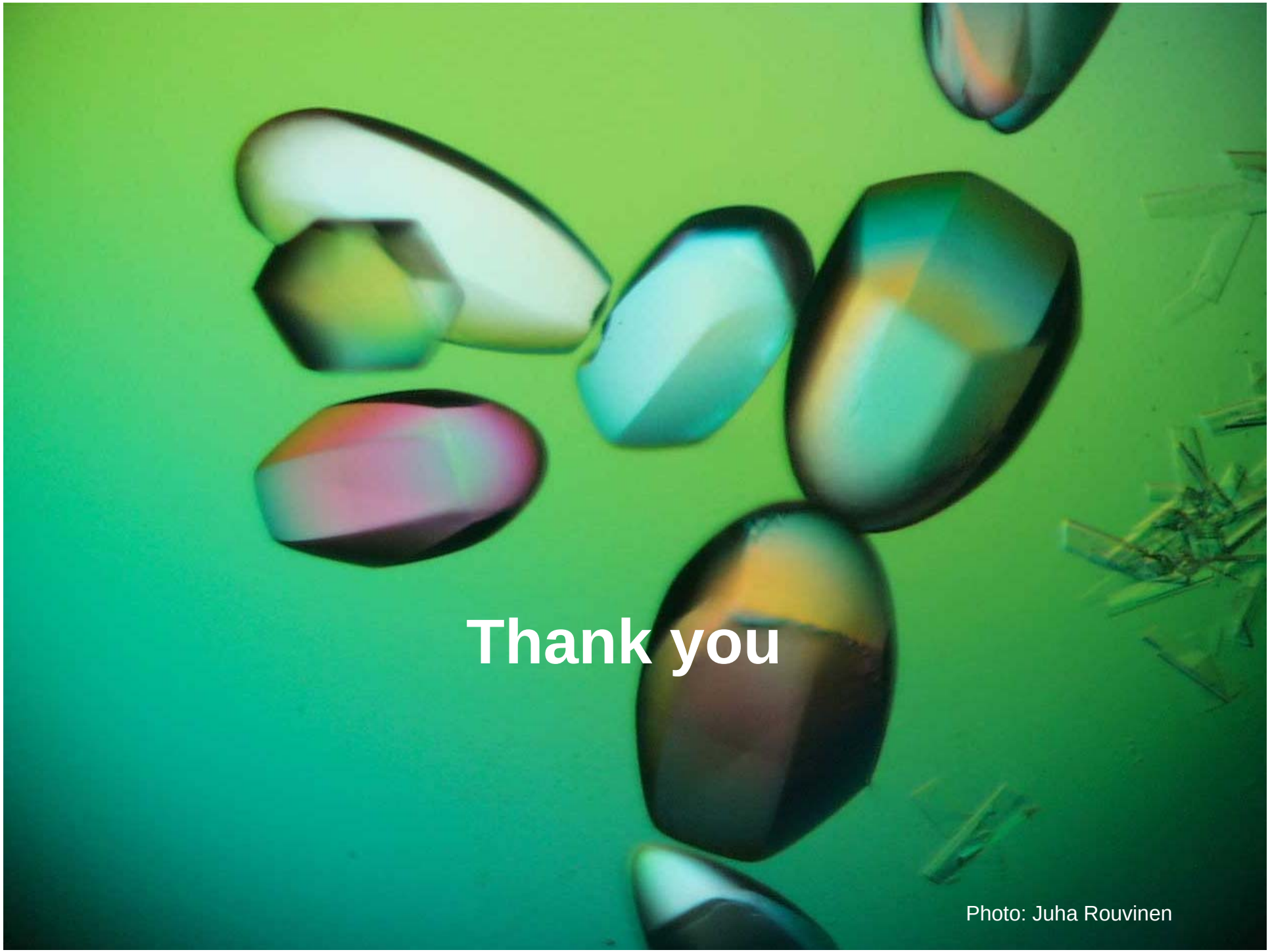
- funded cooperation between industry and research organization

Also some lost opportunities (presentor‘s opinion):

- The pioneering work on the Bacillus secretion failed in patent protection
- Alko and Finnish Sugar did not join forces in 1980‘s
- Cultor (Finnish Sugar) and Genencor was eventually acquired by Danisco (now with DuPont)

ROAL AND AB ENZYMES TODAY

- Today a highly profitable and growing business having the manufacturing and half of the company R&D in Rajamäki – about 180 people
- The owner ABF has shown long term commitment by investing heavily in expanding and upgrading the Rajamäki site during the last ten years
- Roal remains one (the only?) surviving spin-offs of the Alko monopoly sidetracks
- During the first ten years in the 1990's the business survived thanks largely to strong and committed own R&D (not forgetting the other functions), **funding by TEKES and EU**, and through cooperation with the research organizations (e.g. VTT)
- The joint venture structure also provided some shelter during the critical years
- The critical positive turning points have been Röhm acquiring the Primalco enzyme business 1997 and then ABF acquiring the Röhm Enzyme together with Roal 1999
- There has also been a lot of luck … but one better be prepared ☺


Thank you
Photo: Juha Rouvinen

APPENDIX

ASSOCIATED BRITISH FOODS (ABF)

Associated British Foods plc

Market-leading sugar producer in the UK, Spain, and southern Africa, with substantial interests in China

Herbs and spices, world foods, hot beverages, sugar and sweeteners, meat, vegetable oils, bread, baked goods and cereals, with manufacturing facilities in Europe, the Americas and Australasia

Yeast & bakery ingredients and specialty ingredients, with 52 plants in 26 countries

Sugar

Grocery

Ingredients

Agriculture

Retail

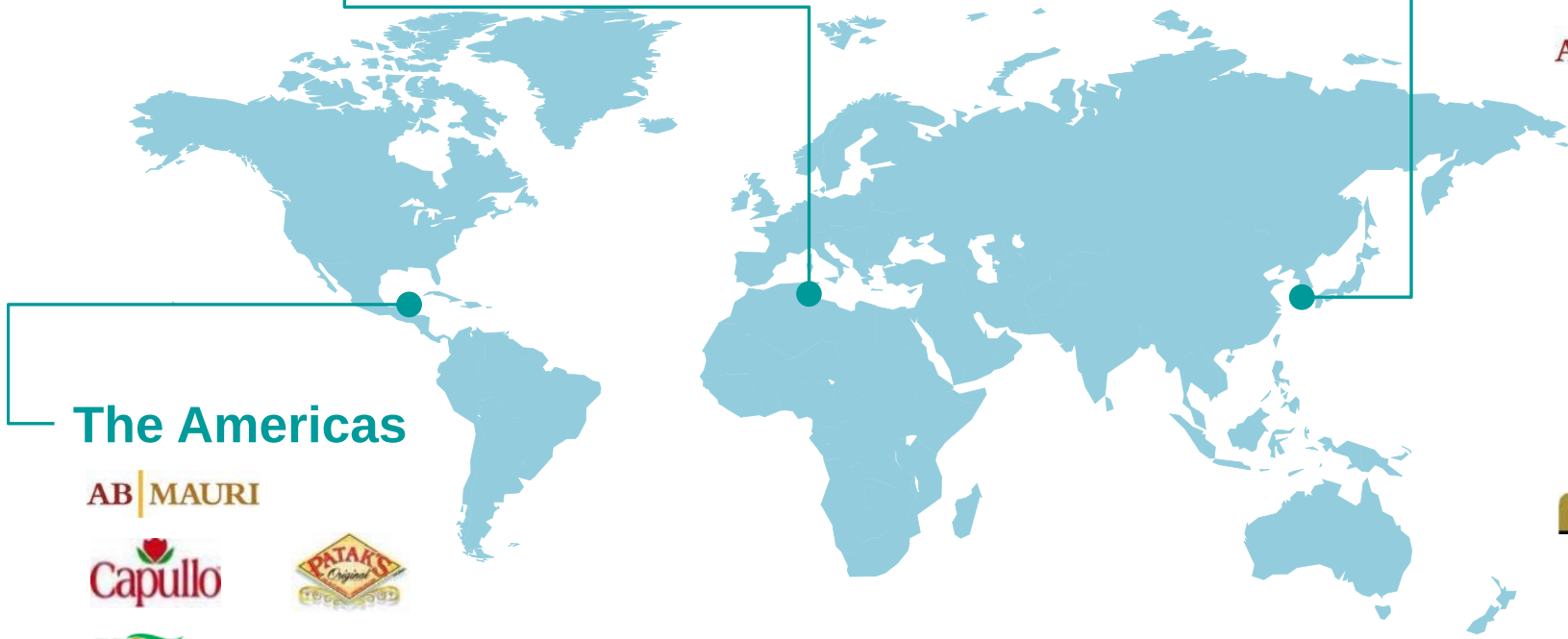
Primark and Penneys: High street value fashion retailer with stores in the UK, Ireland, Spain, Portugal, Germany, Netherlands, Belgium, Austria and France

Animal feed and farm products; manufacturing in the UK and China, distribution across 65 countries

LEADING ABF BRANDS

Europe, Middle East, Africa

Allinson
Billington's
Blue Dragon
Kingsmill
Jordans
ABF ingredients
Ovaltine
Patak's
Ryvita
Silver Spoon
Twinings
Illovo Sugar Limited
Primark
British Sugar
ab agri
AB Mauri



Asia and Oceania

ab agri
AB Mauri
KR Castlemaine
Patak's
Tip Top
Twinings

The Americas

AB Mauri
Capullo
Patak's
Mazola
Twinings

ABF – ABFI – AB ENZYMES

Associated British Foods plc

ABF is a diversified international food, ingredients and retail group with **sales of £13.4 bn**, **130,000 employees** and **operations in 50 countries** across Europe, southern Africa, the Americas, Asia and Australia, which was incorporated in 1935,

- Five divisions: grocery, sugar, agriculture, ingredients, retail
- Listed on the London Stock Exchange
- World's second largest yeast business
- World leader in specialty enzymes

ABF ingredients

ABF Ingredients is a division of ABF, comprising a five companies operating under their own identities and business models, focusing on **high-value ingredients** for both **food** and **non-food applications**.

ABF Ingredients has established **strong market positions** in enzymes, yeast extracts, specialty lipids, emulsifiers, cereal specialties and pharmaceuticals amongst others.

AB Enzymes
an ABF ingredients company

AB Enzymes, established in 1907 as part of Röhm, is 100% owned by ABF with a **10% p.a. growth rate** since 1999 and **300 employees.**

With headquarters in **Germany,** our manufacturing site in **Finland** and a **global presence** in more than **50 *countries,*** we develop, manufacture and supply enzyme preparations for industrial feed, food and technical applications worldwide.

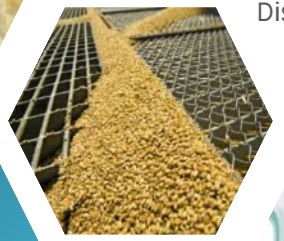
AB ENZYMES INDUSTRIES AND PRODUCTS

Baking

VERON®
Bread
Biscuits
Crackers

Grains & Proteins

ROHALASE® COROLASE ®
Vegetable oil processing
Protein modification
Starch processing
Brewing
Distilling



Fruits

ROHAPECT®
ROHAMENT®
ROHAVIN®
Fruit juice
Fruit firming
Wine

FOOD

TECHNICAL

FEED

Detergents

BIOTOUCH®
Laundry

Textiles

ECOSTONE® BIOTOUCH®
Biofinishing
Pretreatment
Denim

Feed

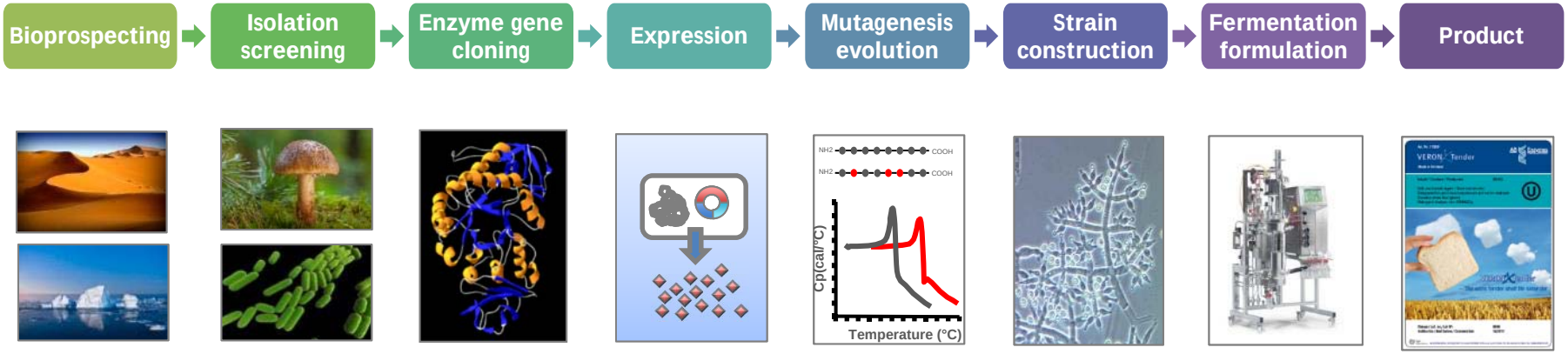
ECONASE®
FINASE®
QUANTUM®
Poultry
Swine
Ruminants

Pulp & Paper

ECOPULP®
Pulp
Paper

R & D - WE HAVE THE FULL R & D SKILL SET

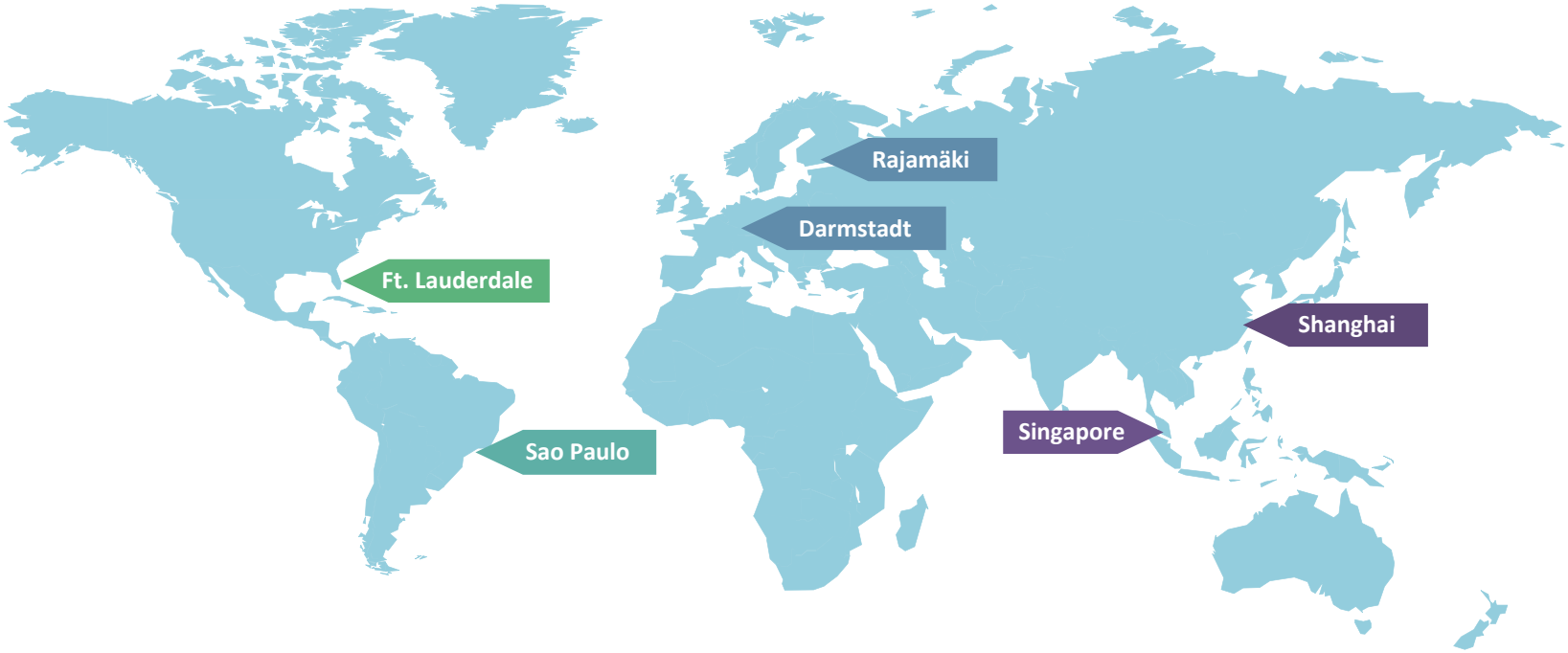
Investment	Over 10% of revenue invested in R & D
Focus	Discovering novel genes, improving existing molecules, developing proprietary technologies
Technology	State-of-the-art cloning, evolution and expression in our proprietary fungal and bacterial production platforms
Patents	Over 550 and growing
Partnerships	Collaborating closely with leading international research organizations in contract and publicly funded projects



Nature | Microorganisms | Wild type enzymes | Analytical amounts for primary characterization | Optimized enzymes | Production strain | Bulk production | Formulation

OUR EXPERTS COVER THE WORLD TO SERVE YOU

27 nationalities in over **60** countries



North America	South America	Europe, Middle East, Africa	South East Asia Pacific	China
Ft. Lauderdale, FL (USA)	São Paulo (Brazil)	Darmstadt (Germany) Rajamäki (Finland)	Singapore (Singapore)	Shanghai (China)