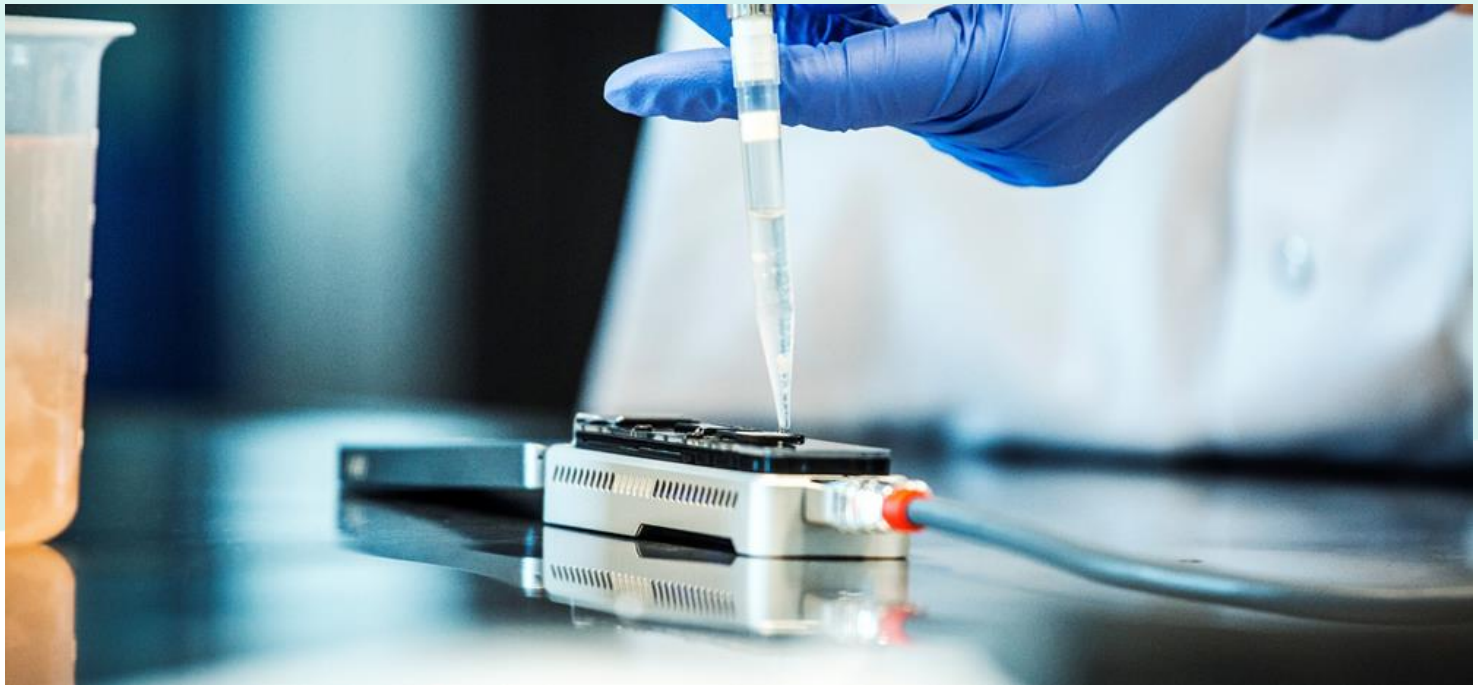
DNAPROKON

Reduce food waste by understanding your spoilers

The future of food production
26 October 2023



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DANISH TECHNOLOGICAL INSTITUTE

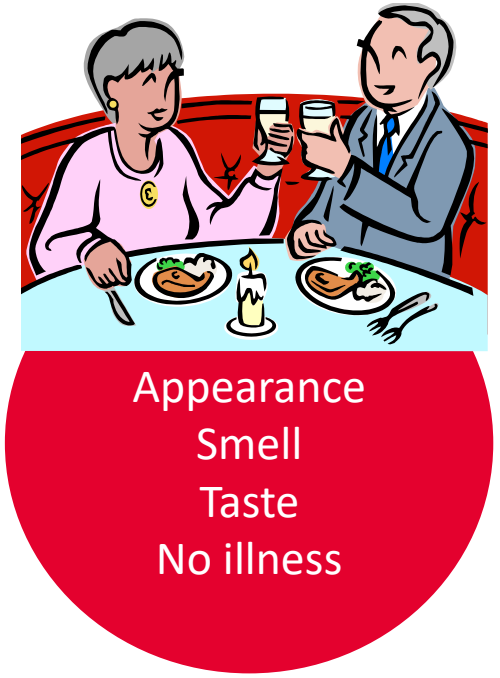
STRYHNS GRUPPEN

CATER FOOD
STOLTE SLAGTERTRADITIONER

ATRIA
Good food – better mood.

Reduce food waste

- Correct shelf life is key for sustainable food production
- Shelf life is affected by:
  - Oxidation (rancid e.g., fat)
  - Colour change (oxidation, enzymatic e.g., brown spots on meat, brown apple slice)
  - Microbiological activity (pathogens, spoilers)
  - Physical changes (too dry, too soft, freeze dry)
- How to improve?

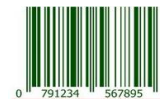


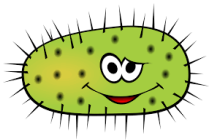
From agar plates to sequencing

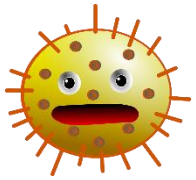
Processing
Storage

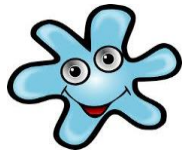
Days/weeks

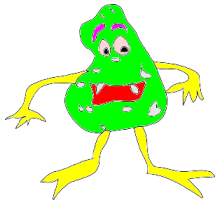
Hours

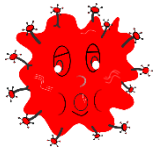


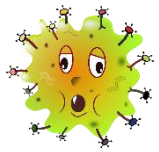










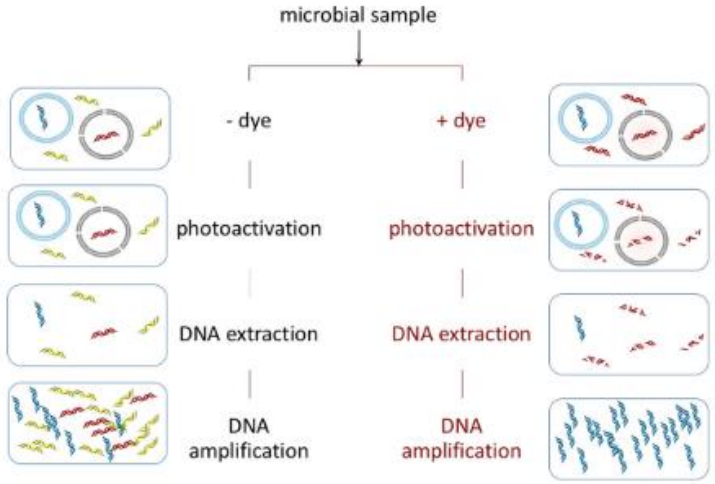


	Fresh				Spoilt				
Leuconostocaceae; Leuconostoc	10.91	2.17	2.63	0	99.88	99.84	99.82	99.93	99.9
Moraxellaceae; Acinetobacter	30.91	21.74	39.47	53.76	0	0	0	0	0
Burkholderiaceae; Burkholderia	16.36	41.3	15.79	6.45	0	0	0	0	0
Sneathiellaceae; Sneathiella	3.64	2.17	13.16	4.3	0	0	0	0	0
Hyphomicrobiaceae; Filomicrobium	5.45	2.17	0	4.3	0	0	0	0	0
Rhodobiaceae; Methyloceanibacter	1.82	2.17	2.63	2.15	0	0	0	0	0
Corynebacteriaceae; Corynebacterium	1.82	0	5.26	4.3	0	0	0	0	0
Bacillales_Incertae_Sedis_XII; Exiguobacterium	3.64	0	2.63	0	0	0	0	0	0
Desulfobacteraceae; Desulfobacter	0	8.7	0	1.08	0	0	0	0	0
Aeromonadaceae; Aeromonas	0	2.17	0	1.08	0	0	0.09	0	0

Food innovation for the future

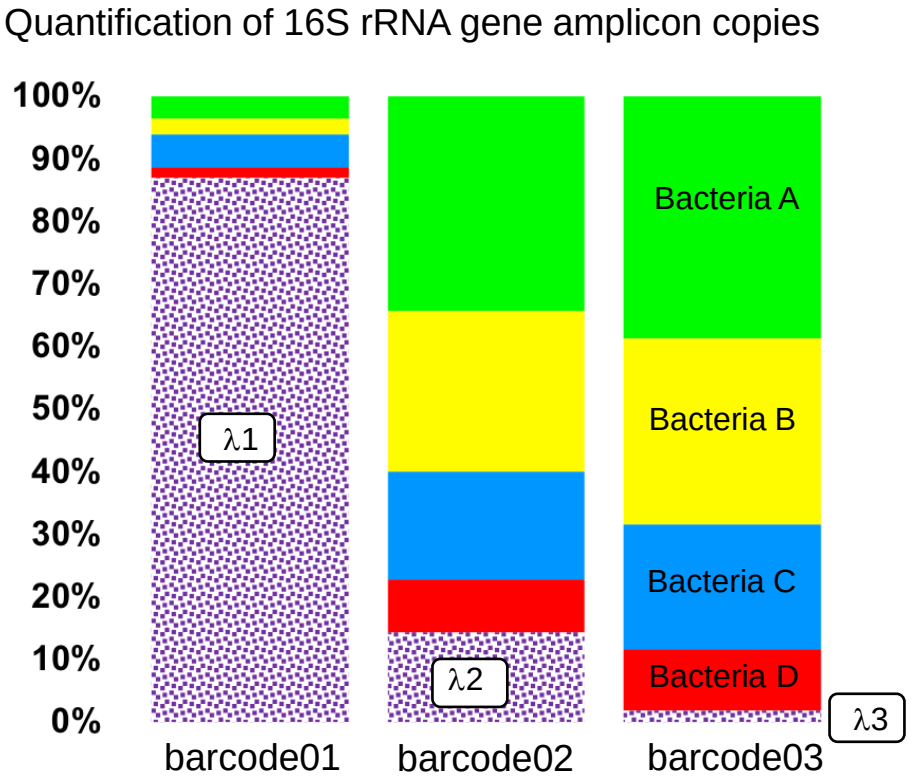
High throughput sequencing made portable and quantitative

- DNA from dead bacterial cells – a challenge
  - DNA is very stable
  - Bacteria is inactivated during processing
    - heat treatment, fermentation, etc.
  - Only live cells will grow and potentially spoil the product
- Several methods tested to distinguish between live and dead cells
- Treating with propidium monoazide followed by photo-activation



High throughput sequencing made portable and quantitative

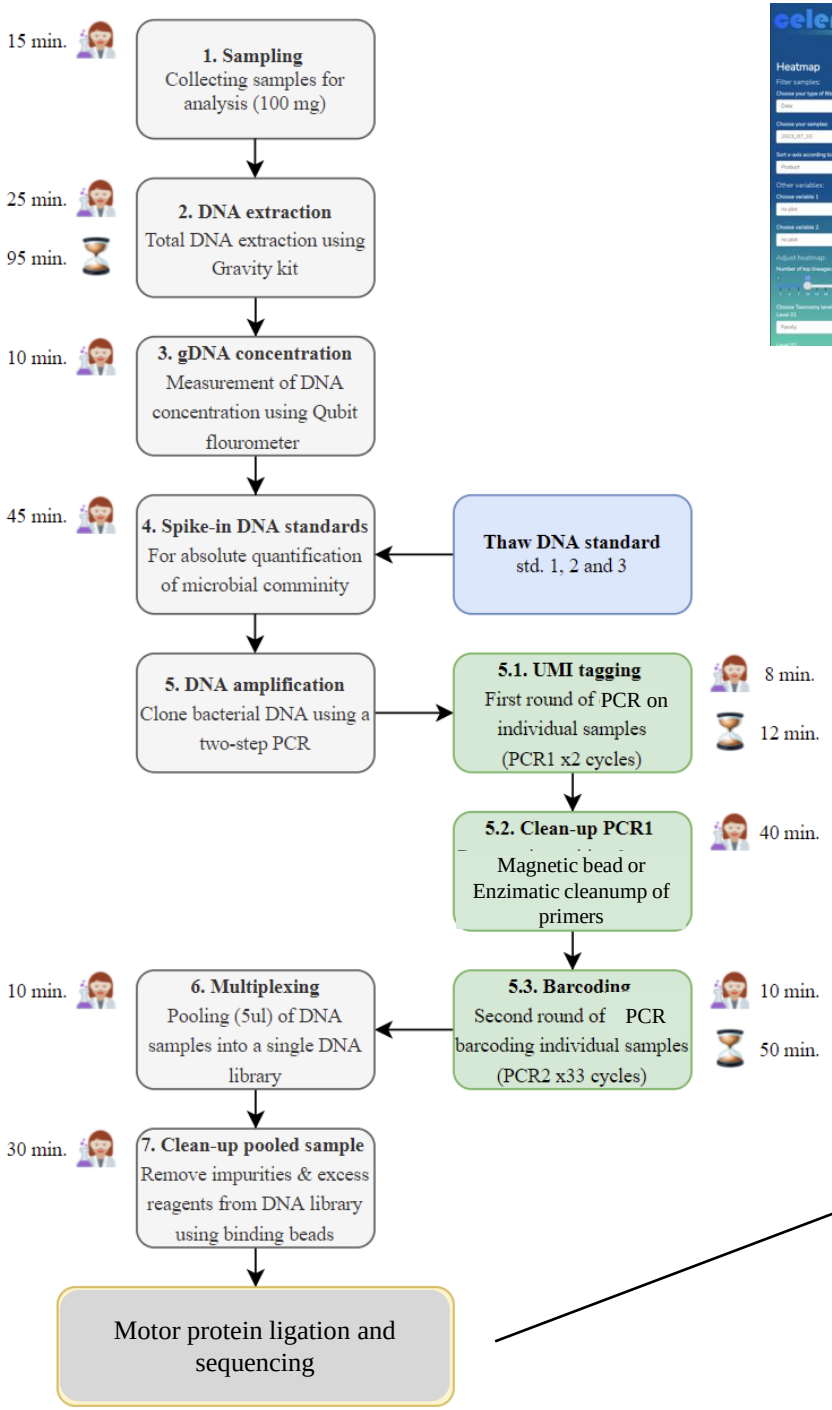
- Today:
  - Quantification is only based on relative bacterial abundance
- The need:
  - Qualitative data
- We developed a method:
  - Cheap, reproducible standard
  - Co-amplified with the ”bacteria” molecules for absolute quantification



Absolute count of 16S rRNA gene copies of bacterium B = aλ + b

The method

- Rapid turnover
  - less than one workday
  - reduced hands-on time and waiting time
- From sample to start of sequencing in less than 6 hours
- Live base-calling = immediate results (but can run overnight)



Coupled with CelerSeq developed by DTI. Live visualization of results

Live base-calling and taxonomy assignment using novel bioinforma-tics tool “NART”

Food innovation for the future

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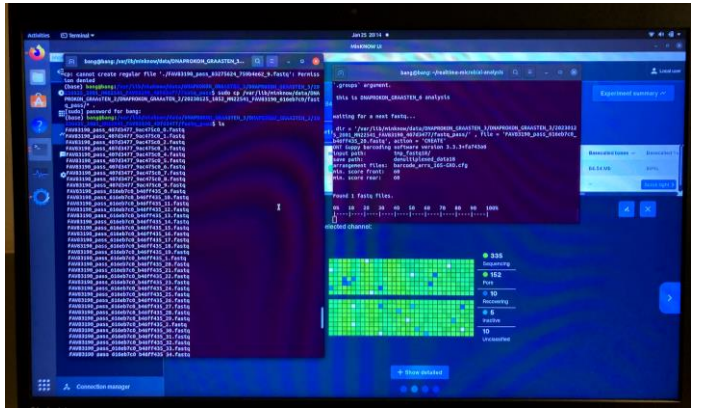
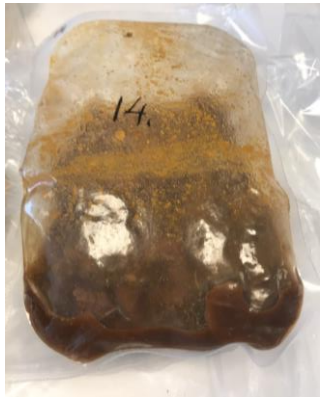
Test at companies – fast & robust but much hands-on

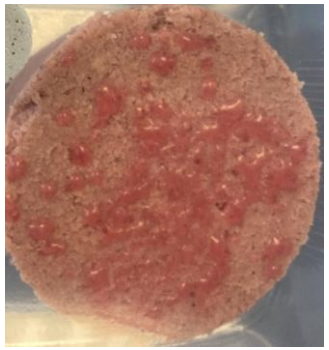


Examples of spoilage

- **Gas production**
  - *Leuconostoc: carnosum, mesenteroides*
  - *Lactobacillus: brevis, alimentarius*
  - *Clostridium estherteticum*
- **Discolouration:**
  - *Leusconostoc gelidum*
  - *Pseudomonas libanensis*
- **Bad smell**
  - *Brochotrix thermospachta*
  - *Clostridium* sp.








Pathogens and toxins: not visible no smell and no taste

Spoilage is caused by different bacteria

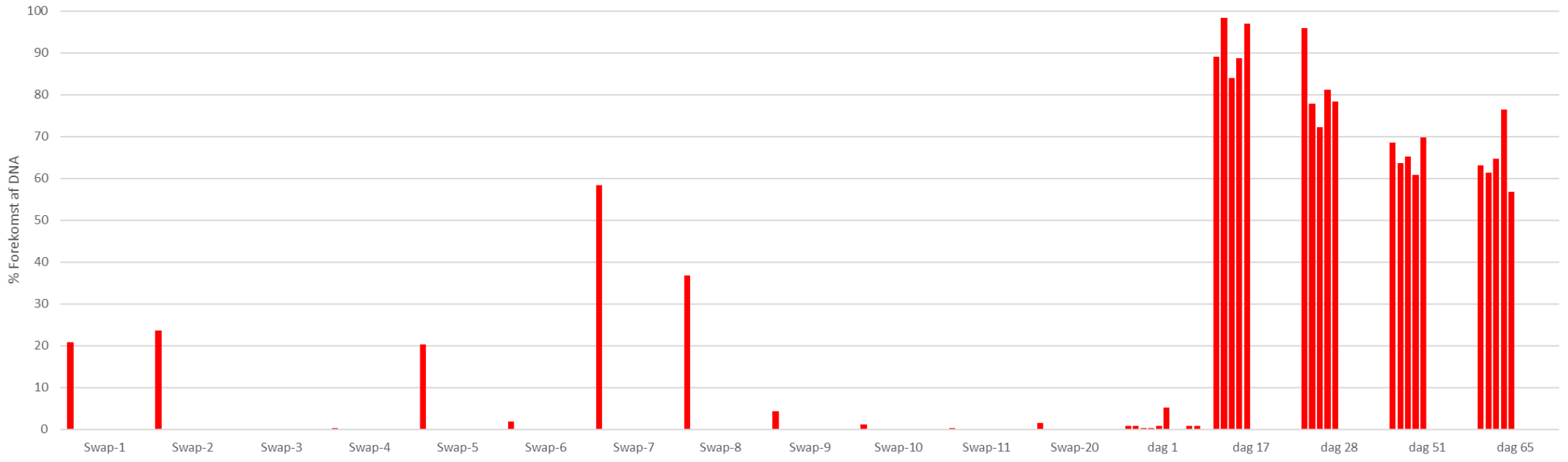
- **Veggie products:**
  - *Leuconostoc:*
    - *mesenteroides, gelidum*
  - *Lactococcus*
  - *Lactobacillus:*
    - *sakei, parabuchnerii*
  - *Carnobacterium*
  - *Pseudomonas fragi*
  - *Bacillus*
  - *Pantoaea agglomerans*
  - others
- **Meat products:**
  - *Leuconostoc:*
    - *carnosum, mesenteroides, gelidum*
  - *Lactobacillus:*
    - *brevis, paraalimentarius, curvatus, sakei,*
  - *Carnobacterium*
  - *Pseudomonas libanensis*
  - *Brochotrix thermospachta*
  - *Clostridium:*
    - *Estherteticum, bowmani*
  - others

Results for troubleshooting and proces control

- **Troubleshooting:**
  - Identify the spoiler(s)
  - Corrective actions:
    - Hygiene, Preservation, raw material, or?
- **Process control**:
  - Combine identification with:
    - Suppliers, raw material, ingredients, hygiene, changes over time, specific sites in the process line, etc.

Finding critical places in the production line

- The spoiler dominate the product after 17 days
- Only few detected at day 1
- Detected at several places on the production line



Reducing food loss at B2B level

Food waste in Denmark is appr. **814.000 ton eadable food/year** (Miljøstyrelsen 2021).

We have looked into **barriers and drivers** for reducing food waste among **canteens, small industrial production facilities, and restaurants**

Value chain role	Estimated food waste tonnes/year (MST 2021)
Primary production	44.000
Food industry	385.000
Retail and wholesale	**96.000**
Restaurants	**42.000**
Households ***TOTAL:***	247.000 ***814.000***

Suggestions from B2B on how to reduce food waste

COMPANY CANTEENS

- **PLANNING** the menu is everything!
- Use smaller plates
- Discuss how to use **leftovers**
- Keep a **constant** focus on food waste - it's money saved!
- Design the buffet smart (expensive food at the end - meat, bread, warm dishes)
- Sell excess food to employees

Some years ago, we reduced the size of the plates by 2 cm. This reduced our meat consumption from appr. 210-240 kg meat/day to 140-150 kg. And we had much less waste

COMMERCIAL KITCHENS

PLANNING the menu is everything!

Know your customers

Talk every day about how to use **leftovers** in new creative ways

Make arrangements with local NGOs to pick up excess food

Share knowledge

Have an **overview** in practice, not just from the PC, that includes frozen food and dry goods

RESTAURANTS

PLAN your menu wisely

Inform customers about their food waste - and your efforts

Use the creativity among the skilled chefs and the other employees for new recipes based on **excess food**

Stay focused on food waste - it's **money saved**!

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Best advice from the chef:

“Start selling excess food to company employees”

Take home message

- DNA sequencing is fast track to identify your spoiler (several days ⟶ 1 day)
- Easy to put a “name” on the bacteria
  - Important to the customers complaining (fx not dangerous bacteria)
- Controlling your process – fermentation, recontamination etc.
- Knowing the spoilers makes it easier to optimize preservation and avoid food spoilage (product development)
- Knowing routes of contamination improve the chance to fight the problem
- Reduce food loss

The future of food production
26 October 2023

DNAPROKON

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- Green Development and Demonstration Programme (GUDP), Danish Agricultural Agency in the Ministry of Food, Agriculture and Fisheries;
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- Danish Pig Levy Foundation

Questions ?