



**TASTE  
CAN BUILD  
A BRIDGE**

# CULTURES AND PHAGES

**IRMA VAN RIJSWIJCK, SCIENTIST BACTERIOPHAGES**



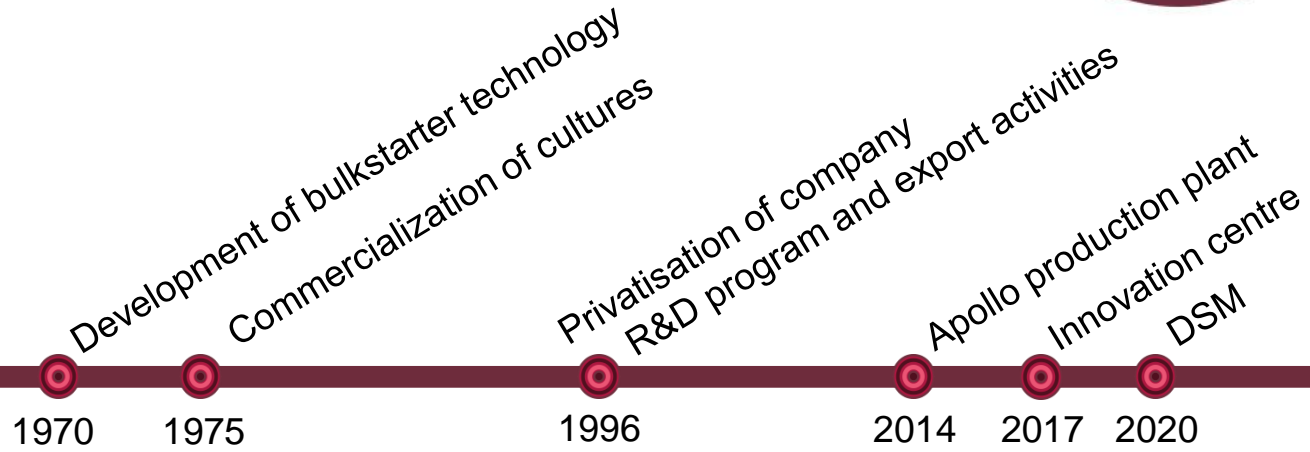
# CULTURES



## History



Traditional backslopping



- + Taste
- + Phage robust
- Consistent product



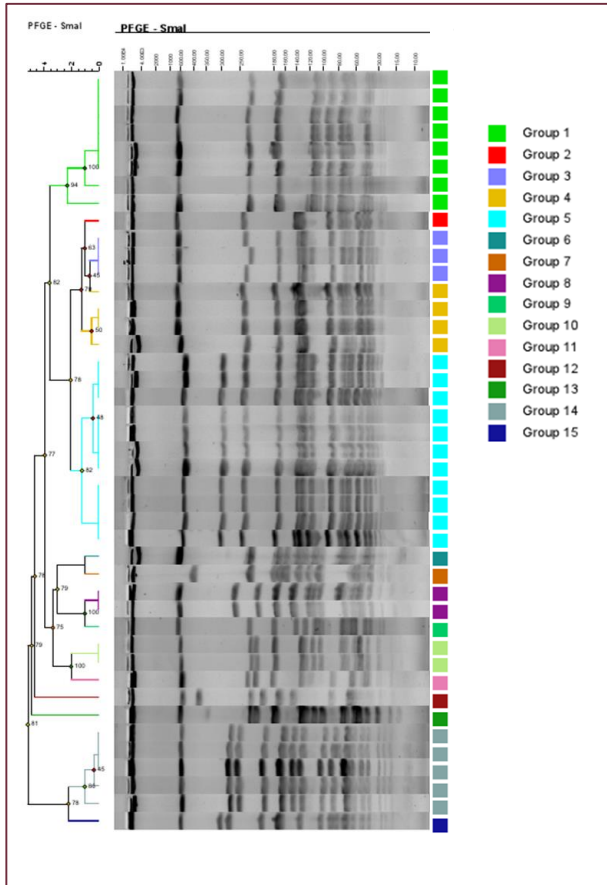
- ++ Taste
- ++ Phage robust
- ++ Consistent product



# CULTURES



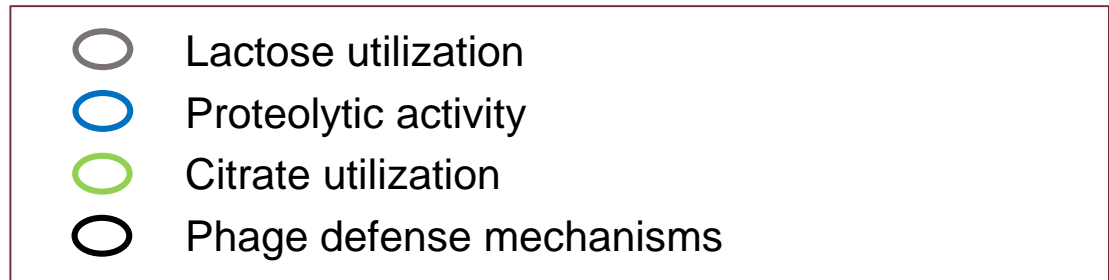
## Microbial community



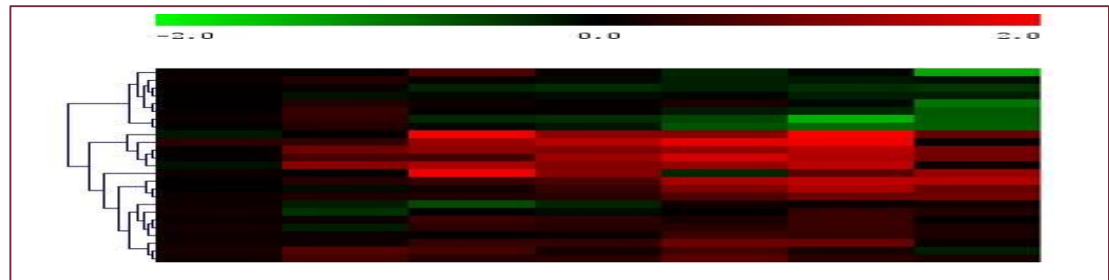
Genomic diversity



Taxonomic diversity



Plasmid diversity



Gene expression

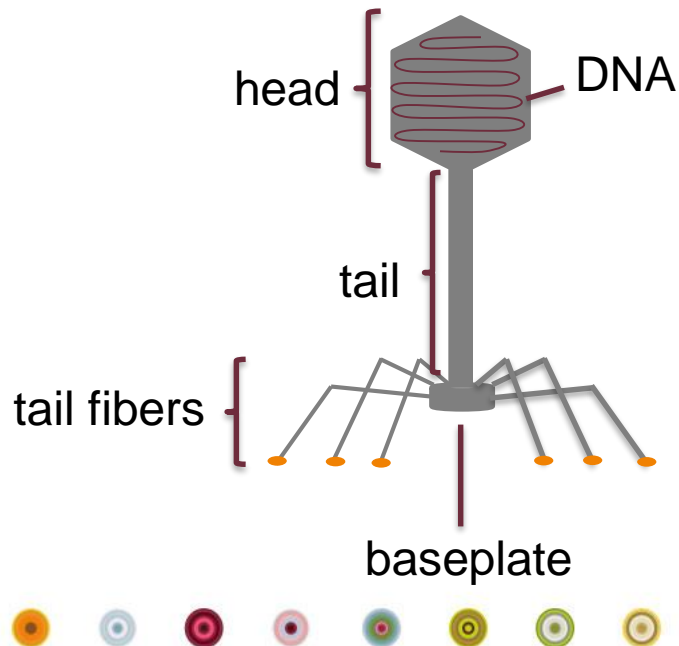
Diversity as result of decades of evolution

# BACTERIOPHAGES



## Dairy

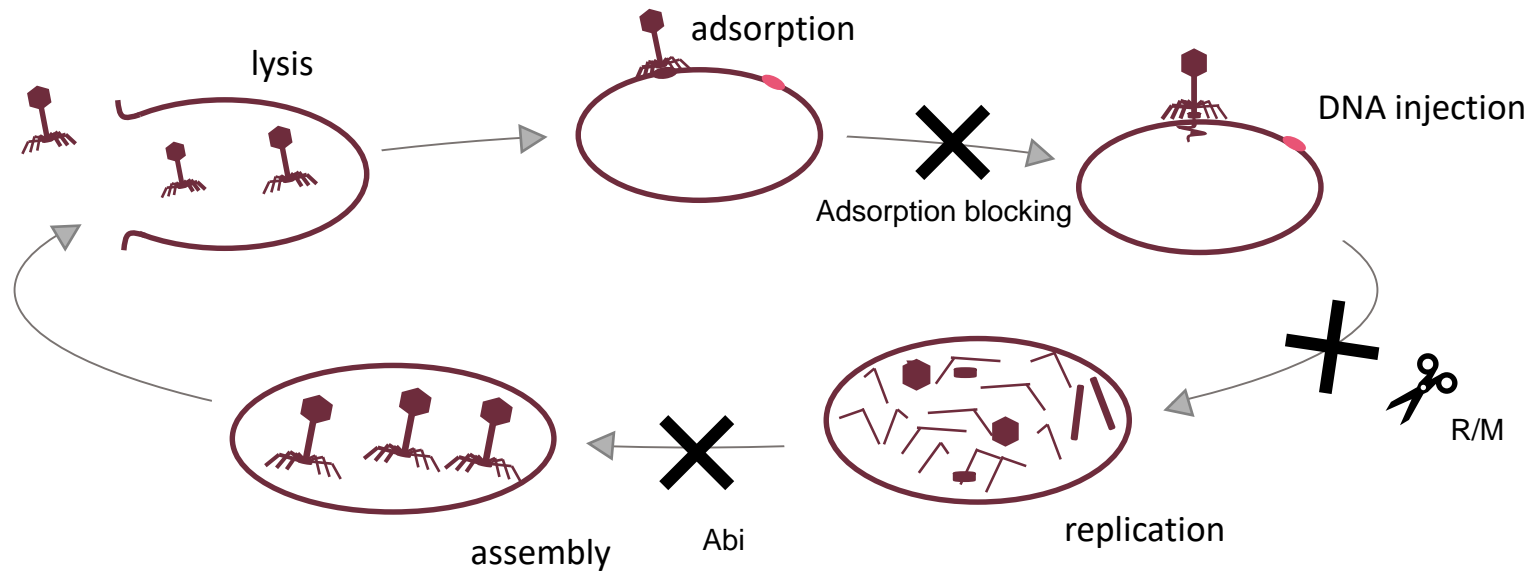
- ⦿ Viruses that infect bacteria
- ⦿ Out rule bacteria 10 times
- ⦿ Omnipresent: raw milk and survive pasteurization



# BACTERIOPHAGES



## Lytic infection cycle

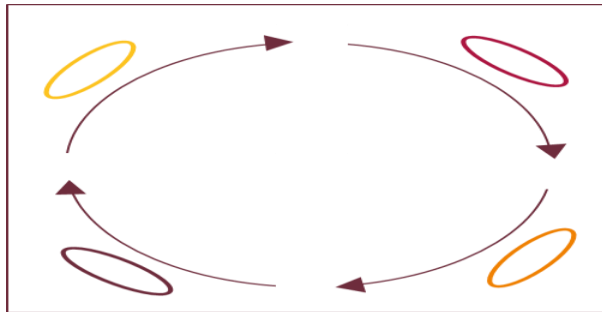


# BACTERIOPHAGES



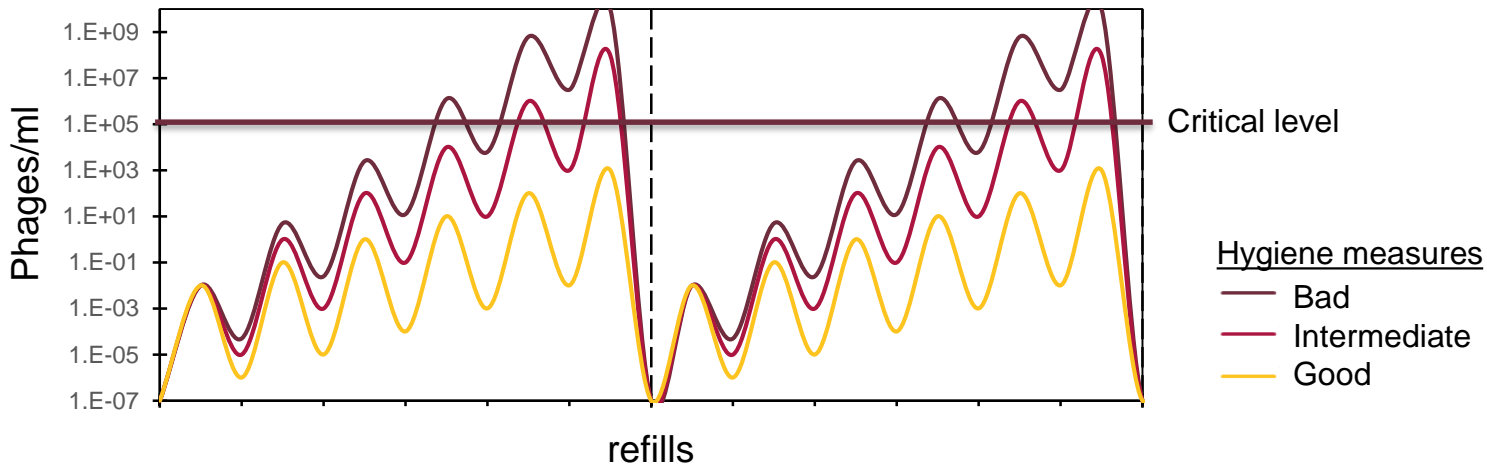
## Control phage infections

Rotation system

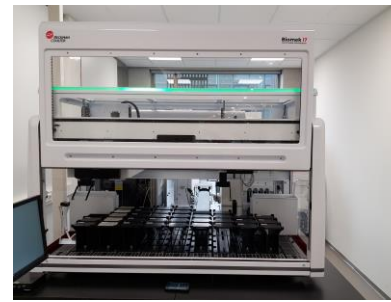


Phage – host relations

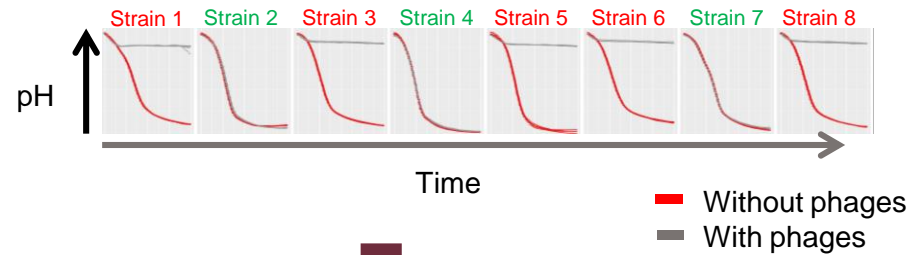
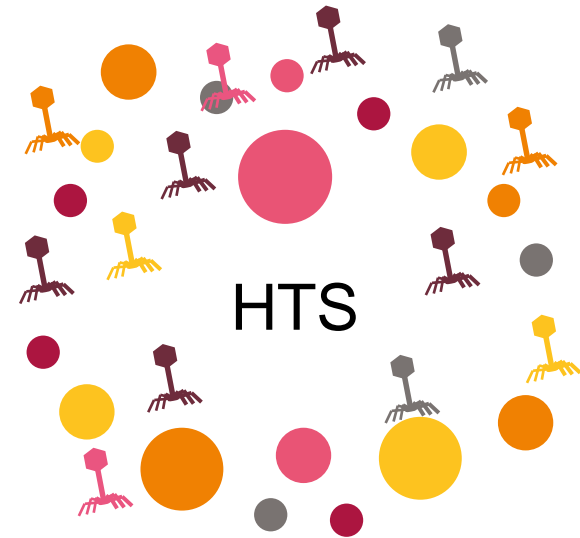
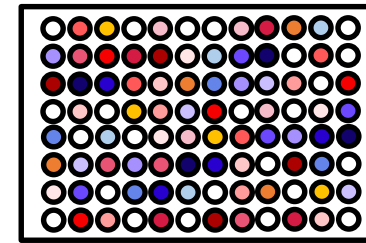
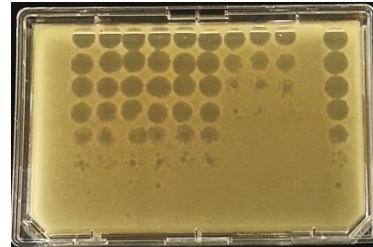
	$\Phi 1$	$\Phi 2$	$\Phi 3$	$\Phi 4$
Strain 1	+	+	+	+
Strain 2	-	-	-	+
Strain 3	+	+	-	-
Strain 4	-	-	-	-
Strain 5	-	-	-	-



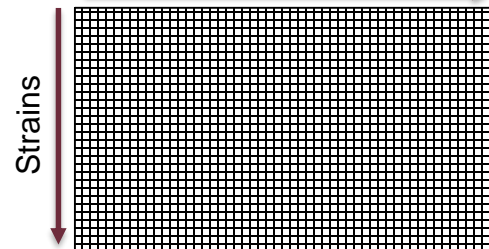
# PHAGE STRATEGY



Defined cultures



Phages



# PHAGE STRATEGY



Defined cultures



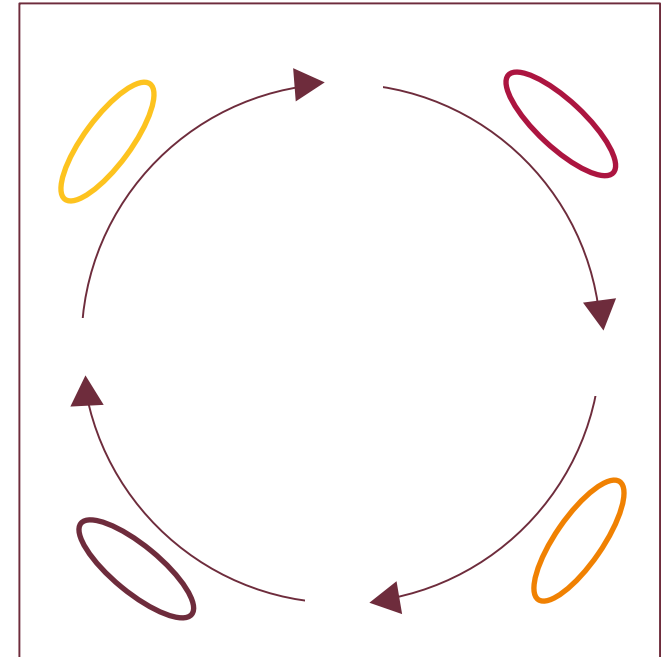
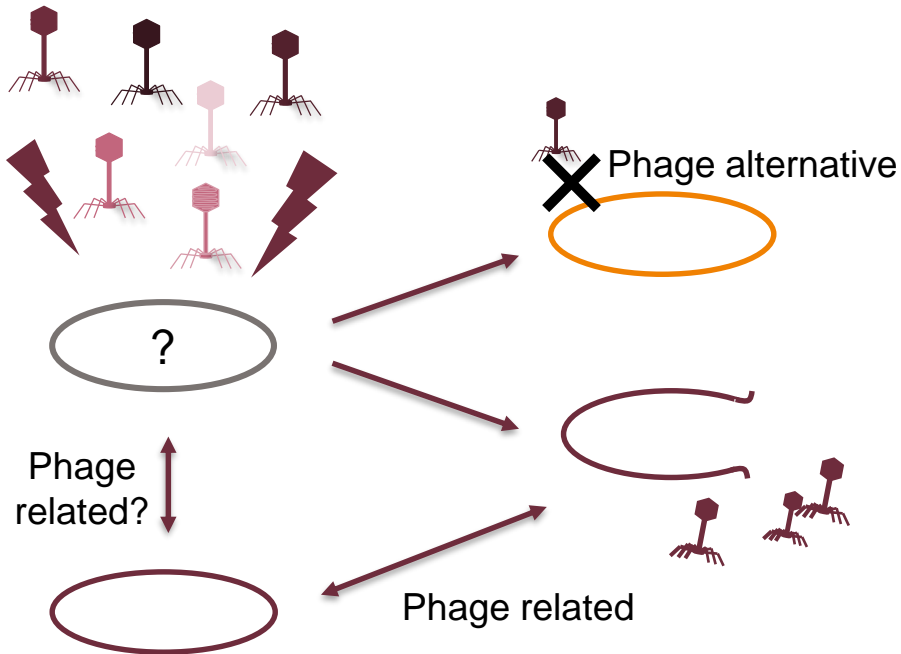


# PHAGE STRATEGY



## Provoke phage evolution

Extreme phage pressure  
Multiple generations



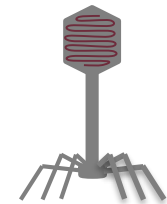
Rotation system design



# TRADITIONAL CULTURES



- Decades of evolution in dairy driven by
  - Utilization of (raw) milk
    - Lactose utilization
    - Proteolytic activity
  - Population dynamics
    - Growth rate
    - Synergy
    - Bacteriophages



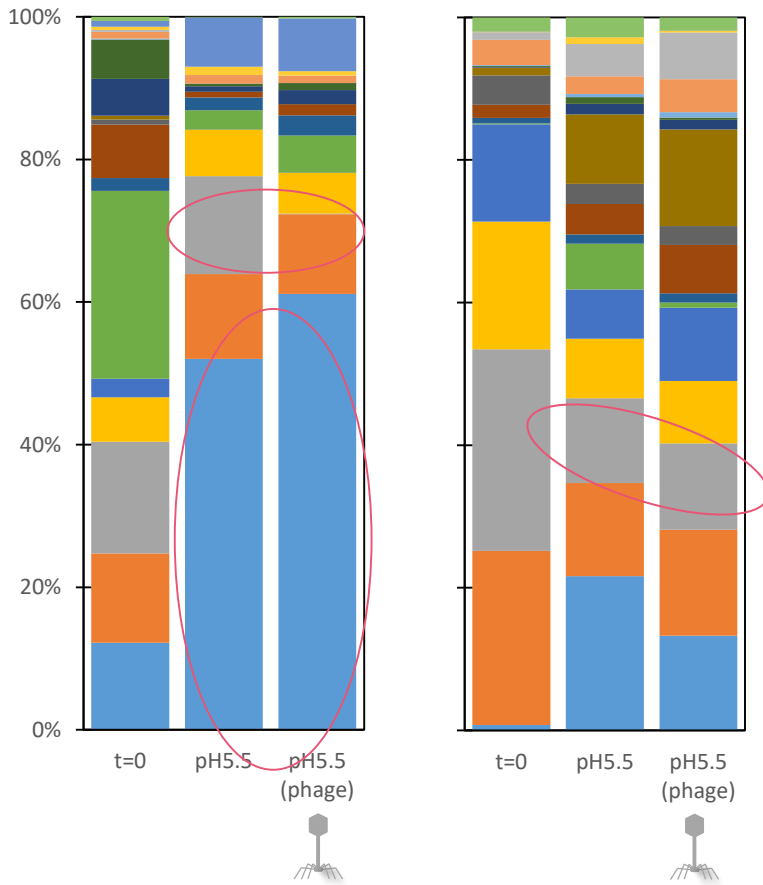
# TRADITIONAL CULTURE



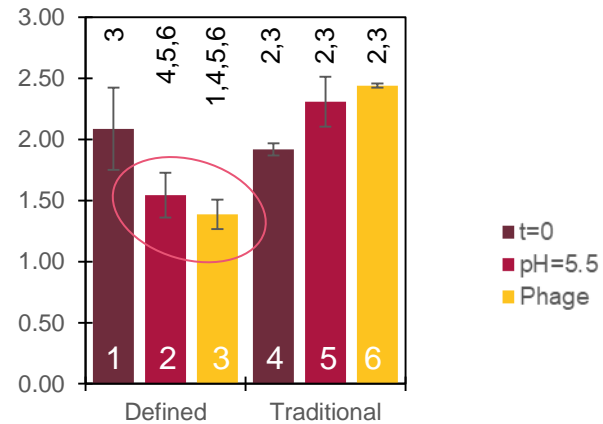
## Defined vs Traditional culture

Defined

Traditional



Shannon index



## Traditional culture

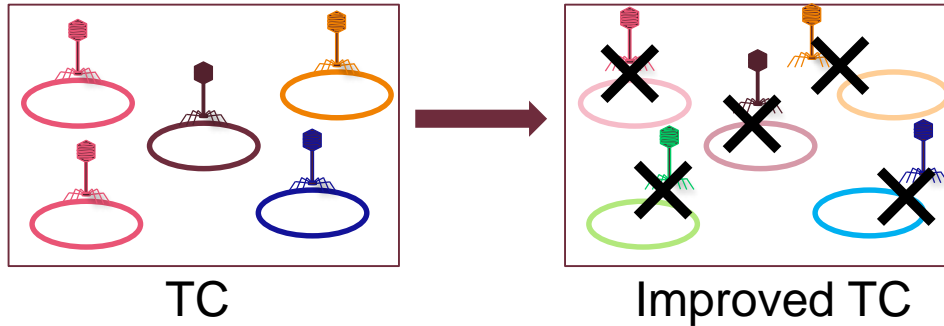
- Shannon index >2
- No impact phage infection

OTU\_1  
OTU\_2  
OTU\_3  
OTU\_4  
OTU\_5  
OTU\_6  
OTU\_7  
OTU\_8  
OTU\_9  
OTU\_10  
OTU\_11  
OTU\_12  
OTU\_15  
OTU\_24  
OTU\_40  
OTU\_43  
OTU\_44  
Other

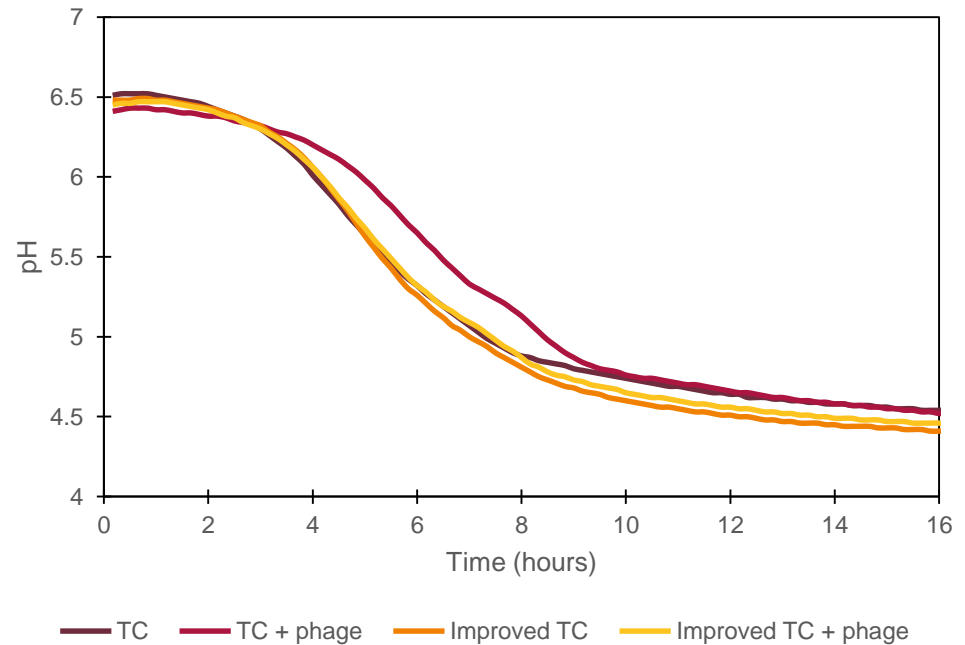
# PHAGE STRATEGY



## Traditional cultures



- Challenge the culture under extreme phage pressure
- Improved phage robustness
  - Maintaining complexity
  - Maintaining performance



# PHAGE STRATEGY



## Traditional cultures

		Phages																				
TC1	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	+	+	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
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TC2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
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TC3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
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- Phage alternative tradition cultures



# CULTURES AND PHAGES



- Phage strategy
  - Provoke phage evolution
  - Unravel phage – host relationships
  - Improve traditional cultures
- Decades of evolution has result in an enormous complexity
  - Subtypes with various phage sensitivity
  - Strain diversity maintained
  - Complex aroma bouquet



# ACKNOWLEDGMENTS



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