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SELECTIVE BREEDING OF TILAPIA: STATUS AND PROSPECTS

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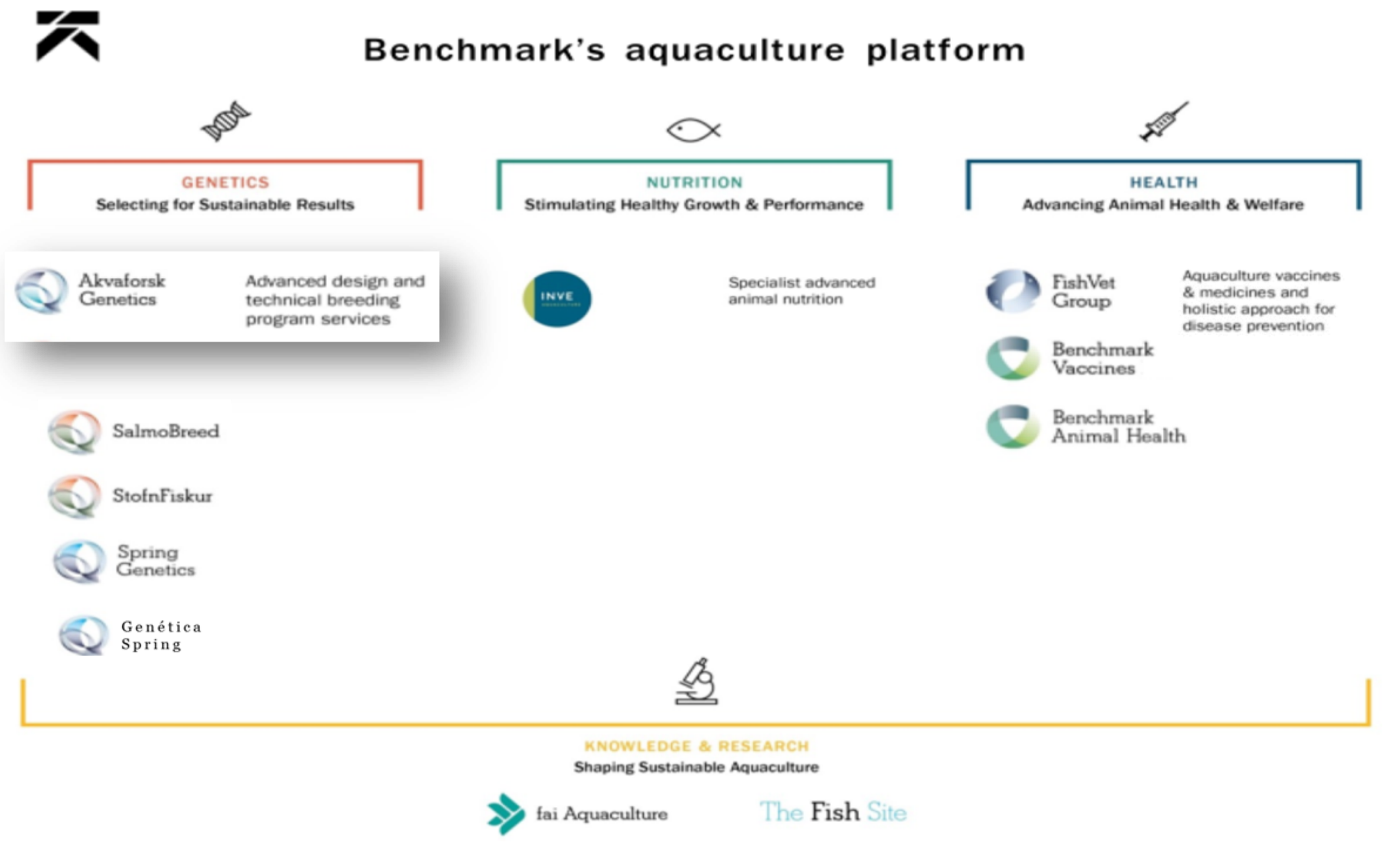
*Spring Genetics

A Benchmark Company

FENACAM 2016, Fortaleza Brazil



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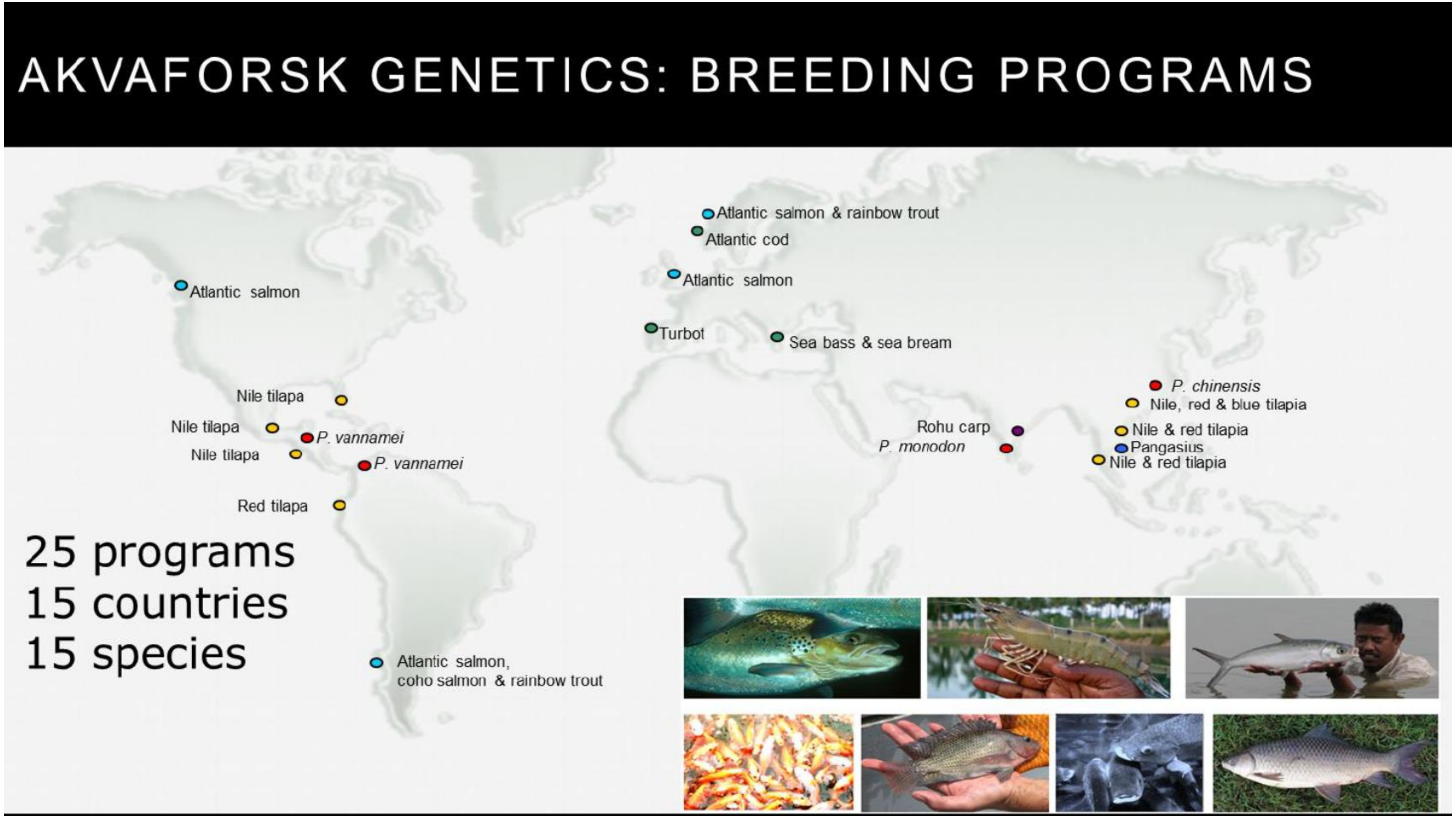
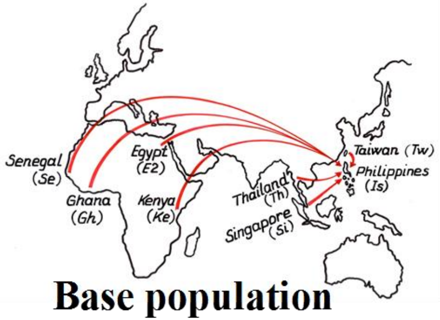

AKVAFORSK GENETICS: BREEDING PROGRAMS
Atlantic salmon & rainbow trout
Atlantic cod
Atlantic salmon
Atlantic salmon
Turbot
Sea bass & sea bream
P. chinensis
Nile, red & blue tilapia
Nile tilapia
Nile tilapia
P. vannamei
Nile tilapia
P. vannamei
Rohu carp
P. monodon
Nile & red tilapia
Pangasius
Nile & red tilapia
Red tilapia
25 programs
15 countries
15 species
Atlantic salmon,
coho salmon & rainbow trout

THE “GIFT-PROJECT” (1988-98)

GIFT

- technology transfer to genetically improve Nile tilapia, the Philippines
- technical support from AKVAFORSK



Gene-ration	Test environments (No. of replicates)							
	S1	S2	P1	P2	W2	C2	C4	RF
Base	1	1	2	2	1	1	1	
G1	1	1	2	2	1	1		
G2			2	2				
G3			2	2				
G4			2	2			1	
G5			2	2			1	1

Different growth environments

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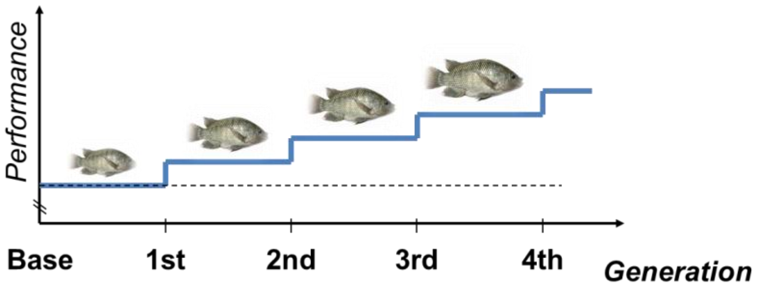
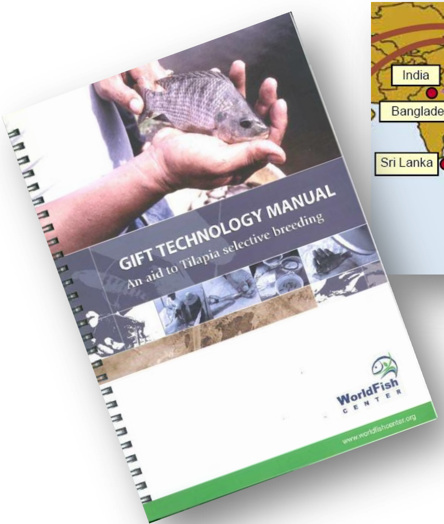
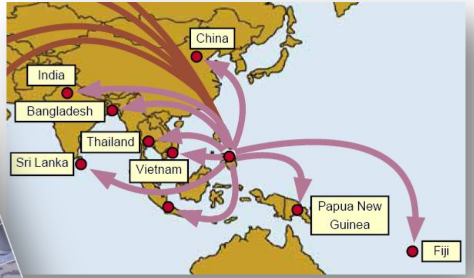
RESULTS FROM THE GIFT PROJECT

- demonstrated the great potential of selective breeding!
- genetically improved GIFT tilapia (G5: 88% larger harvest weight)
- GIFT technology (synchronized family production)







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TILAPIA BREEDING PROGRAMS

Species	Country	Institution *	Period	Selected generations
Nile tilapia	Philippines	G	1988-1997	5
	Vietnam	G	1999-2004	5 (5)
	Nicaragua	P	2004-2008	3 (5+5)
	China	P	2004-	12 (5+5)
	Thailand	P	2008-	9
	USA	P	2010-	4 (5+5+3)
Red tilapia	Ecuador	P	2004-2007	1
	China	P	2008-2014	5
	Thailand	P	2008-	9
Blue tilapia	China	P	2007-	8

* G – Governmental, P - Private

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TRAITS IN THE BREEDING OBJECTIVES

- Production efficiency
  - Growth
  - Survival
  - (Feed utilization)
  - (Fillet yield)

- Robustness
  - Growth/survival in different environments
  - Environmental challenge tests (temperature, salinity)
  - Specific disease tolerance/resistance

- Product quality
  - External color

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CURRENT STATUS

- Progift Aquaculture, China
- Manit Farm, Thailand
- Spring Genetics, US

PROGIFT AQUACULTURE, CHINA

- Nile tilapia (2004, G12)
  - base: GIFT (Vietnam)
- Blue tilapia (2007, G8)
  - base: Chinese & Vietnamese (US) stocks
- Red tilapia (2008, G5)
  - base: Chinese, Ecuadorian & Colombian stocks

Contents lists available at SciVerse ScienceDirect

Aquaculture

journal homepage: www.elsevier.com/locate/aqua-online

Genetic improvement of tilapias in China: Genetic parameters and selection responses in growth of Nile tilapia (*Oreochromis niloticus*) after six generations of multi-trait selection for growth and fillet yield

Jørn Thodesen (Da-Yong Ma) [a,*], Morten Rye [a], Yu-Xiang Wang [b], Kong-Song Yang [b], Hans B. Bentsen [c], Trygve Gjedrem [a,c]

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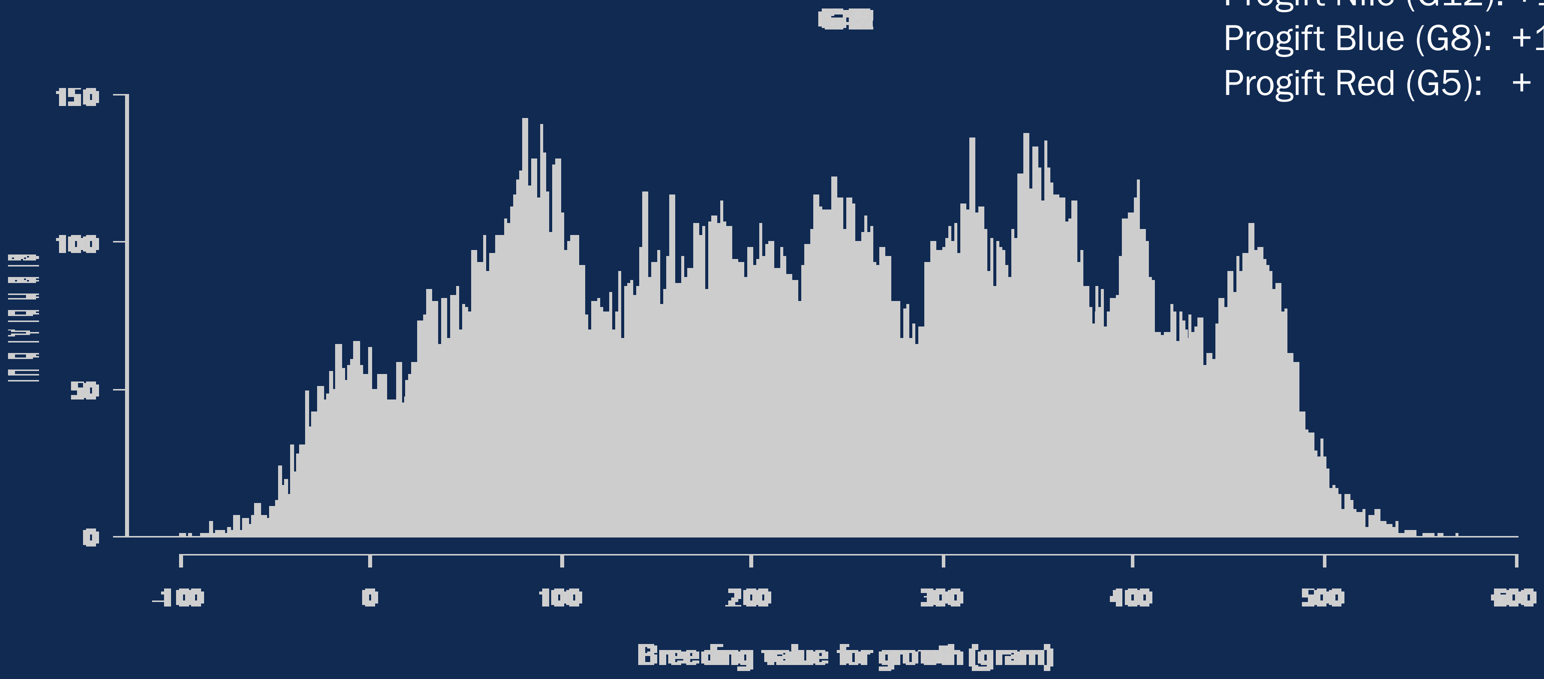
SELECTION RESPONSE - GROWTH

Progift Nile (G12): +130%
Progift Blue (G8): +140%
Progift Red (G5): + 70%



Selective breeding of tilapia: status and prospects (FENACAM 2016, Fortaleza)

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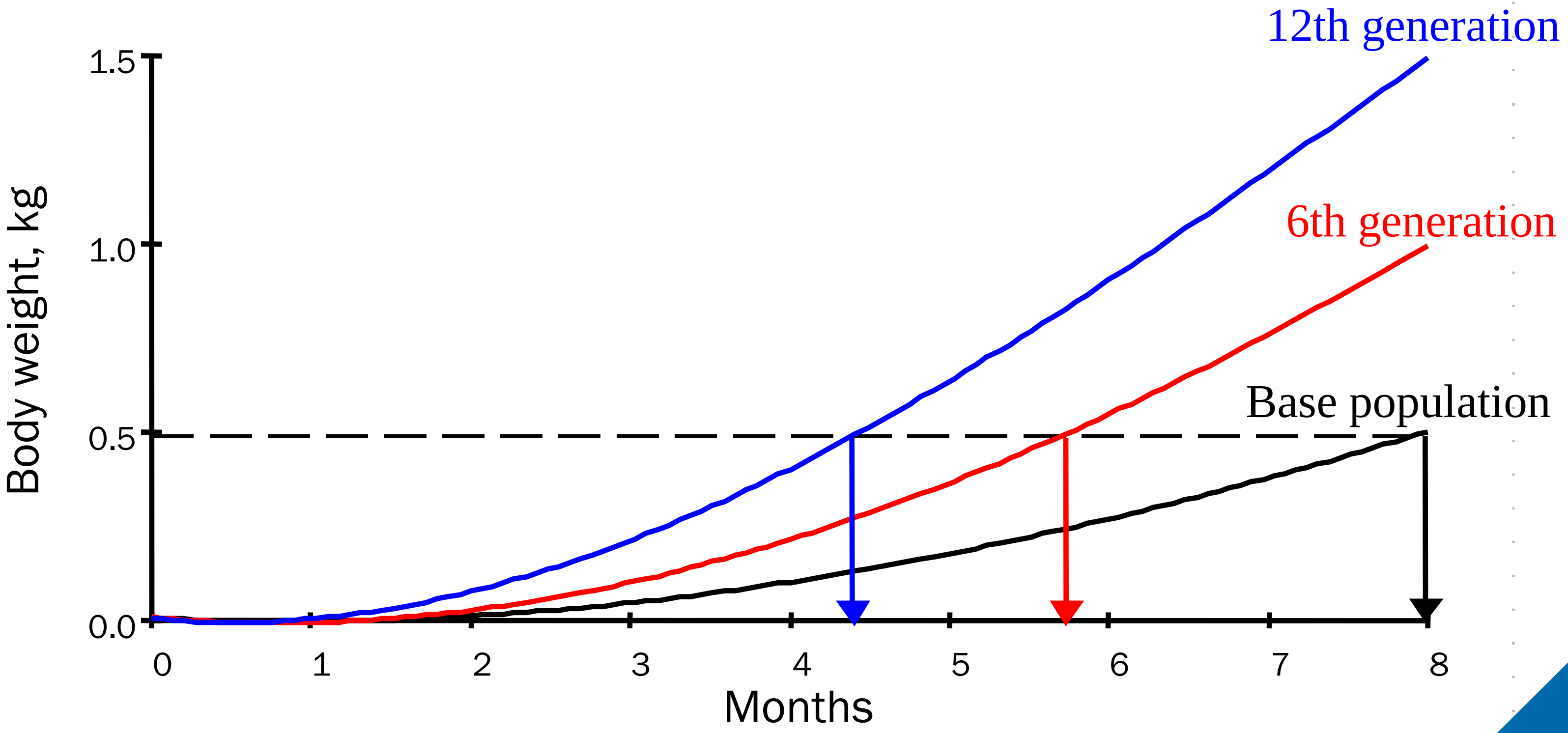
IMPLICATIONS OF FASTER GROWTH



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MANIT FARM, THAILAND

- Nile tilapia (2008, G9)
  - base: Thai stocks (some originated from GIFT)
- Red tilapia (2008, G9)
  - base: Thai & Latin-American stocks
- Strong focus on improving the robustness
  - testing in different grow-out environments
  - salinity challenge-tests

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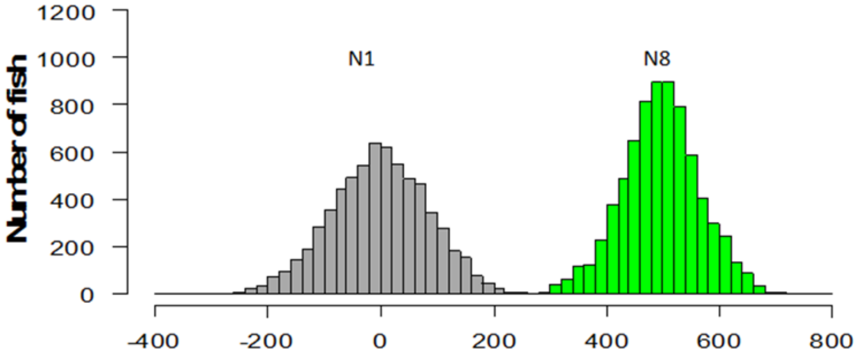
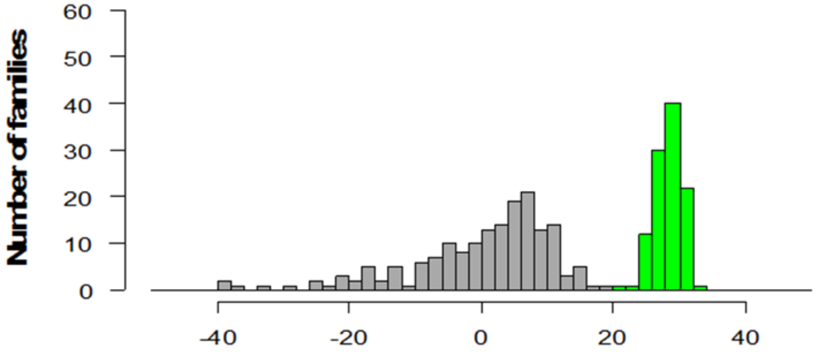
SELECTION RESPONSES – MANIT SUPER BLACK



Harvest weight



Survival

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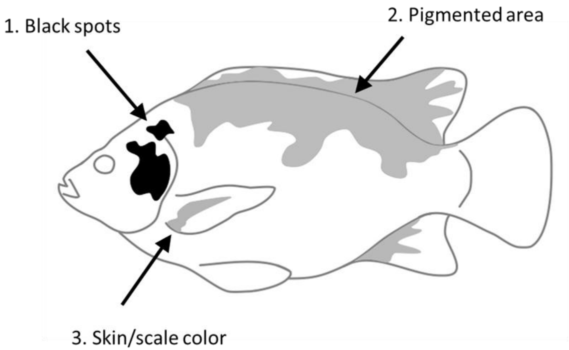
EXTERNAL COLOR – MANIT SUPER RED



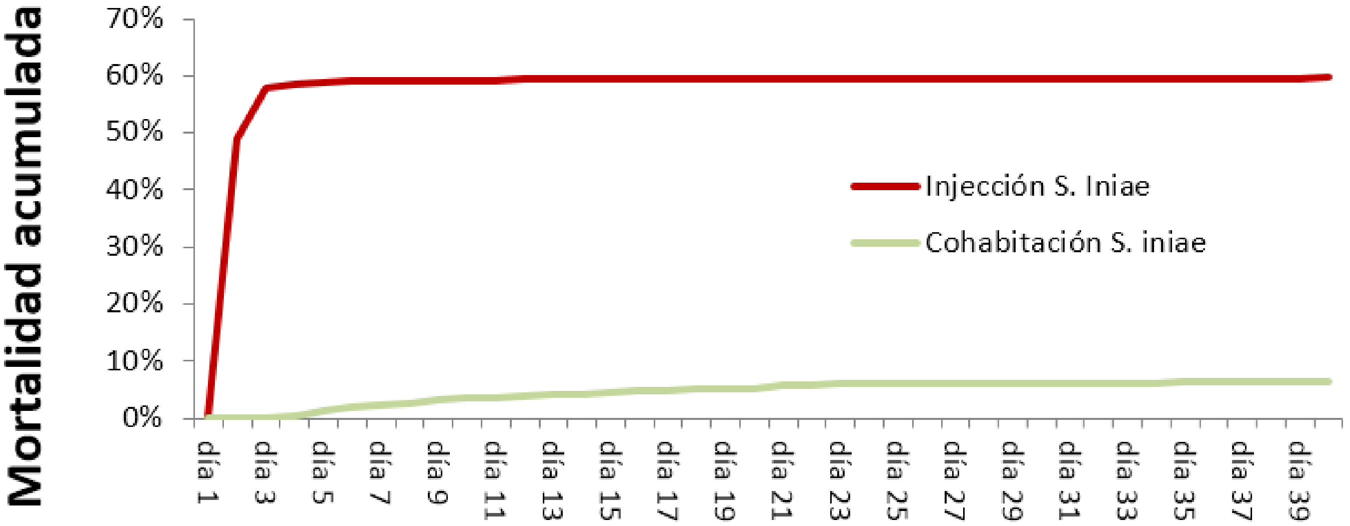
SPRING GENETICS, US

- Nile tilapia (2010, G4)
  - base GIFT (Vietnam → Nicaragua)
- "State of the art" tilapia breeding program
  - building on our Asian experience
- Strong focus on improving the robustness
  - resistance/tolerance *Streptococcus* sp.

PROSPECTS OF FURTHER DEVELOPMENT

- Breeding objective
  - Specific resistance/tolerance to diseases
- Selective breeding technology
  - MAS (based on QTL)
  - Genomic selection (use of medium density SNP micro-assay/chip)
- Testing and phenotypic recording

CHALLENGE - STREPTOCOCCUS



STREPTOCOCCUS RESISTANCE/TOLERANCE

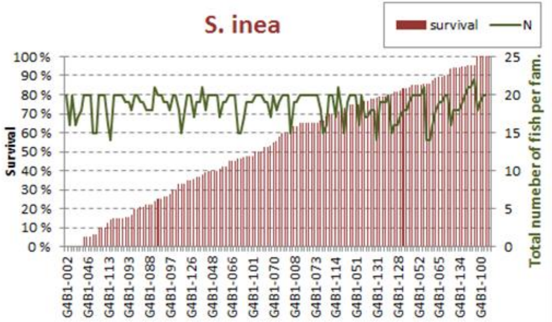


Figure 5. Mean family survival S. inea

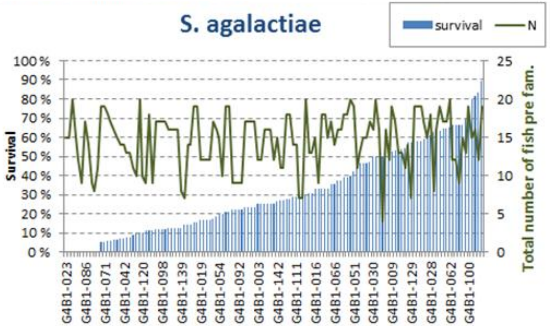


Figure 8. Mean family survival S. agalactiae

h^2 (bin) = 0.52 ± 0.12

r_G = - 0.30 ± 0.19

h^2 (bin) = 0.38 ± 0.11

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EFFECT OF SELECTION – *S. INIAE*

Table 1
Survival results for the families produced with assorative mating for high and low resistance to *Streptococcus iniae*.

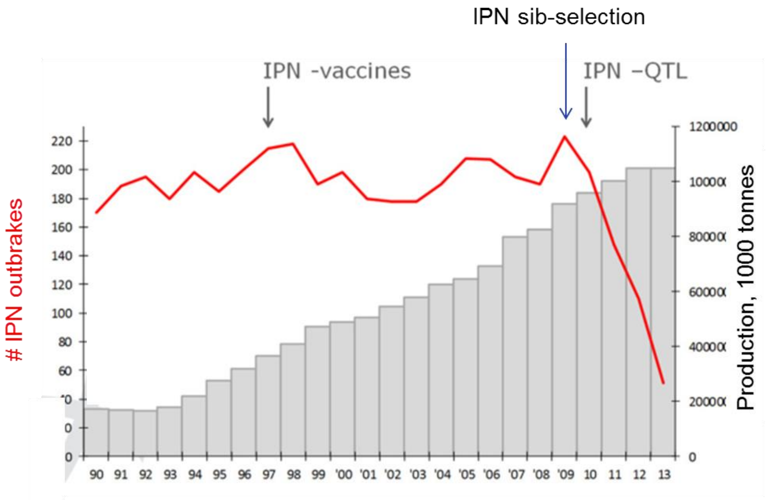
Assortative mating groups	Number of families	Avg_*S. iniae* index parents[a]	Percentage survival to *S. iniae* in 2015			Percentage survival to *S. agalactiae* in 2015		
			Average[b]	Min	Max	Average[c]	Min	Max
None	132	101.6	54	0	100	31	0	89
Yes_high	6	121.9	88	60	100	19	7	50
Yes_low	6	80.2	10	0	42	40	18	59
Total	144							

[a] Index (mean = 100, sd = 10). Avg = (sire index + dam index)/2.
[b] Mean family survival to *S. iniae* during challenge test.
[c] Mean family survival to *S. agalactiae* during challenge test.

Shoemaker *et al*., 2017

MARKER-ASSISTED SELECTION (MAS)

- Advantage: individual selection for "family-traits"
- IPN-QTL (in Atlantic salmon)
    - unique example – "easy" MAS
    - explained ~90% of genetic variation
- MAS for PD (in Atlantic salmon)
    - uses >40 informative SNPs
    - explains <15% of genetic variation



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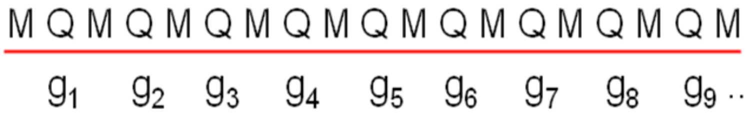
GENOMIC SELECTION

- MAS for polygenic traits requires many markers!
- Alternatively, select based on genomic breeding values
  - trace all segments of the genome with SNP markers
  - divide genome into chromosome segments (based on marker intervals)
  - predict genomic breeding values
    (as the sum of effects over all chromosome segments)



$$\mathbf{GEBV} = \sum_{i}^{p} \mathbf{X}_i \hat{\mathbf{g}}_i$$

# of chromosome segments

RECORDING OF PHENOTYPIC DATA

- Selective breeding requires high-quality phenotypic data!
  - more advanced tools for genetic analyses cannot compensate for poorly recorded data
  - even more important for genomic selection (used as "training population")

- Should develop new technologies and test regimes
  - direct selection for better feed efficiency?


Aquaculture
www.elsevier.nl/locate/aqua-online
Aquaculture 180 (1999) 237–246
ELSEVIER

Feed intake, growth and feed utilization of offspring from wild and selected Atlantic salmon (*Salmo salar*)

Jørn Thodesen, Barbara Grisdale-Helland *, Ståle J. Helland, Bjarne Gjerde

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Accepted 26 April 1999

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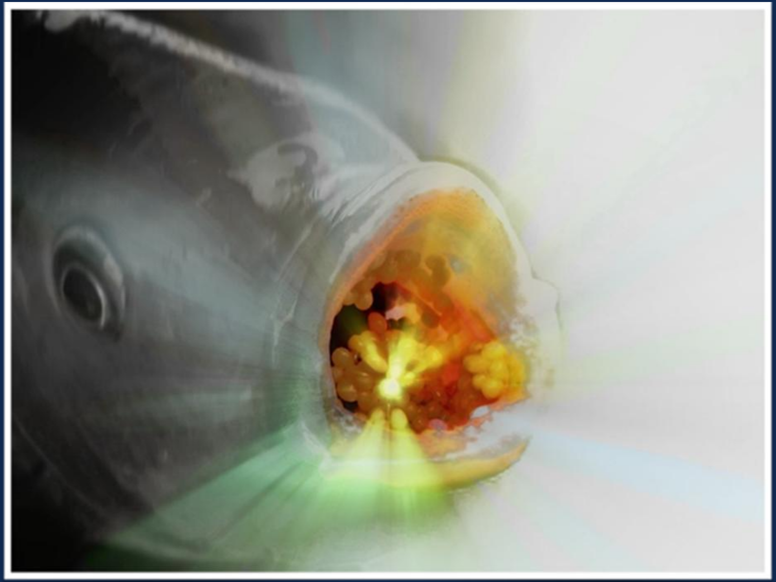
THANKS!



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