GENÉTICA SPRING’S (GS) BREEDING PROGRAM
INTRODUCTION

Benchmark’s aquaculture business
SUMMARY

- 2000:
  - Benchmark Holdings plc
- 2004:
  - Fish Vet Group
- 2014:
  - SalmoBreed
  - Stofnfishur
- 2015:
  - AkvaForsk Genetics
  - Spring Genetics
- 2015:
  - INVE
- 2016:
  - Genética Spring - CENIACUA
Providing an integrated aquaculture solution for our customers across all of the major farmed species.
BENCHMARK
AQUACULTURE BUSINESS

Operations in 27 countries

- R&D facilities and farms
- Diagnostic laboratories
- Commercial services
- Manufacturing/production
AKVAFORSK GENETICS
CONTRACT RESEARCH AND
GENETICS PROGRAMS

25 applied programs in 15 countries

- Atlantic salmon
- Nile tilapia
- Red tilapia
- Nile, red & blue tilapia
- Nile & red tilapia
- *P. vannamei*
- Turbot
- Atlantic salmon, coho salmon and rainbow trout
- Atlantic salmon & rainbow trout
- Atlantic cod
- Sea bass & sea bream
- Rohu carp
- *P. monodon*
- *P. chinensis*
- Pangasius
CENIACUA
- *P. vannamei* breeding program
- Established in 1997
  - For the Colombia farming industry

BENCHMARK
- Acquired the shrimp breeding programs from CENIACUA in 2016
- Genética Spring company is formed
- Developing breeding lines for the global shrimp industry
GENÉTICA SPRING’S (GS) BREEDING PROGRAM

A TALE OF TWO BREEDING PROGRAMS
Specific Pathogen Free SPF

- Free of **LISTED** diseases
  - not free of all diseases
- SPF status linked with the facility
  - not heritable
- Can be disease resistant (SPR) or not
OIE SPF STANDARD LIST

Virus
- TSV
- WSSV
- YHV/GAV/LOV
- IHHNV
- BP
- MBV
- BMN
- HPV
- IMNV

Other pathogens
- AHPND
- NHP

EHP?
DEVELOPMENT OF SPF SHRIMP

F₀
Primary Quarantine
PCR testing 3 times 60 samples
3 weeks interval

F₀
Secondary Quarantine
Maturation
Produce F₁

F₁
Secondary Quarantine
PCR testing 3 times 60 samples after PL-5
3 weeks interval

F₀ - Destroyed
F₁ - SPF enters NBC

SURVEILLANCE SPF SHRIMP/FACILITY

NBC
First year
PCR testing every 3 months
60 samples

NBC
Second year on
PCR testing every 6 months
30 samples
**Specific Pathogen Resistant SPR**

- Resistant to one or more specific pathogen
- Can be SPF or not
- SPR status is heritable
DEVELOPMENT OF SPR

- **SPF**
  - Family
    - Challenge test siblings
    - Family and Individual
    - Challenge test siblings
  - Genomic selection individuals

- **Non-SPF**
  - Mass selection
  - Control inbreeding through DNA finger printing
LINE AND FAMILY CONCEPT

- Line (or strain):
  - Group of families with one or more common characteristic such as:
    - WSSV resistant
    - Fast growing

- Family:
  - Shrimps originated from one individual spawn
    - One male crossed with one female
GENÉTICA SPRING’S (GS) BREEDING PROGRAM

A TALE OF TWO BREEDING PROGRAMS
A TALE OF TWO BREEDING PROGRAMS

Atlantic breeding program
- 1997: Between and within-family selection
- Selected for:
  - Resistance to TSV, NHP and Vibriosis
  - General pond survival and growth
- Base Line

Pacific breeding program
- 2008: Mass selection
- Selected for:
  - WSSV resistance and general pond survival
- WSSV R Line
ATLANTIC LINE – BASE LINE

- Complete pedigree information
- Origin from eight (8) different countries, both wild & farmed
- Actual inbreeding around 9-10%
- Between and within family selection
- 100+ families per batch (full and half sib scheme)
- 2.5 batches for year
- Current preparing the 15th generation
BASED LINE DESIGN: FAMILY BASED SELECTION

Testing units
Sib Testing

Challenge tests
(n diseases)

Field performance
(n environments)

BREEDING NUCLEUS

Breeding candidate testing
Weight

Selection
(M)EBV

Genetic Evaluations

Mating

Broodstock

Family production

Multiplication and selection for local adaptation

Maturation hatcheries

Commercial End Users

Farms
Punta Canoas – Biosecure Facility

- Physically isolated from commercial farms
- Indoor NBC
- Covered MC
- Fenced perimeter
- No visitors
- Testing infrastructure
  - Earth ponds
  - Lined intensive ponds
  - Indoor/outdoor tanks
- Lab infrastructure
  - PCR; Histology; Bacteriology
PACIFIC PROGRAM – WSSV RESISTANT LINE

- Mass selection
- Origin from:
  - Base Line + four (4) lines from Ecuador + one (1) wild population
- High selection pressure
  - <0.001% (1 in 10,000)
- One batch per year
- Selected for WSSV resistance and pond survival
- Current preparing the 10th generation
FAMILY SURVIVAL FOR A 30 DAYS WSSV CHALLENGE TEST

FAMILY GROWTH AT 100 DOC
DIVERSE GENETIC BASE

“GENE SUPERMARKET”

Countries – Original Gene Pool:
- Colombia$^1$
- Costa Rica$^2$
- Ecuador$^2$
- Hawaii$^1$
- Panama$^2$
- Peru$^2$
- El Salvador$^2$
- Venezuela$^1$

$^1$Domesticate stocks; $^2$Wild stocks
GxE interactions are relevant in shrimp culture

DOES ONE SIZE FIT ALL?

THE ANSWER IS NO!
COMMERCIAL LINES UNDER DEVELOPMENT

- **Growth Lines (100 PL/m²):**
  - Growth 60 (60 DOC)
  - Growth100 (100 DOC)
  - Low salinity (<5ppt)

- **Resistant Lines:**
  - WSSV – Genomic Selection
  - AHPND – Genomic Selection
  - General pond survival

- **Hybrid lines:**

- **Maturation in all Lines:**
  - No ablation
  - Dry feed 100%

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**CHALLENGE TEST AHPND – February 2018**

**BATCH 38 + SPF/SPR hybrids**

**Final Family Survival**
SAFE
Does not introduce diseases

ROBUST
Does not amplify prevalent diseases

ADAPTED
Select breeders to local conditions
**P. vannamei TAKES OVER ASIA SHRIMP PRODUCTION**

![Graph showing shrimp production over years]

Source: © FAO - Fisheries and Aquaculture Information and Statistics Service - 24/02/2015
Penaeus vannamei TAKES OVER ASIA SHRIMP PRODUCTION WHY?

- Penaeus monodon
  - Wild broodstock
  - Non SPF
  - Non genetic improved

INCONSISTENT RESULTS
Penaeus vannamei TAKES OVER ASIA SHRIMP PRODUCTION WHY?

- SPF P. vannamei broodstock readily available
- Domesticated stocks
WHY IT SUCCED?

- Some bio-security in place due to WSSV
  - Water
    - Filtration
    - Storage
    - Recirculation/management
  - Crab fence

Water management

Crab fence
WHY IT CONTINUED?

- Cost of production:
  - *P. vannamei*: ~1/2 of production cost

- *P. vannamei* model x *P. monodon*.
  - Shipping cost alone kills the business
  - Sending PPLs is the best option
    - In country partners – HARD!
    - Biosecurity – HARD!
SPF *P. vannamei* BROOSTOCK MARKET EXPORT NUMBERS FROM HAWAII

- 2016 & 2017 ~500,000 ind/year
- ~US$60/ind
- >US$30 million/year industry in Hawaii

Source: Aquaculture and Livestock Support Services - Hawaii Department of Agriculture (ALSS-HDOA)
**Penaeus vannamei**

Global aquaculture value: US$15 billion per year
40% production lost to disease
WSSV & AHPND (“EMS”)

LOST OF PRODUCTIO ALONE*

- Vietnam - 2015
  - WSSV
    - US$ 11 million
  - AHPND
    - US$ 26 million
- Thailand
  - AHPND
    - US$ 7 billion from 2011 to 2016

* Feed sales losses are estimated to be 30% of production losses!

Source: Shinn A.P., et al: *Asian shrimp production and the economic costs of disease — in press*
BASIS FOR A SUCCESSFUL BREEDING PROGRAM

- SPF founder stocks
- Wide genetic pool
- Data base
- Clear defined traits
- **Technical expertise**
- **Long term commitment!**
Pit Tags:
- Individual monitoring of breeders candidates:
  - From growth selection to maturation

Parental assignment:
- 192 SNPs panel
  - Replacing elastomer tagging
  - Common environment

Genomic Selection
- Training data: Trial Base line x WSSV R line
  - 2378 SNPs: different in the two lines
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