Breeding and Disease Management

MODERATOR: Ravi Kumar Yellanki

2024 Shrimp SUMMIT

Dr. Thomas Gitterle

CEO and Genetic Advisor
iBreed Aqua

- As the CEO and Genetic Advisor at iBreed Aqua LLC since April 2022, Thomas Gitterle brings a visionary perspective. He provides invaluable advice on designing and implementing selective breeding programs for aquatic species, always considering the animals within the context of their natural farming conditions. His vision is to harness the adaptability and resilience inherent in aquatic species to optimize genetic selection strategies, paving the way for a sustainable future in aquaculture.

2024 Shrimp SUMMIT

Unleashing the Power of Shrimp Genetics for a Sustainable Production

Shrimp Summit

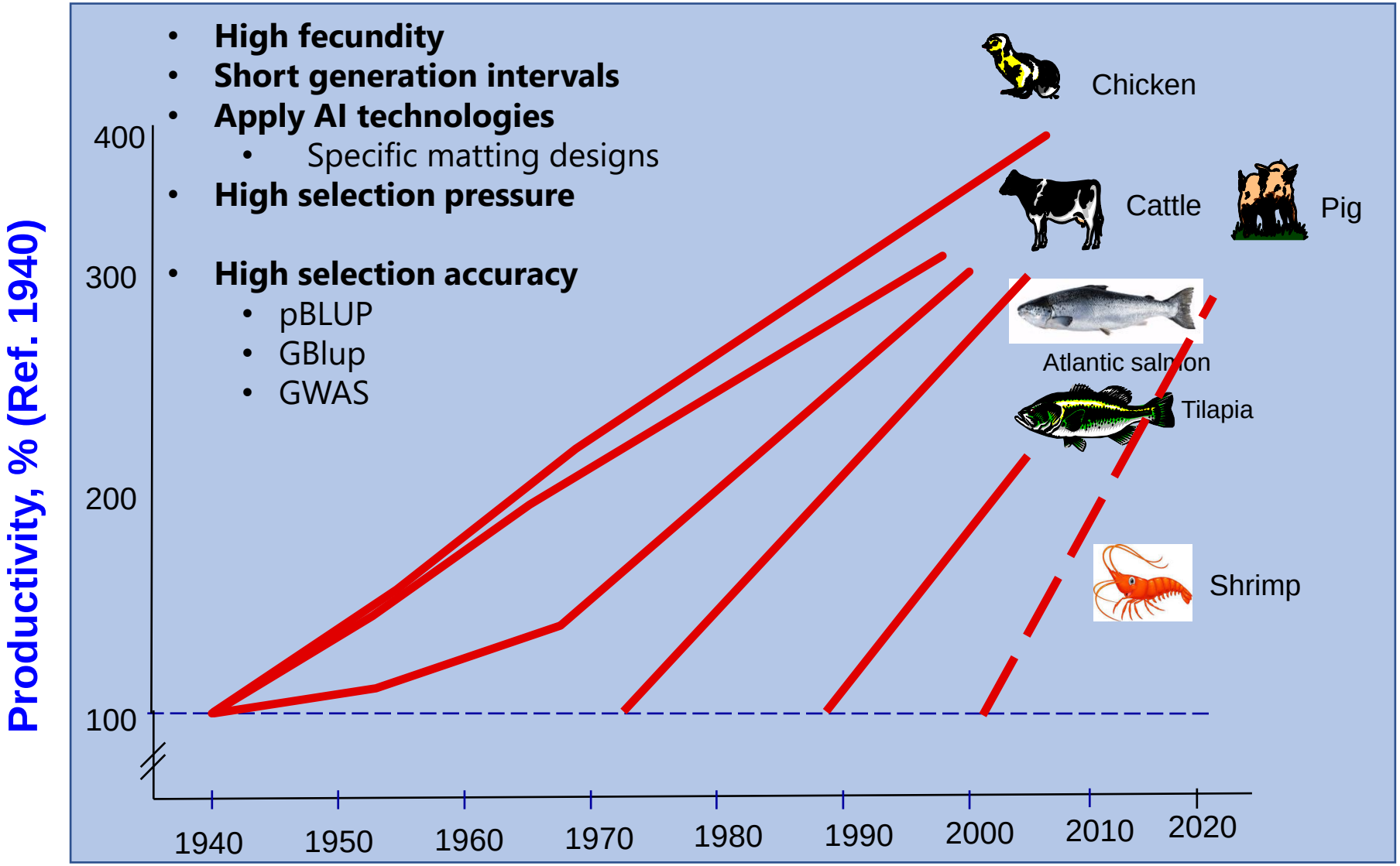
Chennai, India

2024

Thomas Gitterle

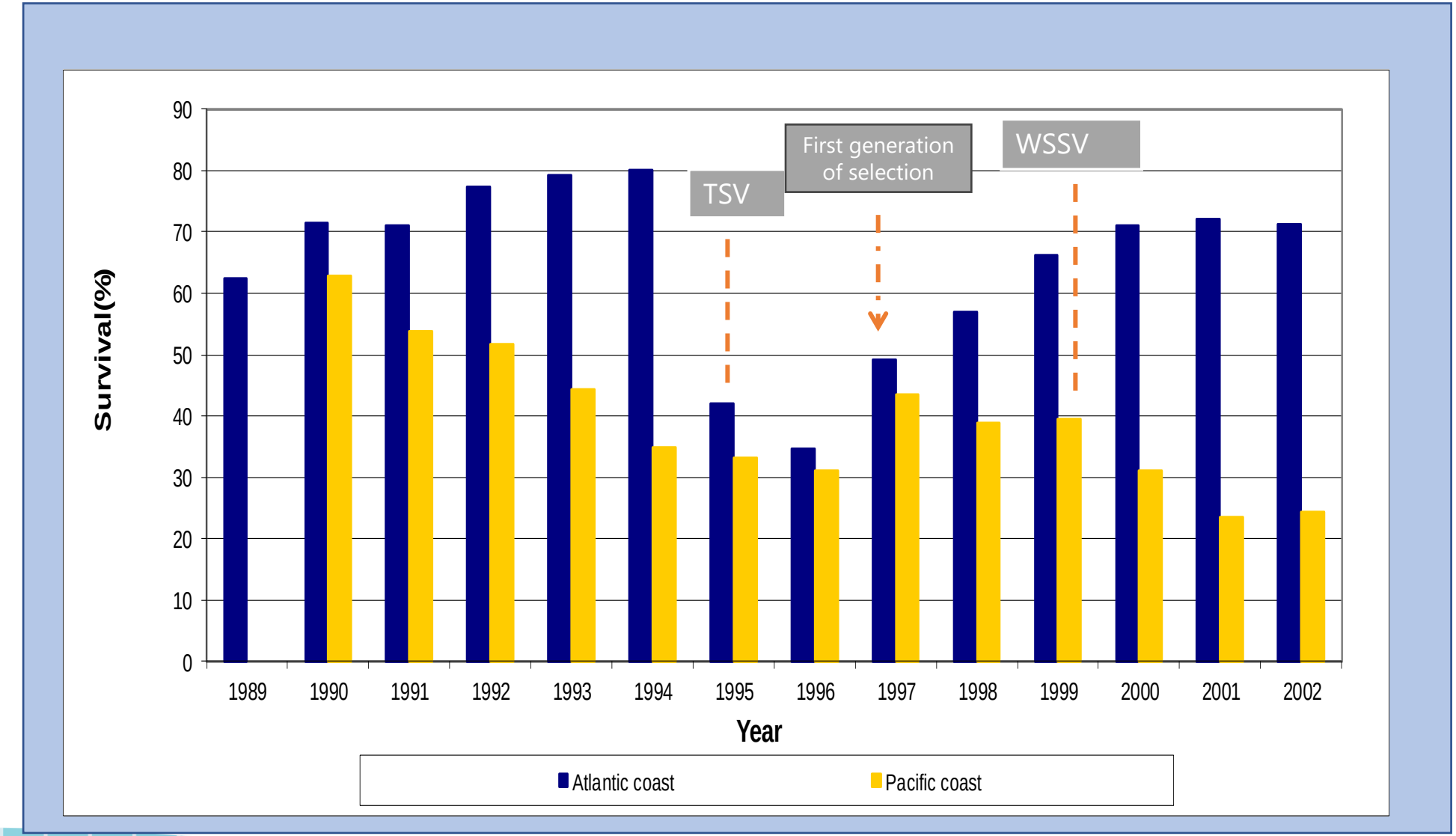
iBreedAqua

P. vannamei deal Specie to apply Selective Breeding

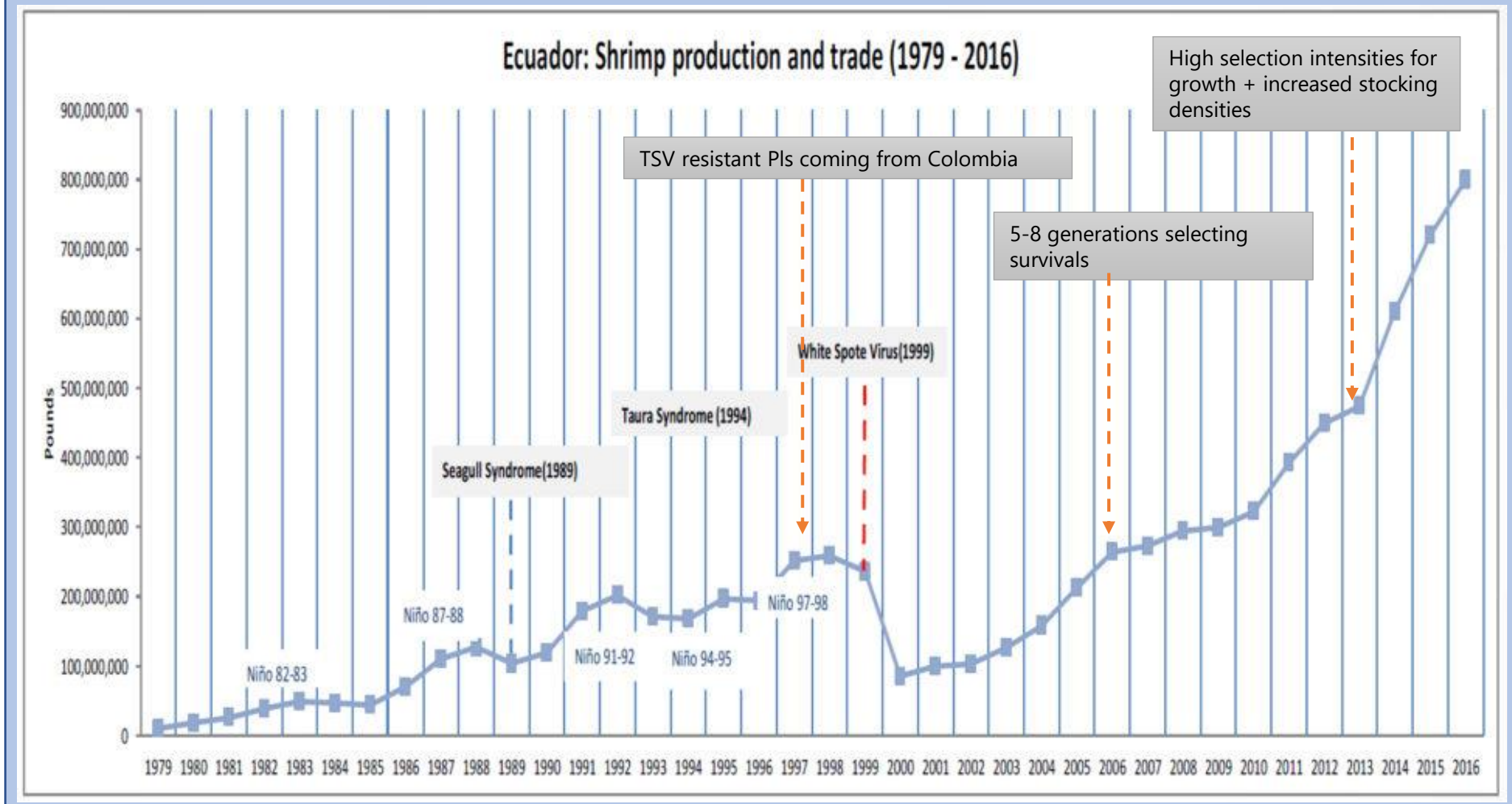


(Modified after Eknath et al., 1991)

Some History:
Colombia was one of the first countries to start a domestic breeding program using TSV-surviving animals.



The Ecuadorian Case

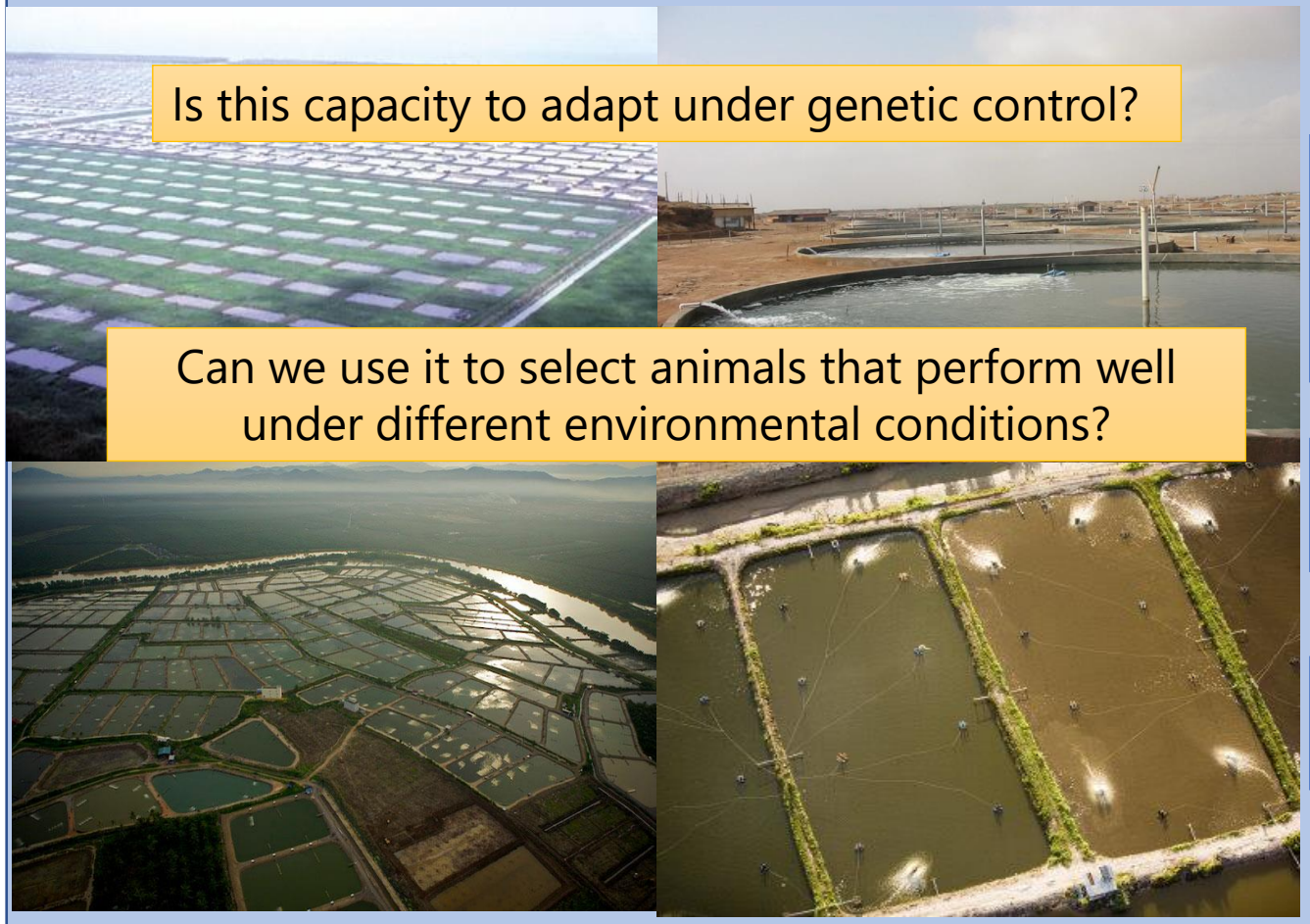


Based on numerous aquaculture conferences, it is evident that the growth and prosperity of the Ecuadorian shrimp industry can be attributed, in part, to their strategy of selecting animals under local environmental conditions.

Modified after Piedrahita, 2019

Very diverse environmental challenges

P. vannamei has an enormous adaptability to different Environmental and Farming conditions



Is this capacity to adapt under genetic control?

Can we use it to select animals that perform well under different environmental conditions?

Stocking densities: between 10 to 500 animals per square meter

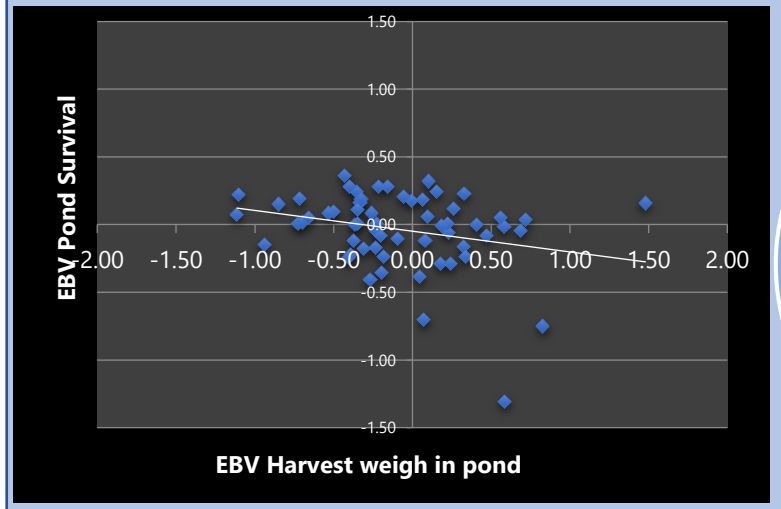
Salinities: between 0 to 40 ppt

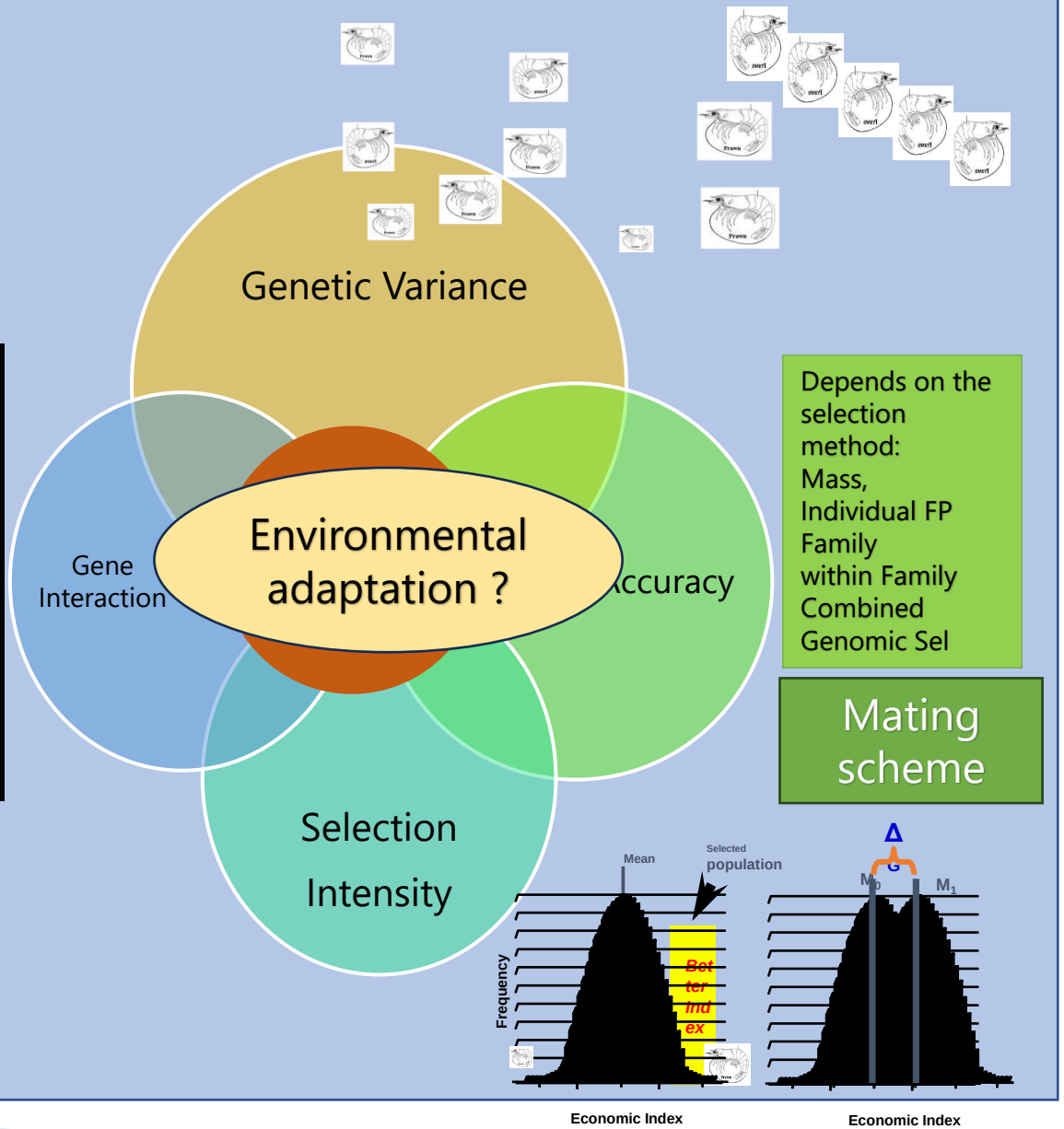
Pond areas: Between 0.6 to 100 Ha

Selecting the Best Animal

Growth unfavorable with viral diseases
TSV (*Argue et al 2001)* and WSSV (*Gitterle et al, 2005*)
… but no correlation with AHPND (EMS)

Other Traits?? Very low information





Key Factors for the Environmental Adaptation

$$DG = i * r^2 * aVar_p / L - dF$$

* Epigenetic effect

where:

DG = annual genetic gain

i = selection intensity

r^2 = selection accuracy

aVar = Genetic variance

L = generation interval

dF = inbreeding depression

changes in gene expression without altering the underlying DNA sequence

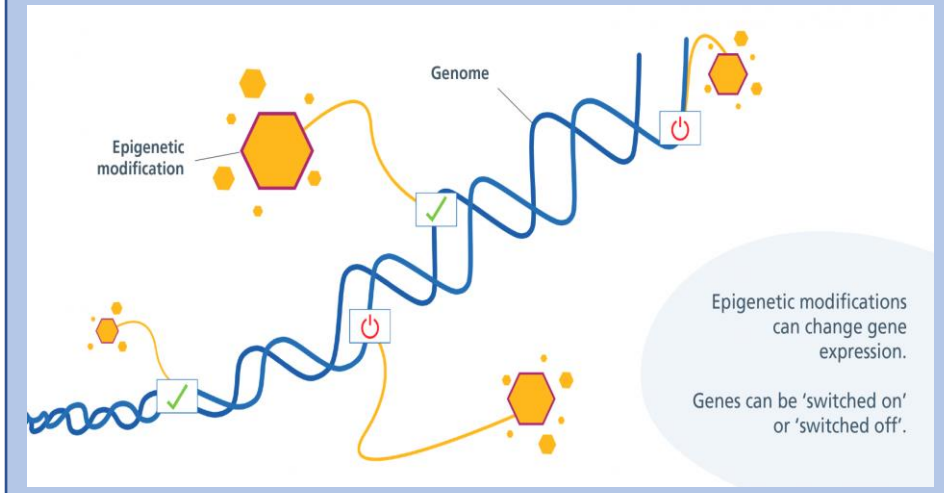
Environmental Sensitivity

The condition of a single genetics to be more or less affected by environmental changes

Epigenetics and Environmental Sensitivity

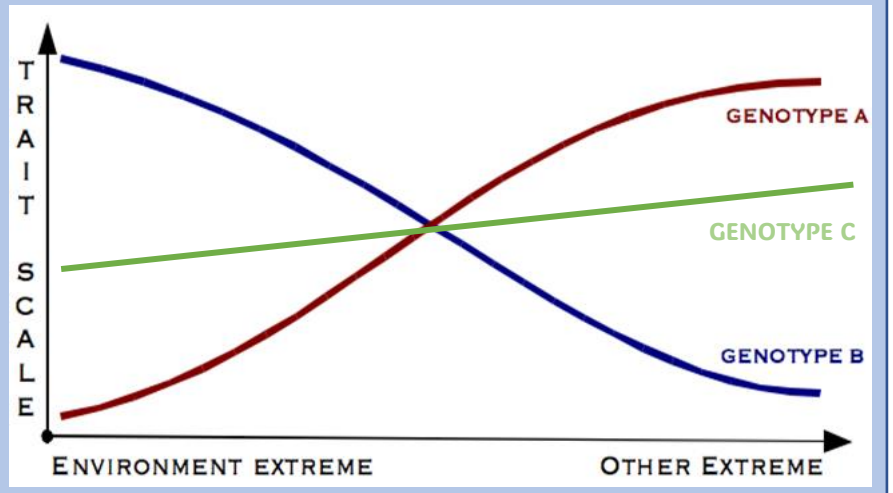
Epigenetic Effect

- Epigenetics refers to changes in gene expression without altering the DNA sequence
- Usually activated by external factors
- It is an acquired condition and it individual
- Can be inherited for at least 3 consecutive generations



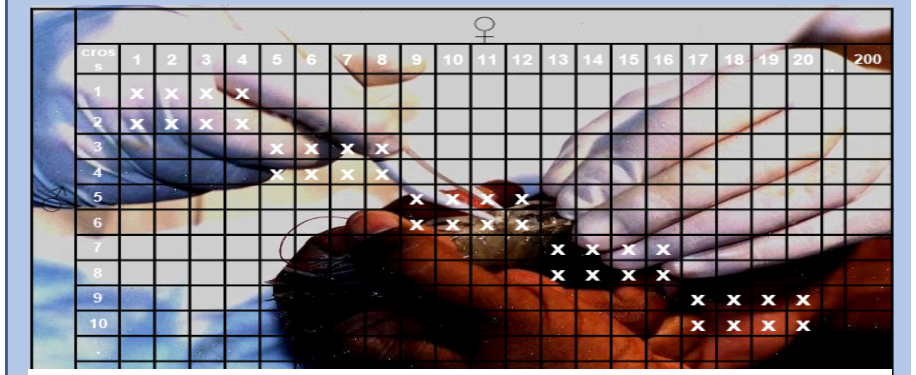
Phenotypic Plasticity or Macroenvironmental Sensitivity

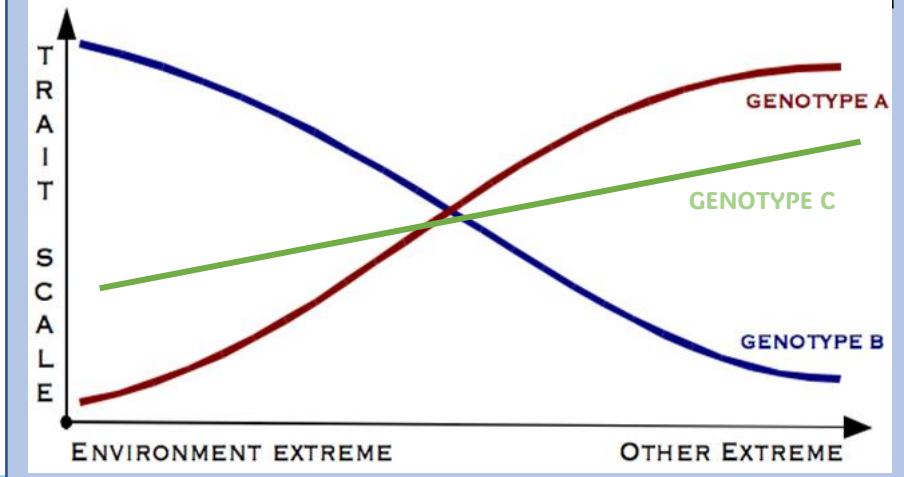
- The condition of a single genetics to be more or less affected by environmental changes
- It is a characteristic that is under genetic control, and it is heritable
- It's evaluated and selected based on family evaluation and not on the individual



Example of *Phenotypic Plasticity*

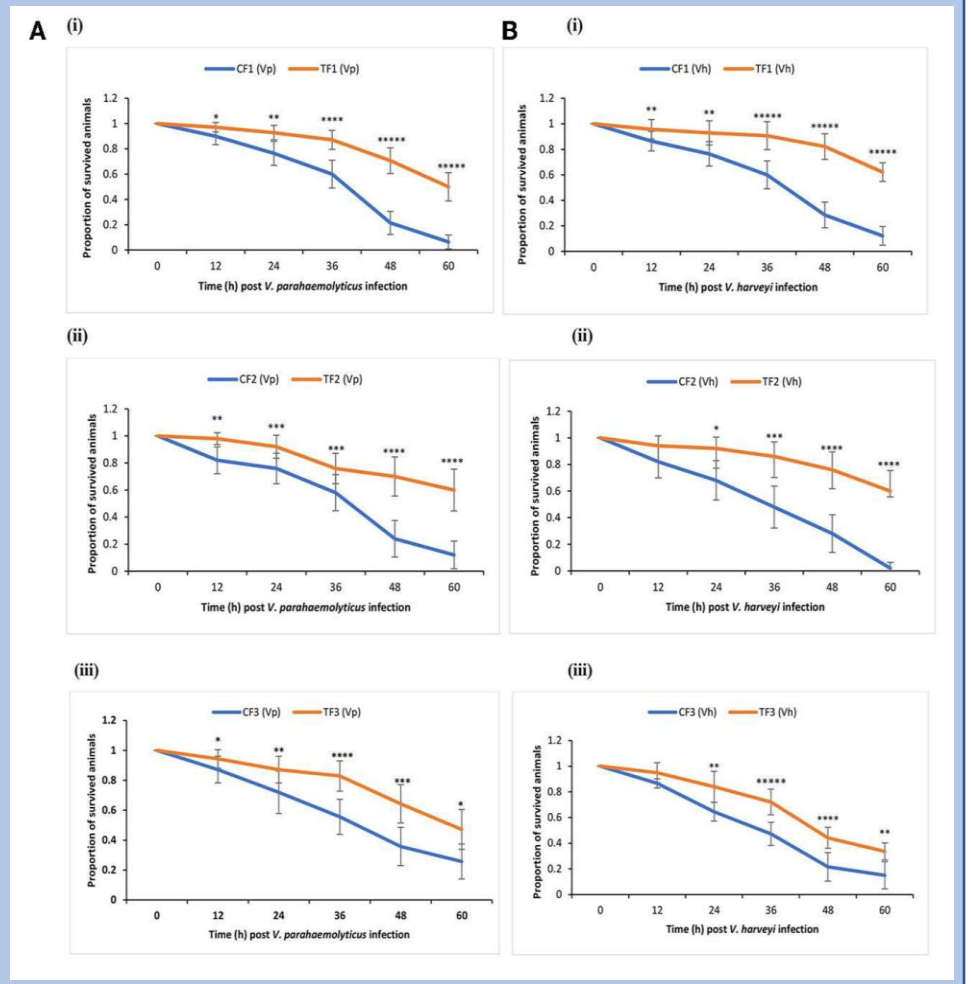
SyAqua Breeding Program produces hundreds of families per year and tests them under very different environmental conditions to select those ones with less ***microenvironment sensitivity for growth and survival***





Example of *Epigenetic Effect*

Phloroglucinol Treatment Induces Transgenerational Epigenetic Inherited Resistance Against Vibrio Infections and Thermal Stress in a Brine Shrimp (Artemia franciscana) Model
Roy et al, 2019



How to include these new approaches in the Commercial Breeding Programs

Select for local commercial conditions!!

- **Test our breeding candidates** under many different commercial environmental conditions and pathogen pressure :
  - Exposition to disease WSSV, EHP, AHPND
  - Favorable Epigenetic effect only in tested animals, not in siblings

High Biosecurity threat, but it is working in Ecuador.

Induce favorable epigenetic effects

- Use toxins or chemicals to induce DNA methylation (Gitterle, 2018)
  - Risk of inducing unfavorable gene suppression or expression

Select for less environmental Sensitivity

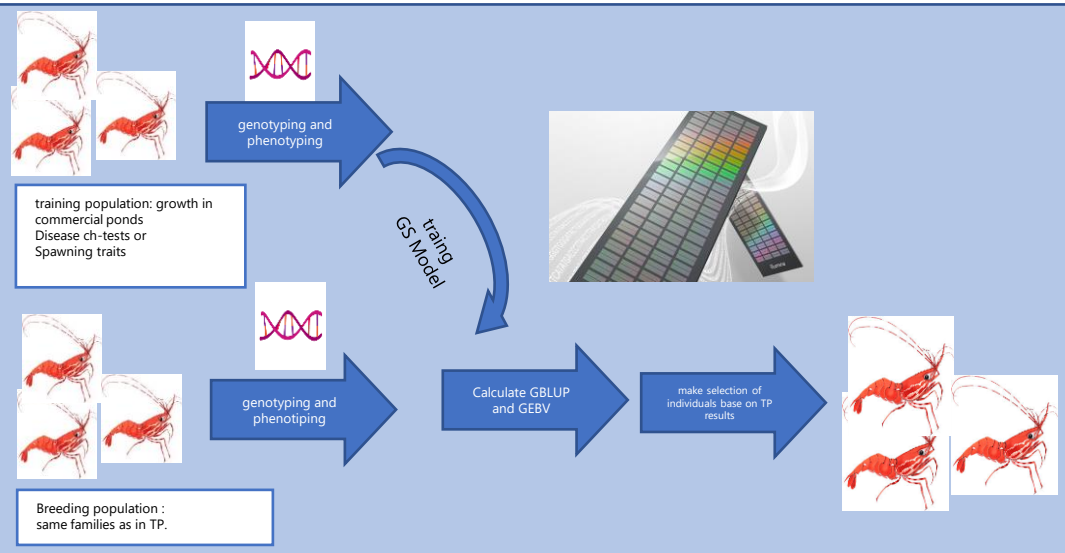
- **Test families** under commercial conditions and select the ones with less environmental sensitivity

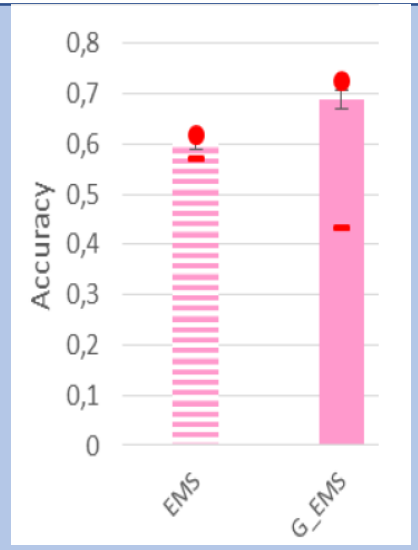
Genomic Selection:

- **Test siblings** in commercial ponds and select breeding candidates in the biosecure nucleus.

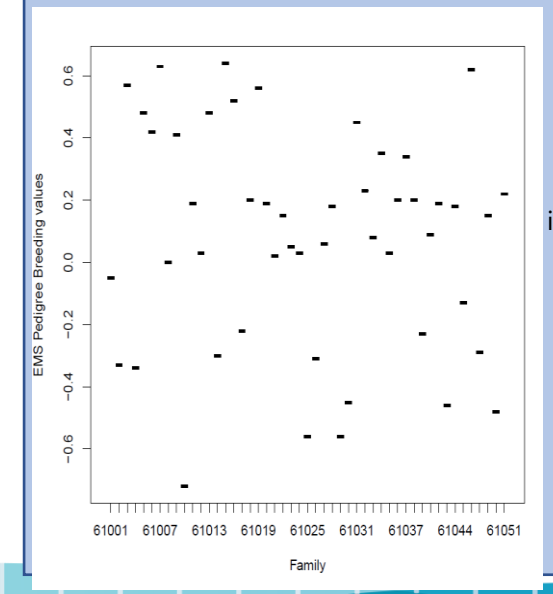
Gene Editing: Find genes with a large effect on diseases

Genomic Selection Results SyAqua Breeding Program



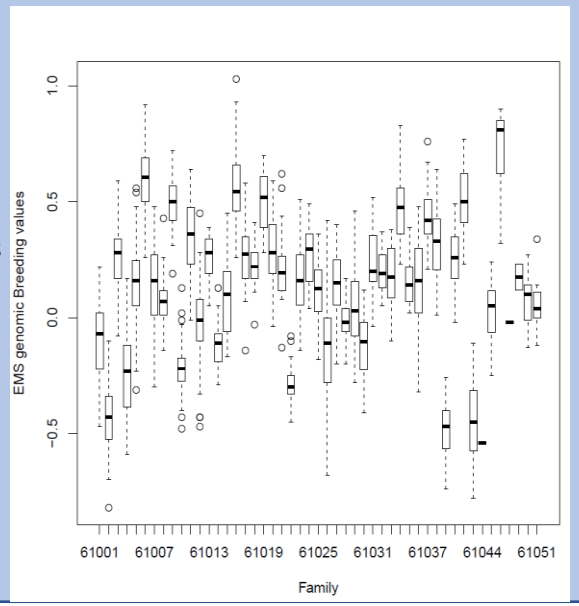


Individual EBV in our breeding population at the GN

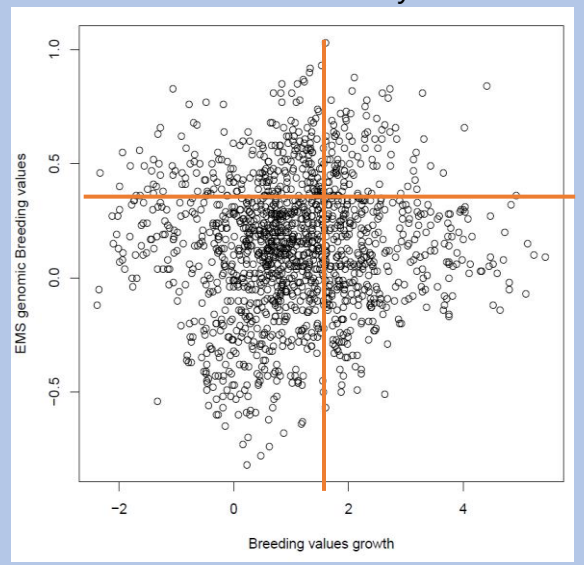


Same individuals =

Individual gEBV in our breeding population at the GN



Correlate traits based on individuals and not only families



Breeding Programs in Producing Countries

Country	# of P.vannamei domestic Breeding Programs	Total production in Mill tons, 2022
Ecuador	**>5**	**1.3**
China	**at least 4**	**1.1**
India	**0**	**0.8**
Vietnam	2	0.7
Other Americas	>5	0.5
Thailand	3	0.5
Indonesia	3	0.5
USA	**5**	**0.01**

To Conclude ….

- One of the main advantages of Ecuador is that they select animals under local commercial conditions and with very high selection pressures.
- Epigenetics might be one cause of the better response of those populations, too.
- It is possible to identify and select good animals by testing them in many different conditions.
- New technologies like Genomic Selection can help select individuals with better resistance to disease and pond performance
- Selecting disease resistance based only on family information doesn’t bring sufficient response due to low accuracies and low selection intensities.