



Disease diagnosis in a fish farmer's backpack

Malaysian Fisheries Society 36th Annual General Meeting
Theme: Aquaculture in the Digital Age, UCSI University, June 10, 2023

Jérôme Delamare Deboutteville, Scientist, WorldFish

Participation funded by:



In collaboration with:



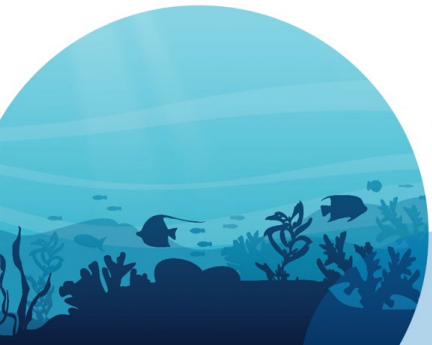
FOREWORD

“

Aquatic foods must occupy a **central place** in the **global agricultural research agenda**, which has traditionally focused on land-based crops and livestock.

”

This task is **critical to ensure a full representation** of the food system, address the complex links among food, land and water systems, and **unlock an ocean of opportunities in an emerging blue economy** that must prioritize social inclusion and equity.



The big facts ON AQUATIC FOODS

204 million tons

The volume of **aquatic food production** by 2030.

\$ 264 billion

The value of aquatic food production through **aquaculture** in 2018.

\$ 24 trillion

The value of the **ocean economy**, including fisheries, shipping lanes and tourism.

3.3 billion

Number of people getting **20%** of their **animal protein** from eating aquatic foods.

17%

Percentage of all **animal protein** consumed globally that comes from **aquatic foods**.

\$ 164 billion

The **global export value** of fish alone in 2018, making aquatic foods among the world's **top traded commodities**.

\$ 70 million

The estimated market size of the **plant- and cell-based aquatic food sectors** by 2030.

2 billion

Number of people suffering the **triple burden of malnutrition** who can benefit from the life-changing option of consuming **nutrient-rich** aquatic foods.

1000 days

Aquatic foods are dense in **vitamins and micronutrients**, which are essential to cognitive development in the first **1000 days of a child's life**.



Aquatic foods naturally contain **healthy omega fats** that are difficult to obtain from land-based food sources, such as crops and livestock.

The intake of **omega-3 fatty acids** from fish and aquatic foods is associated with **lower risk of cardiovascular disease and obesity**.

When consumed as part of a **balanced diet**, fish can increase the absorption of **essential minerals**, such as iron and zinc, from other foods.

84%

Percentage of global **protein** sourced from the sea that comes from **wild fisheries**.

60%

Percentage of the world's farmed fish in 2018 produced through **inland aquaculture**.

66%

Percentage of **fishstocks** currently within **biologically sustainable** levels, compared to 90% in 1990.



The weight of **ocean plastics** will exceed the weight of all fish by 2050, unless **coordinated multistakeholder actions** to curb plastic pollution are taken.

40%

The estimated decline in **tropical fish catch** globally by 2050, unless actions to curb **CO₂ emissions** are taken.

50%

Percentage of the total global catch from **small-scale fisheries**.

70%

Percentage of the planet that is covered by the **ocean**, which houses 80% of all **life on earth** while **sequestering carbon** and providing **half of the world's oxygen**.

\$ 22.5 billion

The **annual loss** of discarded fish alone.

35% of the global harvest from fisheries and aquaculture is **lost or wasted**.



Production of aquatic foods has a **much lower carbon footprint** and **far fewer biodiversity impacts** compared to production of crops and livestock.

800 million

Number of people around the world who depend on **small-scale fisheries and aquaculture** for their livelihoods.

60 millions

Number of people engaged in the primary sector of **fisheries and aquaculture** in 2018.

1 in every 2

Workers in the primary and secondary sectors of fisheries and aquaculture who are **women**.

They are crucial to aquatic food systems, providing **labor, innovative ideas and entrepreneurship**.

90%

Percentage of all **small-scale fishers** living in low- and middle-income countries in the **Global South**.



Our Vision

An inclusive world of healthy, well-nourished people and a sustainable blue planet, now and in the future.

Our Mission

To end hunger and advance sustainable development by 2030 through science and innovation to transform food, land and water systems with aquatic foods for healthier people and planet.

WHERE we are



WorldFish has a
global presence
in **20 countries**
in **3 continents**
with **422 staff** representing
30 nationalities





DOCS HELP LOGIN

Genomic epidemiology of novel coronavirus - Global subsampling

Built with [nextstrain/ncov](#). Maintained by the [Nextstrain team](#). Enabled by data from [GISAID](#).

Showing 3506 of 3506 genomes sampled between Dec 2019 and Nov 2021.

Dataset

ncov
gisaid
global

Date Range

2019-12-19 2021-11-26

PLAY RESET

Color By

Clade

Filter Data

Type filter query here...

Tree Options

Layout

RECTANGULAR
RADIAL
UNROOTED
CLOCK
SCATTER

Branch Length

TIME DIVERGENCE

Show confidence intervals

Branch Labels

clade

Tip Labels

Sample Name

Second Tree

Select...

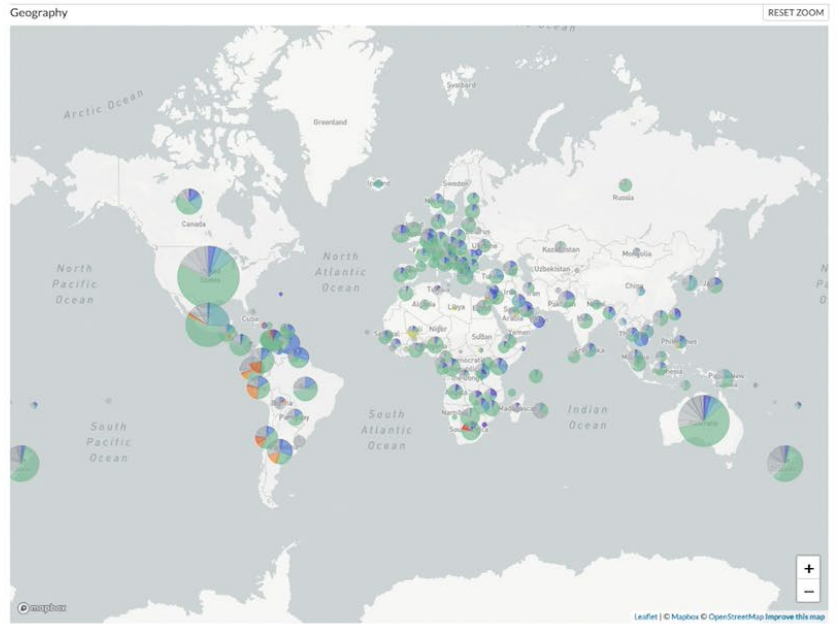
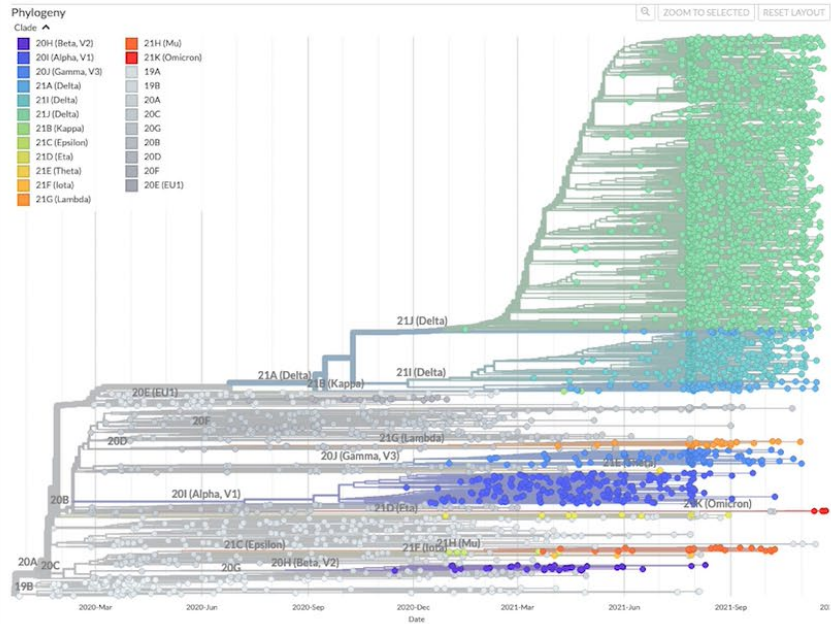
Map Options

Geographic resolution

country

Show transmission lines

Frequency Options



ENTROPY EVENTS AA NT

Inspire Challenge project



Platform for
Big Data
in Agriculture

[ABOUT](#) ▾

[INSPIRE CHALLENGE](#) ▾

[SHARED SERVICES](#)

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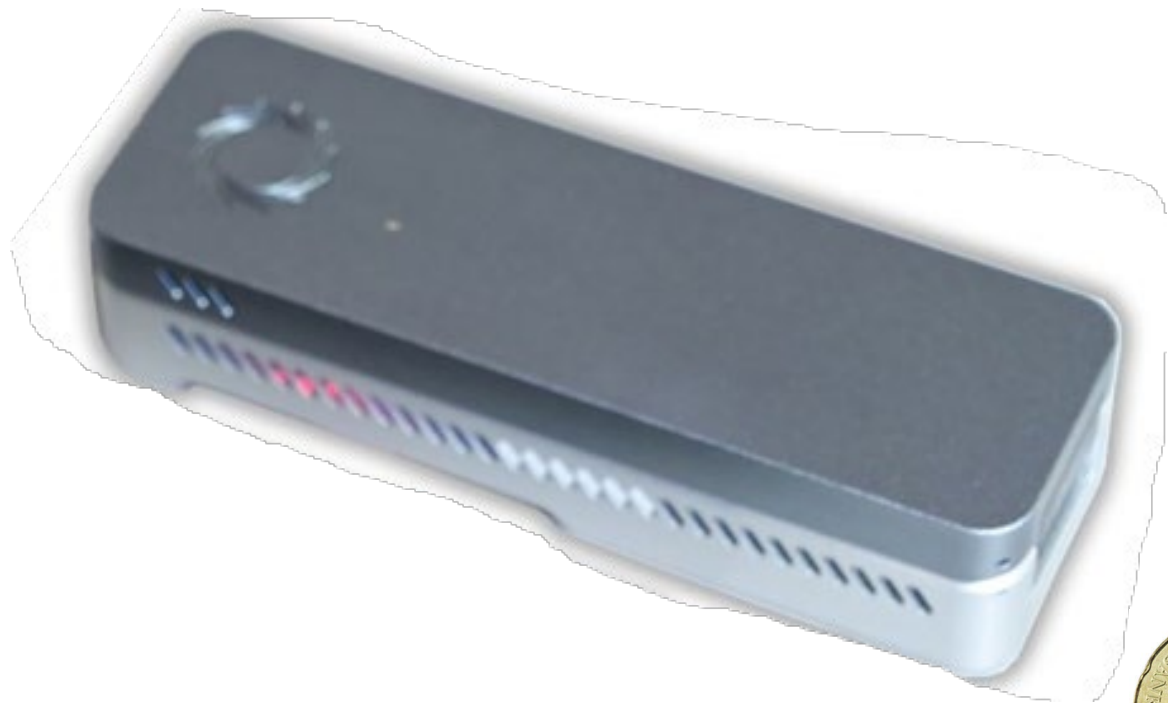


2019 WINNER

Rapid genomic detection
of aquaculture
pathogens

 Malaysia, Bangladesh





Inspire Challenge project: Lab-in-a-backpack

- Lab-in-a-backpack' creates a low-cost workflow for sample processing and genomic sequencing for rapid identification of aquaculture pathogens.
- That can be conducted anywhere, without requiring expensive equipment or reagents, nor generate any toxic waste.

Development of protocols

For disease outbreak investigation on grow-out farms and hatcheries:

- Record management
- Fish sampling for disease diagnostics
- Sample processing
- Nucleic acid extraction
- Sequencing
- Bioinformatics



Development of AquaPath reference database



For now, the AquaPath reference database is limited to few fish **bacterial pathogens**, where sequence data are used for training new classifiers for their rapid genomic detection

Development of cloud-based analytics portal

- Doesn't rely on your hardware
- Internet Connection (cloud)



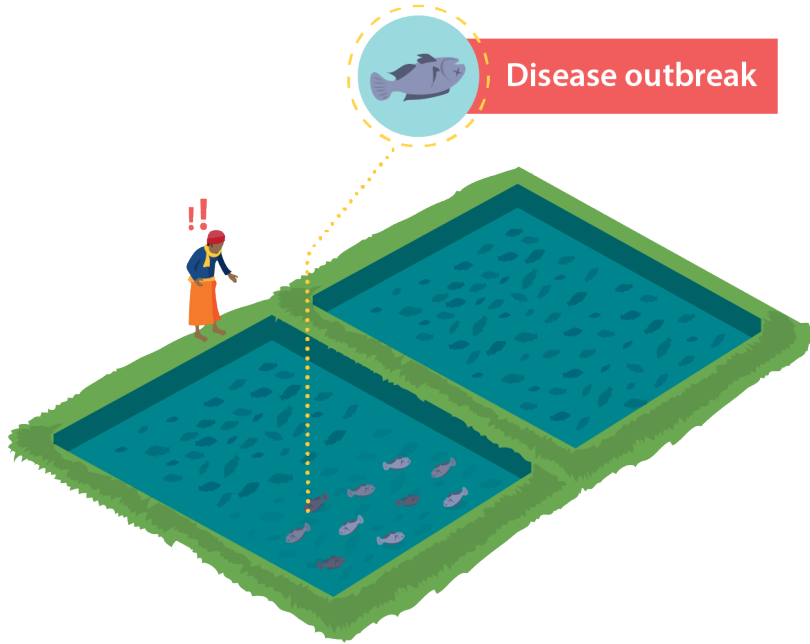
Development of cloud-based analytics portal



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- **R**apid **p**athogen **s**equences (**Rappseq**) for rapid genomic detection of fish pathogens
- Using AquaPath reference database
- Train new classifiers with AI and machine learning; e.g., Group B *Streptococcus* (MLST, serotype)

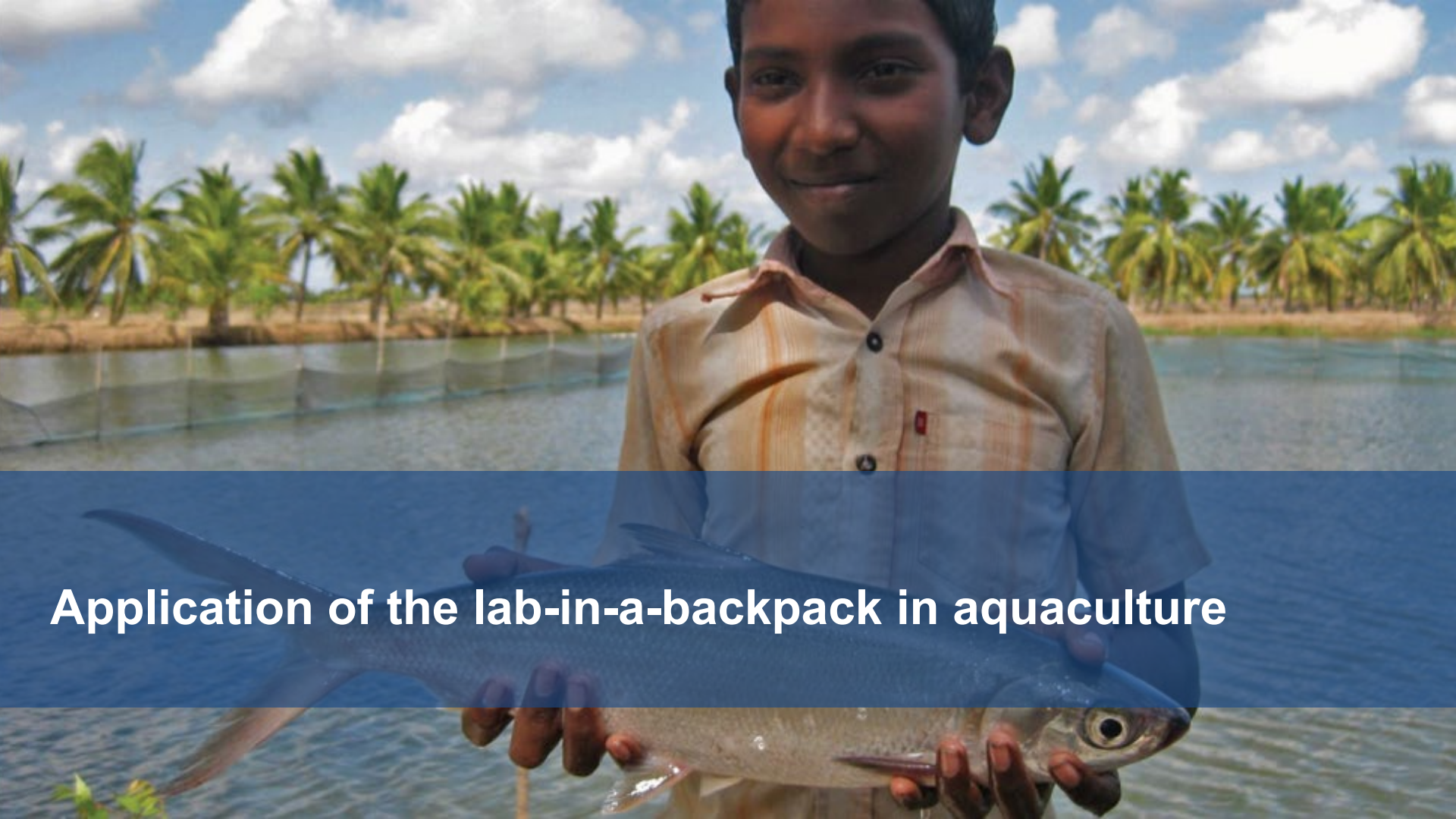
Fish farmers' questions during disease outbreak



What is
killing my
fish?

How can I
treat them?

How can I
prevent
disease in
the next
crop?

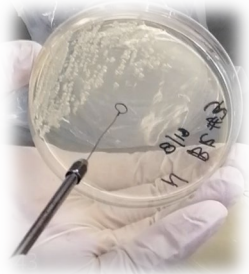
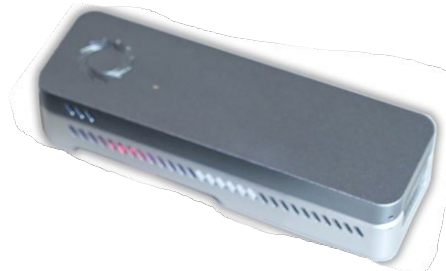
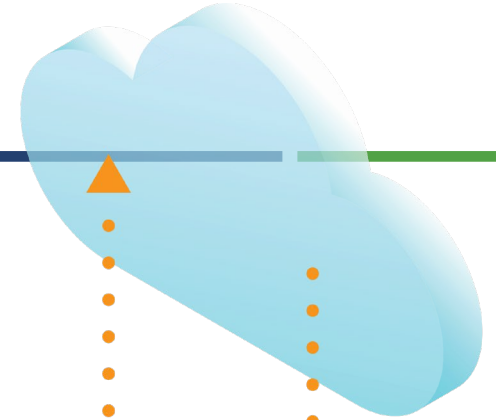


Application of the lab-in-a-backpack in aquaculture

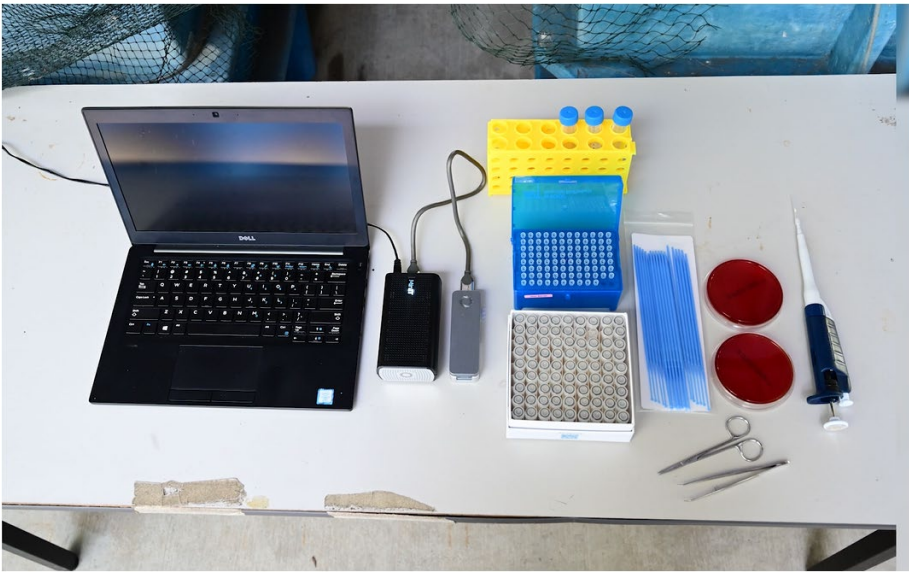
Disease outbreak on grow-out farm



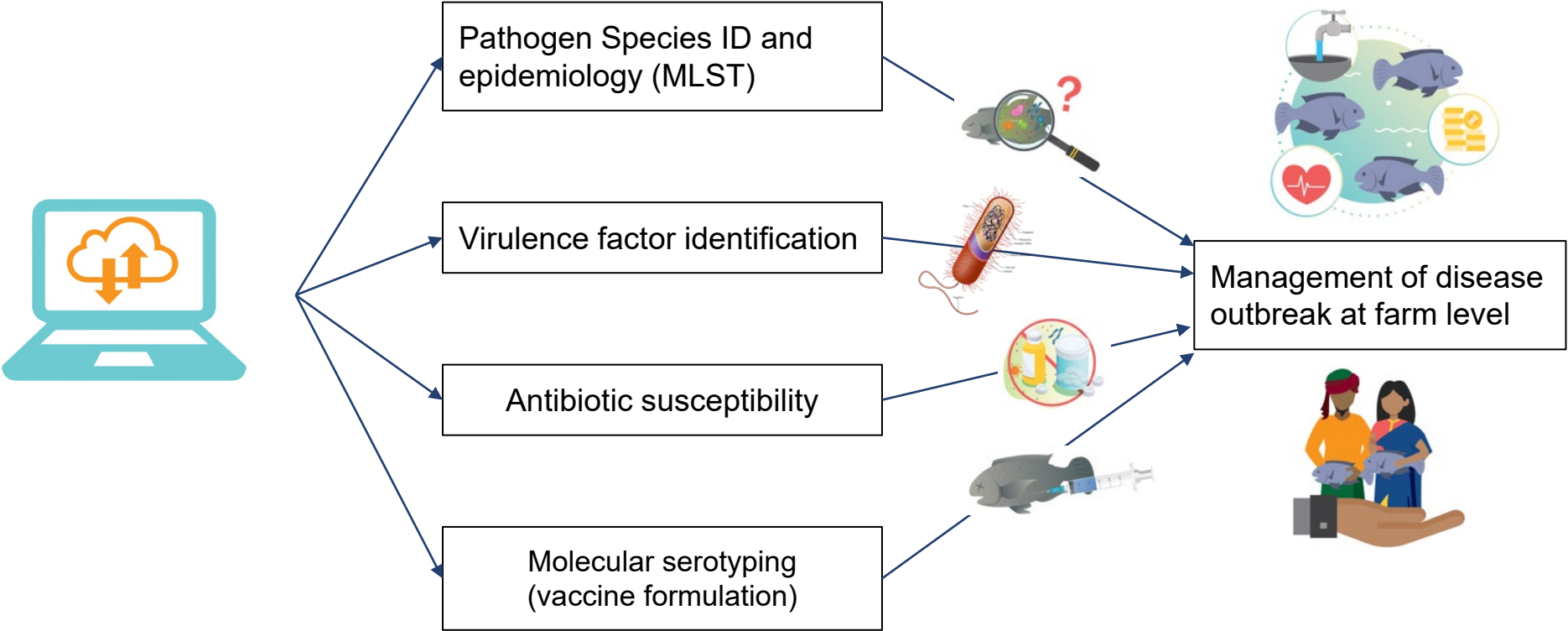
- Sample collection
- Record management
- Sample processing
- Sequencing
- Sequence data submitted to the cloud



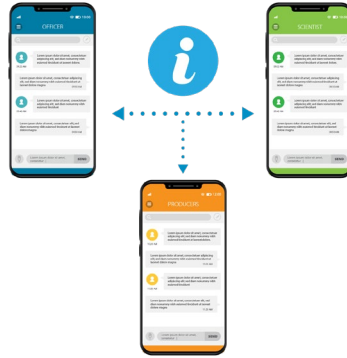
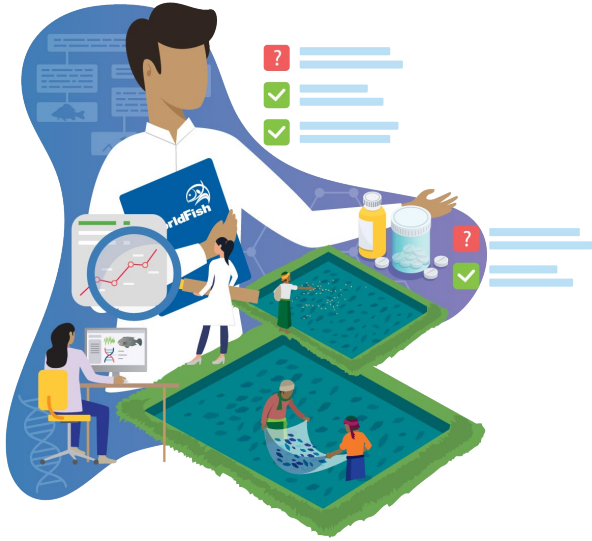
Lab-in-a-backpack



Genome-based classifiers for diagnosis of pathogens in aquaculture



Peer-to-peer sharing of information



- Peer-to-peer sharing of the diagnostics results with Vet, field officer, scientist, producers.

Diagnostic-based management plan for producers

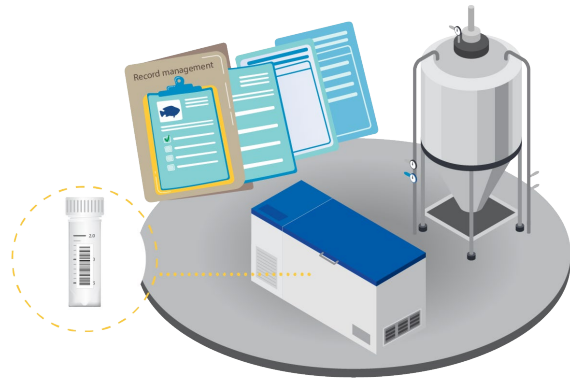
What should the farmer do now? In future

- Immediate advice/action
- Emergency harvest
- Water/feed management
- Antibiotic treatment? By certified professional only using approved antibiotic, clear dosage rate, mode of application, duration and withholding guidelines

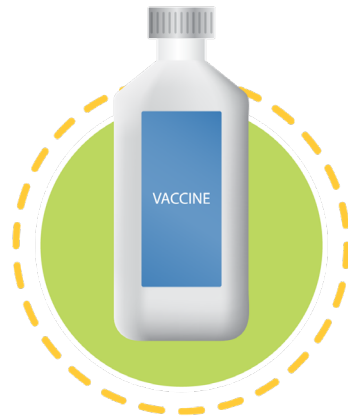


Development of autogenous vaccines

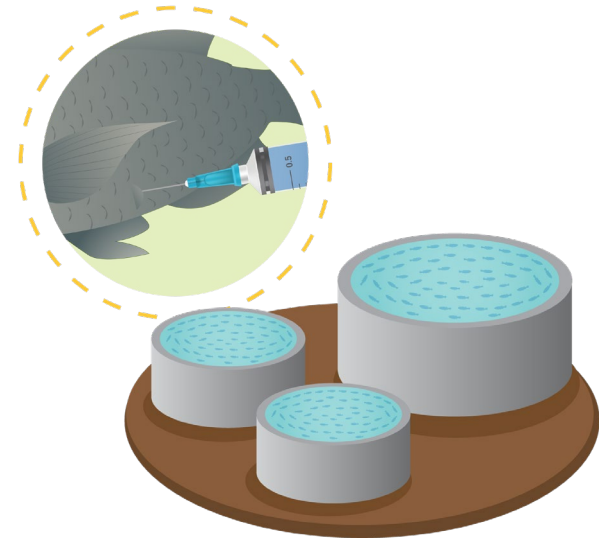
Formulation of custom autogenous vaccines.
Production of vaccines using simple fermentation technologies.



Custom vaccines.
Shipping of vaccines to seed producers.
Cold chain (4C).

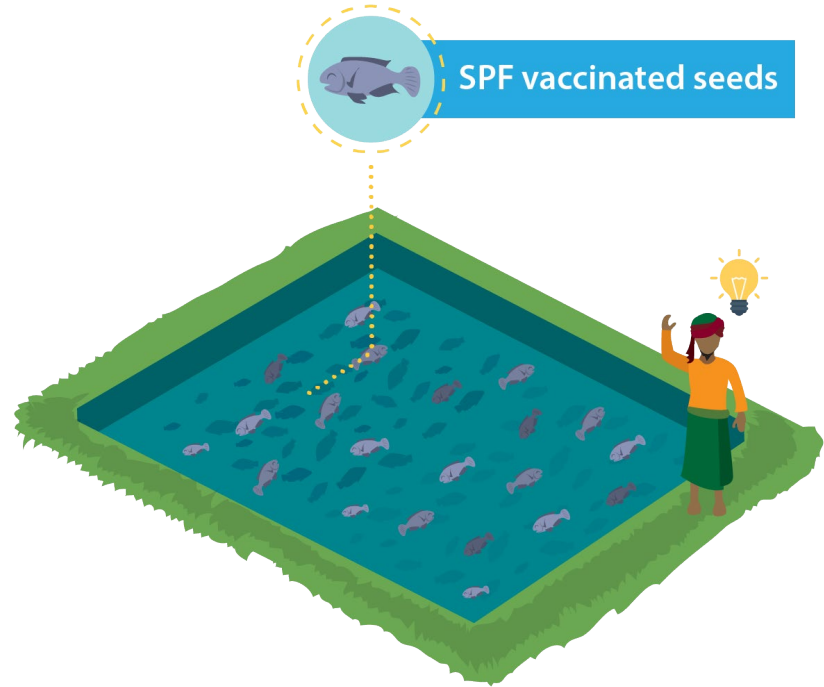


Seed producers.
Broodstock and seeds vaccinated by trained professional



Development of autogenous vaccines

- Vaccinated seeds disseminated to grow-out farmers for restocking
- SPF vaccinated seeds
- Better survival/profitability, reduction of chemicals and antibiotics uses, reduction of AMR = One Health Aquaculture





https://labinabackpack.com/



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Tools

About 38 results (0.34 seconds)

https://labinabackpack.com

Lab in a Backpack

Lab in a Backpack is a workflow for rapid identification of aquaculture pathogens. Traditional methods are slow, expensive, and do not have enough resolution to ...

https://twitter.com › hashtag › labinabackpack

#labinabackpack hashtag on Twitter

See Tweets about #labinabackpack on Twitter. ... of the #NEBPodcast Lessons from Lab & Life featuring @AaronPomerantz . https://nebiolabs.com/PodcastEp6 ...

https://twitter.com › diligentinc › status

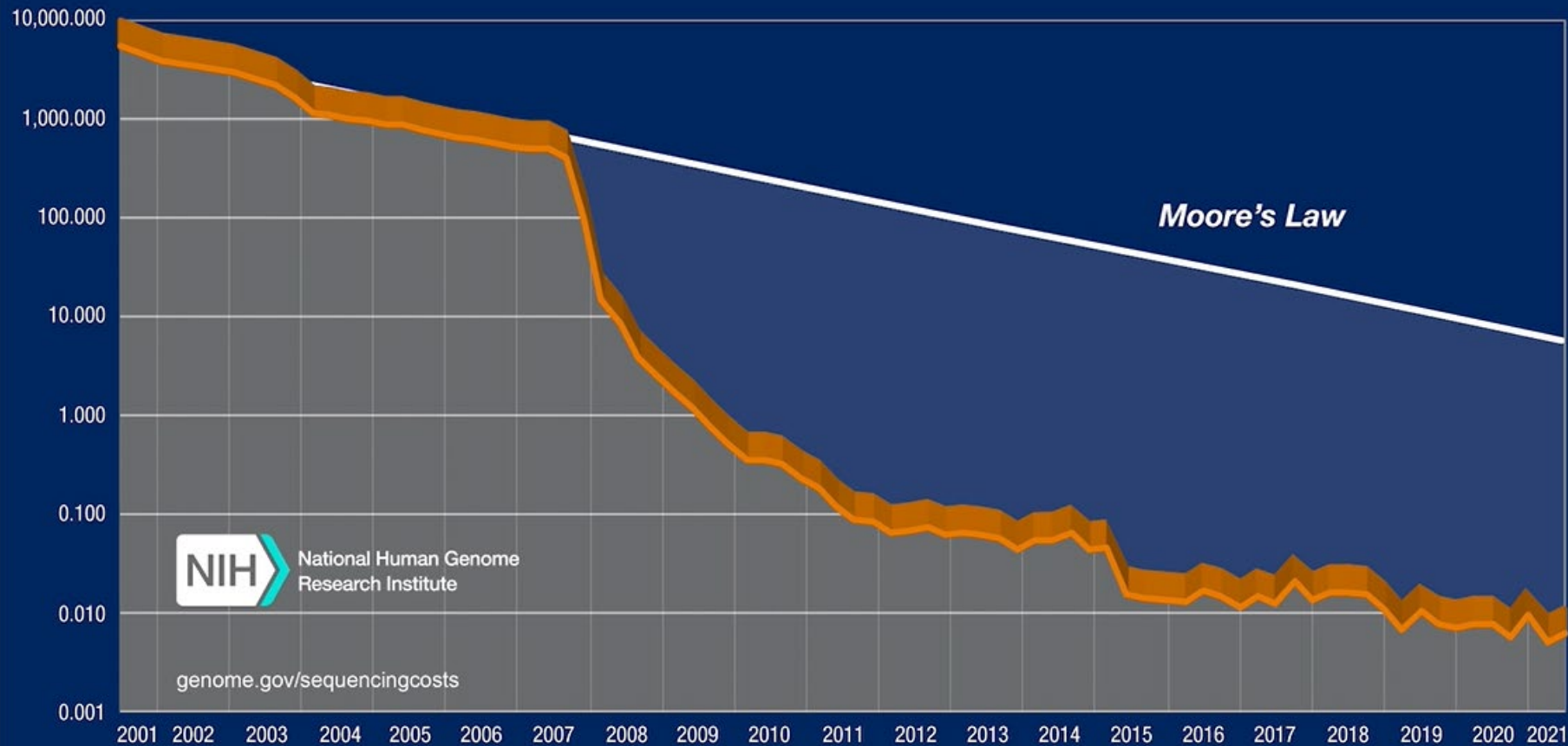


google.com/search?q=https://labinabackpack.com/&client=firefox-b-m&channel=ts&biw=843&bih=

30



Cost per Raw Megabase of DNA Sequence





New Results

Follow this preprint

Multiplex PCR detection and Nanopore-based rapid genotyping of tilapia (*Oreochromis* spp.) pathogens

Jérôme Delamare-Deboutteville, Watcharachai Meemetta, Khaettareeya Pimsannil, Han Ming Gan, Pattanapon Kayansamruaj, Laura Khor Li Imm, Ha Thanh Dong, Vishnumurthy Chadag Mohan, Saengchan Senapin

doi: <https://doi.org/10.1101/2023.05.13.540096>

This article is a preprint and has not been certified by peer review [what does this mean?].



Abstract

Full Text

Info/History

Metrics

Preview PDF

Tilapia aquaculture is threatened by multiple pathogens

1. Tilapia Lake virus (TiLV)
2. Infectious spleen and kidney necrosis virus (ISKNV)
3. *Francisella orientalis*
4. *Streptococcus agalactiae*

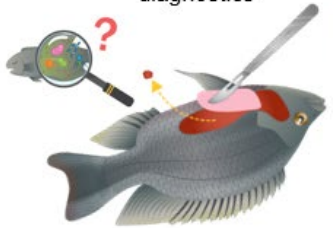
Novel multiplex PCR & Nanopore sequencing

- Current diagnostic methods rely on multiple singleplex PCR reactions, which are time-consuming and expensive.
- Here, we introduce a novel multiplex PCR (mPCR) assay coupled with rapid Nanopore sequencing that allows for the simultaneous detection and sequence-based identification of all four pathogens

Workflow

Capable of detecting single and dual infections in clinical samples within a day.

- 1 Fish sampling for disease diagnostics



30 min

- 2 Nucleic acid extraction



30 min

- 3 Multiplex PCR



2 h

- 4 Gel electrophoresis & DNA clean up



30 min

- 8 Disease control in aquaculture.

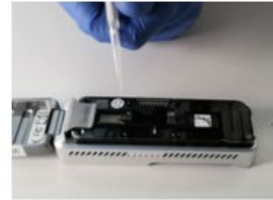


- 7 Mapping to reference



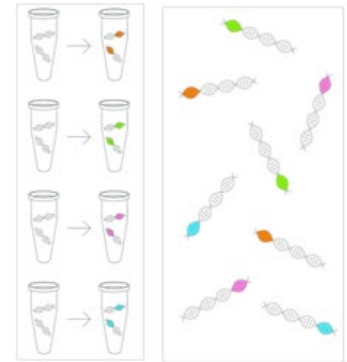
15 min

- 6 MinION sequencing



30 min

- 5 Nanopore multiplex Library preparation

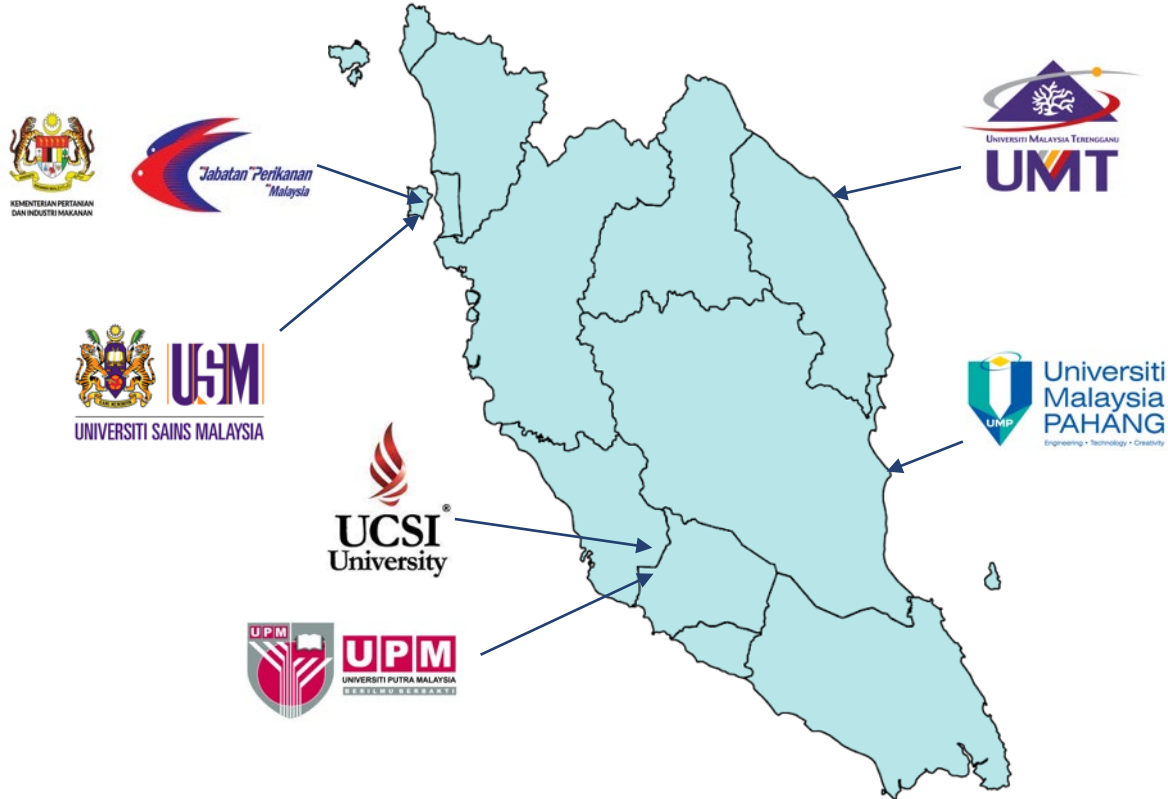


90 min

Our multiplex assay exhibits high sensitivity

- The consensus sequences generated from the amplicons for each sample exhibit 100% sequence identity to publicly available data
- Combining multiplex PCR and Nanopore sequencing provides a promising and cost-effective platform for rapid and accurate diagnostics of major pathogens of tilapia, making it a valuable tool for the aquaculture industry.

Work with Malaysian institutions and participants

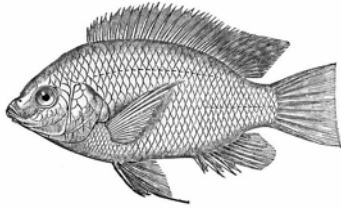


2021 WorldFish NGS Virtual Training Malaysia

Participants samples sequenced by WorldFish

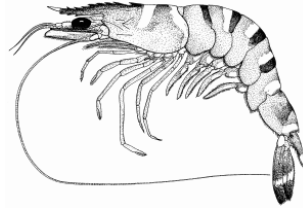
Hosts & isolation sources + bacterial genus & species

***Oreochromis* sp.**



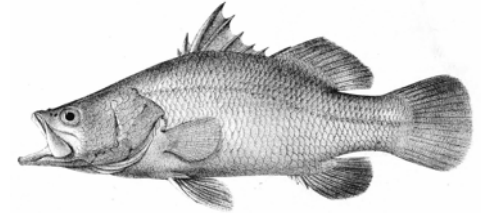
Streptococcus agalactiae

Penaeus monodon



Vibrio parahaemolyticus / *V. owensii* / *V. harveyii*

Lates calcarifer



Vibrio parahaemolyticus

Seawater



Photobacterium sp. / *Bacillus* sp.
Vibrio sagamiensis

Bioflocs



Enterobacter sp.

Holothuria leucospilota



unknown

Sediment



Bacillus cereus

Thank You



This work was undertaken as part of



INITIATIVE ON
Aquatic Foods



Platform for
Big Data
in Agriculture



INITIATIVE ON
One Health



Norad

In partnership with



THE UNIVERSITY
OF QUEENSLAND
AUSTRALIA



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PATRIOT BIOTECH
BIOTECH FOR GOOD