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Catfish (*Clarias gariepinus*) Genetics and Improving Catfish Hatchery and Seed Supply

Dr Suleiman Ihiabe Isa

1st November, 2022 @ IITA Ibadan

Photographer credit if needed

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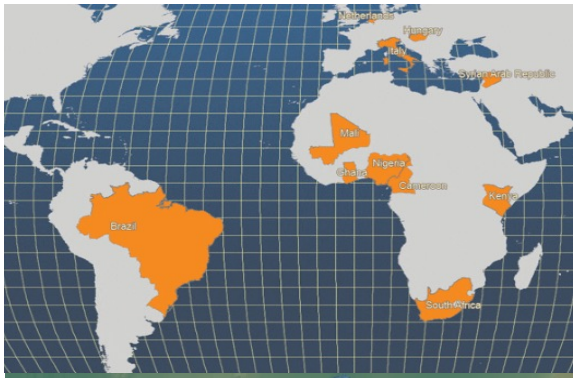
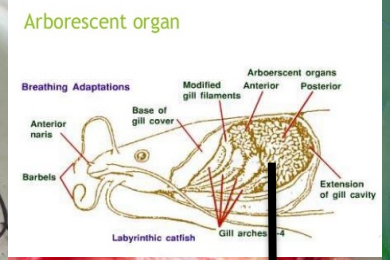
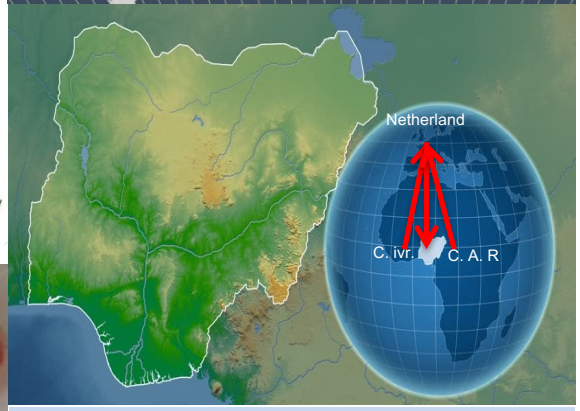
The African catfish

- The African catfish, *Clarias gariepinus* (Burchell 1822)
  - A *Siluriform,* belonging to the family *Claridae* and genus *Clarias*
  - Native to Africa, successful hatchery production started in the 1970s
  - Since then, its culture transcended 4 continents (>200,000 t/y)

✓Nigeria is the largest producer







The Dutch-domesticated strain reintroduced

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The Catfish Journey So Far

PHASE 1

- Identification
- Hatchery Practices

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Institute of Aquaculture

COMMONWEALTH SCHOLARSHIPS

NATIONAL BIOTECHNOLOGY DEVELOPMENT AGENCY
NABDA

PHASE 2

- Hatchery practices
- BMP guidelines

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PHASE 3

- Broodstock evaluation
- Assessment of levels of inbreeding

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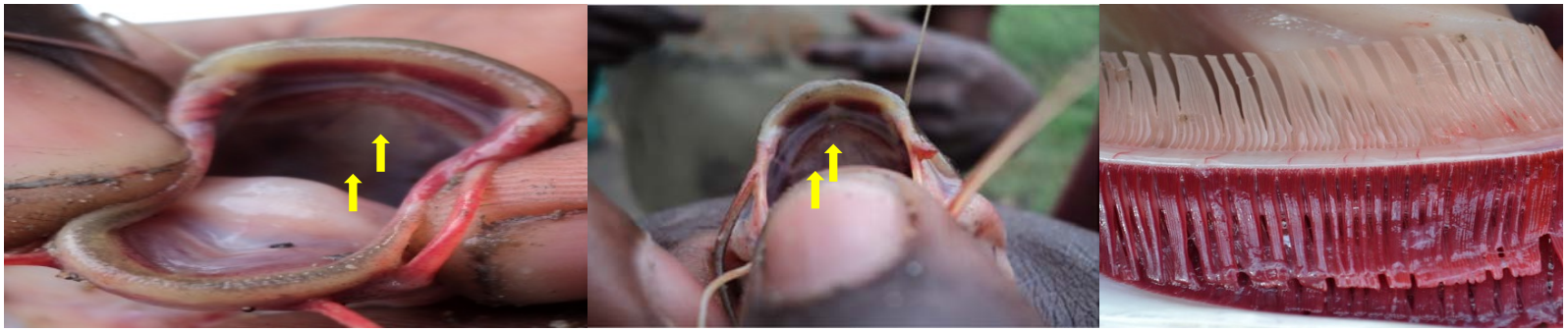
PHASE 1: Identification (Meristic Traits)

- Morphometric and meristic traits
  - Vomerine teeth
  - Number of gill rakers on the first branchial arch
  - Correlation between gill rakers and standard length



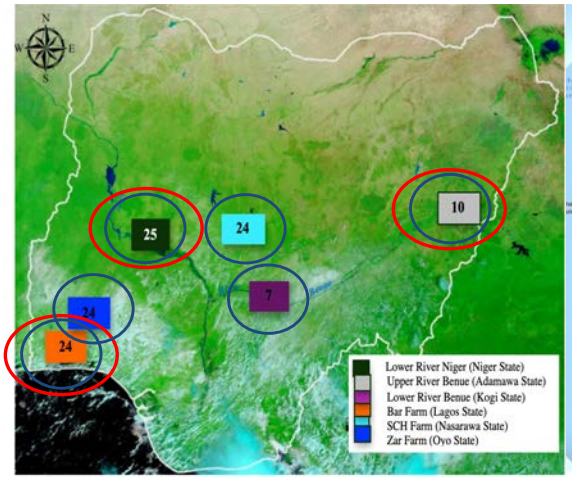
C. anguillaris has no gaps while *C. gariepinus* has gaps

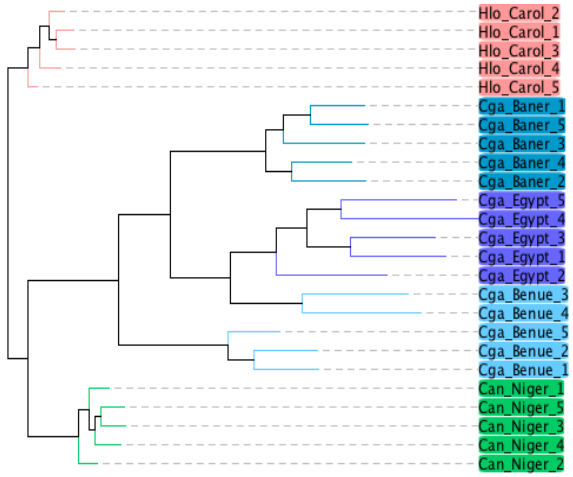
C. anguillaris = 16 - 50 and C. *gariepinus* = 25 - 110

IDENTIFICATION (Molecular Technique)

- Karyotypes – 2n = 54 or 2n = 56
- Allozymes, microsatellites and mtDNA all non-diagnostic and validation with phenotype were not always 100% accurate
- What next in the face of speculations about the Dutch strain and conservation issues?
  - SNP – using Double-Digest RADSeq??

Next-Generation Seq. ddRADSeq

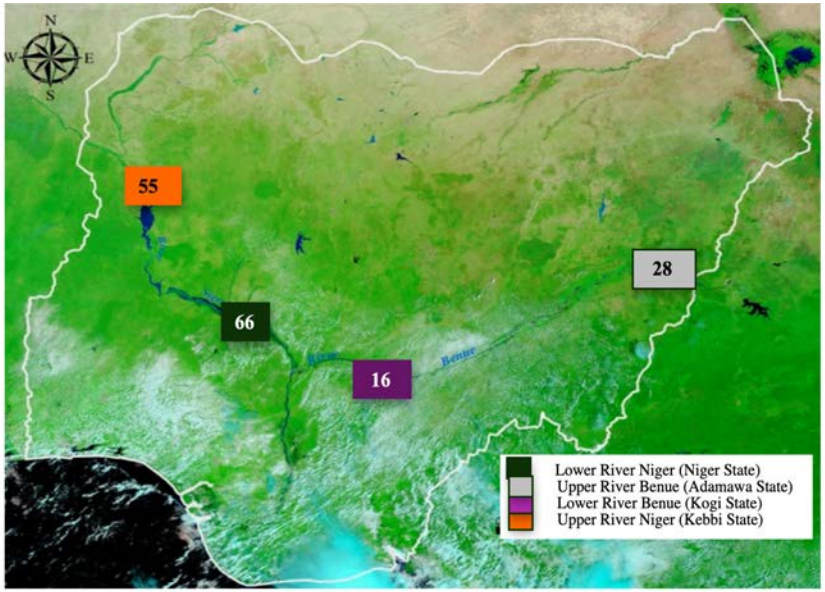




- SNP – using Double-Digest RADSeq?? YES
- 24 Diagnostic SNPs were identified
- Based on 126 markers (349 SNPs)
- KASP Assay validated 100% of the sequenced *Clarias* samples

- Vomerine teeth didn't agree with genotype, hence resampling noting other phenotypes

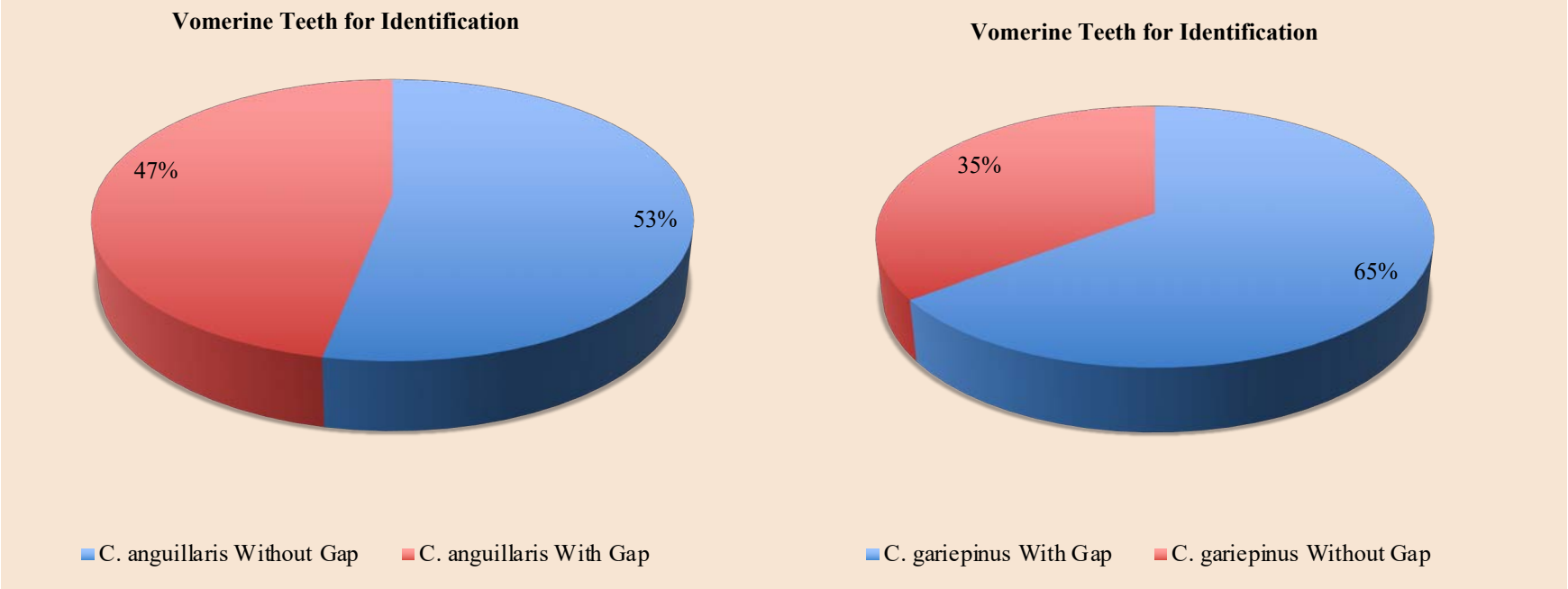
Resampling For Correlation With Meristic Traits



- Putative *C. gariepinus* samples from all the six countries grouped together
- All farmed stock in Nigeria and Dutch strain from The Netherlands, Poland and Hungary aligned with the wild *C. garieinus* from R. Niger, R. Benue and Egypt

- Resampling noting other phenotypes
  - Ray on the first branchial arch
  - Standard length & rays in the dorsal fin
- A total of 298 fish were genotyped

Correlation With Vomerine Teeth



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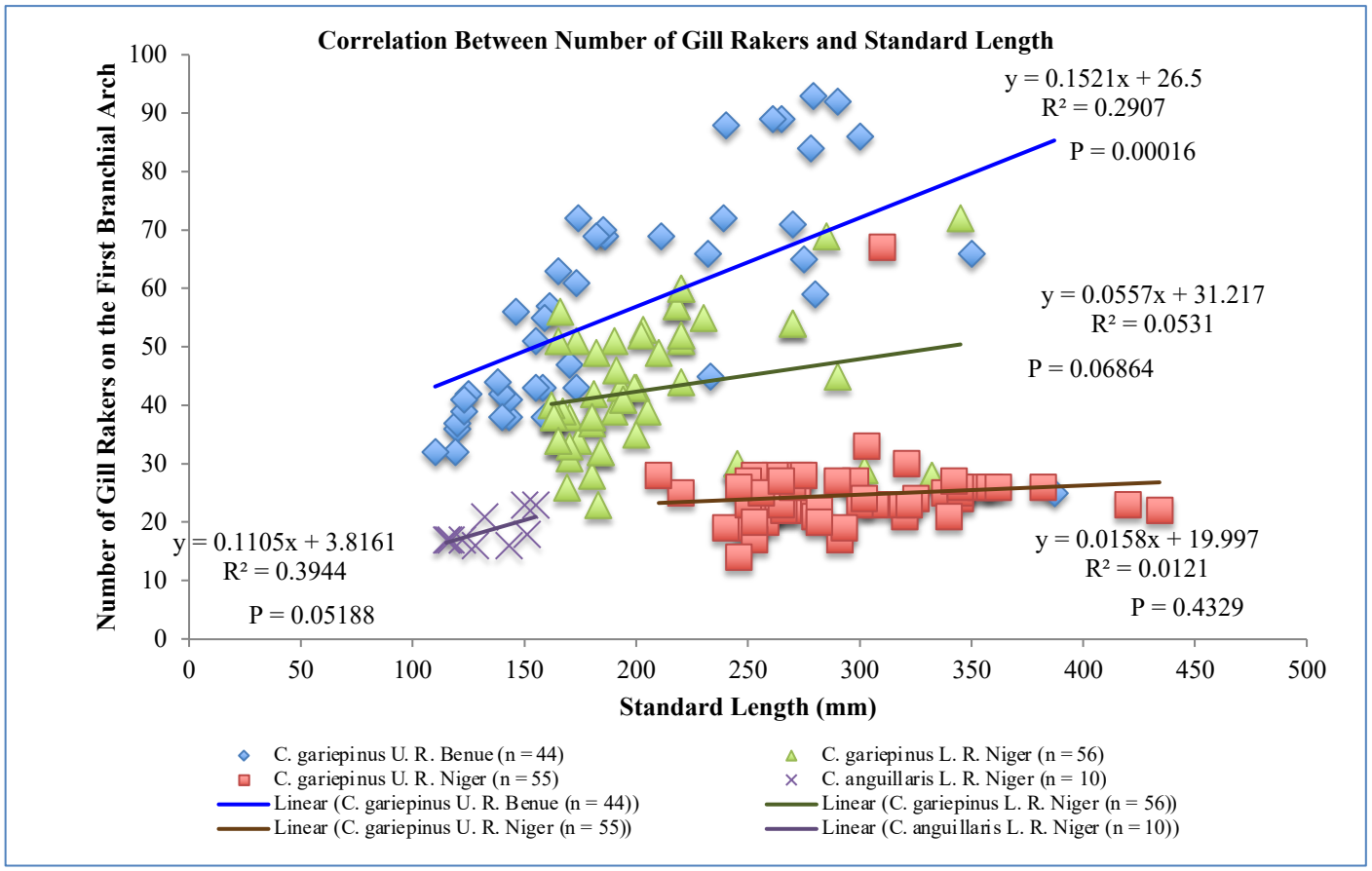
Correlation With Gill Rakers & S. Length



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PHASE 2: Survey Of Hatchery Practices

- Inadequate supply of good quality fish seeds (fingerlings, juveniles) and broodstock
- Limited knowledge on the genetics and genetic management of different strains/populations of this spp. within and between different countries

- As a requisite for setting up a genetic improvement programme, this study aims at evaluating the current practices, problems and prospects of hatcheries

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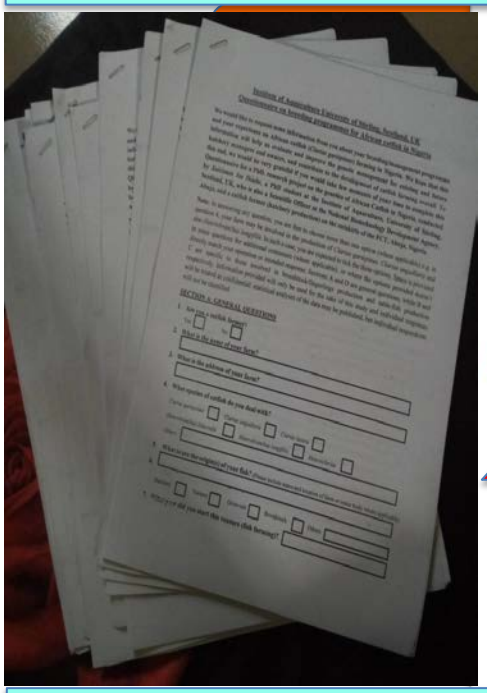
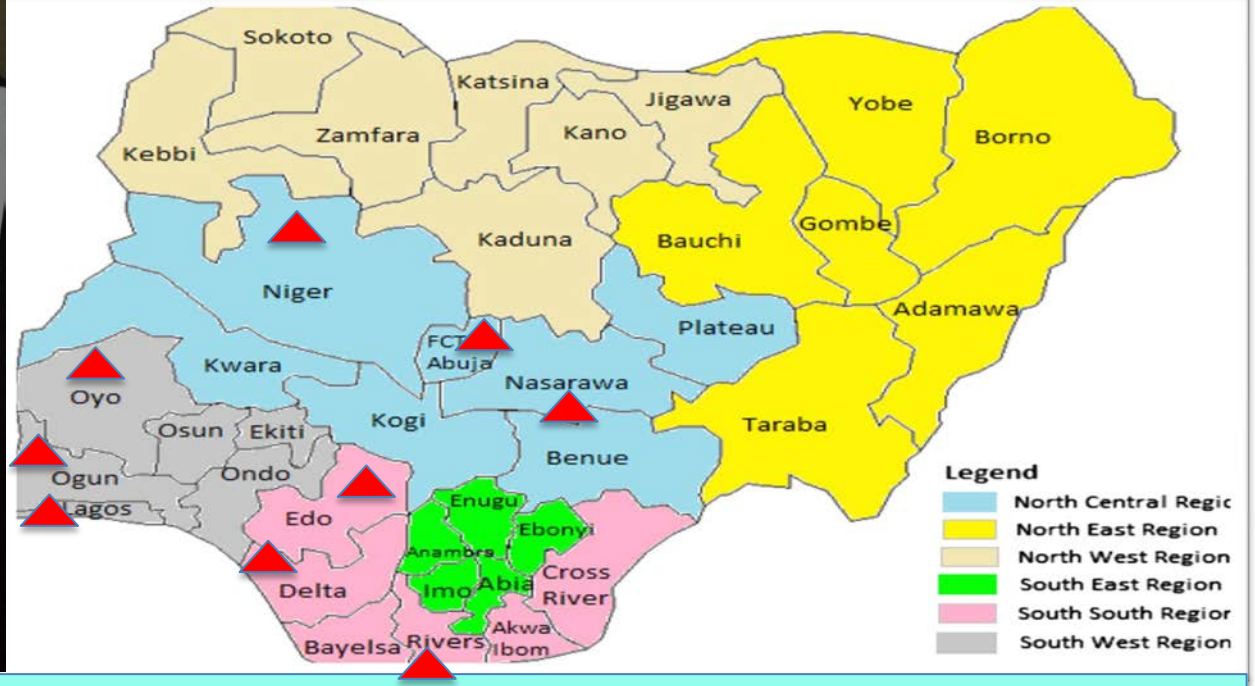
Methodology

A questionnaire containing 150 questions was prep. & administered to 47 farms

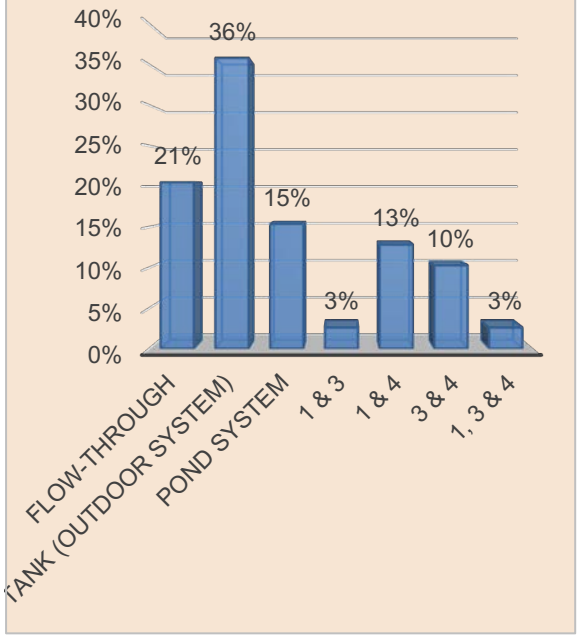




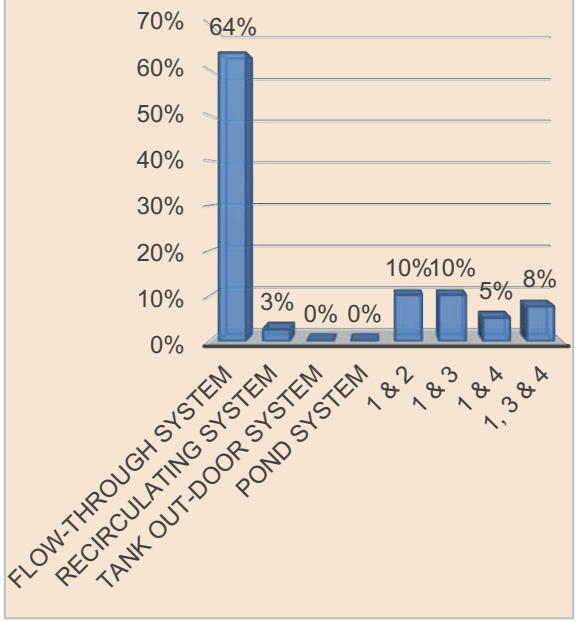
Statistical Analysis: Responses were coded and analysed using MS Excel

Culture Systems

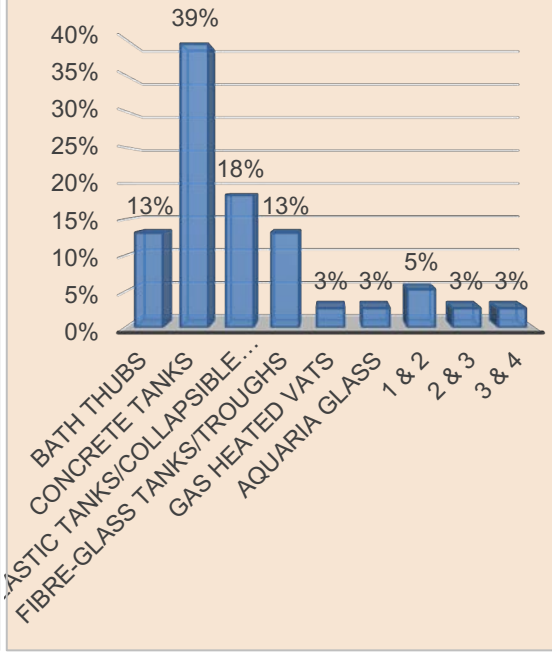
Broodstock culture systems



Types of hatchery systems

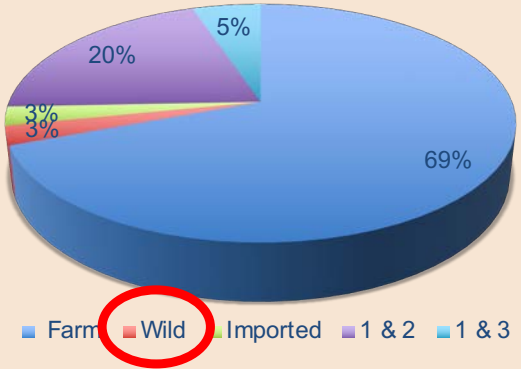


Types of hatching trough

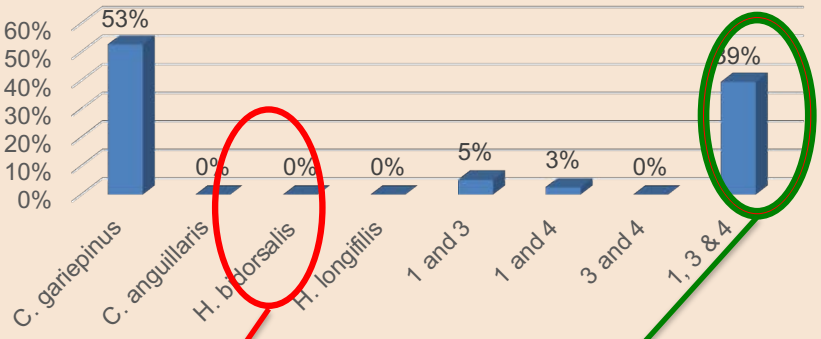


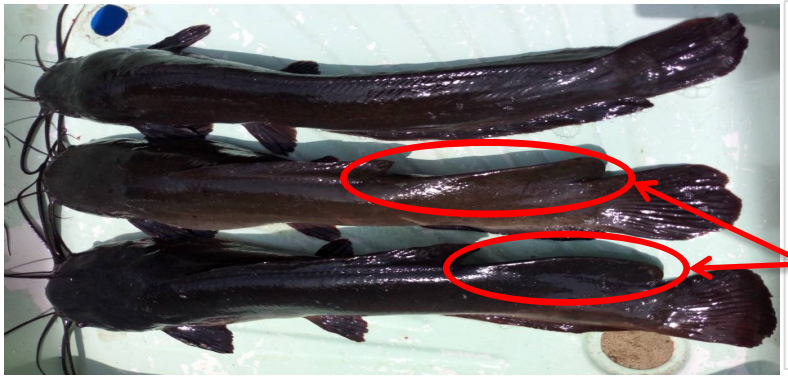
Broodstock Types & Origin

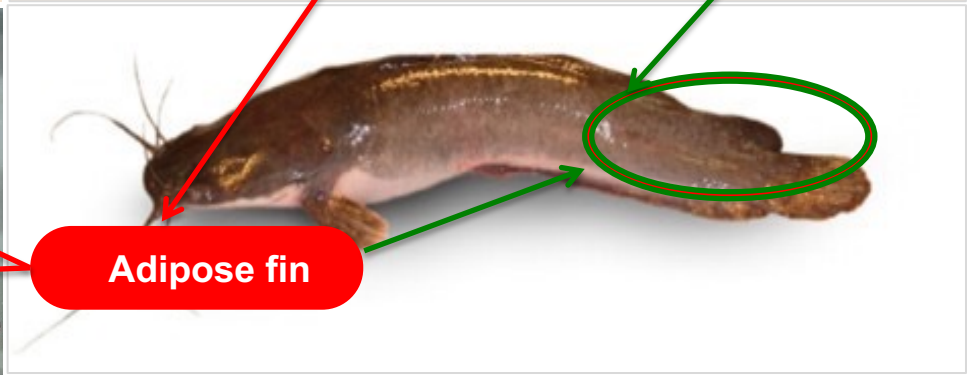
Origin of broodstock



What species of catfish do you deal with?

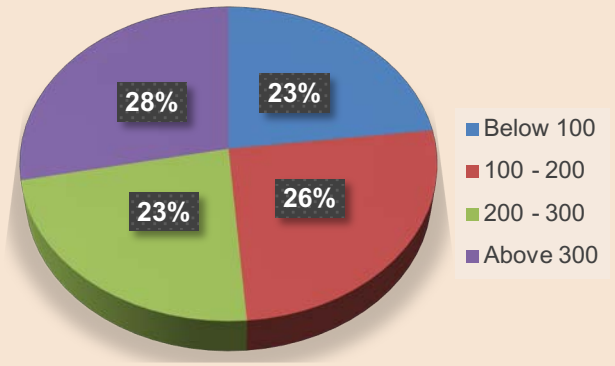




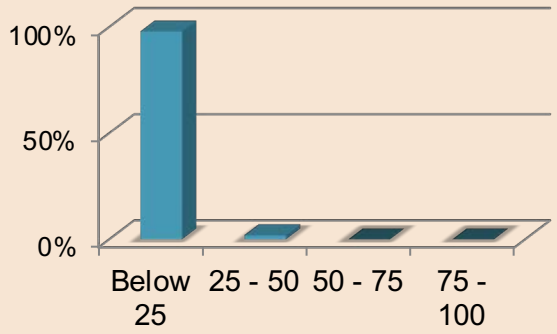


Mating Designs

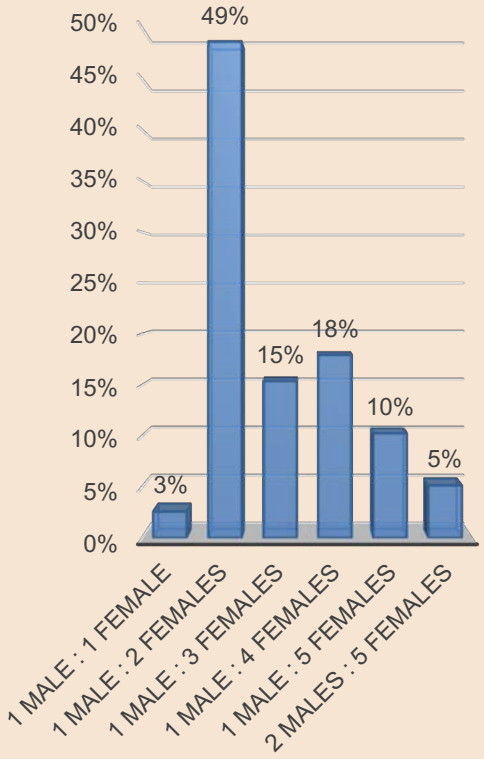
Number of broodstock/year



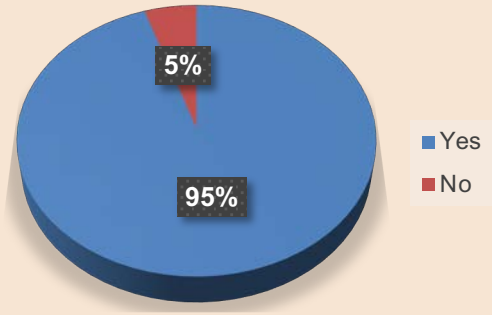
Number of Families Contributing



Mating ratio (Male : Female)



Do you reuse your broodstock?



300 Broodstock

↓

25 Families

↓

Skewed sex ratios results to reduced Ne and increased C. of inbreeding

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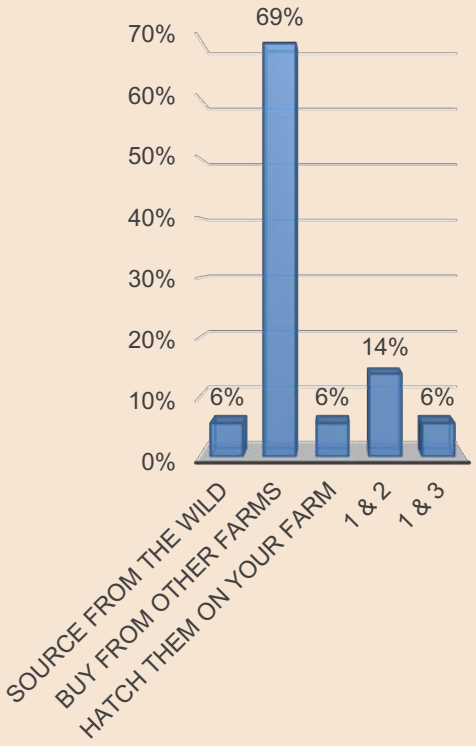
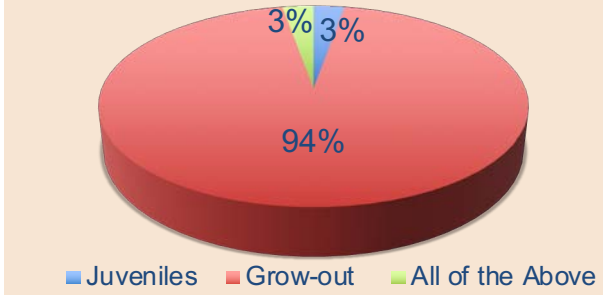
Broodstock Replacement

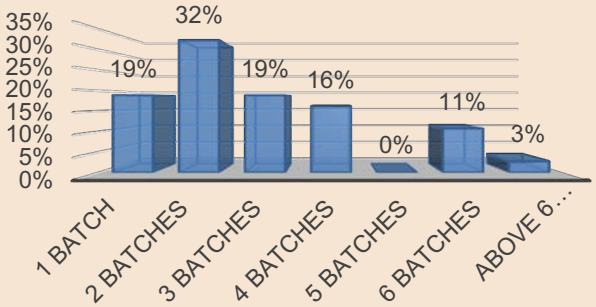
Where is you broodstock sourced replacement?



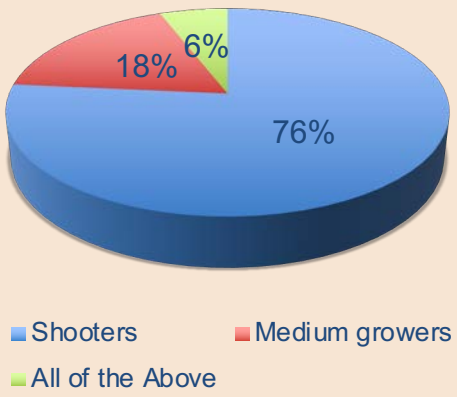
Stage at which broodstock are selected for replacement



How many batches contribute to broodstock replacement?



Group from which broodstock are selected



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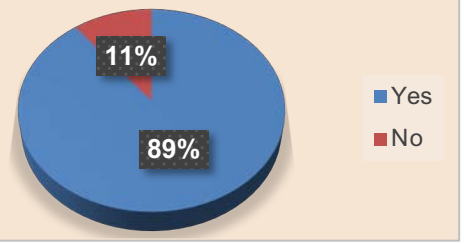
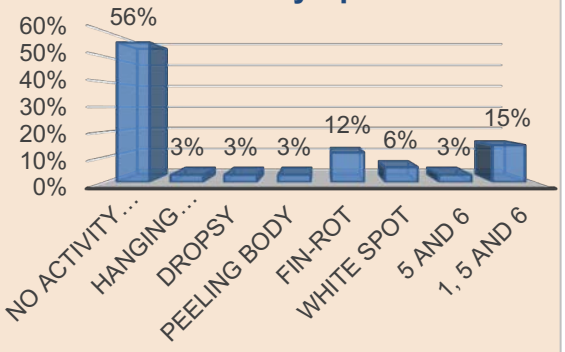
Hatchery Practices Mortality

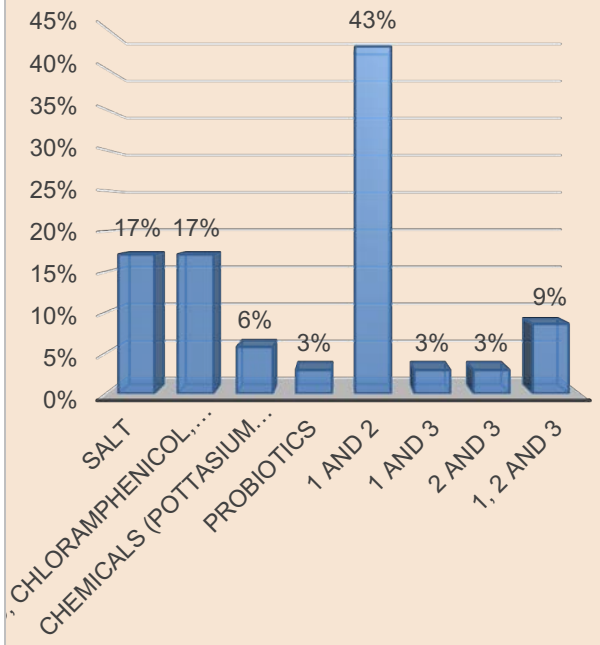
Do you experience mortality?



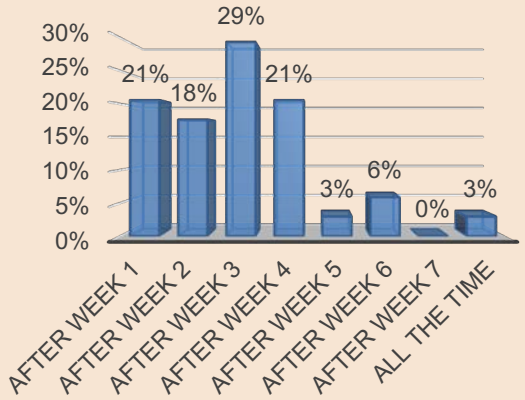
Observed symptoms



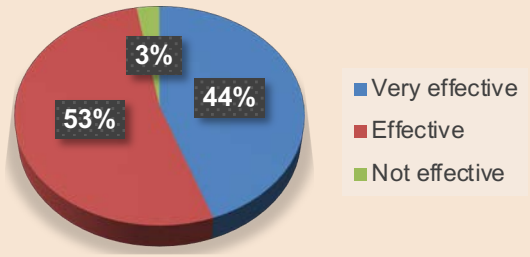
Treament applied



Stages at which mortality mostly occur



Efficacy of treatment in farmers' opinion



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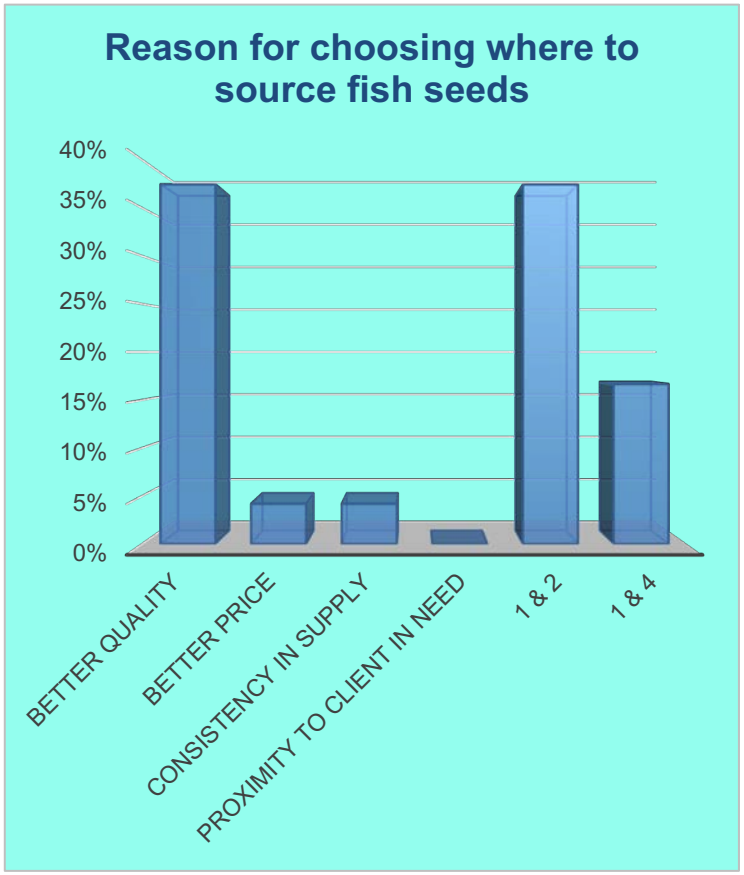
Other Issues

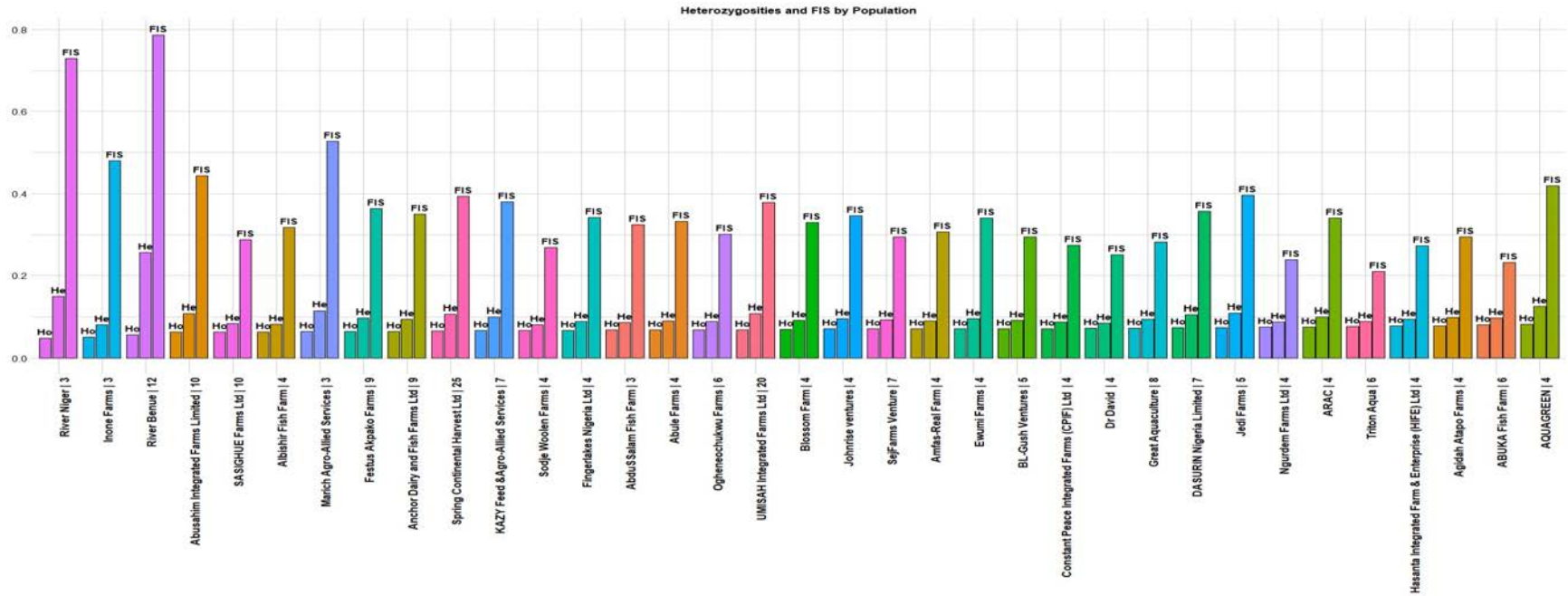
- ✓ Aquaculture Increasingly becoming peri-urban
  - ✓Increased popularity of plastic /collapsible tanks
  - ✓Proximity to market, security and electricity
  - ✓77 % of hatcheries used underground water
- ✓ A large number of hatcheries partake in others aspect
  - ✓No regulation and license required to start-up
  - ✓Many graduated from grow-out to hatchery & only 10% of respondents produce only fish seed
- ✓ Fish feed sellers position themselves as fish seed traders
  - ✓38% of fish seed sellers choose where to source based on quality, 4% based on price and consistency
  - ✓From grow-out to hatchery & broodstock
- ✓ Traceability and biosecurity models required at all stages
  - ✓84% of traders buy fish from different farms
  - ✓100% of fish traders mixed them when needed for sales



PHASE 3 – Broodstock Evaluation

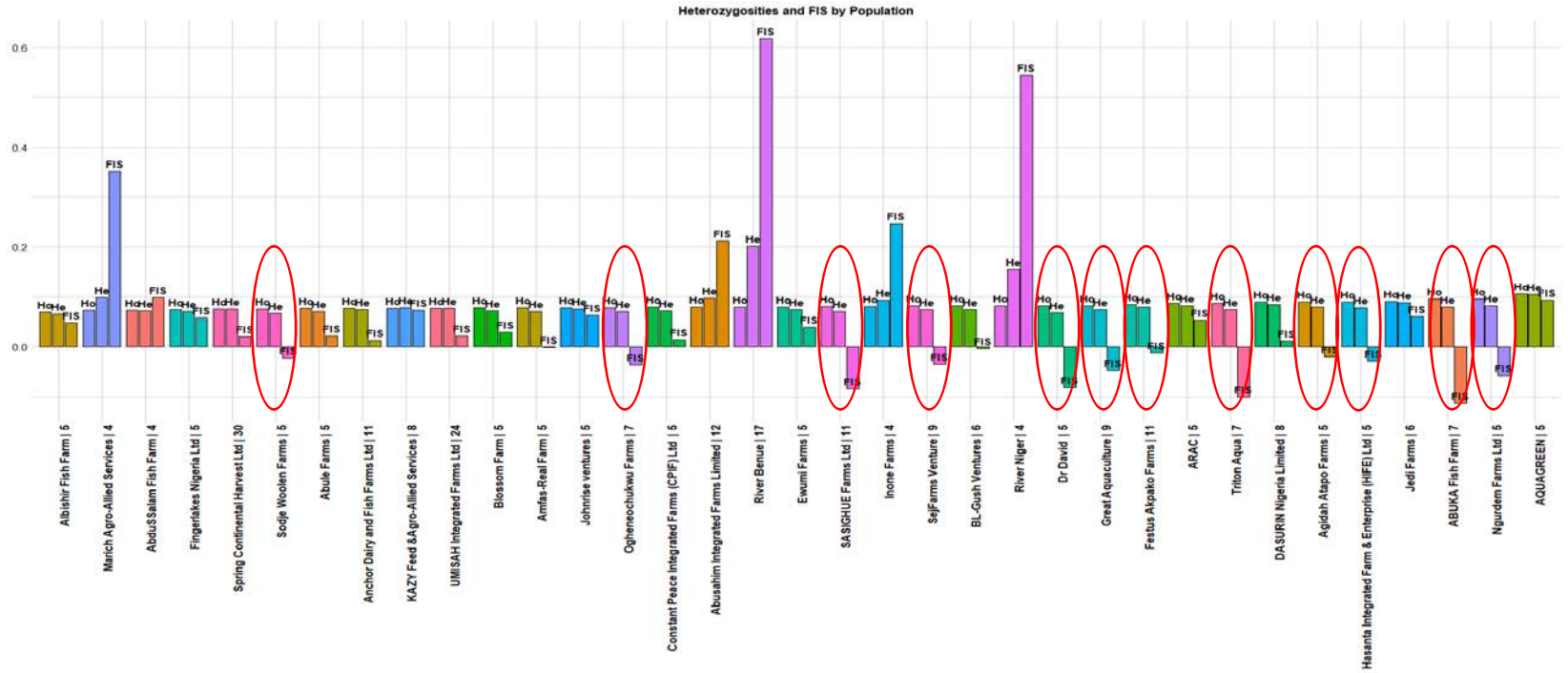
- Objective:
  - to assess the levels of genetic diversity, variation and inbreeding in the farmed catfish
- Methodology:
  - fin-clipping (33 farms and 2 rivers), DNA extraction and sequencing using DArTSeq, analysis using *dartR* package (Gruber *et al.*, 2018) version 2 (Mijangos *et al.*, 2022) in the R software version 4.1.2 (R Core Team, 2022)
- Results:
  - 72,140 loci from 280 individuals, filtered to 6,797 from 276 individuals
  - Average observed heterozygosity: 0.081149 by individual samples
  - Average observed heterozygosity 0.082034 by hatchery/location

HETEROZYGOSITY & FIS by Pop. Unfiltered



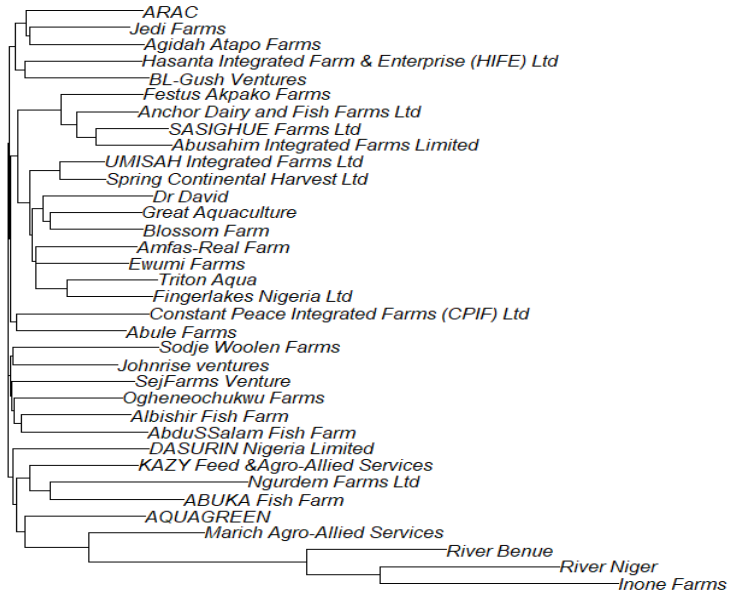
- Average observed heterozygosity: 0.081149 by individual samples
- Average observed heterozygosity 0.082034 by hatchery/location

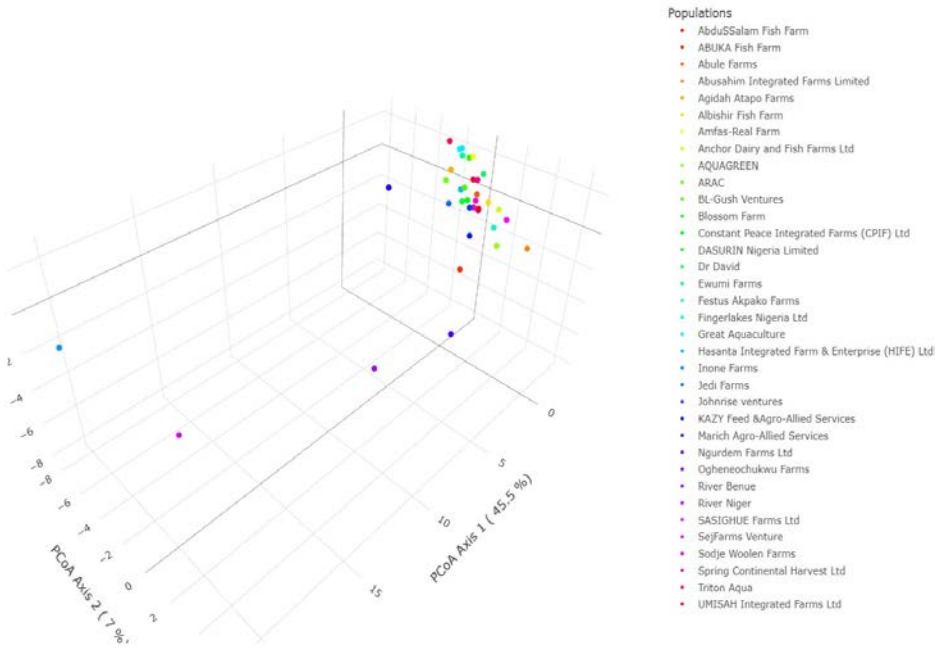
HETEROZYGOSITY & FIS by Pop. Filtered



- Some farms show no inbreeding - good base for sourcing F_0
- Wild strains appear inbred – sampling error and possible family breeding behavior needing investigation

PHYLOGENETIC TREE & PCA





- Wild strain align separately – good variability for genetic improvement

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Summary, conclusion and recommendation

The results of these studies help to inform the development of the first genetic improvement programme for the Nigerian catfish industry

- The Dutch domesticated strain isn't genetically distinct
- Meristic traits unreliable – Need for reliable approaches
- Reduced N_E – Need for genetic improvement programme
- Shooters as broodstock – Need for a scientific basis …….
- Peri-urban nature – Need for GxE research, edu. & license
- Need for adoption of BMP guidelines for catfish hatcheries
- Increased female participation – More opportunities
- Farmed strains are genetically diverse – need for a parallel BP
- Most farmed stocks are inbred – urgent need for a breeding programme

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APPRECIATION

- Dr Sunil Sirwande
- Dr Rohana Subasinge
- Dr Colin Shelly
- Dr John Benzie
- Dr David J. Penman

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Thank You

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