Upgrading the Fisheries Division Hatchery and the development of a Climate Resilient Fish Farm

Community based climate resilience in fisheries sector

Erik Bink, Til-aqua International BV

Content presentation

1. Introduction and project status

2. Short review of The Seed Production Plan (10 min)
   by Eric Bink

3. Upgrading The Fisheries Division's Hatchery (45 min)
   by Jeroen Schuphof – Hanneke van den Dop

4. Development of a Climate Resilient Fish Farm (45 min)
   by Frans Aartsen

Seed Production Plan

short review

Information about seed production plan

Community based climate resilience in fisheries sector

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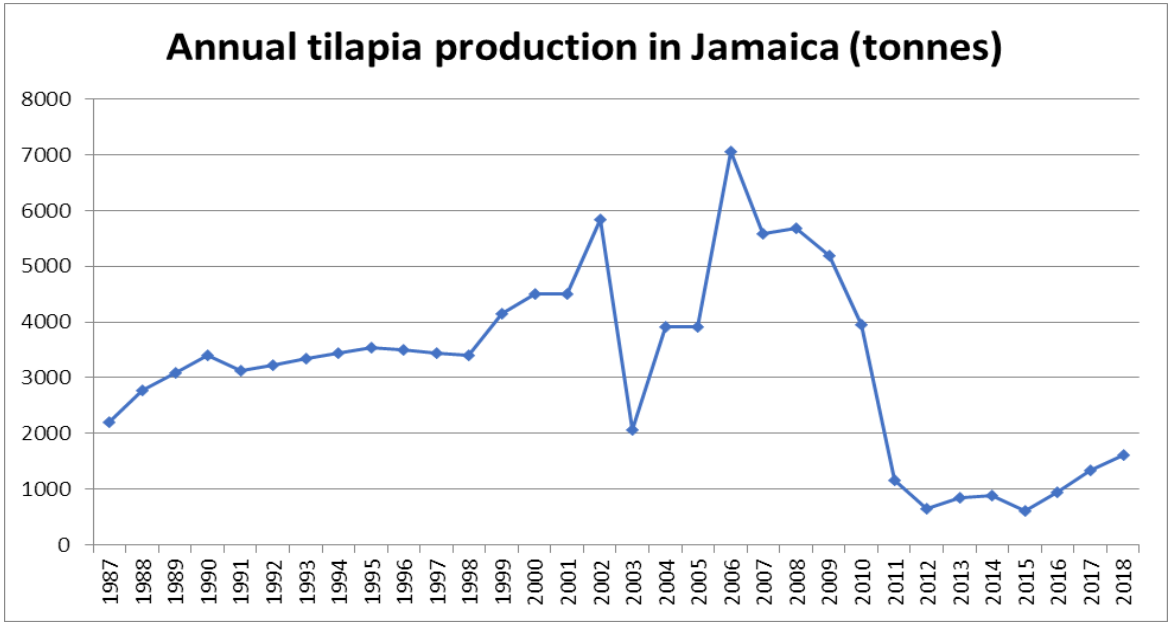
Tilapia production in Jamaica



Comparison between 2011 and 2020 for Jamaican tilapia producers.						
Size	In production	2011	%	2020	%	% Decrease in farmers
Small	0.1-5 acres	115	64	36	78	69
Medium	5-20 acres	38	21	5	11	87
Large	> 20 acres	26	15	5	11	81
		179		46		74

Estimated seed production

3 scenarios based on actual active farmers and their pond surface in use and their available pond surface

Variables	Scenario 1 Extensive	Scenario 2 Semi-intensive	Scenario 3 Intensive
Pond surface in production (acres)	551	660	660
Frequency (rounds/year)	1	2	2
Stocking density (#fish/m^2)	2	2	15
Culling/mortality (%) (From 0.01 to 1.00 gram)	45	45	25
Advanced fry required (mln)	6.5	15.5	116.0

Fry production government hatchery

The production share of the governmental hatchery is arbitrarily determined at **35%**. It results in the following production capacity requirements:

	Scenario 1 Extensive	Scenario 2 Semi-intensive	Scenario 3 Intensive
Fry required (million) in Jamaica	6.5	15.5	116.0
Fry production governmental hatchery	2.25	5.5	40.5

Hatchery design - Goals

- Initial production level for 2021 would be **5 million** 'Advanced fry'
- Partially indoor hatchery constructed above ground
- Enabling easy expansion by modular design
- Decreased water use
- Increased productivity of broodstock
- Decrease labour intensity – less frequent but more efficient and easier harvesting
- Consistent fry production for predictable output and sales
- Use of full Recirculating Aquaculture Systems (RAS)
- Full control over the fish from harvest to sales
- Improved performance of seed and reduction of mortality
- Improved biosecurity in particular with regard to hygiene procedures for persons and materials

Upgrading The Fisheries Division's Hatchery

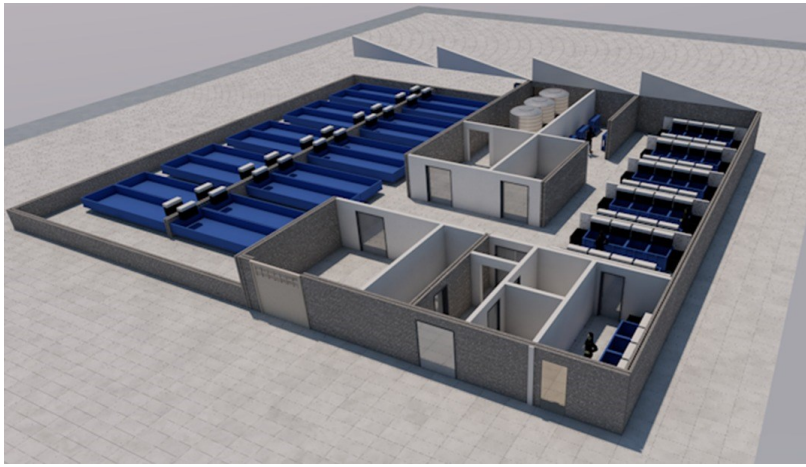
Information about Hatchery Design

Community based climate resilience in fisheries sector

Jeroen Schuphof, Til-aqua International BV

Content of presentation

1. Introduction
2. Systems
3. Lay-out of Hatchery
4. Biosecurity
5. Product-flow
6. Broodstock
7. Production cost price
8. Summary



1. Introduction

The aim is to design a modern climate resilient tilapia hatchery with the capacity to produce 5 million advanced fry/year.

Current:

- Not enough production
- High mortality
- Labour intensive
- Not biosecure
- Leaking ponds
- Poor quality of broodstock

Goal:

- Increase production to 5 million fry/year
- Lower mortality
- Climate resilient
- Biosecure
- Modern
- Modular

2. Systems

Climate resiliant solution: **RAS** (**R**ecirculating **A**quaculture **S**ystems) are **controlled production systems** on which the environment has little effect

Advantages of RAS:

- Low land use
- Low labour
- Low water usage
- **Total Control:**

•Water Quality	→ Optimal growth
• Biosecurity	→ Low risk of diseases
• Parasite control	→ Low mortality
• Treatment	→ Option to take actions
• Grading	→ Uniform batches

2. Systems

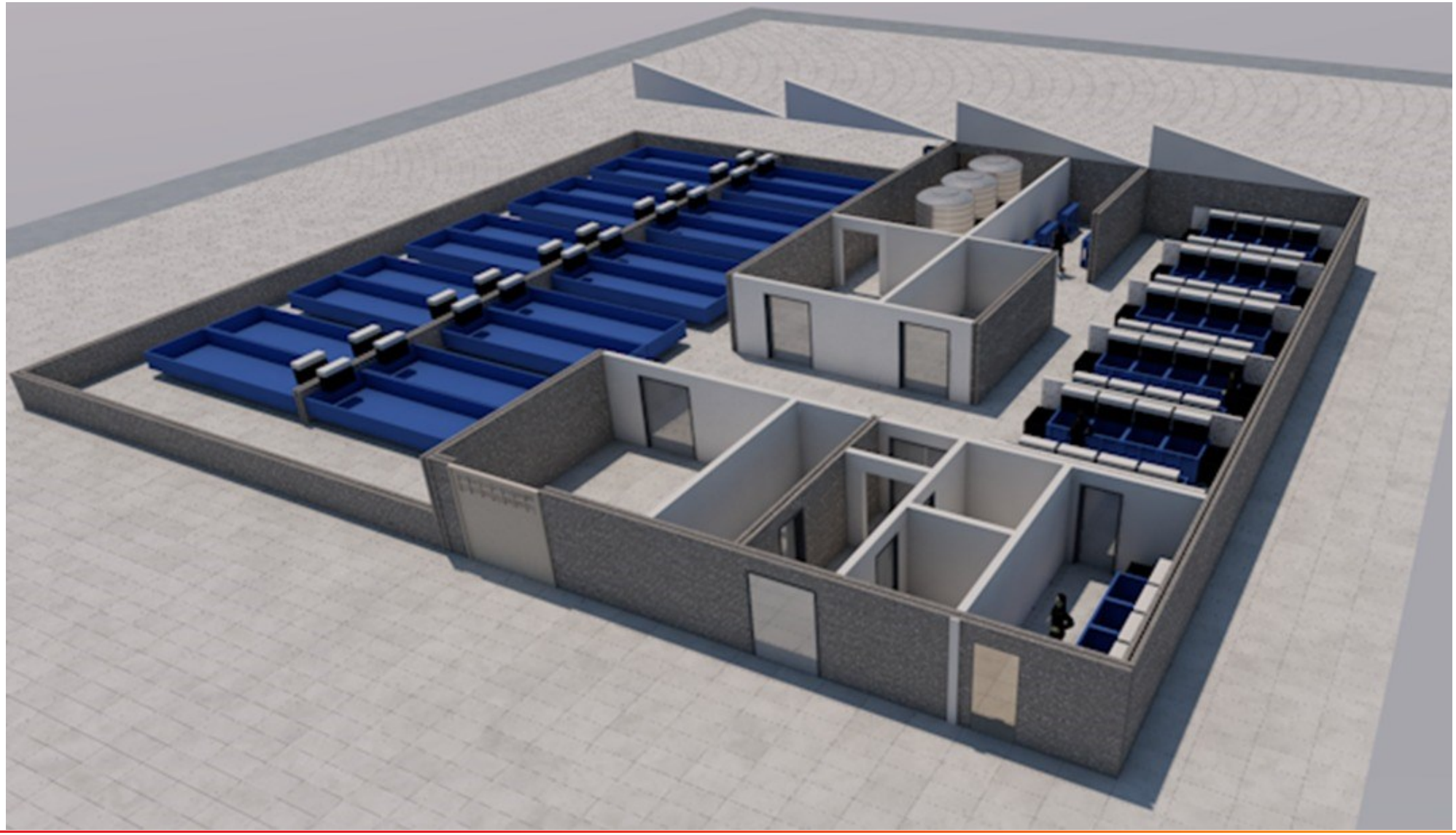
RAS for hatcheries

- Small fish are expensive per kg!
- Small fish → Small system
- Easy to manage:
    - Uniform batches through regular grading
    - Full control → High survival
- Easy to maintain
- Good start is essential for good performance later!
- No influence of weather conditions

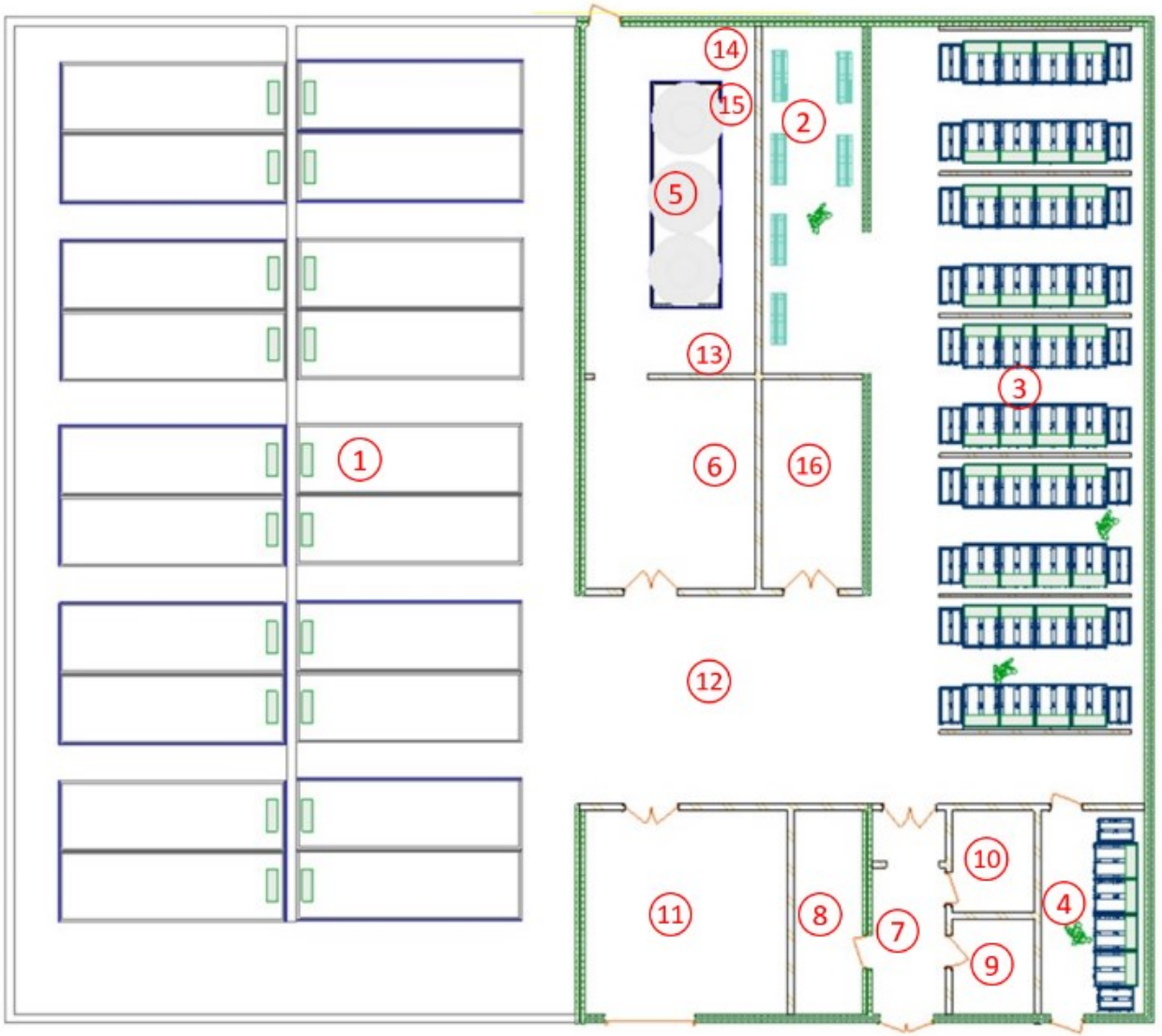
3. Lay-out: Site

3. Lay-out: Site

3. Lay-out: Indoor hatchery



3. Lay-out: Floorplan indoor hatchery

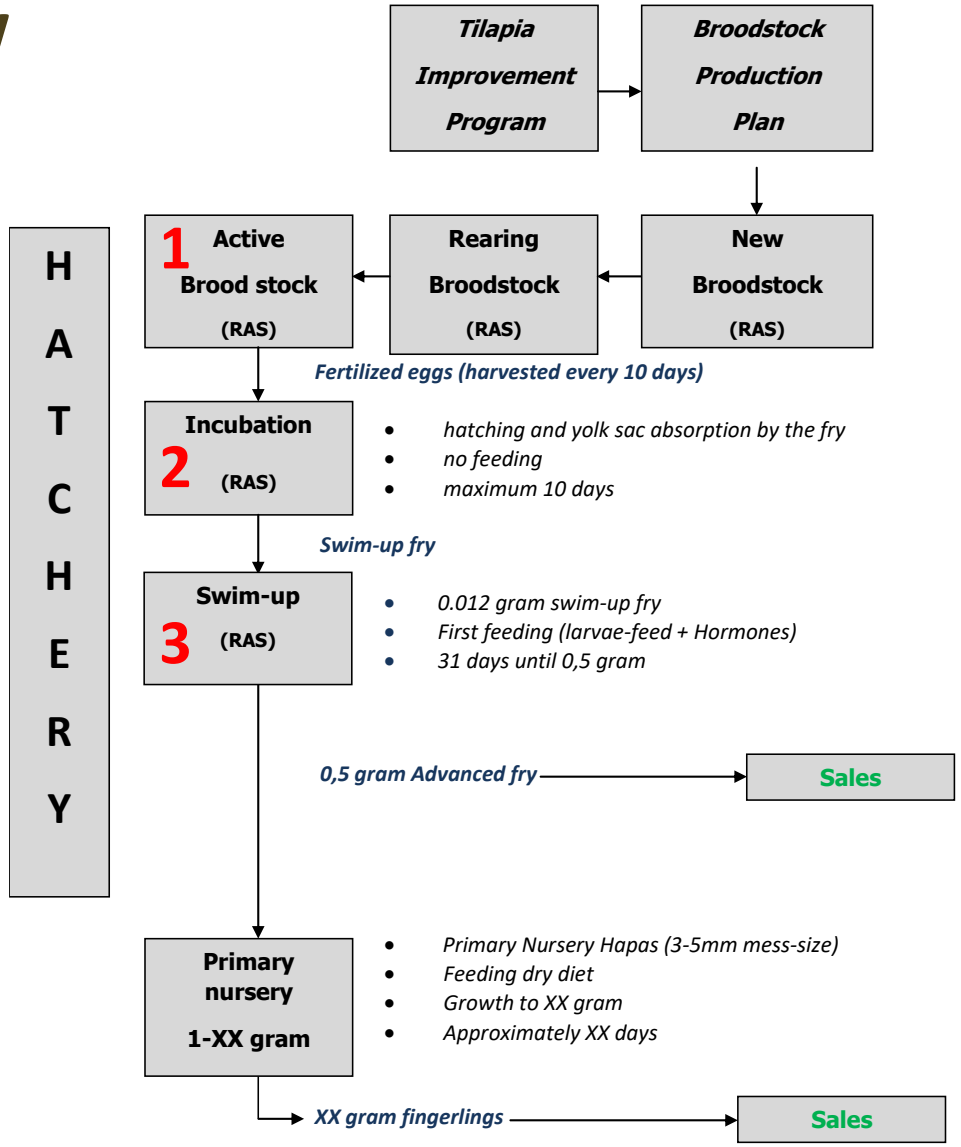


1 = Spawning tanks
2 = Incubation
3 = Swim-up systems
4 = Quarantine
5 = Header tanks/technical room
6 = Wet storage
7 = Entrance + Hygiene barier
8 = Laboratory
9 = Small (feed) storage
10 = Locker-room
11 = Sales/packing area
12 = Space for grading
13 = Electrical switchboard
14 = Blower
15 = Hydrophore
16 = Place for small equipment

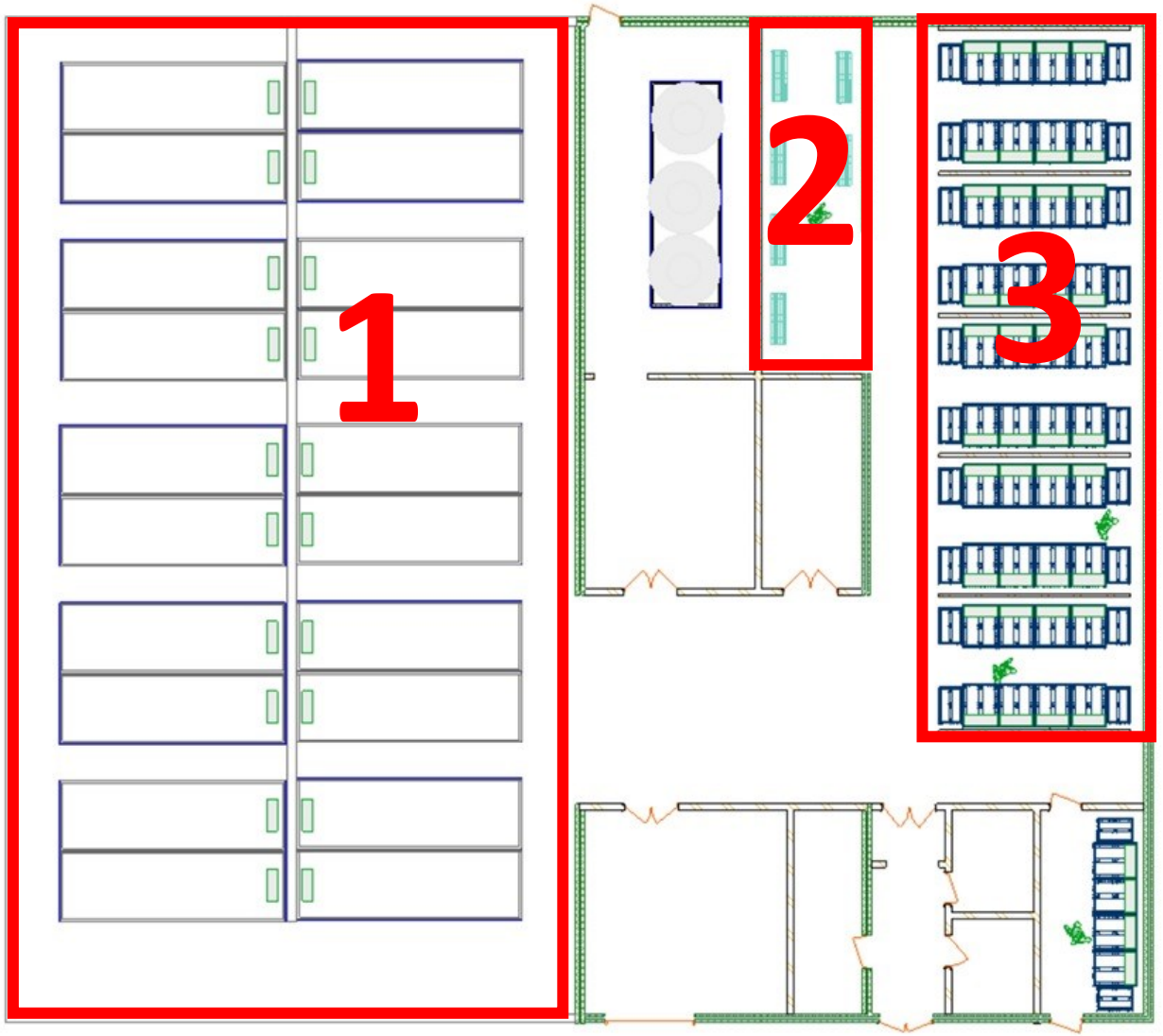
4. Product flow

Focus on:

- Spawning (1)
- Incubation (2)
- Swim-up (3)



4. Product flow



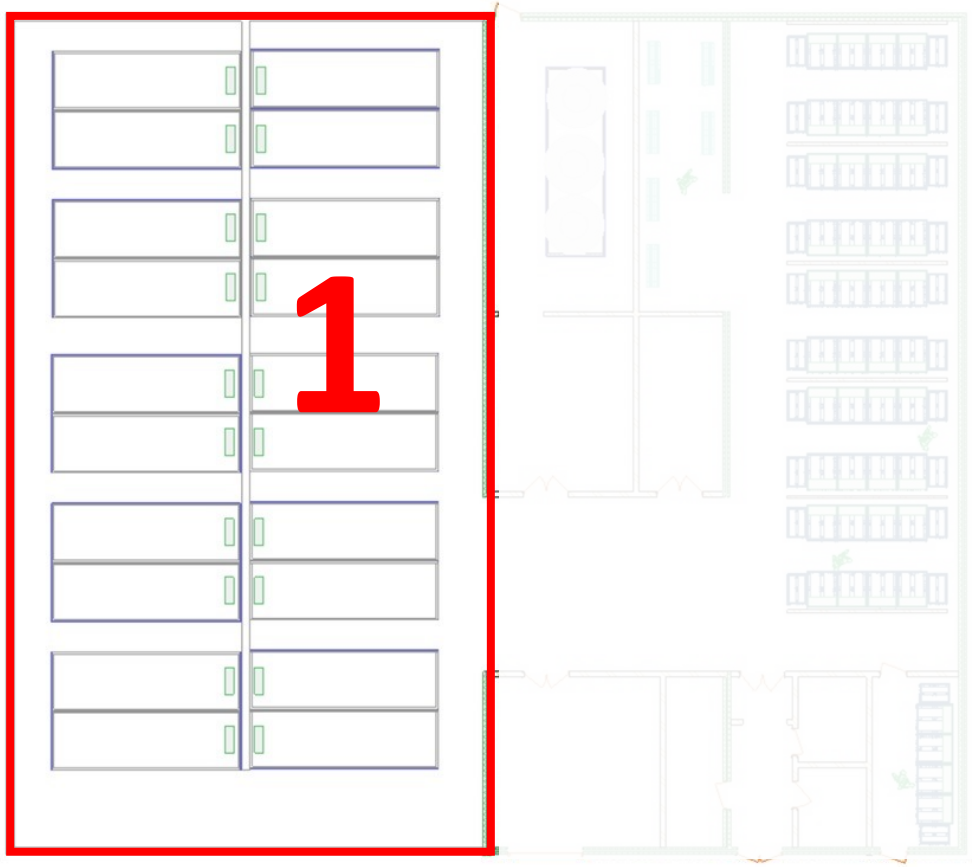
1 = Spawning

2 = Incubation

3 = Swim-up

4. Product flow: Spawning

- 20 Spawning tanks of 20 m^2 each
- Harvest eggs every 10 days
- Production of 12,500/m^2/year



4. Product flow : Spawning

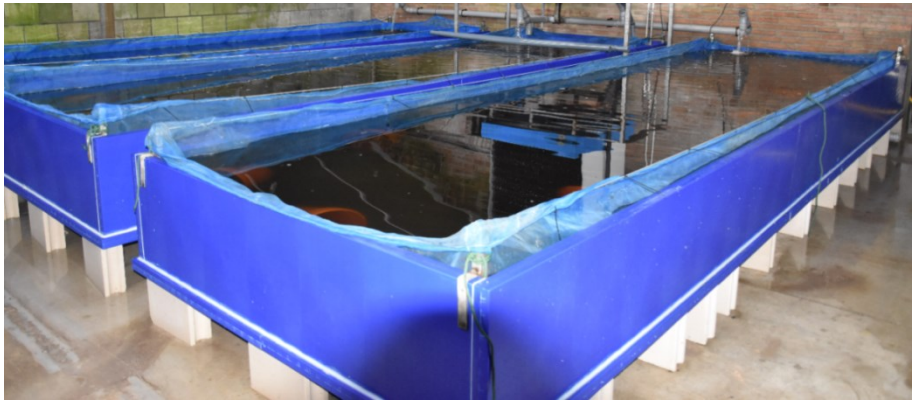
Specifications:

Artificial tanks (concrete or PE)
Hapa of 2.5 x 8 x 1.1 meters
Spawning surface: 20m^2
Water volume: 15m^3

Stocking:
Depending on size of broodstock
1 set/m^2 (equals 1 kg/m^2)

Harvesting:
Every 10 days egg/larvea collection

Production:
7,500 fry/tank/harvest



4. Product flow : Incubation

6 incubation units with 3 hatching jars each
Distinction in developmental stages of eggs
All-In All-out

4. Product flow : Incubation

Recirculating Aquaculture System

Specifications:

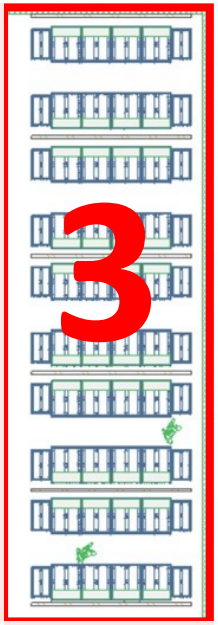
- 3 “McDonald” incubation jars
- 1 Sedimentation tank with filter blocks
- 1 Submergible pump
- 1 UV light

Water volume: 400L

40,000 eggs/jar
All-in → All-out
Easy to manage

4. Product flow : Swim-up

20 Swim-up systems with 2 tanks each



4. Product flow : Swim-up

Recirculating Aquaculture System

Specifications:

- 2 HDPE fish tanks (1.2m x 1.0m x 0.76m)
- 1 Sedimentation tank with filter blocks
- 1 Submersible pump
- 1 UV light
- 2 Bio-towers with distribution plates

Water volume: 1.200L
Electricity: 115 Watt

40,000 swim-up fry/tank
All-in → All-out
Easy to manage

5. Broodstock

Current production of broodstock is very low and needs to be improved

Better feeding: special broodstock feed

Faster replacement of broodstock

Better water-quality in small concrete spawning tanks with biofilter

Tilapia Improvement program:

- New local genetics to improve genetic variation
- Selection of new generation of broodstock each year
- Better performance each generation: >10% improvement on growth per generation

6. Biosecurity

Biosecurity: essential for fish health

OIE establishes the standards for biosecurity

WTO members recognize the OIE standards -> Jamaica WTO member since 9/3/1995

Current status government hatchery: especially lack of hygiene procedures

New design hatchery:

- Modular
- Indoor hatchery from spawning to advanced fry
- Completely controlled and focussed on hygiene procedures
- Training staff and employees; regular review and update of protocols

6. Biosecurity

Biosecurity measures focussed on:

- **Watersource:** indoor hatchery sand filter and UV

  -> insure high larval survival

- **Fish movement:** risk to (introduce) and spread diseases within or off the farm

  -> all-in all out; only healthy well graded fish to customers

- **Health and husbandry:** optimum health -> optimum resistance

  -> minimize stress; proper nutrition; monitor frequently;
  remove (and bury) dead or dying fish; record keeping

- **Farm traffic:** disease transmitters are **persons**, animals, vehicles and equipment

  -> fences; restricted areas; entrance, clothing and hygiene protocol for persons;
  footbaths; wheel bath for vehicles; prohibition for domestic animals; rodent
  control plan

- **Cleaning and disinfection:** protocols to avoid disease transfer between or within units

7. Production cost price

Production cost price (JMD)	fry / piece (0.5 gram)	%	fingerling /piece (5 gram)	%
Broodstock	0.3	11%	3	11%
Feed	0.2	7%	2	7%
Electricity and water	0.4	14%	4	15%
Labour	0.7	25%	6	22%
Other	0.1	4%	1	4%
Depreciation and interest	0.6	21%	6	22%
Crop tax	0.5	18%	5	19%
Cost price of production	2.8	100%	27	100%
Sales price	4.0	142%	40	148%

Sales of 5 million fry and 300,000 fingerlings result in:

Total revenu of hatchery: **30.8 million JMD**
Net profit after tax and interest: **9.35 million JMD**

8. Summary

The farming principle which has been selected is **intensive recirculation** in order to minimise the interaction with the environment (maximise controls)

The complete hatchery is modular in design and exists of:

- 2 Lined ponds for the growing up of new parent stock; outdoors
- 2 Quarantine units (RAS) with sedimentation tank and bio-towers; indoors
- 20 Spawning units (RAS) with small bio-towers covered by shade nets
- 6 Incubation units (RAS) with sedimentation tank; indoors
- 20 Swim-up units (RAS) with sedimentation tank and bio-towers; indoors
- 2 Lined ponds for fingerling and juvenile production; outdoors

Labour→ only 7 people to run total hatchery for 5 million fry year

Survival→ with RAS survival is >90%

Production cost is 2.8 JDM/Fry

Total investment: 48million JMD → Net profit after tax and interest: 9.35 million JMD

Development of a Climate Resilient Fish Farm

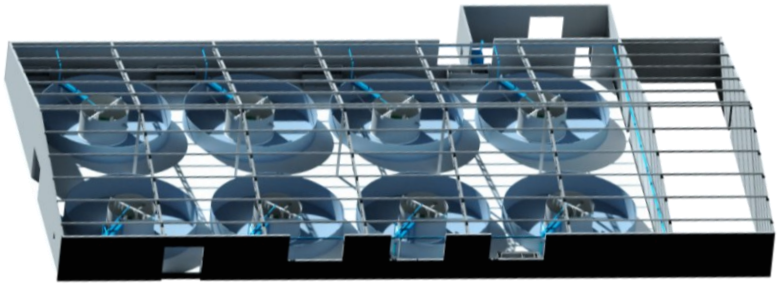
Information about Fish Farm Design

Community based climate resilience in fisheries sector

Frans Aartsen, Holland Aqua BV

Content of the presentation

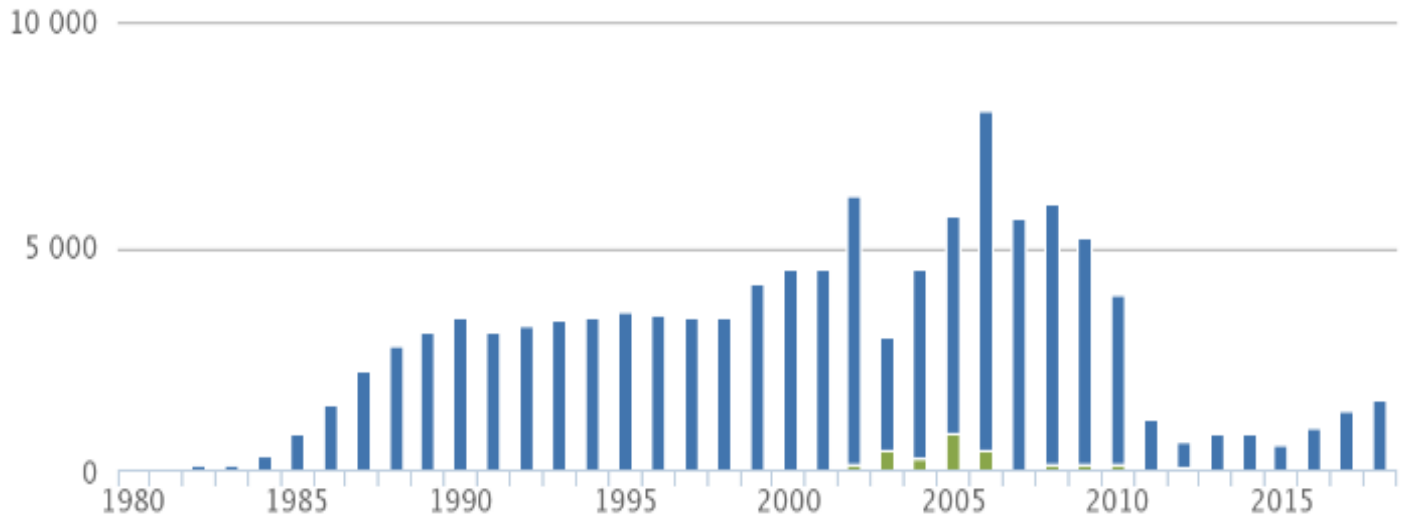
1. Introduction, objective of the design phase
2. Sector specifications to define farm capacity
3. Comparison of possible farming systems
4. Climate factors and mitigation routes
5. Farm specifications
6. Financial overview
7. Summary of climate-resilient farm design



1. Introduction

The aim is to formulate a climate-resilient and sustainable farm concept that can be technically and financially verified against actual farm conditions in Jamaica.

This final study contains a technical and biological design, an operational plan and a business plan.



2. Sector specifications to define farm capacity

Number of farms in Jamaica in 2001, 2011, 2020 with a forecast towards 2030.

indicative numbers	2001	2011	2020	Forecast 2030
Total number of farmers	**400** (100%)	**179** (100%)	**48** (100%)	**45** (100%)
Small farms (1-4 acres)	300 (75%)	115 (62%)	29 (60%)	15 (33%)
Medium farms (5-20 acres)	76 (19%)	38 (21%)	11 (23%)	10 (22%)
Large farms (>20 acres)	**24** (6%)	**26** (14%)	**8** (17%)	**10** (22%) (+20)

Indication of the total production, divided over the 3 classes of farms in Jamaica.

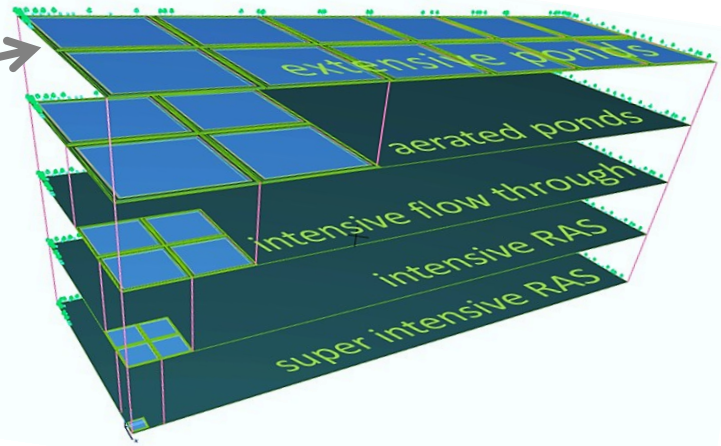
indicative volumes tons /y	2001	2011	2020	Forecast 2030
Total output tons / year	**4450** (100%)	**1152** (100%)	**1600** (100%)	**5000** (100%)
Small farms tons / year	500 (11%)	150 (14%)	100 (7%)	100 (3%)
Medium farms tons / year	950 (22%)	150 (14%)	200 (13%)	400 (9%)
Large farms tons / year	3000 (67%)	800 (72%)	1250 (80%)	**4400** (88%)

The conceptual design of the resilient farm is based on a production capacity range of the **medium type of farm (5 - 50 tons /year).**
For Small farmers a step forward, for Medium farmers securing climate resilient production and for Large farmers exploring new technology that may be useful.

3. Comparison of possible farming systems

Footprint of farming technology for production of 12.000 kg fish	Extensive ponds (no aeration)	Aerated ponds (part of the time)	Flowthrough or aerated tanks	Intensive RAS aerated ponds	Super-intensive RAS tank system aerated
Number of ponds or tanks	12	4	4	4	1
Ponds or tanks size m^2	4.000	4.000	1.000	250	100
Total area m^2	48.000	16.000	4.000	1.000	100
Total area hectares	4,8	1,6	0,4	0,1	0,01
Productivity $kg/m^2/year$	0,25	0,75	3	12	120
Water consumption m^3/kg	**22**	**24**	**49**	**1,2**	**0,4**
Investment land USD 2 $/m^2$	96.000	32.000	8.000	2.000	200
Investment culture volume	156.000	52.000	43.000	10.750	10.325
Capex farm volume/kg	**13,0**	**4,3**	**3,6**	**0,9**	**0,9**

Compare: Footprint, Water consumption, Farm investment in USD / kg capacity

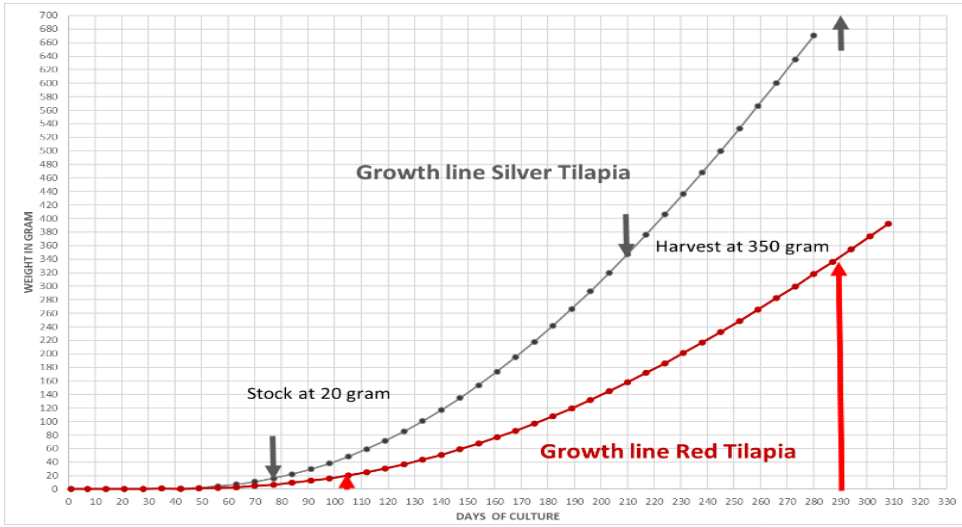


4. Climate factors and mitigation routes

Topic	Consideration	Measures to be included to make resilient farm design
1) WATER	Water saving > 90%	Water recirculation with physical & biological filtration
	Reduce evaporation	Smaller footprint / more intensive farming
	Secure intake water quality	Use of borehole water
	Minimise consumption rate	Target for <1 m^3 / kg fish
2) WIND	Wind breaking	Wind shielding, dikes and trees
	Wind proofing	Superstructure indoor construction or cover
3) RAIN	Erosion	Use pond liner, wall protection or concrete
	Flooding	Overflow, secure enough drains
	Escaping fish	Fenced overflow, prevention
4) ELECTRICITY	Secure supply	Generator to backup grid power
	Price and usage	Use low energy consumption equipment
	Alternative source	Solar
5) LOSSES	Praedial Larceny	Reduce area to secure (prevents 5-10% losses)
	Predation	Reduce bird foraging (prevents 20% loss)

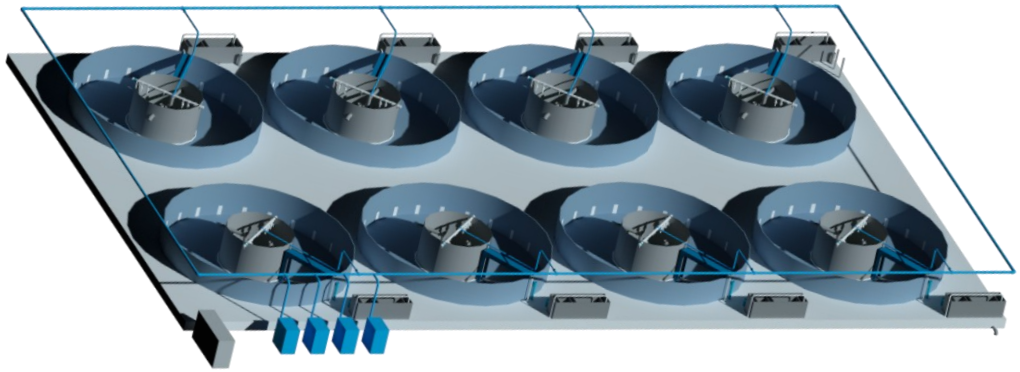
4. Farm specifications

Topic	Unit	Actual production level 2020, according to field reports Jamaica	Proposed production schedule for the resilient farm
Pond size	Ha	0.5 – 1.0 (5000-10000 m^2)	0.05 – 0.01 (tanks of 50 m^2)
Growth	grams	20 - 350	20 - 350
Days of cycle	days	180 -210	150
Density	#/m^2	2 - 3 (**max 0,6 - 1** kg/m^3)	170 (**max 60 kg**/m^3)
Survival	%	50 - 70%	85 - 95%
FCR	-	1.4 - 2.5	1.2 - 1.4
Yield	kg/m^2/y	0.75 - 2.5	120
Cycles	#/year	1-2	2.4
Water usage	m^3/kg fish	20	0.4 - 1



5. Farm specifications

Investment	
Building and infrastructure	13,720,000
Growout hardware	27,552,000
Farm investment (net value)	**41,272,000**
Farm working capital	**9,593,383**



Type of farm : 8 tank (50 m^3) Recirculation Aquaculture System (RAS)

Superstructure : Framework with coated steel plate cover, or canvas liner

Type of tank : 8 x corrugated steel frame with aqua liner

Oxygenation : Fine bubble aeration, low energy roots blowers supporting > 12 kg O2/h

Biofiltration : Moving bed bio reactor (MBBR) for ammonia removal within the tank

Solid removal : Packed sedimentation reactor

Water consumption : 500-750 liter per kg feed

Type of fish : Tilapia red, Oreochromis niloticus **(50 - 350 grams in 22 weeks)**

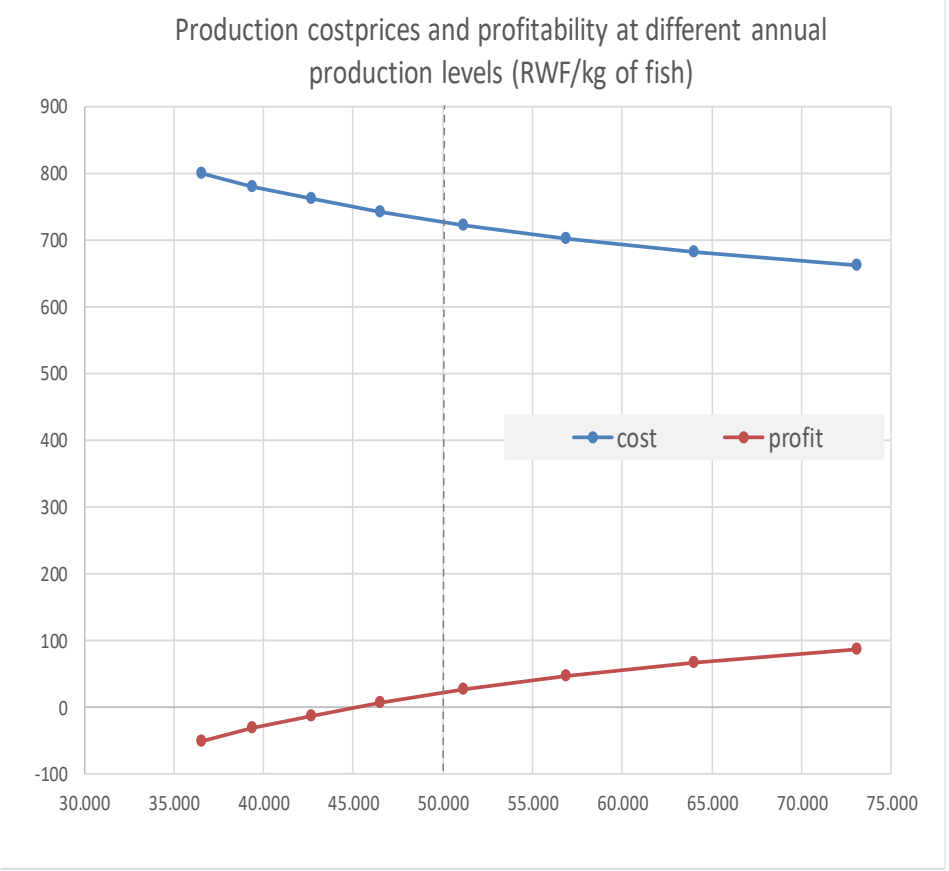
Feed : Daily 8 –36 kg, average 24 kg per tank and 200 kg of feed per day

Output : **Tilapia red, net production 50000 kg, sales volume annual 58000 kg**

6. Production cost price

Production cost prices of market-size fish

Annual production costs	JMD / kg	JMD/Lb	%
Fingerlings	140	64	19%
Feed	205	93	28%
Electricity and water	100	45	14%
Labour	84	38	12%
Others	32	15	4%
Operational costs	562	255	78%
Depreciation	61	28	8%
Interest costs	34	15	5%
Corporate taxes	65	30	9%
Finance costs	160	72	22%
Cost price of production	**722**	**328**	**100%**



7. Summary of climate-resilient farm design

The farming principle that has been selected is **intensive recirculation** in order to minimize the interaction with the environment (no predators, less diseases, maximum controls) and to **prevent impact of changing climate factors** (droughts, rains, floods, tropical storms, rise of sea level).

Main takeaways:

• Footprint	80 x smaller than ponds
• Fish density	60 x higher
• Survival	50% higher
• Growth	20% faster
• Productivity per m^2	75 x higher
• Feed conversion	33% reduction
• Labour intensity	33% reduction
• Water consumption	95% reduction, potential plant fertilizer

- Farm investment JMD 825 / kg capacity, which equals investment level of ponds.

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