How to measure Tilapia Welfare?

Welfare Indicators: measuring and scoring health, environmental, behavioural and nutritional parameters for tilapia

Marius Nicolini
FAI Farms, Project manager-Thailand

Measuring welfare indicators in tilapia farms in Thailand

Dr.Win Surachetpong
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Measuring welfare indicators in tilapia farms in China

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Welfare Indicators: measuring and scoring health, environmental, behavioural and nutritional parameters for tilapia

Marius Nicolini, FAI Farms

June 2023

OUR APPROACH

Develop species specific operational Welfare Indicators, **for health, behaviour, nutrition and environment**

Develop welfare assessment Protocol and App **to help farmers monitor and implement welfare improvements**

Create interactive, free, multi-language online training to **implement welfare in aquaculture, from hatchery to slaughter**

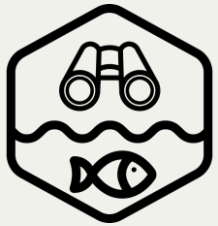
TILAPIA

Welfare assessment protocol

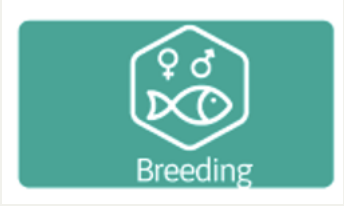
- 10,000 academic articles reviewed (SIGMA methodology)
- Indicators reflecting welfare status
- Publication
- Develop Welfare assessment protocol
    - On-farm tested and validated in Brazil, Thailand and China
    - Metrics reflective of robustness, commercial practicality and ability to utilize data
    - Empowering farmers through self-assessment process

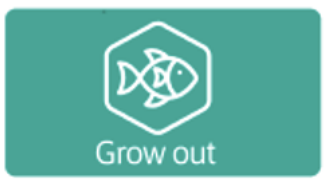
WELFARE INDICATORS






Health	Environment	Behaviour	Nutrition
Eyes Jaws Operculum Skin Fins Gills Spine Ectoparasite Mortality	Temperature pH D.O. Alkalinity NH4 NH3 Transparency Terrestrial predators Interspecific inhabitant	Respiratory Frequency Swimming behaviour Foraging behaviour Recovery from anaesthesia Loss of consciousness	Amount of Feed (% Biomass) Feeding frequency Feeding distribution Condition Factor (K) Protein concentration Feed Conversation ratio

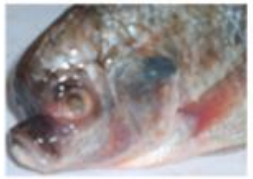




WELFARE INDICATORS - HEALTH

Health

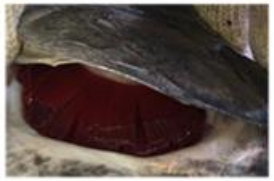
Eyes
Jaws
Operculum
Skin
Fins
Gills
Spine
Ectoparasite
Mortality

	1	2	3
EYES	 Normal and healthy appearance.	 Unilateral (one eye): bleeding, swollen eye or traumatic injury.	 Bilateral (two eyes): bleeding, swollen eye or traumatic injury; chronic condition, impaired vision.
JAWS & MOUTH	 Normal aspect, healthy.	 Moderate bleeding, redness or injury or deformity (without affecting eating).	 Severe bleeding, redness or injury or deformity (affecting eating).
OPERCULUM	 Normal and healthy appearance.	 Absence of tissue (<25%).	 Bleeding, redness, absence of tissue (≥25%).

WELFARE INDICATORS - HEALTH

Health

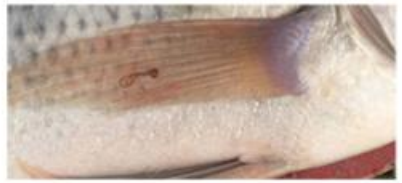
- Eyes
- Jaws
- Operculum
- Skin
- Fins
- Gills
- Spine
- Ectoparasite
- Mortality

	1	2	3
FINS	 Normal and healthy appearance.	 Scar tissue, mild necrosis or splitting.	 Severe necrosis or bleeding, redness, exposure of rays, adhered foreign body/ectoparasite.
GILLS	 Normal and healthy appearance.	 Light injury, mild necrosis, splitting or thickening.	 Bleeding, redness, pallor, severe necrosis, excess of mucus, spots, swelling, deformation, adhered foreign body, ectoparasite.
SPINE	 Normal structure.	 Light deformity (kyphosis, lordosis or scoliosis, normal weight.	 Severe deformity (kyphosis, lordosis or scoliosis, weight loss).

WELFARE INDICATORS - HEALTH

Health

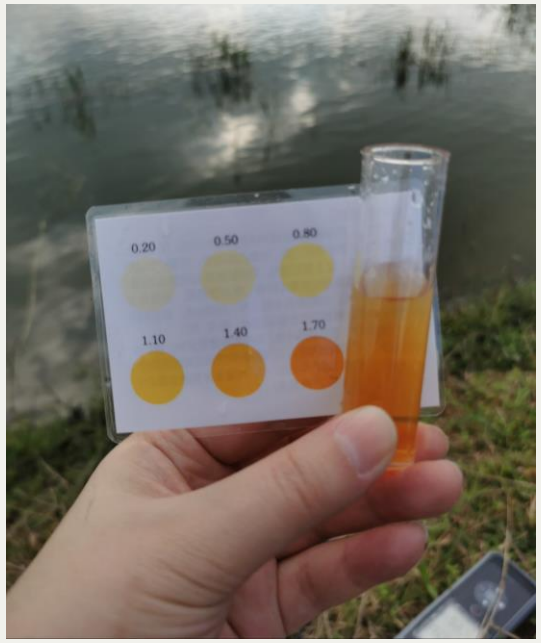
Eyes
Jaws
Operculum
Skin
Fins
Gills
Spine
Ectoparasite
Mortality

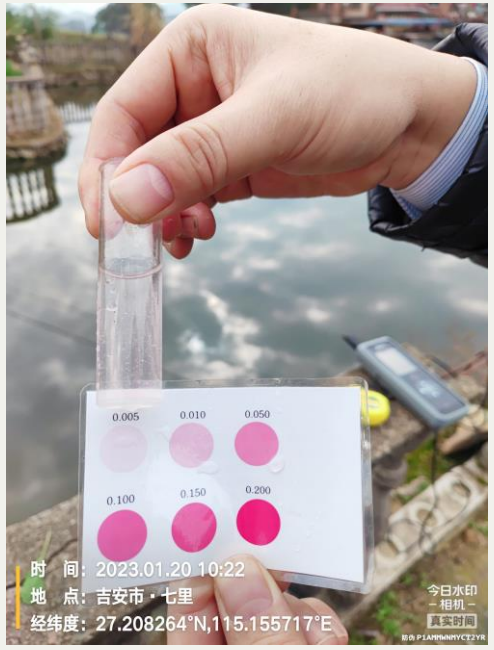
	1	2	3
ECTOPARASITES	 No infestation.	 Moderate infestation (≤5 ectoparasites).	 Intense infestation (>5 parasites).
SKIN	 Normal and healthy appearance.	 Localized loss of scales, ulcers or superficial lesions <1cm².	 Rising or general loss of scales, ulcers or superficial lesions > 1cm², redness, necrosis, darkening or lightening, bleeding, swelling, presence of parasites.
MORTALITY (%)	≤10	11 - 25	≥26

WELFARE INDICATORS - ENVIRONMENT

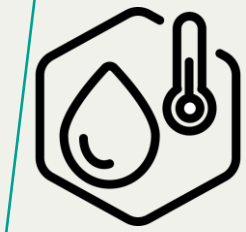
Environment

Temperature
pH
D.O.
Alkalinity
NH4
NH3
Transparency
Terrestrial predators
Interspecific inhabitant





WELFARE INDICATORS - ENVIRONMENT

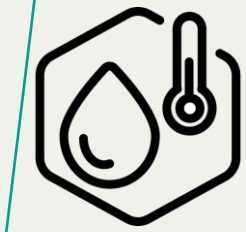


Environment

Temperature
pH
D.O.
Alkalinity
NH4
NH3
Transparency
Terrestrial predators
Interspecific inhabitant

Indicator Name	Score	Hatchery/Broodstock	Nursery/Juveniles 2g)	Grow out and finish ponds
Temperature (°C)	1	25 - 32	25 - 32	25 - 32
	2	20 - 24 OR 33 - 37	20 - 24 OR 33 - 37	20 - 24 OR 33 - 37
	3	**≤ 19 OR ≥ 38**	**≤ 19 OR ≥ 38**	**≤ 19 OR ≥ 38**
pH	1	6.0 - 8.5	6.0 - 8.5	6.0 - 8.5
	2	5.5 - 5.9 OR 8.6 – 9.0	5.5 - 5.9 OR 8.6 – 9.0	5.5 - 5.9 OR 8.6 – 9.0
	3	**≤ 5.4 OR ≥ 9.6**	**≤ 5.4 OR ≥ 9.6**	**≤ 5.4 OR ≥ 9.1**
Transparency (cm)	1	30 - 40	30 - 40	41 - 65
	2	20 - 29 OR 41 - 50	20 - 29 OR 41 - 50	25 - 40 OR ≥ 66
	3	**≤ 19 OR ≥ 51cm**	**≤ 19 OR ≥ 51cm**	**≤ 24**
Oxygen saturation (%)	1	70 - 95	70 - 95	70 - 95
	2	40 - 69	40 - 69	40 - 69
	3	**≤ 39 OR ≥ 96**	**≤ 39 OR ≥ 96**	**≤ 39 OR ≥ 96**

WELFARE INDICATORS - ENVIRONMENT



Environment

Temperature
pH
D.O.
Alkalinity
NH4
NH3
Transparency
Terrestrial predators
Interspecific inhabitant

Indicator Name	Score	Hatchery/Broodstock	Nursery/Juveniles 2g)	Grow out and finish ponds
Non ionized ammonia (NH_3) mg/L	1	0.00 - 0.05	0.00 - 0.05	0.00 - 0.05
	2	0.051 - 0.10	0.051 - 0.10	0.051 - 0.10
	3	**≥ 0.11**	**≥ 0.11**	**≥ 0.11**
Nitrite (NO_2) mg/L	1	0.00 - 0.50	0.00 - 0.50	0.00 - 0.50
	2	0.51 - 1.00	0.51 - 1.00	0.51 - 1.00
	3	**≥ 1.01**	**≥ 1.01**	**≥ 1.01**
Alkalinity (mg/L)	1	30 - 100	30 - 100	30 - 100
	2	20 - 29 OR 101 - 200	20 - 29 OR 101 - 200	20 - 29 OR 101 - 200
	3	**≤ 19 OR ≥ 201**	**≤ 19 OR ≥ 201**	**≤ 19 OR ≥ 201**
Terrestrial predators	1	Absent	Absent	Absent
	2	Controlled presence	Controlled presence	Controlled presence
	3	**Uncontrolled presence**	**Uncontrolled presence**	**Uncontrolled presence**
Non specific inhabitants (aquatic competitors /predators)	1	Absence (avoided by mechanical barriers)	Absence (avoided by mechanical barriers)	Absence (avoided by mechanical barriers)
	2	Controlled presence	Controlled presence	Controlled presence
	3	**Uncontrolled presence**	**Uncontrolled presence**	**Uncontrolled presence**

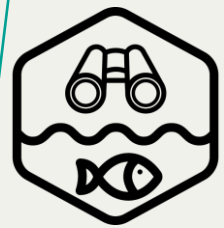
WELFARE INDICATORS - BEHAVIOUR

Behaviour

Respiratory Frequency
Recovery from anaesthesia
Swimming behaviour
Foraging behaviour
Loss of consciousness

	1	2	3
Respiratory rate (Opercular beat per min)	**41 - 60** movements / min	**21-40** OR **61-80** movements / min	**≤20** OR **≥81** movements / min
Recovery from anaesthesia (min)	Induction in 1 - 3 minutes and recovery in ≤ 5 minutes	Induction and recovery in ≥ 5 minutes	No induction or no recovery. Death

WELFARE INDICATORS - BEHAVIOUR

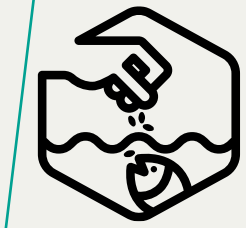


Behaviour

Respiratory Frequency
Recovery from anaesthesia
Swimming behaviour
Foraging behaviour
Loss of consciousness

	1	2	3
FORAGING BEHAVIOUR The foraging behaviour is a measure of the time taken to eat all feed. Tilapia usually take 3 to 6 minutes to eat all feed provided by the farmer.	All feed eaten 3 to 6 minutes.	All feed eaten 2 to 3 minutes.	All feed eaten in less than 2 minutes or in more than 6 minutes.
SWIMMING BEHAVIOUR The swimming behaviour can be observed and scored during feeding and harvest. Fish use their bodies and fins to swim. When tilapia swim, the entire body is underwater.	Normal swimming, no visisble dorsal fins or belly on the water surface.	Excited swimming behaviour, but few fish with dorsal fins or belly on the water surface.	Swimming in different directions or decreasing activity, fish stuck against net, fish floating on side, body exposed to air for prolonged periods of time, fish show signs of exhaustion.
EFFECTIVE STUNNING We measure the time it takes for fish to lose consciousness during stunning. Consciousness is verified by four clinical reflexes: 1) Opercular beat (OR) 2) Vestibulo-ocular reflex (VOR) 3) Equilibrium (EQ) 4) Tail grip reflex (TGR)	Instantaneous loss of all four reflexes: - Equilibrium (EQ). - Tail grip reflex (TGR). - Opercular beat (OR). - Vestibulo-ocular reflex (VOR).	**Instantaneous loss of:** - Equilibrium (EQ). - Tail grip reflex (TGR). **Progressive loss in less than 30 seconds of:** - Opercular beat (OR). - Vestibulo-ocular reflex (VOR).	Progressive loss of all four reflexes after 30 seconds.

WELFARE INDICATORS - NUTRITION

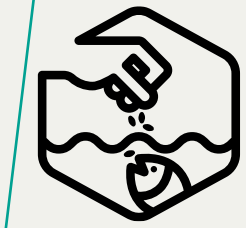


Nutrition

Amount of Feed (% Biomass)
Feeding frequency
Feeding distribution
Condition Factor (K)
Protein concentration
Feed Conversation ratio

	1	2	3
Amount of feed	**3.1 - 6 %**	**1.51 - 3 %**	**≤1.5 %** OR **≥ 6.1 %**
Feeding frequency Pond, Tank, >20g	2-3 time or continuous feeding	1 time	Less than 1 time
Amount of feed	>75% of surface's area covered	50 - 75% of surface's area covered	<50% of surface's area covered

WELFARE INDICATORS - NUTRITION



Nutrition

Amount of Feed (% Biomass)
Feeding frequency
Feeding distribution
Condition Factor (K)
Protein concentration
Feed Conversation ratio

	1	2	3
Condition factor (K=(W*L^-3)*100)	**1.6 – 1.9**	**1.1–1.5** OR **2.0–2.3**	**≤ 1.0** OR **≥2.4**
Protein concentration Pond, Tank, >20g	**28 - 35 %**	**25 - 27 %**	**≤ 24 %** OR **≥36 %**
Feed conversion ratio Pond, Tank, >20g	≤ 1.6	1.7 – 1.9	≥ 2.0

THANKS
& QUESTIONS

Integrated Quality Consulting

悦孜

Measuring Welfare Indicators in Tilapia Farms in China

中国罗非鱼农场福利评估

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2023-05-23

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a About IQC 有关IQC

b Tilapia farms in Guangdong and Hainan 广东和海南的罗非鱼场

c On-site communication & assessment 现场交流和评估

d Selected results 部分结果

e Summary & Focus for the future 小结以及未来的侧重点

IQC 悦孜 Integrated Quality Consulting

About IQC 有关IQC

IQC is a Sino-German management consulting company providing professional service on food safety, quality management, digital systems and sustainability to all stakeholders along the food supply chain. 悦孜（IQC）是一家中德合作，向食品链企业提供食品安全、精益生产、信息化服务和可持续发展的专业咨询公司。

IQC cooperates with international standard organizations about farm, processing, logistics, catering, retail, and provides implementable solutions. 悦孜聚焦食品链，关注农场，养殖场，加工，贮存，物流，餐饮及零售等标准，并与相关国际标准方合作，为食品链企业提供落地可实施的方案。

IQC
助您打造安心食品链
Ensuring peace of mind across the entire food value chain

IQC's Mission 我们的使命

Creating profitable value for our clients seeking long-term and sustainable solutions across China's food value chains.

助力食品链企业持续发展，
成为可信赖的行业标杆

IQC's Vision 我们的愿景

Build China's leading food industry consultancy focusing on food safety, sustainability and social value.

通过一流服务，成为
食品链优秀企业信赖与尊重的咨询机构

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Animal Welfare

Help understand animal welfare certification, achieve related commitments.

Content

- Animal welfare standard establishment and promotion
- Animal welfare assessment, training & consulting
- Animal welfare product certification (laying hens, broilers)
- Animal welfare label and promotion
- Animal welfare market research, supply and demand

Target Clients

- International market brand
- Production enterprise
- Planting and breeding enterprise
- NGO

Selected Clients- Cooperate with domestic and international organizers , provide effective solution

fai
CERTIFIED HUMANE RAISED & HANDLED
IKEA
Coca-Cola 可口可乐
OVODAN 欧福
快乐de蛋 Happy Eggs
SGS
sunner 圣农
韩伟集团 HANWEI GROUP
信德 XINDE
天融牧园
中良农牧
偏关永奥
intertek
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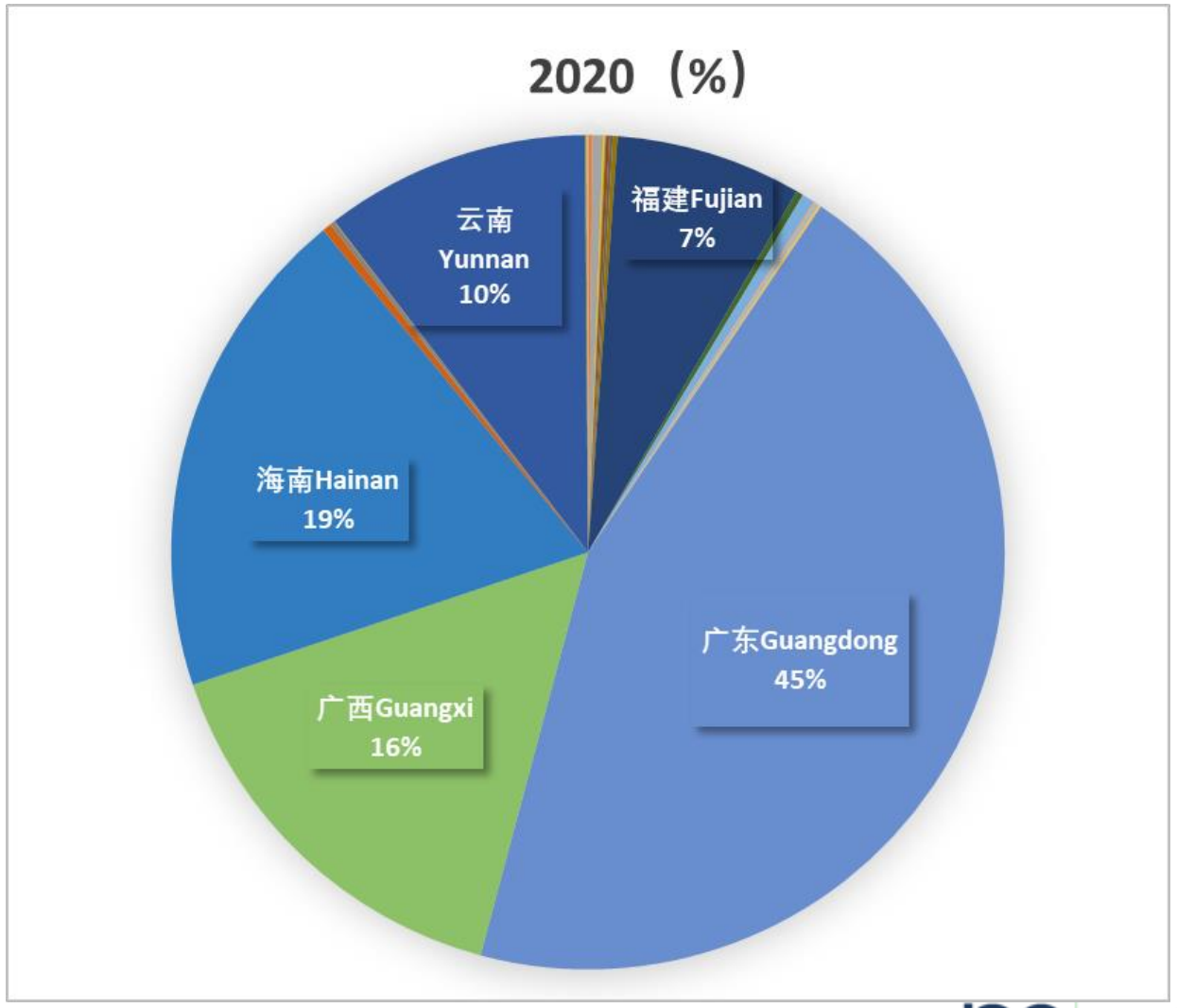
Tilapia farms visited in Guangdong and Hainan
在广东和海南拜访的罗非鱼场



China fishery statistical yearbook
中国渔业年鉴

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On-site Communication 现场交流

Farm information 农场基本信息

Number of ponds 塘的数量

Size of ponds 塘的大小

Total annual production 年产量

……

Animal welfare perception 动物福利认知

Language barrier

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On-site Assessment 现场测量

Environment 环境

Temperature (Degree Celsius)
pH
Transparency (cm)
Oxygen saturation (%)
Non-ionized ammonia (NH3) (mg/L)
Nitrite (NO2) (mg/L)
Alkalinity (CaCO3) (mg/L)
Salinity (PSU or 0/00)
Shading (%)
Terrestrial predators (birds, otter)
Non specific inhabitants (Aquatic competitors / predators)
Specific non-desired inhabitants (Accident Tilapia population)
Stocking density (kg/m3)

Health 健康

Eyes
Jaws (and mouth)
Operculum
Skin
Fins
Gills
Spine
Ectoparasites
Mortality estimation since stocking (%)
What is the total estimated number of fish in the handling?

Behavior 行为

Swimming behaviour
Gulping at surface
Scales in water
Describe the Distribution in tank/pond
Feeding/foraging behaviour
Coping style
Recovery from Anaesthesia
Response to light exposure
Response to air exposure
Social behaviour
Effective Stunning
Fasting period (Hours)
Depuration period (Days)
What was the stunning efficacy in %

Nutrition 营养

Do they use 100% commercial feed?
How many kilograms of feed do you provide per day?
Feeding frequency (number of times per day)
How many cubic meter of water in the pond / tank?
Crude protein in the feed (%)
Feed Conversion Ratio - FCR (estimation)
Feed distribution
Biomass of fish (kg) in the tank/pond/cage
Feed quantity in % of the biomass
What is the condition factor (K factor)

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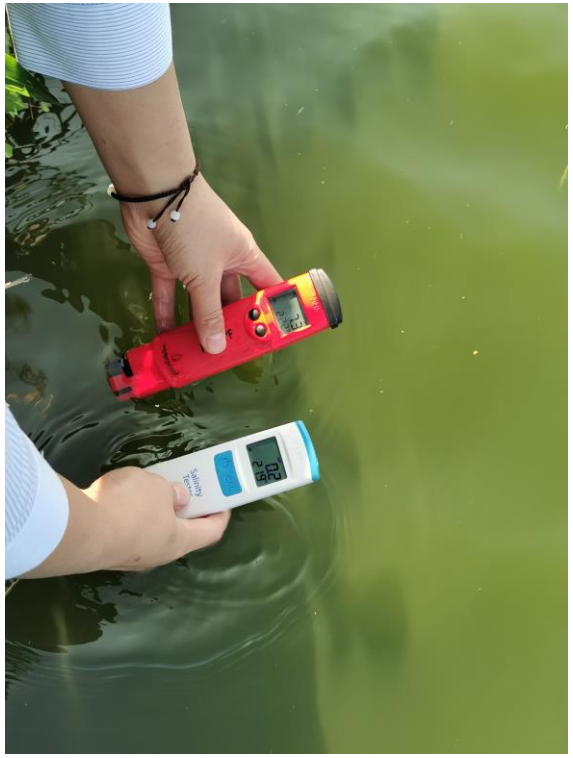
On-site Assessment 现场测量

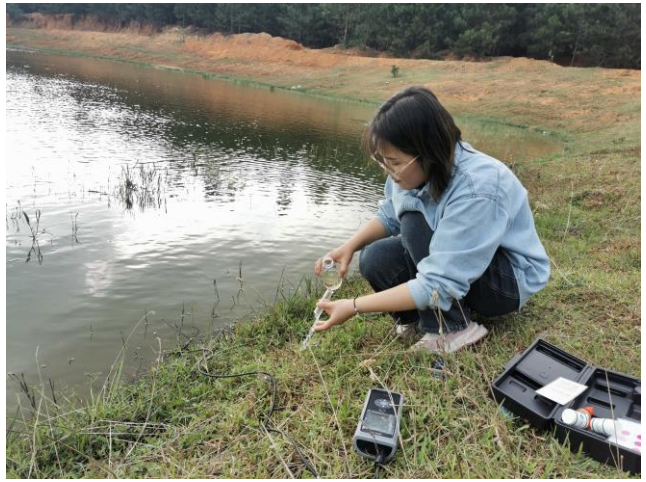
Environment 环境



pH, Salinity盐度

Transparency透明度

Non-ionized ammonia
非离子氨
Nitrite (NO2)
Alkalinity (CaCO3)



Oxygen saturation
溶氧

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On-site Assessment 现场测量

Environment 环境

December（Adult fish）	Hainan						Guangdong		
	1	2	3	4	5	6	1	2	3
pH	7.5/1	7.6/1	7.5/1	7.1/1	7.8/1	-	7.5/1	7.5/7	7.7/1
Transparency（cm）	29.7/1	28.1/1	28.3/1	13/3	29/1	-	29.8/1	37.5/1	26.5/1
DO（mg/l）	-	-	-	-	-	-	-	-	-
Un-ionized ammonia	0.006/1	0.026/1	0.019/1	0.01/1		-			
Nitrite（mg/l）	0.008/1	0.004/1	0.05/1	0/1	0/1	-	0.026/1	0.25/1	0.28/1
Alkalinity（mg/l）	75/1	48.8/1	22.6/2	67.5/1	101.3/2	-	78.8/2	78.8/2	95.6/1
Terrestrial predators	NA/3	NA/3	NA/3	NA/3	NA/3	-	NA/3	NA/3	NA/3
Interspecific inhabitant	2	2	2	2	2	-	-	-	2
Stocking density (fish/㎡)	4/3	4-5/3	4.7/3	4-5/3	4-5/3	-	4-5/3	6-7/3	1-2/1

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On-site Assessment 现场测量

Environment 环境

March（Rapid growing）	Hainan						Guangdong (June)
	1	2	3	4	5	6	3
pH	7.3/1	7.1/1	6.8/1	6.4/1	7.5/1	7.5/1	8.1/1
Transparency（cm）	28.3/1	25.3/1	21.0/1	-	22/3	33/1	25.5/1
DO（%）	-	29/3	52/2	43/2	17/3	59/2	73/1
Un-ionized ammonia							0.007/1
Nitrite（mg/l）	0.1/1	0.1/1	0.1/1	0.15/1	0.15/1	0.01/1	0.13/1
Alkalinity（mg/l）	112.5/2	45/1	22.5/2	22.5/2	135/2	112.5/2	101.25/2
Terrestrial predators	NA/3	NA/3	NA/3	NA/3	NA/3	NA/3	NA/3
Interspecific inhabitant	2	2	2	2	2	-	2
Stocking density (fish/㎡)	6/3	4-5/3	7/3	9/3	4/3	-	89-90/3

On-site Assessment 现场测量

Health 健康

Body evaluation 外观评分

Mortality estimation
死淘率
Not available – 无数据

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On-site Assessment 现场测量

Health 健康 --- Body evaluation 身体评分

	eyes	jaw and lips	operculum	skin	fins	gills	spine	Ectoparasite	K factor
1	26	23	30	10	0	6	30	30	2
2	3	7	0	5	21	20	0	0	22
3	1	0	0	15	9	4	0	0	6
	86.7%	76.7%	100.0%	33.3%	0.0%	20.0%	100.0%	100.0%	6.7%
	10.0%	23.3%	0.0%	16.7%	70.0%	66.7%	0.0%	0.0%	73.3%
	3.3%	0.0%	0.0%	50.0%	30.0%	13.3%	0.0%	0.0%	20.0%

Dajiu

	eyes	jaw and lips	operculum	skin	fins	gills	spine	Ectoparasite	K factor
1	29	29	27	13	4	23	30	30	0
2	0	1	3	15	22	5	0	0	18
3	0	0	0	2	4	2	0	0	11
-	0	0	0	0	0	0	0	0	1
	96.7%	96.7%	90.0%	43.3%	13.3%	76.7%	100.0%	100.0%	0.0%
	0.0%	3.3%	10.0%	50.0%	73.3%	16.7%	0.0%	0.0%	60.0%
	0.0%	0.0%	0.0%	6.7%	13.3%	6.7%	0.0%	0.0%	36.7%

Pawpaw

	eyes	jaw and lips	operculum	skin	fins	gills	spine	Ectoparasite	K factor
1	29	30	30	5	0	30	30	30	3
2	1	1	0	7	19	0	0	0	16
3	0	0	0	18	11	0	0	0	1
	0	0	0	0	0	0	0	0	0
	96.7%	100.0%	100.0%	16.7%	0.0%	100.0%	100.0%	100.0%	10.0%
	3.3%	3.3%	0.0%	23.3%	63.3%	0.0%	0.0%	0.0%	53.3%
	0.0%	0.0%	0.0%	60.0%	36.7%	0.0%	0.0%	0.0%	3.3%

Banana

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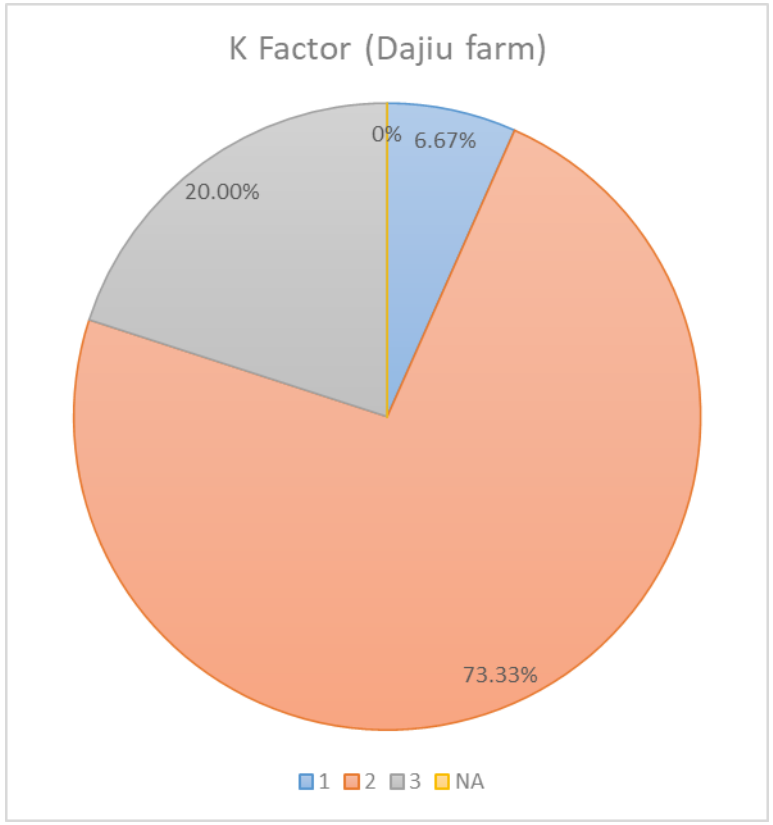
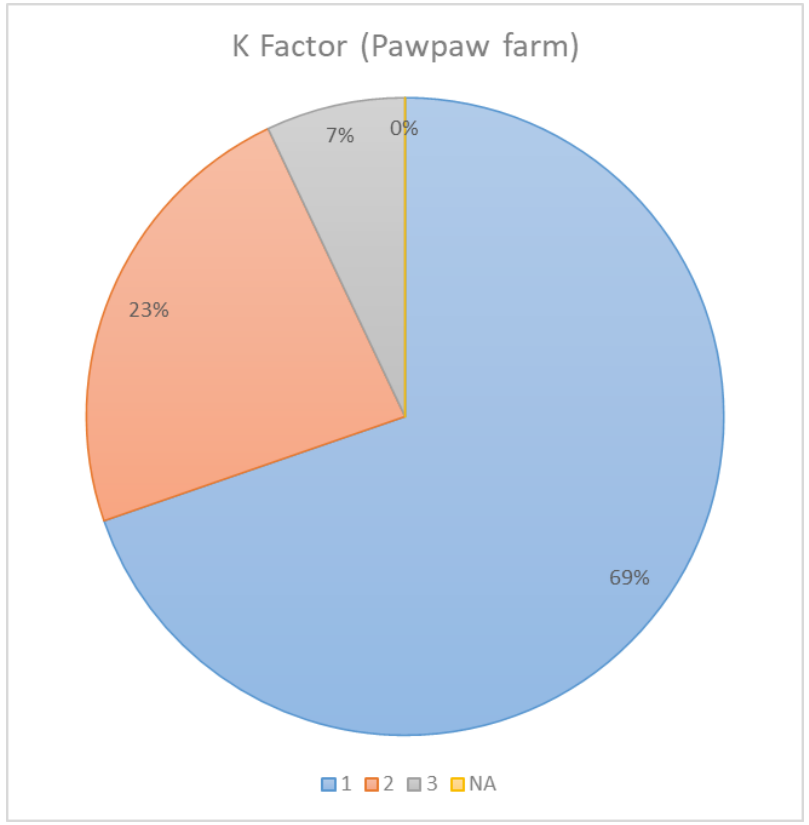
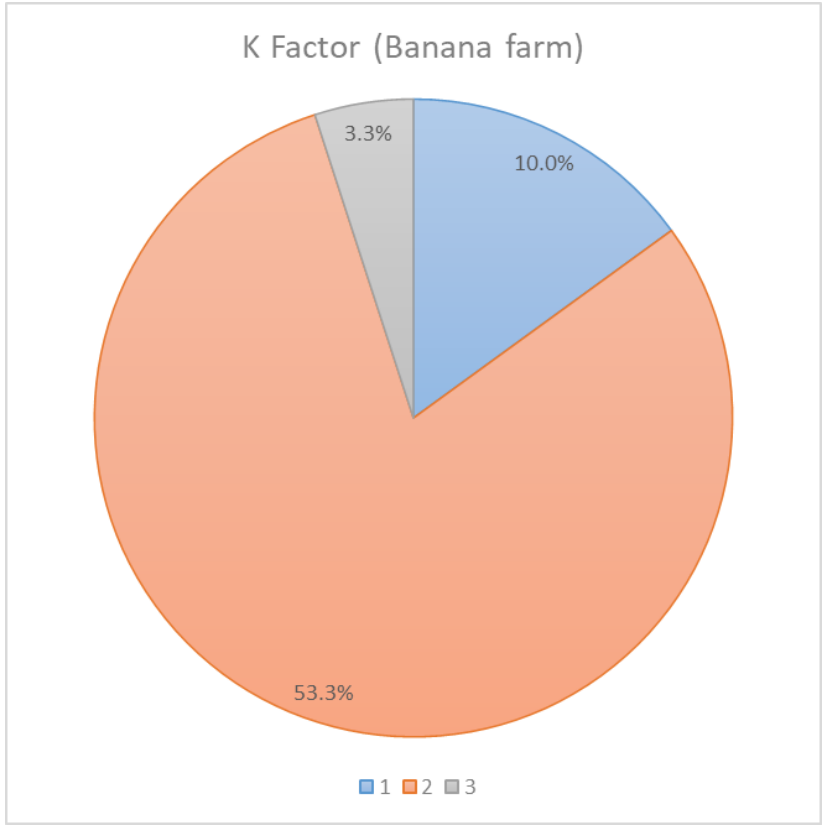
On-site Assessment 现场测量

Health 健康 --- K factor







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On-site Assessment 现场测量

Behavior 行为

Behavior underneath the water is not visible
鱼水下的行为不可见

Behavior during feeding
在喂料时的行为

Behavior during harvest
在捕捞时的行为

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On-site Assessment 现场测量

Nutrition 营养

Interview, communication
访问交流

Behavior during feeding
在喂料时的行为

Feed information
饲料信息

On-site Assessment 现场测量

Nutrition 营养

December	Hainan						Guangdong		
	1	2	3	4	5	6	1	2	3
FCR	0.8-0.9/1	0.8/1	0.7/1	-	-	-	-	-	0.8/1
CP	31-36/1	30/1	30/1	-	-	-	-	-	30/1
Formulated feed amount	1-1.5%/2; 16%/3	0.8%/3	2%/3	3.75%/2	-	-	3.8%/2	2%/2	-
Feed distribution	<50%/3	<50%/3	<50%/3	<50%/3	<50%/3	-	<50%/3	<50%/3	<50%/3
Feeding frequency	2-3/1	2-3/1	2/1	2/1	2/1	-	1/2	1/2	2/1
Foraging time for feed	-	-	-	-	-	-	-	-	-

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On-site Assessment 现场测量

Nutrition 营养

March	Hainan						Guangdong (June)			
	1	2	3	4	5	6	1	2	3	4
FCR	-	-	-	-	-	-	-	-	-	-
CP	30/1	30/1	30/1	30/1	30/1	-	30/1	30/1	30/1	30/1
Formulated feed amount	1.7-4.4%/3	2.3-2.8%/3	1.5-2%/2	0.8%/1	1.0%/2	-	1.7%/2	-	-	0/3;2.5%/1
Feed distribution	＜50%/3	＜50%/3	＜50%/3	＜50%/3	＜50%/3	-	＜50%/3	＜50%/3	＜50%/3	＜50%/3
Feeding frequency	2/1	2/1	2/1	2/1	2/1	-	2/1	-	-	1/2
Foraging time for feed	-	-	-	-	-	-	-	-	-	-

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Contents 内容

a About IQC 有关IQC

b Tilapia farms in Guangdong and Hainan 广东和海南的罗非鱼场

c On-site communication & assessment 现场交流和评估

d Selected results 部分结果

e Summary & Focus for the future 小结以及未来的侧重点

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Summary 小结

- **Environment 环境**
  - >Predator control 捕食者控制
  - >Stocking density 饲养密度
  - >Water quality control management 水质监测管理
- **Health 健康**
  - >Predator control 捕食者控制
- **Behavior 行为**
- **Nutrition 营养**
  - >Feed distribution
  - >Formulated feed amount

- **Welfare perception**

  动物福利意识

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Future perspective 未来侧重点

- **Standardized farming system**

  养殖体系标准化

- **Community technical support**

  – water quality, disease control

  社区化技术支持 – 水质检测、疾病控制

- **Farming/harvest facility upgrades**

  – feeding system, fish handling system

  养殖/收获 设备升级 – 饲喂系统、鱼操作系统

- **Increase animal welfare awareness**

  提高动物福利意识

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