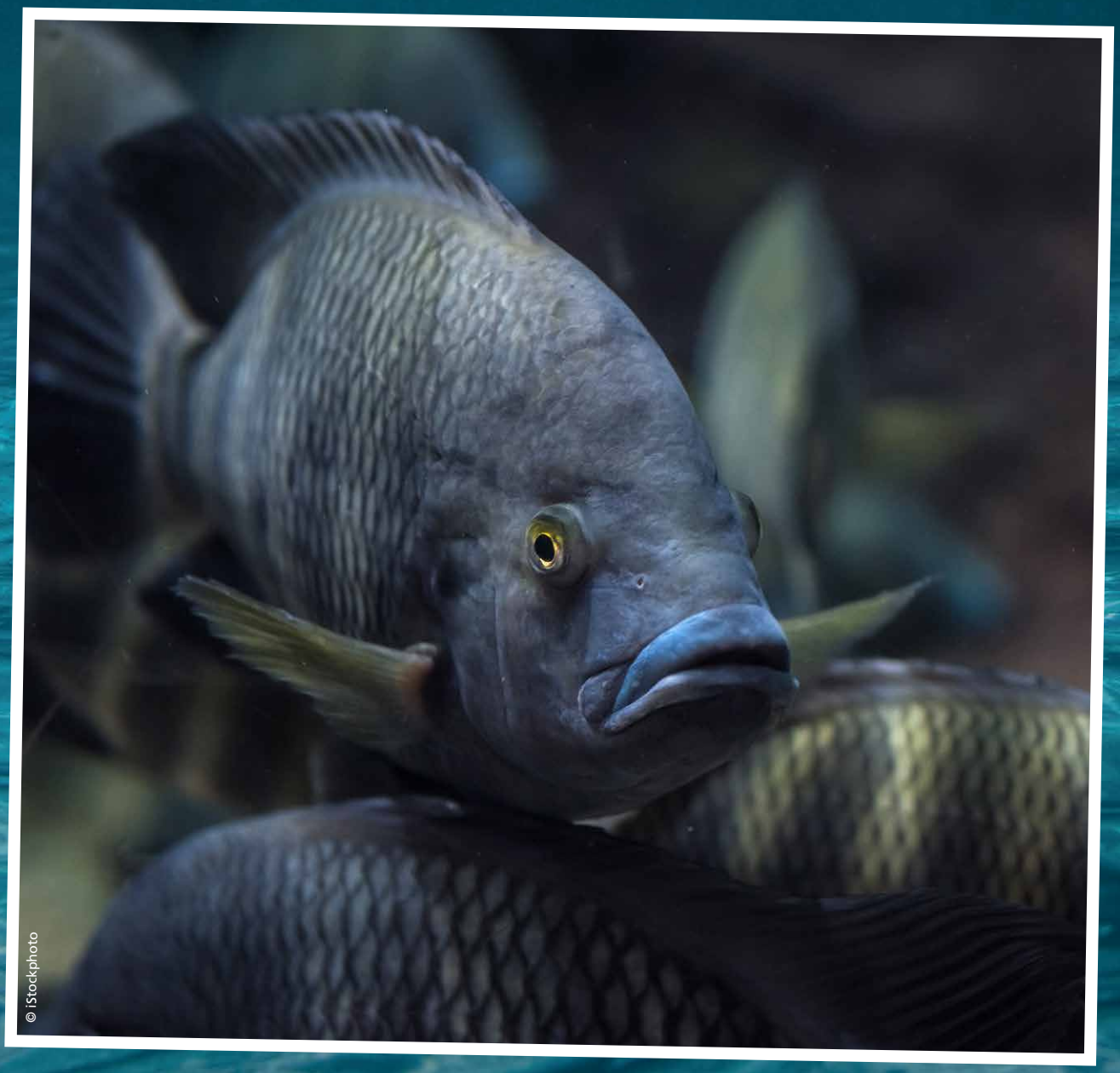
Improving the welfare of farmed Nile tilapia at rearing



COMPASSION in world farming Food Business

Foreword

In order to address farm animal welfare and manage it efficiently throughout their business, food companies are encouraged to write and publicise a corporate policy on farm animal welfare. Nile tilapia are sentient beings that must be provided with a good quality of life in a farmed environment. The Nile tilapia welfare policy should address the provision of good housing, good feeding, good health and opportunities to express appropriate behaviours to Nile tilapia. High stocking densities, poor water quality, and procedures that require handling, lead to stress and poor welfare. Any practices that compromise the welfare of tilapias must be addressed in the Nile tilapia welfare policy. Ensuring the welfare of Nile tilapia during rearing requires specific management aspects, including:

- Stocking density management based on behavioural observation of the fish.
- Health and welfare management and associated action plan, under the supervision of a fish welfare professional.

We recommend

✔ Good Environment

- Maximum stocking density should be limited to 3 fish/m^2 (approximately 1.6 kg/m^3) in ponds or shallow enclosures, or 50 fish/m^3 (approximately 26.5 kg/m^3) in nets or cages. Tilapias may become territorial and aggressive if stocking densities are low, therefore their behaviour should be observed to adjust the stocking density accordingly. Stocking density should be calculated by taking in consideration the volume of water available for the fish to move and not just the water surface area. The exact density should be determined based on water quality, the behavioural and physiological needs of Nile tilapia, health status, production system and feeding method so that welfare is optimised.
- Water quality parameters such as temperature, dissolved oxygen, un-ionised ammonia and turbidity should be monitored continuously. Measurements should be taken not only from surface waters but throughout the depth of the enclosure. This data is crucial to understanding how the fish behave and aggregate in the enclosure. When changes in the environment occur which lead to sub-optimal conditions within an enclosure, or if rapid changes are detected, management steps should immediately be taken to address any welfare impacts upon the fish e.g. by oxygenating the water, reducing the stocking density within the enclosure. Farms should be distant enough and transfer of fish or equipment between enclosures reduced to minimise the risk of pathogen transfer.

✔ Good Feeding

- Feed must be of optimal quality for the nutritional needs of Nile tilapia. The feeding method used must ensure all fish have access to food, while minimising food wastage to prevent water deterioration and avoiding any type of aggression or hunger.
- Fasting period should be no longer than is required for fish welfare benefits (e.g. emptying the gut to prevent water degradation during transport) and should be below 24 hours and ideally not exceed 13.5 hours. Records of the dates and duration of fasting should be kept. If the tilapia are put under a depuration period before slaughter, they should be fed, and any fasting time during this period should be included in the fasting maximum time.
- Compassion recommends the farming of Nile tilapia without the addition of formulated feed and rely on the natural production of the system. Where feed is required, Compassion also recommends that the amount of fishmeal and fish oil (FMFO) in feed for Nile tilapia to be reduced or eliminated as much as possible, while still providing for the nutrition needs of farmed Nile tilapia. For that, we recommend fulfilling the need for dietary essential amino acids rather than protein for replacement calculations. Many FMFO fisheries face sustainability challenges and the welfare of fish caught in FMFO fisheries is poor due to the lack of humane capture, landing and killing. The amount of FMFO can be reduced by replacing it with other ingredients that can meet nutritional requirements and any FMFO provided should be sourced from trimmings and not from whole fish.

✔ Good Health

- All treatments and vaccines should be recorded and included in a veterinarian health and welfare plan. Such a plan should also include an assessment of the fish for suitability before any disease treatment or management procedure. The veterinarian health and welfare plan should outline planned husbandry procedures, risk assessments, disease monitoring and all treatments carried out.
- Antimicrobials should not be used prophylactically and the quantity, active ingredient and reason for use should be recorded. Quality of antimicrobials and any other drug must be assessed prior to the start of the treatments to avoid exposing tilapia to unnecessary chemicals. Banned antimicrobials and chemicals shall not be used.

✔ Good Handling and Opportunities to Express Appropriate Behaviour

- Crowding and handling are a source of severe stress and potentially injuries and therefore should be performed only when absolutely necessary, be as gentle as possible, and Nile tilapia must not be out of the water for more than 15 seconds. For both road and boat transport, sufficient water must be used to ensure the fish are able to maintain equilibrium, prevent water quality from deteriorating and oxygen levels must not drop below the recommended levels for the species (4 mg/l). Crowding must not last more than 2 h with 48 h between crowds to allow the fish time to recover. Crowding must be limited to a maximum of two crowding in a week and three in a month. Nile tilapia should not be repeatedly crowded during harvest. Compassion is against the prolonged starving and crowding of tilapia for acclimation to transport.
- Nile tilapia become territorial when there is enough space to claim territory, becoming aggressive. They are bottom foragers feeding on detritus and periphyton, and small invertebrates. Nile tilapia should be provided with an environment and feeding methods that promote the expression of known natural behaviours, and stocking density and environment should be adjusted to reduce the risk of aggression linked with territoriality.

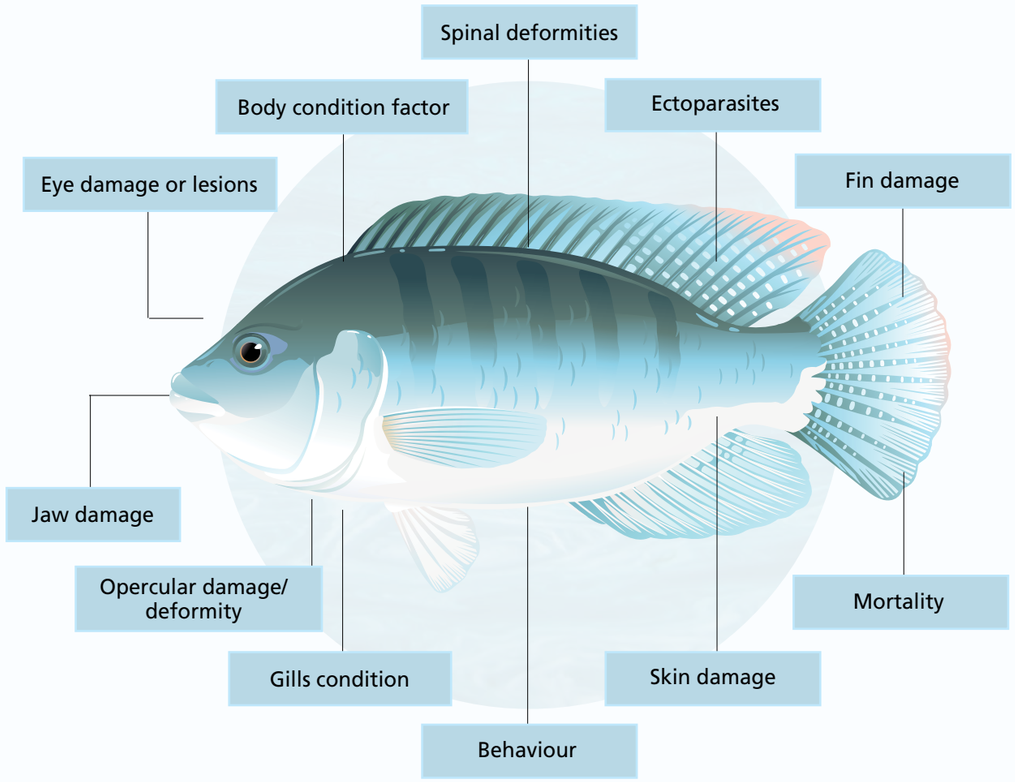
Welfare outcome measures

Welfare outcomes should be measured and recorded for Nile tilapia and include parameters such as swimming behaviour, feeding behaviour, breathing behaviour, colour change and physical damage. Further work to develop indicators of positive welfare for Nile tilapia are required (e.g. colouration of the skin on the mouth and belly area).

Welfare outcome measures should be used as part of a proactive programme of welfare monitoring and continuous improvement, including target setting. Such programme should involve a continuous cycle of:

Regular monitoring of welfare outcomes enables swift detection of problems, implementation of corrective actions and continuous improvement plans to be implemented. Some measures should be continuously recorded, while other measures can be recorded on a representative sample (i.e.: minimum 50 fish). Target setting should be used for all measures to drive improvement.

Welfare outcomes



Mortality

WHAT: Record incidence of dead and moribund fish in each pond/cage/hapa/tank/raceway.

WHY: Widely collected data (often required daily) and a crude indicator of on-farm welfare issues as it is retrospective. However, increases in mortality rate can indicate welfare issues that have been overlooked.

HOW: Count the number of dead and culled fish in each pond/cage/hapa/tank/raceway, ideally on a daily basis, as they are removed and analysed for cause of death and for disposal. The total mortality should also be calculated at harvest (number of stocked fish – number of harvested fish)/((number of stocked fish) x100), but also as a cumulated mortality on a daily, weekly or monthly basis. Mortality should include any loses that occurred during the rearing period regardless of the cause of death (transfer, predation, environmental, diseases and treatments, handling, culling…). Report % and cause of death, if known. Suggested scoring for mortality levels, 1: ≤10%; 2: ≤25%; 3: ≤ 50%; 4: >50%.

TARGET: As low as possible, ≤10% or score 1 on the scoring scale.

Body condition factor

WHAT The body condition factor assesses and monitors the body fat reserves (condition) of individual fish. It will also help identifying any thin or emaciated fish.

WHY: Good nutritional status, measured by the condition factor, is required for successful production as well as for good welfare. A drop in the condition factor generally indicates a welfare issue. Common causes for loss of condition include adverse environmental conditions, poor feeding, disease and stress. Emaciated fish, being smaller, will quickly be outcompeted for food and can experience low welfare for a long time before they die, and can also be a target of aggressive behaviour. These fish can also be a vector for transmitting diseases to other healthier fish.

HOW: The body condition factor (K) is calculated as: $K=100 \times (\text{weight (g)} \times \text{length}^{-3} \text{ (cm)})$. It can be measured automatically image/video analysis technology. If manually, it should be measured as frequently as possible and at least during high-risk periods such as fasting, stressful periods and in case they are fed less than what they should. Body condition can be evaluated via a 3 points scoring system: 1: 1.6-1.9; 2: 1.1-1.5 or 2.0-2.3; 3: ≤ 1 or ≥ 2.4. The body condition score reported is the mean of the body condition factors of the fish sampled.

TARGET: Condition factor 1.6 to 1.9 (a score of 1).

Fin damage

WHAT: Fin damage can be scored by looking at fin erosion, splitting (a loss of tissue between fin rays), ray deformity or necrosis. It is measured as an individual welfare indicator where the severity and prevalence of fin damage and lesions are manually scored on a scale from 1 to 4 (see below).

WHY: Fin damage can indicate welfare problems such as recent rough handling, disease or aggression.

HOW: Individual fish are scored by checking all fins. 1: Normal, healthy appearance; 2: Scarred or slightly necrotic tissue; 3: Moderate injury or necrosis (thickening/splitting); 4: Severe necrosis, bleeding, inflammation, exposure of the rays.

Jaw damage

WHAT: Record incidents and severity of jaw damage/deformity and lesions via a manual scoring system.

WHY: Often occurs in relation to handling procedures such as crowding, brailing or pumping.

HOW: Damage/deformities of individual fish can be scored as follows: 1: Normal aspect, healthy; 2: Light superior or inferior deformity (aesthetics); 3: Moderate superior or inferior deformity (affecting feeding).

Eye damage or lesions

WHAT: Record the incidence and severity of eye condition (exophthalmia and vision), damage and lesions (haemorrhage, cataracts) via manual scoring system.

WHY: Fish have no eyelids, and their eyes protrude so are very vulnerable to damage. Trauma can indicate recent poor handling procedures. Causes of cataracts are multifactorial (nutritional deficiencies, osmotic imbalances, water temperature or salinity changes), and also linked to exposure to repetitive stress or secondary to other diseases. Whilst minor changes may not affect vision, development of cataracts eventually leads to blindness, inability to feed and thus poor welfare. In the case of tilapia, exophthalmos is a clinical sign of bacterial diseases and of virus like the lake virus disease (TiLV).

HOW: Individuals can be scored on eye images or by direct observation at the farm using a scale from 1 to 4: 1: Apparently functional and healthy; 2: Unilateral haemorrhage, exophthalmia, traumatic injury; 3: Bilateral haemorrhage, exophthalmia, traumatic injury; 4: Bilateral cataract, chronic condition, impaired vision.

Skin damage

WHAT: Loss of tissue or lesions anywhere on the fish's body. Can be accompanied by haemorrhaging, ulceration or changes in skin colour (Table 1).

WHY: Fish with damaged skin are more vulnerable to infections and secondary bacterial infections; skin damage is likely to cause pain and large ulcers/lesions may affect the fish ability to osmoregulate. Also, skin damage is compatible with bacterial and virus diseases meaning it can be consequence or a symptom, but also that it can increase susceptibility to diseases.

HOW: Skin condition can be observed directly at the farm and can scored be on a 4 points scale: 1: Normal aspect, healthy; 2: Scar tissue, scale loss, ulcers or superficial injuries < 1 cm^2; 3: Ulcers or superficial injuries >1 cm^2, redness, light necrosis; 4: Severe necrosis, darkening, bleeding, inflammation.

Opercular damage or deformity

WHAT: Shortened, "soft", missing or warped opercula.

WHY: Damaged opercula reduces fish respiration efficiency because they cannot pump water effectively over their gills. Deformities are caused by suboptimal rearing conditions, dietary deficiency, and pollution.

HOW: Opercula condition can be scored on a 4 points scale: 1: Normal aspect, healthy; 2: Partially covering the gills (≥75% covered); 3: Partially covering the gills (<75%); 4: Unilateral or bilateral absence.

Tilapia with exophtalmia.

Gills condition

WHAT: Record incidence and severity of gill damage and lesions via a manual scoring system on the gills aspect.

WHY: Reduced gill function affects not only the fish's ability to exchange gases but also to excrete waste products and osmoregulate. Bacterial, parasitic, viral and fungal pathogens and poor water quality can all cause gill problems which will be reflected visually. Chronic gill disease and gill bad condition makes the fish more sensitive to stress, reduces growth and can cause high mortalities. Also, gill lamellae will collapse and adjacent filaments will adhere if fish are subject to prolonged air exposure, which can occur during massive handling events.

HOW: Gill condition can be assessed visually on the farm by examining a sample of fish or recently harvested fish. A scoring system can be used: 1: Normal aspect, healthy; 2: Light injury or necrosis, thickening or splitting; 3: Moderate injury or necrosis, thickening or splitting; 4: Severe necrosis, bleeding, inflammation, pallor or darkening.

Spinal deformities

WHAT: Deformities of the spine and weight difference as an additional indicator of the severity of the condition.

WHY: Spinal and other skeletal deformities are often due to malnutrition, although it may also be due to other factors such as stress. Spinal deformities impact morphology and swimming behaviour and therefore fish welfare. In addition, deformities may affect processes that involve the use of equipment that depends on the body shape.

HOW: Scoring system on a 3 points scale: 1: Normal structure; 2: lordosis or scoliosis, normal weight; 3: Lordosis or scoliosis, weight loss.

Ectoparasites

WHAT: Presence of ectoparasites at the skin or gills.

WHY: Ectoparasites are a common issue in aquaculture and is frequently associated with inadequate water conditions and high stocking densities. Presence of ectoparasites is a critical fish welfare issue, affecting locomotion, competition skills and foraging behaviour.

HOW: It can be assessed on farm by counting parasites presence of a fish sample and give a score on a 3 points scale: 1: No infestation; 2: Moderate infestation (≤5 parasites); 3: Intense infestation (>5 parasites). The average of the sample can be used to score the enclosure population.

Behaviour

WHAT: A range of behavioural measures that can indicate poor or good welfare in tilapia, as listed in Table 1.

WHY: Behavioural measures are useful and easy to implement welfare indicators, since the assessment is non-invasive and doesn't require handling of the fish or removal from the water. Behavioural indicators have the advantage of being easy to observe and to record during daily management routines. Whilst large scale fish observations can easily be integrated into some aquaculture management systems, there is still further scope for improving technical equipment for behavioural observations in large fish groups and farmed tilapia.

Behaviour provides a snapshot of the experience of the fish. For example, exploratory behaviour and feed anticipatory behaviour can all be signs of good welfare. On the other hand, abnormal behaviour can indicate poor management of the pond/pen/cage, poor health status or suboptimal environmental conditions.

HOW: Use underwater/mobile feed cameras or surface observations to observe behaviours such as feeding, swimming speed, and air-breathing frequency. Changes in feeding and swimming behaviour and air-breathing may indicate welfare issues. One challenge is that many behaviours are difficult to quantify and rely on skills and training of the observer and knowing what normal is for each life stage/production system/water environment (Table 1).

Table 1: Tilapia behavioural signals of good or poor welfare that can be assessed during routine observations and activities.

Behavioural indicator	Evidence of positive or good welfare	Evidence of stress and/or poor welfare	Welfare issue/explanation
Aggression		Chasing, nips, attacks.	Very low density may elicit territoriality and consequently increase aggression. Growth of both dominant and subordinate is reduced. High stocking density and/or limited access to feed can also result in aggressive behaviours. The presence of sexually mature tilapia in the population can lead to increased confrontation.
Shoaling, distribution	Uniform distribution, or big groups and not many territorial fish.	Significant numbers of individual fish keeping a section of the enclosure. Groups of subordinate fish.	Very low density may elicit territoriality and consequently increase aggression. Growth of dominant and subordinate is reduced. Uniform distribution may relate to uniform feed distribution, similar size across the group, not a high aggression and likely good water quality.
Depth displacements and distribution	Fish distributed across the whole water column. Migration between surface and bottom depending on water temperatures.	Continuous uneven distribution with fish only at the bottom or at the surface.	Continuous uneven distribution in the water column can be a sign that water temperature is not adequate for the tilapia: if they are only at the bottom, temperature might be too low; if they are only at the surface, it might be too high. Although, vertical migration is related to temperature avoidance it also indicates that the system provides with enough depth to display such a behaviour. If tilapia are only at the surface, it can also be due to low oxygen levels or to un-ionised ammonia in the water that might harm gills.
Spatial distribution	Uniform distribution across the enclosure.	Accumulating in a corner or near walls.	Bottom or solid surfaces grazing is a natural behaviour and is expressed when appropriate feed is provided in the environment. Poor feeding behaviour can be due to low feed quality, high competition, husbandry stressors, disease, and can result in hunger.
Air-breathing		Breaking the water surface to breath, congregate at the top of the water column	Frequent air-breathing is an indicator of low dissolved oxygen and poor water quality.

Table 1: Tilapia behavioural signals of good or poor welfare that can be assessed during routine observations and activities. (continued)

Behavioural indicator	Evidence of positive or good welfare	Evidence of stress and/or poor welfare	Welfare issue/explanation
Abnormal swimming		Swinging, corkscrew like motion, flashing, itching against wall or objects. Floating at water surface and bending the head to one side. Erratic swimming patterns.	Maybe related with skin irritation, ectoparasites, or symptoms of a disease.
Colouration change		Skin darkening, more specifically the vertical “bands”. Eye darkening.	Related to tilapia´s stress response. Skin darkening related to several diseases. The darker the eyes, the more stressed. Both can be related with hierarchical position.
Ventilatory rate	Low/normal frequency.	Increased frequency.	Sign of stress.

Nile tilapia hand fed in a cage.